APPENDIX I –
AIR QUALITY IMPACT ASSESSMENT

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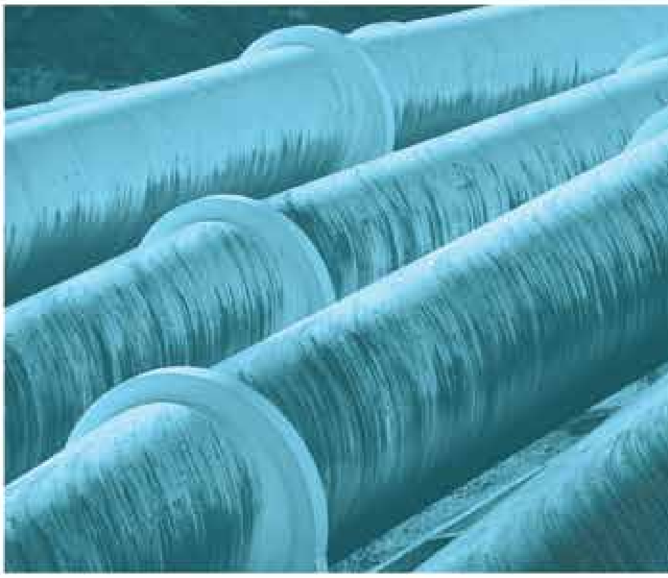
Luddenham Advanced Resource Recovery Centre

Air quality impact assessment

Prepared for Coombes Property Group & KLF Holdings Pty Ltd
July 2020



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Luddenham Advanced Resource Recovery Centre

Air quality impact assessment

Report Number

J190749 RP29

Client

Coombes Property Group & KLF Holdings Pty Ltd

Date

21 July 2020

Version

v2 Final

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21 July 2020

Executive Summary

ES1 Overview and assessment approach

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The site is host to an existing shale/clay quarry. It is proposed to develop an advanced resource recovery centre (ARRC) within the lot to the north of the existing quarry void.

This air quality impact assessment (AQIA) has been prepared to assess the air quality impacts of the ARRC on sensitive assessment locations in the area.

ES2 Existing environment

The nearest sensitive locations to the ARRC were identified for the purpose of assessing potential air quality impacts. The closest residence is located adjacent to the lot's northern boundary and about 70 m east of the site access road. This residence is unoccupied. The Hubertus Country Club is located immediately west of the site.

It is noted that land use in the vicinity of the site is subject to future changes, with the implementation of the Western Sydney Aerotropolis Plan. A shift from the existing semi-rural/residential assessment locations to commercial/industrial receptors is expected. The impact assessment criteria used in this report are expected to be no different for future commercial/industrial land use, and therefore the results and conclusions presented in this report for existing assessment locations are also relevant and applicable to any change to land use in the future.

Analysis of meteorology for the local area is presented based on data obtained from the Bureau of Meteorology (BoM) automatic weather station (AWS) monitoring site at Badgerys Creek, located approximately 2.4 km south of the site.

To assess compliance with impact assessment criteria, consideration of cumulative impacts is required. Cumulative impacts were assessed by taking into account the existing baseline or background air quality, which is described based on monitoring data from the closest available monitoring site, while also taking into account the adjacent Western Sydney Airport, which is currently under construction. Future changes to the local air quality environment can be expected from the reactivation of the Luddenham Quarry (consent until 2024) and the future operation of the Western Sydney Airport (from 2026).

ES3 Emissions and modelling

To assess the potential impacts from the ARRC, a single emissions scenario was modelled based the maximum throughput rate of 600,000 tonnes per annum (tpa). The air quality impacts of the ARRC were assessed with atmospheric dispersion modelling, using the regulatory dispersion model AERMOD. Predicted project increment and cumulative ground level concentrations (GLCs) for key pollutants were presented for each assessment location and compared against the NSW Environment Protection Authority's (EPA's) impact assessment criteria.

Two potential cumulative scenarios are identified for this assessment:

- Scenario 1 - concurrent operation of the ARRC with the Luddenham Quarry and construction phase of the WSA for approximately 2–3 years (from ~2022 to 2024); and
- Scenario 2 - concurrent operation of the ARRC with the operation of the WSA, from the completion of quarry rehabilitation.

It is noted that the quarry will be rehabilitated following the completion of quarrying, however this would be subject to separate development consent and is not explicitly modelled in this assessment. Subject to approval, this will include filling the quarry void will with unrecyclable material from the ARRC. The details of filling the void are not yet known, however, the equipment required, and the intensity of the activity are expected to be less than the quarry operations. Therefore, Scenario 1 can be taken to be representative of a cumulative scenario up to completion of quarry rehabilitation, noting that there will be a lower cumulative contribution from WSA, as it moves from construction to operational phase.

Modelling results are summarised as follows:

- annual average PM_{10} - there are no exceedance of the impact assessment criterion at any receptor;
- 24-hour average PM_{10} - at receptor R3, there are six additional days over the impact assessment criterion for Scenario 1 and two additional days over the impact assessment criterion for Scenario 2;
- annual average $PM_{2.5}$ - for both cumulative assessment scenarios, there is an exceedance of the impact assessment criterion at R3, while for scenario 1 only, there is an exceedance of the impact assessment criterion at R6, primarily due to the high background concentrations;
- 24-hour average $PM_{2.5}$ - there are two additional days over the impact assessment criterion for both scenarios at R3 only;
- annual average TSP – for scenario 1, there is an exceedance of the impact assessment criterion at R3; and
- annual average dust deposition - there are no exceedances of the impact assessment for dust deposition and nuisance dust impacts will be contained within the site boundary (ie no impact to airport operations).

The most effective way to control potential exceedances will be to control wheel generated dust from trucks entering and exiting the site, which is the largest contributing source. This will be achieved though the installation of a wheel wash (which has not been incorporated into emission reduction measures for modelling) and through deployment of a street sweeper twice a day. Both measures will act to reduce the silt loading of the road surface and will significantly reduce dust emissions from truck movements.

The risk of exceedance is significantly higher during Scenario 1 (the concurrent construction phase of the WSA and operation of the quarry), which is expected to be relatively short-lived (ie limited to the first 2–3 years of operation of the ARRC). It is noted that the quarry will be rehabilitated (filled) following the completion of quarrying, however the intensity of this activity is expected to be less than the quarry operations and impacts during quarry rehabilitation are expected to the lower than during these first 2–3 years.

ES4 Greenhouse gas assessment

Annual average GHG emissions (Scope 1 and 2) generated by the project represent approximately 0.001% of total GHG emissions for NSW and 0.0003% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

ES5 Management and monitoring

The waste handling and stockpiling will be within an enclosed building and the current site access road will be sealed.

The potential for short-term impacts will be managed by planning for adverse weather and through reactive and corrective dust controls, which will be formally documented in an air quality management plan. An *Air Quality Monitoring Programme* was developed in 2009 for the operation of the quarry (Golder 2009) and will be reviewed and augmented following approval for the reactivation of the Luddenham Quarry. It is anticipated that if the ARRC is also approved, a combined or complementary air quality management plan can be developed for the site, whereby an air quality monitoring programme is shared for the operation of the Quarry and ARRC.

Development of a combined Air Quality Management Plan for both the quarry and ARRC site would enable management of operations across the entire site and allocation of the appropriate additional controls to the most relevant area of the site.

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Tables

Figures

1 Introduction

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the subject property') within the Liverpool City Council municipality (Figure A.1). The site is host to an existing shale/clay quarry.

CPG owns, develops, and manages a national portfolio of office, retail, entertainment, land, and other assets. The company's business model is to retain long-term ownership and control of all its assets. CPG has the following staged vision to the long-term development of the site:

- Stage 1 Quarry Reactivation: **Solving a problem**. CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities, the void will be prepared for rehabilitation.

- Stage 2 Advanced Resource Recovery Centre and Quarry Rehabilitation: **A smart way to fill the void**: CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration between the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered for use to rehabilitate the void. This will provide a sustainable and economically viable method of rehabilitating the void for development.

- Stage 3 High Value Employment Generating Development: **Transform the land to deliver high value agribusiness jobs**. CPG intends to develop the rehabilitated site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery research and development (R&D) initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and Outer Sydney Orbital.

KLF is an Australian-owned and operated waste management company that operates two strategically located resource recovery and recycling facilities in Sydney; one at Camellia and another at Asquith. KLF has 20 years' experience in the waste recycling and resource recovery industry. KLF facilities are licensed by the NSW Environment Protection Authority (EPA) and have full International Organisation for Standardisation (ISO) accreditation.

This report relates to a new development application relating to the delivery of Stage 2 above.

1.1 The site

There is an existing clay and shale quarry on the subject property approved under Development Consent DA-315-7-2003, as modified. The quarry is currently inactive. CPG and KLF (the 'applicants') have commenced the application process to modify the quarry's consent to allow quarry operations to recommence, with the primary intention of changing the approved access to the subject property to allow quarry operations (Modification 5, also referred to as MOD 5).

It is proposed to develop an advanced resource recovery centre (ARRC) within the same lot to the north of the existing quarry void. The ARRC site is shown in Figure A.2.

The project is integral in achieving the intended future commercial/industrial land use for the subject property as the project provides a commercially viable means to infill the quarry void (subject to separate development consent). This will support the ongoing development of the Western Sydney Aerotropolis.

A new State significant development (SSD) consent under Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is required to establish the ARRC. On 24 April 2020, the Department of Planning, Industry and Environment (DPIE) issued Secretary's Environmental Assessment Requirements (SEARs) for the environmental impact statement (EIS) for the project. The SSD consent application number is SSD-10446.

This report has been prepared by EMM Consulting Pty Limited (EMM) on behalf of the applicants.

1.1 Project overview

The key components of the ARRC project are as follows:

- construction and operation of an advanced construction and demolition resource recovery centre;
- accepting and processing up to 600,000 tonnes per annum (tpa) of waste for recycling;
- dispatch of up to approximately 540,000 tpa of recycled product;
- dispatch of approximately 60,000–120,000 tpa of unrecyclable material either to an offsite licensed waste facility or to the adjacent quarry void (following approval to place the unrecyclable material in the void);
- if required, upgrade the access road from the subject property to Adams Road;
- use of the access road from subject property to Adams Road;
- the ARRC will not accept putrescibles, liquid or hazardous waste; and
- the ARRC will operate up to 24 hours a day, 7 days per week.

The ARRC will accept general solid waste comprising building and demolition waste as well as selected commercial and industrial waste. No special, liquid, hazardous, restricted solid water, putrescible solid waste, or odorous waste will be accepted at the ARRC.

The vast majority of materials accepted will be recovered, the remaining minor amount (10–20%) of unrecyclable materials will be disposed of at an offsite licensed landfill or to the quarry void on the site as part of rehabilitating the void.

The proposed project layout is shown in Figure A.2.

1.2 Assessment requirements

This air quality impact assessment (AQIA) has been prepared to assess the air quality impacts of the ARRC on sensitive assessment locations in the area. The Planning Secretary's Environment Assessment Requirements (SEARs) for SSD-10446 were issued on 24 March 2020. The SEARs relevant to this AQIA, and how they are addressed, are summarised in Table 1.1. Specific requirements of the Environment Protection Authority (EPA) are also listed in Table 1.1.

Table 1.1 Air quality impact assessment requirements

Agency	Requirement	How this is addressed
DPIE	A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant NSW Environment Protection Authority guidelines. This is to include the identification of existing and potential future sensitive receivers, including the Western Sydney Airport, and consideration of approved and/or proposed developments in the vicinity.	The AQIA is prepared in accordance with the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. It is noted that no sources of odour are identified for the ARRC (discussed further in Section 5.1). The potential dust impacts on the operation of Western Sydney Airport are described in the *Aeronautical Impact Assessment* (Landrum & Brown 2020).
	The details of buildings and air handling systems and strong justification (including quantitative evidence) for any material handling, processing or stockpiling external to a building.	All material handling, processing and stockpiling will be inside the warehouse. The building will not have mechanical air extraction, however missing sprays will operate at each exit point to mitigate dust. Refer to Figure A.2 and for project layout and detailed design.
	Details of proposed mitigation, management and monitoring measures	Refer to Section 7.
NSW EPA	The Facility must be enclosed - The EPA requires that all waste and materials are stored and processed inside an enclosed building. All waste handling activities, including receival, sorting, processing, sampling, quarantine, storage and loading must be conducted within an enclosed building. No waste, including finished products, may be stored outside. Any external haulage areas or roads must be sealed hardstand. Any unused external surfaces must be sealed hardstand or vegetated.	All material handling, processing and stockpiling will be inside the warehouse. All haulage routes will be sealed hardstand. Refer to Figure A.2 for project layout and detailed design.
	The EIS should include an air quality assessment that identifies all potential air emission from the Premises. The Applicant must assess the impact of any discharges and demonstrate effective control of all identified air emissions from the Premises.	Emission sources and controls are described in Section 5.
	Please refer to Attachment B for details for what is to be included in the air quality impact assessment.	This AQIA has been prepared in accordance with the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* and EPA's EIS requirement for SSD-10446.

2 Assessment approach

2.1 Introduction

This AQIA presents a quantitative assessment of potential air quality impacts, with an emphasis on emissions of particulate matter (PM) – the key pollutant associated with the ARRC. Air pollutants likely to be generated by the operation of the ARRC will comprise of:

- particulate matter, specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 microns in aerodynamic diameter (PM_{10});
  - particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$).
- oxides of nitrogen (NO_x);
- sulphur dioxide (SO_2);
- carbon monoxide (CO); and
- volatile organic compounds (VOCs).

Particulate matter pollutants (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 receptors. This assessment will therefore focus 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.

No odorous waste streams would be accepted by the ARRC. Vegetation waste (eg garden waste, branches, leaves, grass) and timber and wood waste (eg pallets, offcuts, shavings, building and demolition timber) will be accepted, however the processing of this waste will be limited to shredding and blending (all of which will occur within the warehouse). There will be no composting onsite. No sources of odour emissions are identified and odour is not considered further in this report.

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

The AQIA uses a Level 2 assessment approach, as follows:

- emissions were estimated for all relevant activities, using best practice emission estimation techniques;
- dispersion modelling using a regulatory dispersion model was used to predict ground-level concentrations for key pollutants at surrounding sensitive receptors; and
- cumulative impacts were assessed, taking into account the combined effect of the project with existing baseline air quality, as well as neighbouring projects and proposed/approved future development.

2.2 Assessment criteria

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 2.1. The assessment criteria for PM_{10} and $PM_{2.5}$ are consistent with the national air quality standards that are defined in the *National Environment Protection (Ambient Air Quality) Measure* (DoE 2016).

TSP, which relates to airborne particles less than around 50 µm in diameter, is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (NSW EPA 2013). Particles less than 10 µm in diameter, accounted for in this assessment by PM_{10} and $PM_{2.5}$, are a subset of TSP and are fine enough to enter the human respiratory system and can therefore lead to adverse human health impacts. The NSW EPA impact assessment criteria for PM_{10} and $PM_{2.5}$ are therefore used to assess the potential impacts of airborne particulate matter on human health.

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[1], and compared against the 100th percentile (ie 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 Approved Methods for Modelling specifies criteria for the project-only increment and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

Table 2.1 Impact assessment criteria for particulate matter

PM metric	Averaging period	Impact 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)

Notes: µg/m^3: micrograms per cubic meter; g/m^2/month: grams per square metre per month

2.3 Assessment locations

The nearest sensitive locations to the quarry have been identified for the purpose of assessing potential air quality impacts. Details are provided in Table 2.2 and their locations are shown in Figure 2.1. The closest residence (R3) is located adjacent to the lot's northern boundary and about 70 m east of the site access road. This is currently unoccupied. The closest occupied residence (R6) is adjacent to the lot's western boundary and about 200 m west of the closest part of the ARRC site. The Hubertus Country Club and pistol range is located south-west of the ARRC site.

[1] NSW EPA (2016) 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.

It is noted that land use in the vicinity of the site is subject to future changes, with the implementation of the Western Sydney Aerotropolis Plan. A shift from the existing semi-rural/residential type assessment locations to commercial/industrial receptors is expected. The impact assessment criteria used in this report are expected to be no different for future commercial/industrial land use, and therefore the results and conclusions presented in this report for existing assessment locations, are also relevant and applicable to any change to land use in the future.

Furthermore, although modelling results are specifically presented for the assessment locations in Table 2.2, the report also presents contour plots, allowing potential impacts to be assessed in the context of future land use changes.

Table 2.2 Assessment locations

ID	Address	Classification	Easting	Northing
R1	2161–2177 Elizabeth Drive, Luddenham	Residential	288774	6250224
R2	2111–2141 Elizabeth Drive, Luddenham	Residential	289130	6250072
R3	285 Adams Road, Luddenham	Residential	288940	6249722
R4	5 Anton Road, Luddenham	Residential	288347	6249272
R5	185 Adams Road, Luddenham	Residential	288273	6249161
R6	225 Adams Road, Luddenham	Residential	288751	6249563
R7	161 Adams Road, Luddenham	Residential	287916	6249080
R8	2510–2550 Elizabeth Drive, Luddenham	Residential	288334	6250275
C1	Hubertus Club – restaurant including outdoor facilities	Commercial	288680	6249400
AR1	Hubertus Country Club – outdoor firing range	Active recreation	288643	6249324

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Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

Subject property

ARRC site

Cadastral boundary

Assessment location

Active recreation

Commercial

Residential

Assessment locations

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Air Qualtiy Impact Assessment

Figure 2.1

EMM creating opportunities

3 Overview of local meteorology

3.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. Analysis of meteorology for the local area is presented based on data obtained from the Bureau of Meteorology (BoM) automatic weather station (AWS) monitoring site at Badgerys Creek, located approximately 2.4 km south of the site.

3.2 Selection of a representative dataset for modelling

In selecting a representative year for modelling, the following criteria were considered:

- data availability – the higher the data capture rate the better and the more complete the modelling period;
- representativeness of the meteorology – this is particularly important for wind conditions, which have a greater influence on dispersion for fugitive dust sources; and
- representativeness of the existing ambient background – the modelling year should also avoid years with significantly lower or higher ambient background concentrations, if these are not representative of longer-term averages.

Six years of hourly data were reviewed for the period 2013 to 2018 and the calendar year 2017 was selected for modelling based on the following observations:

- Figure B.1 shows the percentage data capture rate by year, with the red bars indicating gaps in the data. The calendar year 2017 has the highest data capture rate of recent years for the majority of parameters;
- annual wind roses for the period 2013 to 2018 are presented in Figure 3.1. The analysis shows consistency in wind direction, average wind speed and percentage occurrence of calm winds (≤0.5 m/s) for all years; and
- the calendar year 2019 was specifically excluded because the extensive bushfire events in November and December have resulted in elevated levels of PM_{10} and $PM_{2.5}$ which are not representative of a typical year (refer Section 4). In 2019, exceptional events led to poor air quality on 127 days, compared with 50 days in 2018 and 18 days in 2017 (DPIE 2020).

3.3 Prevailing winds

The dominant wind direction for 2017 is from the southwest, with winds from all other directions recorded for a small percentage of time (Figure 3.1). The annual average wind speed for 2017 is 2.5 m/s and percentage occurrence of calm winds is 7.1%. Seasonal and diurnal variation in winds is show in Figure B.3. During autumn and winter, there is a higher proportion of winds from the south-west, particularly at night. During spring and summer, there is a higher frequency of winds from the north-east. During night-time hours, mean wind speeds are lower than during the day and the percentage occurrence of calm winds is generally higher.

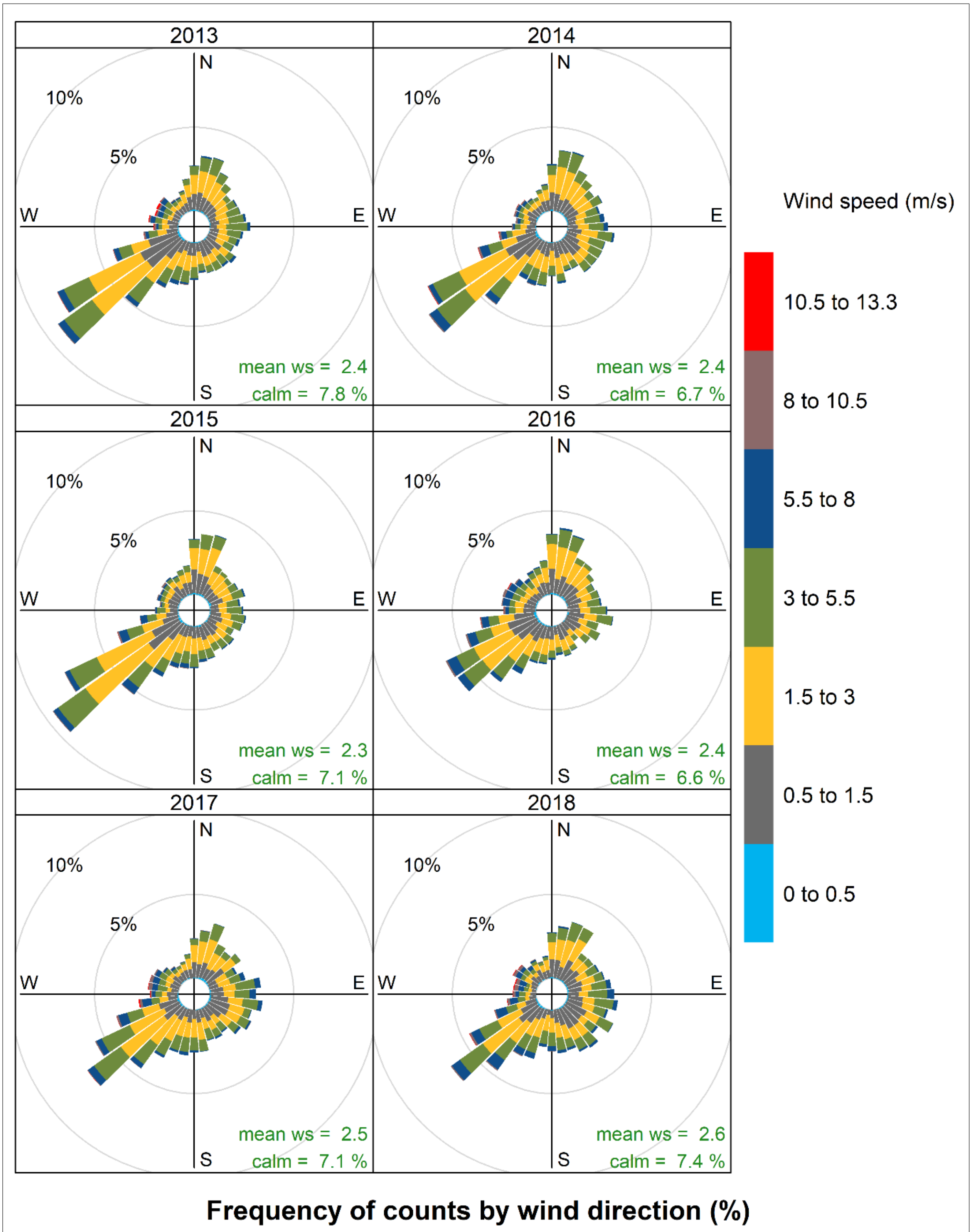

Figure 3.1 Interannual wind roses for Badgerys Creek AWS – 2013–2018

3.4 Ambient temperature

The inter-annual variation in temperature for Badgerys Creek is presented as a box and whisker plot in Figure B.4. The inter-annual variation in temperature is presented for a longer 10-year period from 2009–2019. The plot shows that the monthly minimum, maximum, mean and upper and lower quartile temperatures for the modelled year (2017) are consistent and therefore representative when compared with longer-term measurements.

3.5 Rainfall

To provide a conservative (upper bound) estimate of the particulate matter concentrations, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report. Furthermore, the emission inventories developed for this study have not applied a natural mitigation factor[2] for rainfall and are therefore more conservative (higher) than if rainfall was incorporated.

3.6 Meteorological modelling

Atmospheric dispersion modelling for this assessment has been completed using the American Meteorological Society (AMS)/United States Environmental Protection Agency (US-EPA) regulatory model (AERMOD) (model version v18081). The meteorological inputs for AERMOD were generated using the AERMET meteorological processor using local surface observations and upper air profiles generated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) TAPM meteorological modelling module.

Hourly average meteorological data from the Badgerys Creek AWS were used as observations in the TAPM and AERMET modelling. Further details of the TAPM meteorological modelling and AERMET data processing completed to prepare the inputs for AERMOD are documented in Appendix B.

3.6.1 Atmospheric stability and mixing depth

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

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

The overall diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by AERMET based on observations collected at the Badgerys Creek AWS in 2017, is shown in Figure 3.2. The diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during day-time hours and lowest during evening through to early morning hours.

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

[2] The US EPA AP-42 emission factor documentation for unsealed roads (Chapter 13.2.2) describes a 'natural mitigation' factor, which can be applied for rainfall and other precipitation, based on the assumption that annual emissions are inversely proportional to the number of days with measurable rain, defined as the number of days with greater than 0.25 mm recorded.

Hourly-varying atmospheric boundary layer depths were generated by AERMET, the meteorological processor for the AERMOD dispersion model. The variation in AERMET-calculated boundary layer depth by hour of the day is shown in Figure 3.3. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

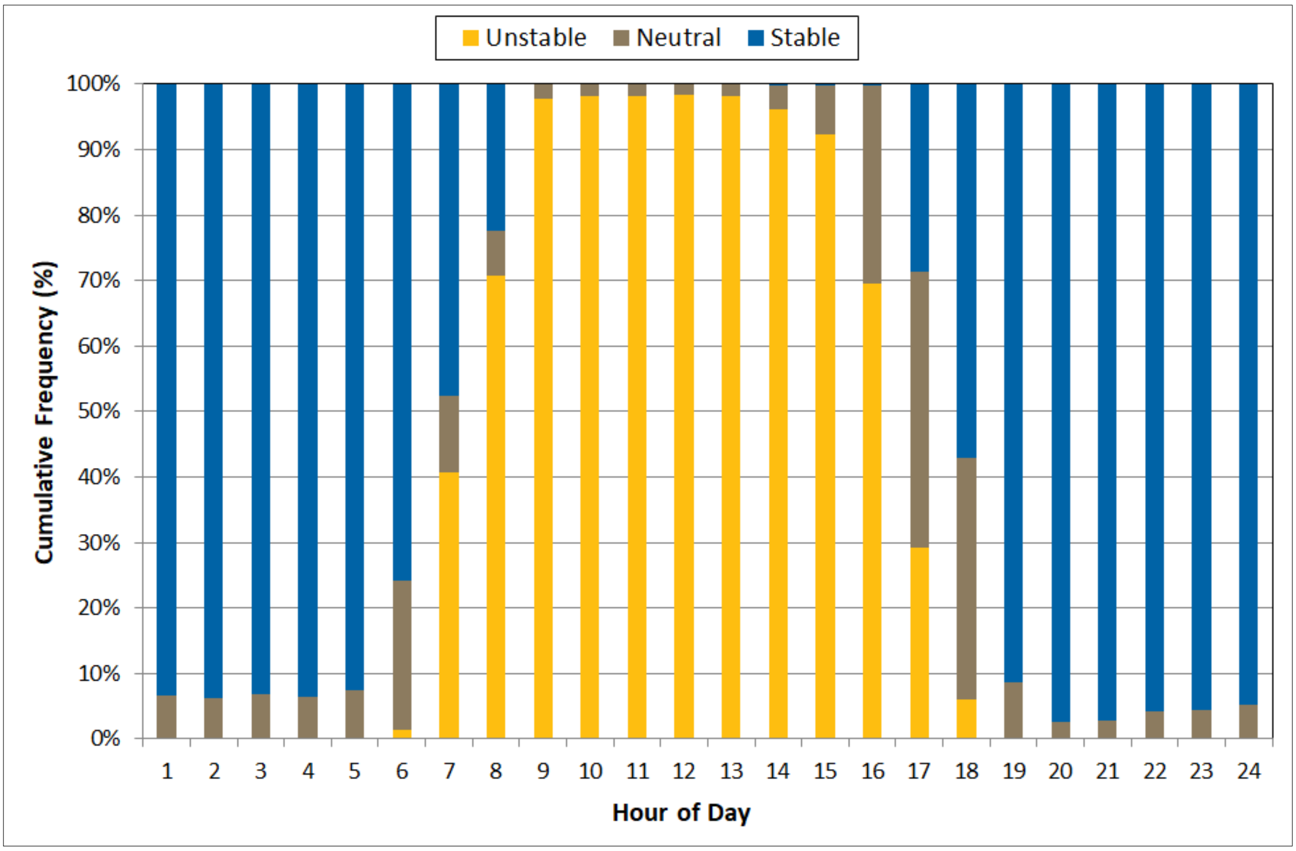

Figure 3.2 Diurnal variations in AERMET-generated atmospheric stability

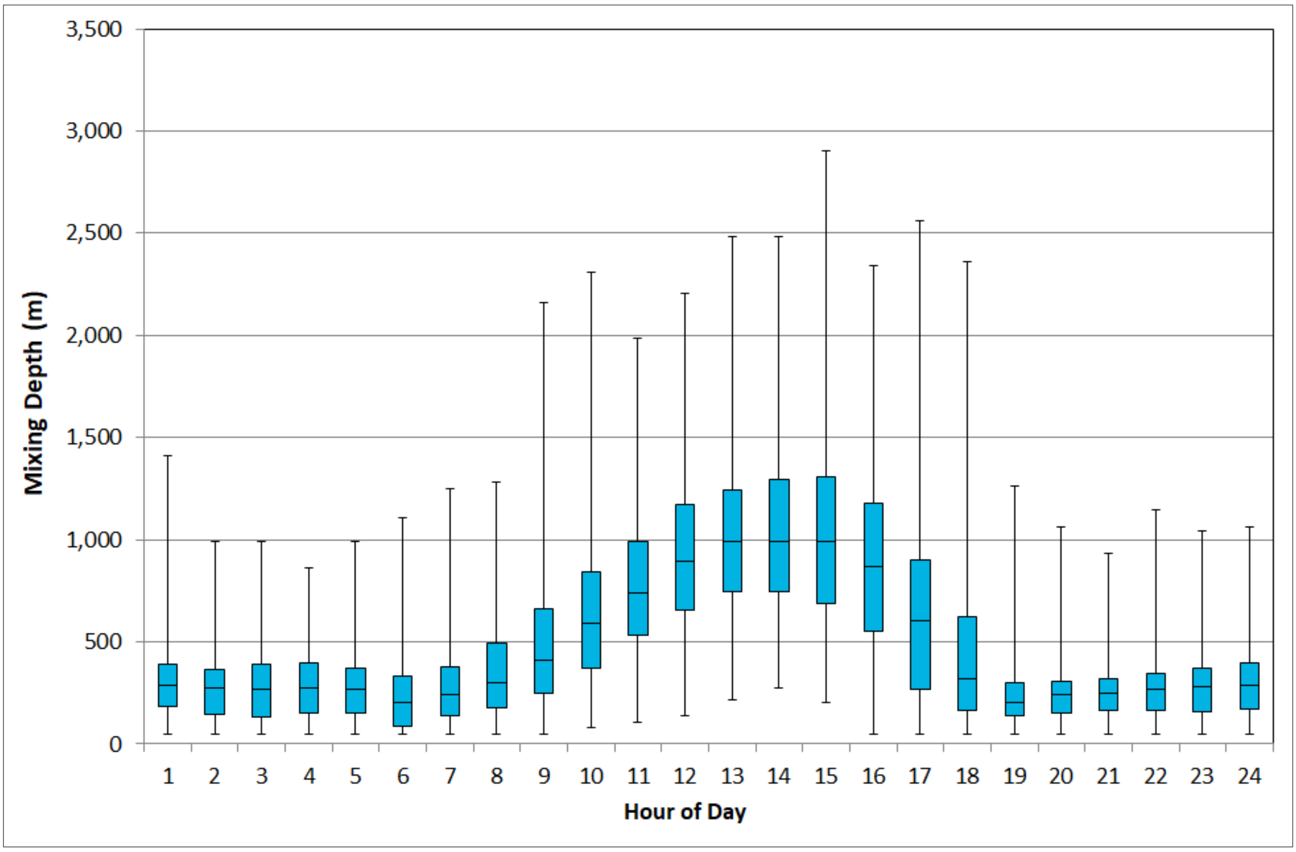

Figure 3.3 Diurnal variation in AERMET generated mixing heights

4 Existing air quality

4.1 Introduction

Consideration of cumulative impact is required to assess how the project will interact with existing and future sources of emissions to determine compliance with impact assessment criteria. Cumulative impacts are assessed by taking into account the existing baseline or background air quality and potential future development that is not captured by historical background monitoring data.

The existing local air quality environment is expected to be primarily influenced by traffic, other commercial activity, seasonal emissions from household wood heaters, episodic emissions from bushfires and the construction of the Western Sydney Airport (bulk earthworks started in late 2018). The existing baseline or background air quality is described based on monitoring data collected at the closest publicly available monitoring site (the Department of Planning, Industry and Environment (DPIE) monitoring site at Bringelly, located approximately 6 km south-east of the site.

Future changes to the local air quality environment can be expected from the reactivation of the Luddenham Quarry (until 2024), filling of the quarry void and the future operation of the Western Sydney Airport (from 2026) (discussed further in Section 4.6).

4.2 PM_{10} and $PM_{2.5}$ concentrations

4.2.1 Summary statistics

The relevant baseline summary statistics for PM_{10} and $PM_{2.5}$ for the previous five years are presented in Table 4.1 (monitoring for $PM_{2.5}$ commenced in 2016). In 2019, a significantly higher number of exceedances occurred as a result of the extensive bushfire that occurred in November and December. Exceptional events led to poor air quality on 127 days across NSW, compared with 50 days in 2018 and 18 days in 2017 (DPIE 2020). Therefore, 2019 is not considered a representative year for a discussion on existing air quality.

Excluding 2019, annual mean PM_{10} concentrations range from 15.8 µg/m³ in 2015 to 21.2 µg/m³ in 2018. On average baseline concentrations are 18.5 µg/m³, or 74% of the NSW EPA annual average criterion of 25 µg/m³. Excluding 2019, annual mean $PM_{2.5}$ concentrations range from 7.5 µg/m³ in 2017 to 8.0 µg/m³ in 2018 and on average baseline concentrations are 7.3 µg/m³ or 92% of the NSW EPA annual average criterion.

Exceedances of the 24-hour average reporting standards for PM_{10} occurred in all years, ranging from one day in 2015 to nine days in 2018. Exceedances of the 24-hour average reporting standards for $PM_{2.5}$ occurred in 2017 (twice) and 2018 (four times). The highest concentration not above the relevant NSW EPA annual average criterion is also presented in Table 4.1. This is used for cumulative assessment to determine if additional exceedances would occur.

Table 4.1 Summary statistics for particulate matter at Bringelly

Pollutant	Statistic	2015	2016	2017	2018	2019
PM_{10}	Annual mean concentration (µg/m³)	15.8	16.9	19.8	21.2	23.6
	Maximum 24-hour average concentration (µg/m³)	57.0	61.6	83.7	92.9	134.0
	Number of days that the 24-hour average concentration is above 50 µg/m³	1	3	6	9	24
	Highest 24-hour average concentration not above 50 µg/m³ (µg/m³)	37.4	40.4	49.5	49.2	49.2
$PM_{2.5}$	Annual mean concentration (µg/m³)	-	7.6	7.5	8.0	11.3
	Maximum 24-hour average concentration (µg/m³)	-	21.6	52.5	55.6	178.0
	Number of days that the 24-hour average concentration is above 25 µg/m³	-	0	2	4	27
	Highest 24-hour average concentration not above 25 µg/m³ (µg/m³)	-	14.7	22.1	20.3	24.6

4.2.2 2017 dataset

As described above, the calendar year 2017 was selected for modelling. To provide a continuous dataset for modelling, gaps in the data were filled as follows:

- for hours where one of PM_{10} or $PM_{2.5}$ concentrations is missing, gaps were filled using a simple linear regression, derived by plotting the relationship between all measurements over the 5-year period; and
- for remaining hours where both the PM_{10} and $PM_{2.5}$ concentrations were missing, gaps were filled using the 70th percentile of the complete data record.

Timeseries plots of the daily 24-hour PM_{10} and $PM_{2.5}$ concentrations for 2017 are presented in Figure 4.1 and Figure 4.2. There are six existing exceedances of the daily PM_{10} criterion and two existing exceedances of the daily $PM_{2.5}$ criterion in the 2017 background dataset (Table 4.1).

The *NSW Air Quality Statement for 2017* (OEH 2018) reported that three of the PM_{10} exceedances where due to exceptional events (bushfires, hazard reduction burns and dust storms) and three of the PM_{10} exceedances where due to non-exceptional events. Both of the $PM_{2.5}$ exceedances were attributed to exceptional events, with the highest occurring during a hazard reduction burn on 14 August 2017. For PM_{10}, the plots also show two additional days when background concentrations are elevated but just below daily PM_{10} criterion, both occurring immediately following an exceedance event. For example, the elevated background concentration on 15 August 2017 (49.5 µg/m³), is due to lingering smoke from a hazard reduction burn on the previous day and the elevated background concentration on 23 September 2017 (49.4 µg/m³) is due to a regional dust storm event[3].

[3] https://www.environment.nsw.gov.au/research-and-publications/publications-search/dust-episode-from-22-to-24-september-2017

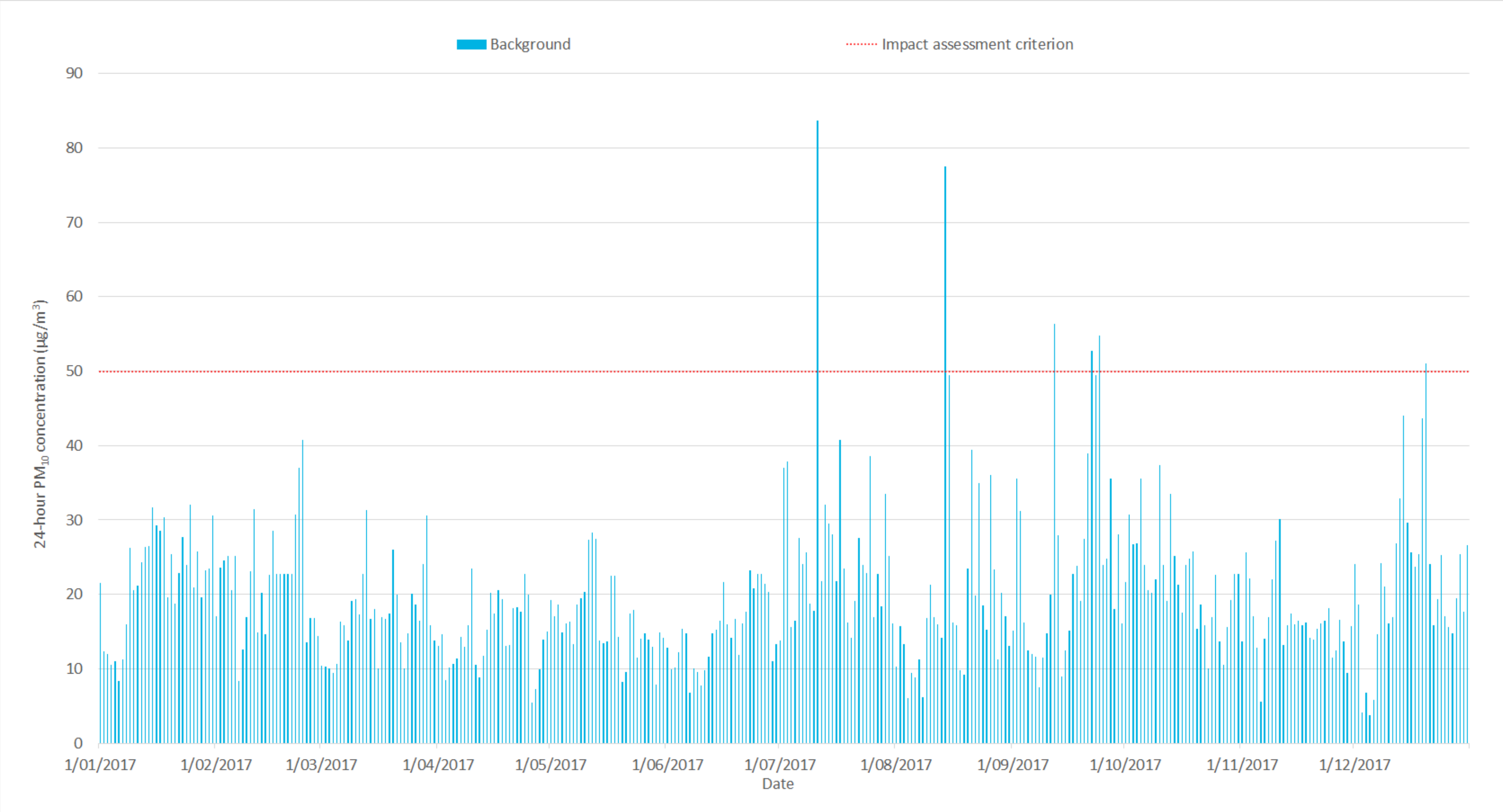

Figure 4.1 Daily varying background 24-hour average PM_{10} concentrations (µg/m³)

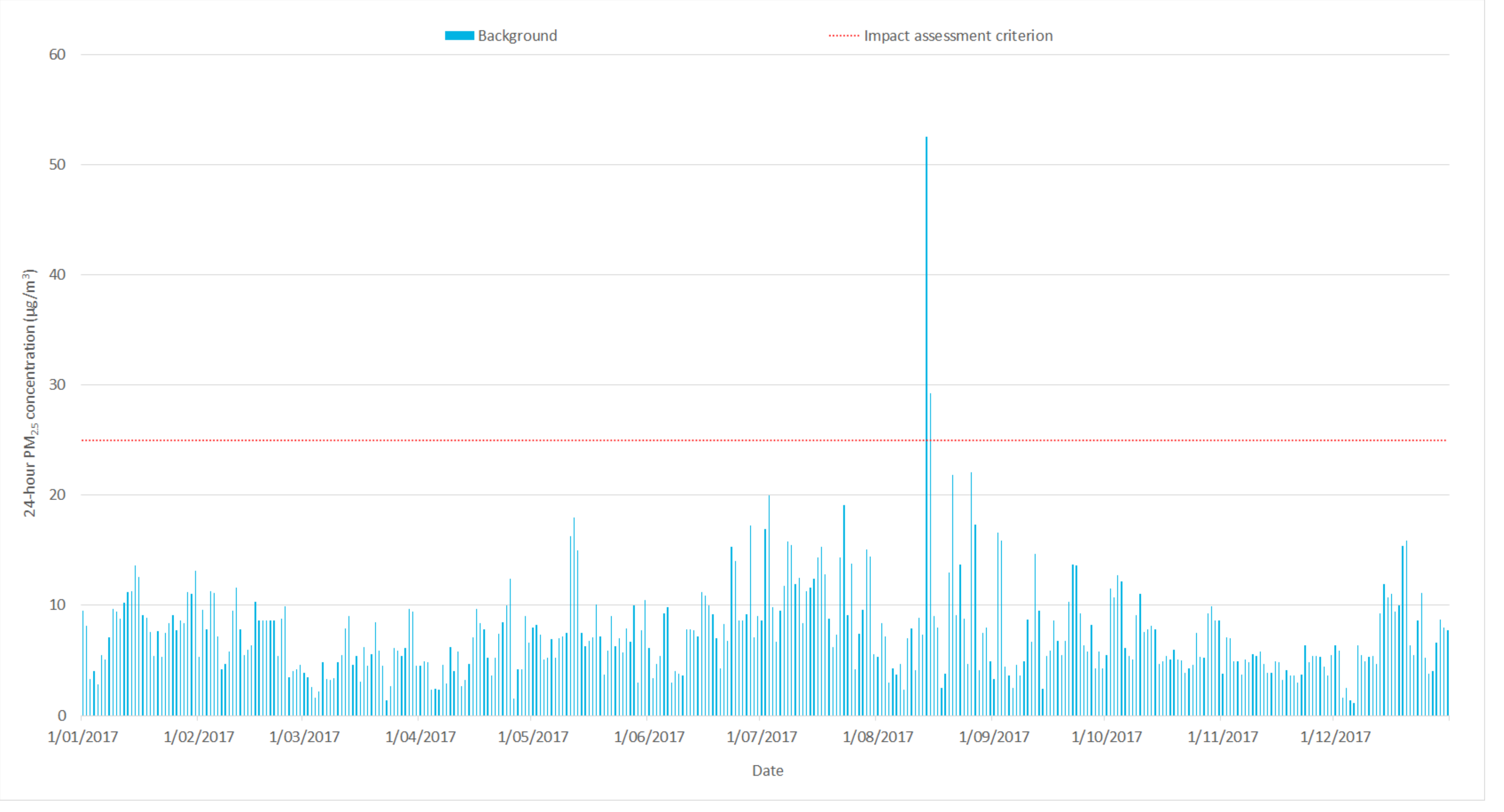

Figure 4.2 **Daily varying background 24-hour average $PM_{2.5}$ concentrations (µg/m³)**

4.3 Total suspended particulate concentrations

TSP concentrations are not measured at Bringelly, however annual average TSP concentrations can be derived from the PM_{10} data, based on ratios of PM_{10}/TSP which would typically range from 0.4 to 0.5 (ie PM_{10} is typically 40% to 50% of TSP).

4.4 Dust deposition

Dust deposition monitoring was conducted onsite between 2015 to 2018. A summary of the monitoring results is presented in Table 4.2. As shown, a complete year of monthly monitoring results are available for 2016 and 2017 only and the annual average dust deposition for these years range from 0.7 to 3.7 g/m^2/month, with an average across all sites of 1.5 g/m^2/month.

Table 4.2 Summary of dust deposition monitoring results (expressed as insoluble solids)

Year	D1 Adams Rd		D2 East House		D3 Jackson Rd		D4 South Paddock	
	Average (g/m^2/month)	No. of samples	Average (g/m^2/month)	No. of samples	Average (g/m^2/month)	No. of samples	Average (g/m^2/month)	No. of samples
2015	1.5	1	-	-	3.6	2	7.2	2
2016	1.1	12	1.1	12	0.9	12	2.9	12
2017	1.1	12	0.7	12	0.7	11	3.7	12
2018	1.1	4	0.8	4	1.0	4	3.4	4

4.5 Proposed future development

The construction of the WSA is currently underway, however the influence of associated emissions on local air quality is not necessarily captured by the 2017 monitoring data at Bringelly. Based on the *Western Sydney Airport Construction Plan – Stage 1 Development* (WSA Co 2018), the key period of construction activities will occur between 2022 and 2025. Bulk earthwork activities, which feature the highest potential for particulate matter emission generation, are expected to completed by the end of 2022 prior to the start of ARRC operations.

The future operation of the WSA (scheduled to operate from 2026) will also influence local air quality and the re-activation of the Luddenham Quarry and quarry rehabilitation (if approved) will also contribute to cumulative local air quality impacts. There are no other quarries, resource recovery centres or other ongoing activities within the vicinity of the site that require specific consideration as part of the cumulative impact assessment (ie that are not already considered through the inclusion of background air quality).

An air quality impact assessment prepared for the WSA (PEL 2016) presented modelling predictions for the construction and operation of the airport and included receptor locations near the site (at the Hubertus Country Club (receptor C1) and at the corner of Adams Road and Elizabeth Drive). The operation of the airport was assessed in stages, with Stage 1 scheduled to reach capacity of 10 million passengers per year five years after opening (ie in 2030). Stage 2 would not operate for another 40 years. A summary of the WSA air quality modelling predictions for construction and operation is presented in Table 4.3 and Table 4.4. It is assumed that the bulk earthworks would have finished by the time the ARRC is operational, therefore the results in Table 4.3 for the aviation infrastructure phase are used for the cumulative assessment in this report.

EMM prepared the air quality impact assessment for the reactivation of the Luddenham Quarry (EMM 2020a), therefore cumulative impacts of quarry operations have been modelled with the operation of ARRC for all assessment locations. If the current application to reactivate the quarry is approved, the quarry would operate for approximately 4 years, until the end of 2024. The quarry will be rehabilitated following the completion of quarrying, however this would be subject to separate development consent and is not explicitly modelled in this assessment.

Subject to approval, this will include filling the quarry void will with unrecyclable material from the ARRC. The details of filling the void are not yet known, however, the equipment required and the intensity of the activity are expected to be less than the quarry operations. Therefore, Scenario 1 can be taken to be representative of a cumulative scenario up to completion of quarry rehabilitation, noting that there will be a lower cumulative contribution from WSA, as it moves from construction to operational phase.

Site establishment and construction of the ARRC are expected to take approximately 15 to 18 months, therefore, assuming operation of the ARRC commences around 2022, the following potential cumulative scenarios are identified for this assessment:

- Scenario 1: concurrent operation of the ARRC with the Luddenham Quarry and construction phase of the WSA for approximately 3-4 years (from ~2022 to 2025), noting that if the void filling is subsequently approved, this scenario would can be taken to be representative of a cumulative scenario for this activity also;

- Scenario 2: concurrent operation of the ARRC with the operation of the WSA, from the completion of quarry rehabilitation. It is noted that the modelled operational scenario for Stage 1 of the WSA assumes full passenger capacity in 2030, therefore technically the results presented for this cumulative scenario would be from 2030 onwards.

Table 4.3 Modelling predictions for the construction phase of the WSA

		Stage	Hubertus Club	Corner Adams Rd and Elizabeth Drive
PM_{10}	Annual average	WSA bulk earthworks	1.4	1.0
	Maximum 24-hour average		6.9	6.5
$PM_{2.5}$	Annual average		0.3	0.2
	Maximum 24-hour average		2.0	1.8
Dust dep	Annual average		0.3	0.2
PM_{10}	Annual average	Aviation infrastructure	0.4	0.3
	Maximum 24-hour average		3.7	3.6
$PM_{2.5}$	Annual average		0.1	0.1
	Maximum 24-hour average		1.5	1.1
Dust dep	Annual average		0.1	0.1

Table 4.4 Modelling predictions for the Stage 1 operation of the WSA

Metric	Averaging period	Stage	Hubertus Club	Corner Adams Rd and Elizabeth Drive
PM_{10}	Annual average	Stage 1	0.2	0.1
	Maximum 24-hour average		1.8	0.7
$PM_{2.5}$	Annual average		0.2	0.1
	Maximum 24-hour average		1.7	0.7

4.6 Adopted background for cumulative assessment

A summary of the adopted background for cumulative assessment is presented in Table 4.5

Table 4.5 Summary of background and adopted approach for cumulative

Parameter	Background/baseline	Additional 'background' for cumulative Scenario 1	Additional contribution for cumulative Scenario 2
24-hour PM_{10} concentration	Daily varying Bringelly data for 2017	Contribution from the construction phase of WSA included by adding the maximum predicted 24-hour average concentration to every day of the background dataset (3.7 µg/m³ or 3.6 µg/m³)[1]. Contribution from Luddenham Quarry included by adding daily modelling predictions for each receptor[2].	Contribution from the operational phase of WSA included by adding the maximum predicted 24-hour average concentration to every day of the background dataset (1.8 µg/m³ or 0.7 µg/m³)[1].
Annual average PM_{10} concentration	4-year average of Bringelly data for 2015–2018[3] of 18.5 µg/m³	Contribution from the construction phase of WSA (0.4 µg/m³ or 0.3 µg/m³)[1]. Contribution from Luddenham Quarry included by adding modelling predictions for each receptor.	Contribution from the operational phase of WSA (0.2 µg/m³ or 0.1 µg/m³)[1].
24-hour $PM_{2.5}$ concentration	Daily varying Bringelly data for 2017	Contribution from the construction phase of WSA included by adding the maximum predicted 24-hour average concentration to every day of the background dataset (1.5 µg/m³ or 1.1 µg/m³)[1]. Contribution from Luddenham Quarry included by adding daily modelling predictions for each receptor.	Contribution from the operational phase of WSA included by adding the maximum predicted 24-hour average concentration to every day of the background dataset (1.7 µg/m³ or 0.7 µg/m³)[1].
Annual average $PM_{2.5}$ concentration	4-year average of Bringelly data for 2015–2018 (filled data) of 7.3 µg/m³	Contribution from the construction phase of WSA (0.1 µg/m³). Contribution from Luddenham Quarry included by adding modelling predictions for each receptor.	Contribution from the operational phase of WSA (0.2 µg/m³ or 0.1 µg/m³)[1].

Table 4.5 Summary of background and adopted approach for cumulative

Parameter	Background/baseline	Additional 'background' for cumulative Scenario 1	Additional contribution for cumulative Scenario 2
Annual average TSP concentration	Annual average concentration of 49.7 µg/m³ derived from the PM_{10} dataset and assuming PM_{10} is 40% of TSP	Contribution from the construction phase of WSA (added to PM_{10} dataset). Contribution from Luddenham Quarry included by adding modelling predictions for each receptor.	Contribution from the operational phase of WSA (added to PM_{10} dataset).
Annual average dust deposition	annual average dust deposition level of 1.5 g/m²/month, derived from the average of the onsite measurements for 2016 and 2017.	Contribution from the construction phase of WSA (0.3 or 0.2 g/m²/month) [1]. Contribution from Luddenham Quarry included by adding modelling predictions for each receptor.	NA

[1] Value chosen based on proximity of assessment location to the relevant WSA modelling prediction for Hubertus Club or Corner of Adams Rd and Elizabeth Dr

[2] Would also be a conservative scenario for quarry rehabilitation / void filling

[3] 2019 excluded due to extensive bushfire activity

5 Emission inventory

5.1 Emission sources

The ARRC will accept construction and demolition waste (non-putrescible) as follows:

- mixed waste (recyclable) – including building and demolition waste, soils and construction spoils;
- masonry waste – including building and demolition waste and associated materials from non-building and demolition activities (eg bricks, concrete, tiles and similar masonry materials);
- vegetation waste – including garden waste, wood waste and non-putrescible vegetative waste;
- timber and wood waste – including wood associated with manufacturing of timbers and timber products, both treated and untreated, and timbers emanating from building and demolition waste; and
- metals – including metals from building and demolition waste.

As previously discussed, no odorous waste streams would be accepted by the ARRC the processing of vegetation and wood waste will be limited to shredding and blending (all of which will occur within the warehouse). Therefore, no sources of odour emissions are identified, and the assessment focuses on emission of particulate matter.

All material handling and processing will occur within the warehouse, which is enclosed on all sides. All dust emissions, except for wheel generated dust on the access roads, will be generated with the warehouse and subject to controls afforded by enclosure. Sources of emissions are summarised as follows:

- Emissions sources outside the warehouse:
  - wheel generated dust from the movement of vehicles transporting waste and product across the paved access roads;
- Emission sources within the warehouse:
  - unloading waste material at the receival area;
  - sorting, handling and conveying of waste material;
  - processing of material (screening, crushing, shredding);
  - movement of vehicles (front end loaders, trucks);
  - rehandle of material to stockpiles;
  - loading of product to truck for dispatch; and
  - diesel fuel combustion by on-site plant and equipment[4].

[4] Emissions of other pollutants (including oxides of nitrogen, carbon monoxide and sulphur dioxide) associated with diesel fuel combustion are likely to be minor relative to particulate matter emissions and were not included in this assessment.

Wind erosion from stockpiles and other surfaces would not occur within the building, however it is included as an emission source for completeness with a control factor added for enclosure (refer Section 5.4).

As discussed in Section 4.6, dust emissions associated with the reactivation of the quarry are included in this modelling. Details of how these emissions were derived and modelling is presented in EMM (2020a).

5.2 Emission factors

Fugitive dust sources associated with the operation of the ARRC were quantified using the National Pollution Inventory (NPI) emission estimation techniques and United States Environmental Protection Agency (US-EPA) AP-42 emission factor equations (US-EPA 1987, 1998a and 1998b). 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 particles ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42).

5.3 Emissions scenario

To assess the potential impacts from the ARRC, a single emissions scenario was modelled based the maximum throughput rate of 600,000 tonnes per annum (tpa). The emission factors used for the emission inventory are mostly relevant to material such as building and demolition waste, soil and masonry. It is expected that the dust emission potential for timber, wood and metal waste is minimal. Regardless, emissions are generated based on the maximum throughput, thereby assuming all waste types have an equal propensity for dust.

The following general assumptions were made in deriving the emission inventory:

- annual throughput of 600,000 tpa, comprising 600,000 tpa of waste in and 540,000 tpa of recyclable material (product) out;
- an additional 60,000 tpa of non-recyclable material will also be transported off-site;
- 100% of the recyclable material would be screened;
- approximately 25% of the recyclable material would be crushed;
- approximately 50% of the recyclable material would be shredded;
- waste would be delivered using a variety of trucks, skip bin trucks and light vehicles. An average truck payload of 4.4 tonnes is assumed, consistent with the Traffic Impact Assessment (EMM 2020b);
- product/unrecyclable materials would be dispatched using various trucks. An average payload of 33.5 tonnes is assumed, consistent with the Traffic Impact Assessment (EMM 2020b); and
- hours of operation are 24 hours, 7 days a week.

5.4 Emission reduction factors

The following dust mitigation measures have been incorporated into the emission inventory based on emission reduction factors reported in the literature as follows:

- 85% control factor applied for all activities within the warehouse (based on a combination of 70% for enclosure and 50% for water misting sprays at each exit point) (Katestone 2010);
- use of controlled emission factors for crushing and screening, based on the application of water sprays at the crusher and screen;
- 99% control factor applied for wind erosion within the warehouse (based on enclosure) (Katestone 2010); and
- 70% control factor applied for a water cart operating on the external sealed access routes (US-EPA 2011).

5.5 Particulate matter emissions

A summary of calculated annual emissions by source type is presented in Table 5.1. The most significant source of emissions of TSP and PM_{10} is associated with the haulage of waste and product (external to the warehouse), followed by activities occurring within the warehouse. The significance of diesel combustion emissions increases with decreasing particle size (diesel combustion is the largest source of $PM_{2.5}$).

The relative significance of key source types by particle size is illustrated in Figure 5.1. Further details regarding emission estimation factors and assumptions are provided in Appendix C.

Table 5.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions

Emissions source	Calculated annual emissions (kg/year) by source		
	TSP	PM_{10}	$PM_{2.5}$
Haulage			
Waste trucks in	2,028	389.3	94.2
Waste trucks out	744	142.7	34.5
Product/unrecyclable materials trucks in	880	168.8	40.8
Product/unrecyclable materials trucks out	1,771	340.0	82.3
Material handling and processing in shed			
Internal haul - waste trucks	1,014.0	45.3	11.0
Internal haul - product trucks	511.4	15.7	3.8
Trucks unloading waste in warehouse	36.7	17.4	2.6
Excavator sorting/picking	36.7	17.4	2.6
Non-recyclable material - rehandle	3.7	1.7	0.3
Recyclable material - conveyor/transfer	165.2	16	2.4
Recyclable material - screening	89.1	30.0	2.0
Recyclable material - rehandle	33.0	15.6	2.4
Crushing concrete/masonry	12.2	5.5	1.0
Shredding timber	24.3	10.9	2.0
Future processing - shredding tyres	1.8	0.8	0.2
Future processing - sand screening at wash plant	16.5	5.6	0.4
Future processing - rehandle	14.7	3.5	0.5
Rehandle processed material to stockpile bins	24.8	11.7	1.8
FEL wheel generated dust	22	4.3	0.0
Product - rehandle to truck	36.7	17	2.6
Wind erosion			
Shed area	11.9	6.0	0.9
Miscellaneous			
Onsite diesel consumption	308	308	299
Total (kg/year)	**7,782**	**1,573**	**578**

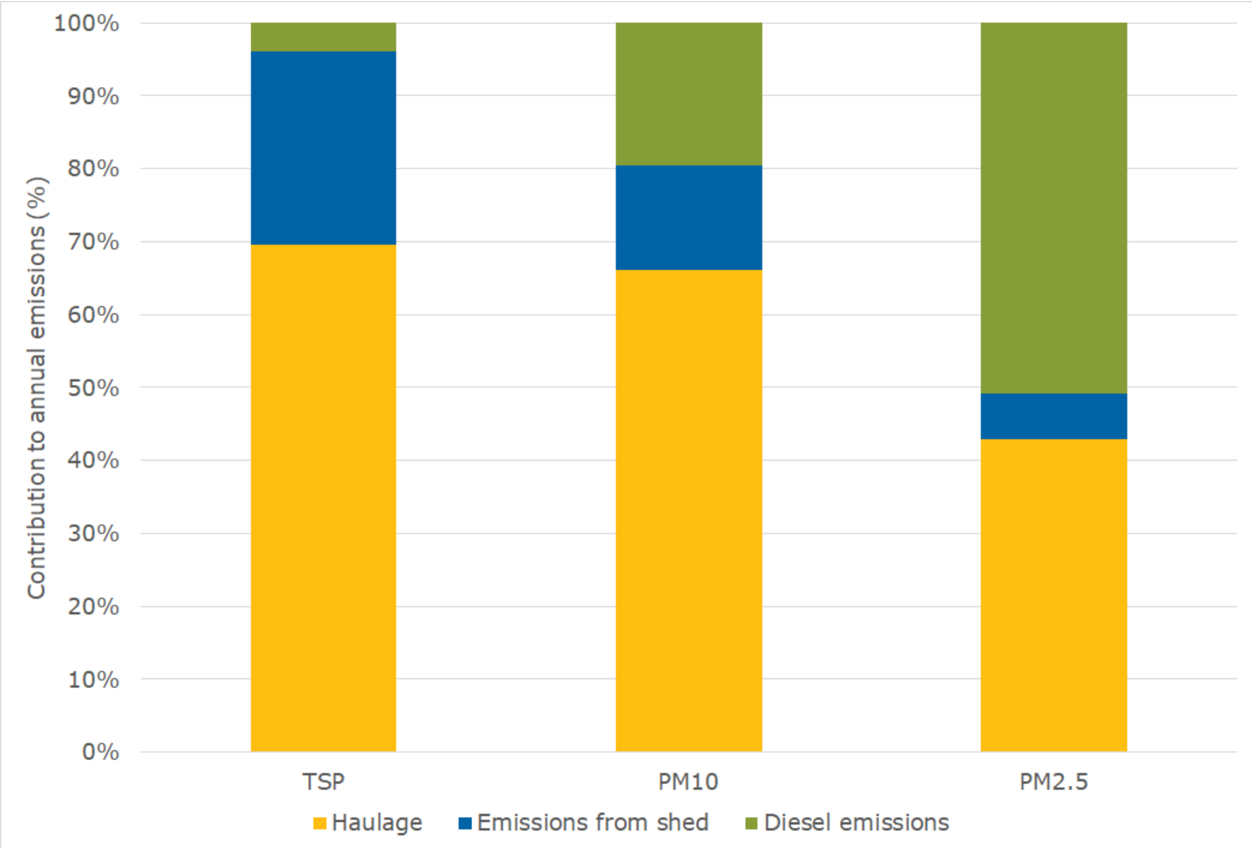

Figure 5.1 **Relative contribution of emission sources to total annual emissions**

6 Modelling results

6.1 Dispersion model selection

The atmospheric dispersion modelling completed for this assessment used the AERMOD dispersion model (version v18081). 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. Specific activities and emission sources (listed in Table 5.1) were represented by line-volume and volume sources. Vehicles entering and leaving the site are modelled using the line-volume sources positioned along the access roads. All emissions generated withing the warehouse are modelled as volume sources located at the entry and exit points of the warehouse building. The modelled source locations are shown in Figure C.1.

The predicted project increment and cumulative ground level concentrations (GLCs) are tabulated for each assessment location. Gridded GLCs were also predicted over a 4 km by 4 km domain with a 100 m resolution and used to generate concentration isopleth plots (Appendix D).

6.2 Annual average PM_{10} and $PM_{2.5}$

The predicted project increment and cumulative annual average PM_{10} and $PM_{2.5}$ concentrations are presented in Table 6.1. Exceedances of the impact assessment criteria are shown in bold.

Cumulative results are presented for the cumulative scenarios discussed in Section 4.6, as follows:

- Cumulative scenario 1: ARRC increment + background + construction of WSA + Luddenham Quarry operations (2022–2024); and
- Cumulative scenario 2: ARRC increment + background + operation of WSA (ie after quarry rehabilitation).

Table 6.1 Predicted incremental and cumulative annual average PM_{10} and $PM_{2.5}$ concentrations

	PM_{10} (µg/m³)			$PM_{2.5}$ (µg/m³)		
	Increment	**Cumulative Scenario 1 (Construction of WSA + Luddenham Quarry)**	**Cumulative Scenario 2 (Operation of WSA only)**	**Increment**	**Cumulative Scenario 1 (Construction of WSA + Luddenham Quarry)**	**Cumulative Scenario 2 (Operation of WSA only)**
Goal	**25 µg/m³**			**8 µg/m³**		
R1	0.2	19.1	18.8	0.1	7.5	7.5
R2	0.3	19.4	18.9	0.1	7.6	7.5
R3	3.9	24.7	22.6	1.3	**9.2**	**8.8**
R4	0.1	19.4	18.8	0.1	7.6	7.6
R5	0.1	19.2	18.8	0.1	7.6	7.6
R6	1.1	21.2	19.8	0.4	**8.2**	7.9
R7	0.1	19.1	18.8	0.0	7.6	7.5
R8	0.1	19.0	18.7	0.0	7.5	7.4
C1	0.5	20.8	19.2	0.2	8.0	7.7
AR1	0.3	20.5	19.1	0.2	7.9	7.7

The highest predicted project increment for annual average PM_{10} is 3.9 µg/m^3 at assessment location R3. The next highest predicted project increment (1.1 µg/m^3) occurs at R6. There are no exceedances of the impact assessment criterion for annual average PM_{10}.

The highest predicted project increment for annual average $PM_{2.5}$ is 1.3 µg/m^3 also at assessment location R3. The next highest predicted project increment (0.4 µg/m^3) occurs at R6. For both cumulative assessment scenarios, there is an exceedance of the impact assessment criterion for annual average $PM_{2.5}$ at R3 (9.2 µg/m^3 for Scenario 1 and 8.8 µg/m^3 for Scenario 2). For Scenario 1, while the construction of the WSA and the operation of the quarry are both occurring, there is also an exceedance of the impact assessment criterion for annual average $PM_{2.5}$ at R6 (8.2 µg/m^3).

Contour plots for the predicted project only annual average PM_{10} and $PM_{2.5}$ concentrations are presented in Appendix D.

6.3 24-hour average PM_{10} and $PM_{2.5}$

The predicted project increment and cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in Table 6.2. Exceedances of the impact assessment criteria are shown in bold, and the number of additional days above the goal are shown in brackets. Contour plots for the predicted project-only 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in Appendix D.

Table 6.2 Predicted incremental and cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations

	PM_{10} (µg/m^3) (number of additional days above goal shown in brackets)			$PM_{2.5}$ (µg/m^3) (number of additional days above goal shown in brackets)		
	Increment	**Cumulative scenario 1 (Construction of WSA + Luddenham Quarry)**	**Cumulative scenario 2 (Operation of WSA only)**	**Increment**	**Cumulative scenario 1 (Construction of WSA + Luddenham Quarry)**	**Cumulative scenario 2 (Operation of WSA only)**
Goal	**50 µg/m^3**			**25 µg/m^3**		
R1	0.9	47.9	45.0	0.4	23.6	23.6
R2	1.2	48.1	45.0	0.5	23.4	23.4
R3	9.1	**53.4 (6)**	**50.4 (2)**	3.2	**26.2 (2)**	**26.2 (2)**
R4	1.9	48.0	46.0	0.9	23.7	23.7
R5	0.9	48.1	46.1	0.5	23.7	23.7
R6	5.0	49.6	47.0	2.1	24.3	24.3
R7	1.1	47.8	45.8	0.5	23.7	23.7
R8	1.1	47.7	44.7	0.5	23.2	23.2
C1	3.4	49.5	47.1	1.4	24.0	24.0
AR1	1.9	49.2	46.9	1.0	24.0	24.0

The highest predicted project increment for 24-hour average PM_{10} is 9.1 µg/m^3, at assessment location R3. The next highest predicted project increment (5.0 µg/m^3) occurs at assessment location R6. The highest predicted project increment for 24-hour average $PM_{2.5}$ is 3.2 µg/m^3, at assessment location R3. The next highest predicted project increment (2.1 µg/m^3) occurs at R6.

The cumulative daily-varying 24-hour average results at each receptor are derived as follows:

- Cumulative Scenario 1: The 2017 Bringelly daily monitoring data is combined with the maximum predicted 24-hour average concentration from the construction of WSA, added to every day of the background dataset. The project-only predicted increment for each day is then added to this background plus WSA contribution and then combined with the predicted increment for the Luddenham Quarry on the same day;

- Cumulative Scenario 2: The 2017 Bringelly daily monitoring data is combined with the maximum predicted 24-hour average concentration from the operational phase of WSA, added to every day of the background dataset. The project-only predicted increment for each day is then combined with this background plus WSA contribution.

As described in in Section 4, there are six existing exceedances of the daily PM_{10} criterion in the 2017 background dataset. With the additional contribution from the construction and operation of the WSA, there are another two exceedances of the daily PM_{10} criterion (total of eight existing exceedances across all receptors assumed for background). Therefore, for PM_{10}, the 9th highest cumulative concentrations are presented.

As shown in Table 6.2, for 24-hour PM_{10} concentrations, there are additional days over the impact assessment criterion for Scenario 1 and 2 at R3 (6 additional days and 2 additional days respectively). The contribution of each component to cumulative 24-hour average concentrations for each exceedance day is presented in Figure 6.1. It is clear from Figure 6.1 that background (plus WSA) contributes most to each daily exceedance (6 days for Scenario 1 and 2 days for Scenario 2). It is also evident that on a number of days the exceedance is negligible and based on the conservative assumptions used in the modelling, these would be unlikely to eventuate.

For $PM_{2.5}$, there are two existing exceedances of the daily $PM_{2.5}$ criterion in the 2017 background dataset. With the additional contribution from the construction and operational phase of the WSA, no additional exceedances would occur. Therefore, the third highest cumulative concentrations are presented for 24-hour average $PM_{2.5}$ for both scenarios. There are two additional days over the impact assessment criterion for both scenarios at R3.

The contribution of each component to cumulative 24-hour average concentrations for each exceedance day is presented in Figure 6.2. It is clear from Figure 6.2 that background (plus WSA) contributes most to each daily exceedance and that each exceedance is marginal.

The most effective way to control potential exceedances will be to control wheel generated dust from trucks entering and exiting the site, which is the largest contributing source. This will be achieved though the installation of a wheel wash (which has not been incorporated into emission reduction measures for modelling) and through deployment of a street sweeper twice a day. Both measures will act to reduce the silt loading of the road surface and will significantly reduce dust emissions from truck movements.

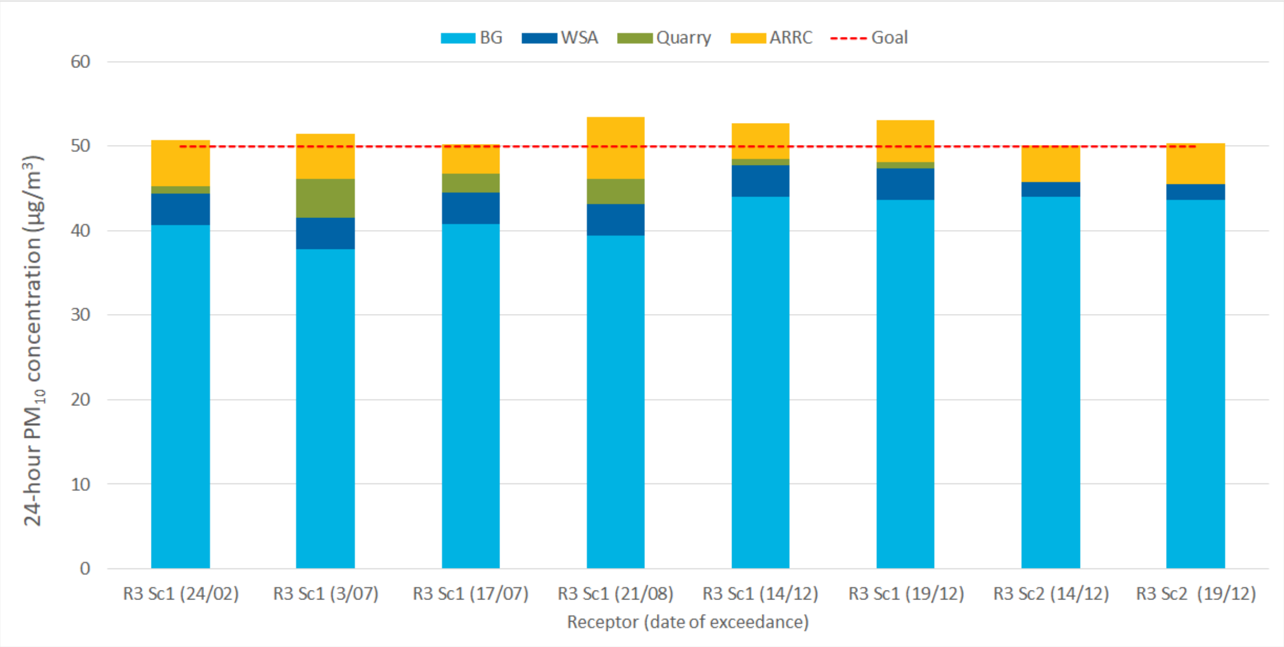

Figure 6.1 **Contribution to exceedances for cumulative 24-hour PM_{10} concentration at R3**

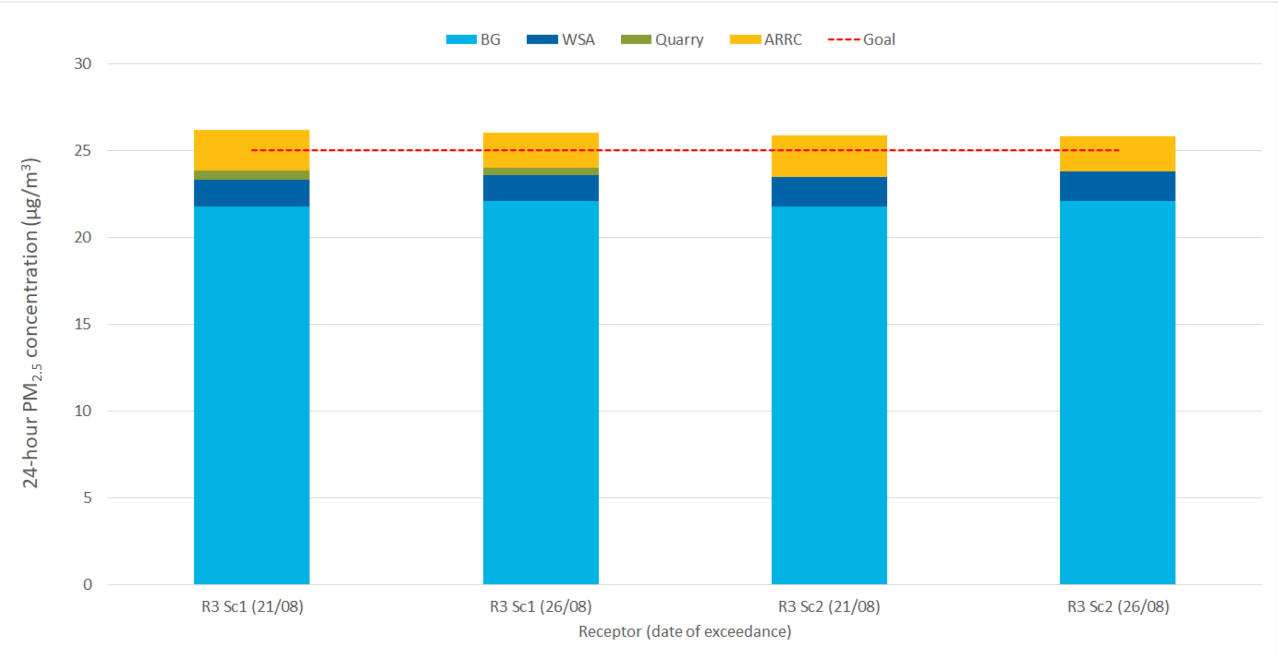

Figure 6.2 **Contribution to exceedances for cumulative 24-hour $PM_{2.5}$ concentration at R3**

6.4 Annual average TSP and dust deposition

The predicted project increment and cumulative annual average TSP concentrations and dust deposition levels are presented in Table 6.3. Exceedances of the impact assessment criteria are shown in bold.

Table 6.3 Predicted incremental and cumulative TSP concentrations and dust deposition levels

	TSP (µg/m³)			Dust deposition (g/m²/month)		
	Increment	Cumulative Scenario 1 (Construction of WSA + Luddenham Quarry)	Cumulative Scenario 2 (Operation of WSA only)	Increment	Cumulative Scenario 1 (Construction of WSA + Luddenham Quarry)	Cumulative Scenario 2 (Operation of WSA only)
Goal	90 µg/m³			2 g/m²/m	4 g/m²/month	
R1	0.5	51.2	50.2	0.03	1.7	1.6
R2	1.1	52.9	50.8	0.06	1.7	1.6
R3	16.7	**92.5**	66.4	0.8	2.4	1.7
R4	0.5	51.1	50.2	0.02	1.6	1.6
R5	0.3	50.7	50.0	0.01	1.6	1.6
R6	3.9	61.2	53.6	0.2	1.8	1.6
R7	0.2	50.2	49.9	0.01	1.6	1.6
R8	0.3	50.5	50.0	0.01	1.6	1.6
C1	1.7	54.9	51.4	0.07	1.7	1.6
AR1	1.1	53.1	50.8	0.05	1.6	1.6

The highest predicted project increment for annual average TSP is 16.7 µg/m³, at assessment location R3. The highest predicted project increment for annual average dust deposition (0.8 g/m²/month at R3) is below the incremental impact assessment criterion of 2 g/m2/month.

For cumulative scenario 1, there is an exceedance of the impact assessment criterion for annual average TSP at R3 (92.5 µg/m³). There are no exceedances of the cumulative impact assessment criterion of 4 g/m²/month for dust deposition.

Contour plots for the predicted project only annual average TSP concentrations and dust deposition levels are presented in Appendix D.

6.5 Modelling predictions for future airport receptors

Modelling results are also presented for future receptors associated with the Western Sydney Airport. Three discrete receptor points are placed at the future terminal area, runway area, fuel farm area and airport infrastructure area, and modelling predictions are presented in Table 6.4 for Scenario 2 only (as the Quarry would not operate concurrently with airport operations). The modelling results indicate that there would be no exceedances of the impact assessment criteria at the airport terminal, runway, fuel farm or infrastructure areas.

Table 6.4 Incremental and cumulative modelling predictions for airport receptors – Scenario 2

	24-hour PM_{10} (µg/m³)		Annual PM_{10} (µg/m³)		24-hour $PM_{2.5}$ (µg/m³)		Annual $PM_{2.5}$ (µg/m³)		Annual TSP (µg/m³)		Annual dust deposition (g/m²/month)	
	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
Terminal R1	1.1	45.8	0.04	18.9	0.7	23.8	0.02	7.5	0.1	49.8	0.06	1.6
Terminal R2	0.8	45.8	0.04	18.9	0.4	23.8	0.02	7.5	0.1	49.8	0.05	1.6
Terminal R3	0.8	45.8	0.05	19.0	0.3	23.9	0.03	7.5	0.2	49.9	0.08	1.6
Runway R1	1.3	45.8	0.06	19.0	0.6	23.8	0.03	7.5	0.2	49.9	0.12	1.6
Runway R2	1.3	45.9	0.12	19.0	0.7	23.8	0.06	7.6	0.4	50.1	0.19	1.6
Runway R3	1.4	45.8	0.13	19.0	0.8	23.9	0.07	7.6	0.4	50.1	0.18	1.6
Fuel farm R1	1.9	45.9	0.33	19.2	0.8	24.2	0.14	7.6	1.3	51.0	0.60	1.7
Fuel farm R2	2.8	45.9	0.42	19.3	1.4	24.2	0.19	7.7	1.5	51.2	0.75	1.7
Fuel farm R3	3.0	45.9	0.32	19.2	1.4	24.0	0.16	7.7	1.1	50.8	0.52	1.6
Infrastructure R1	0.4	45.8	0.03	18.9	0.2	23.8	0.01	7.5	0.1	49.8	0.04	1.6
Infrastructure R2	0.5	45.8	0.04	18.9	0.4	23.8	0.02	7.5	0.1	49.8	0.06	1.6
Infrastructure R3	0.4	45.8	0.03	18.9	0.2	23.8	0.02	7.5	0.1	49.8	0.05	1.6

7 Dust management and monitoring

7.1 Best management practice

The proposed dust controls for the site were incorporated into the emission inventory developed for this assessment, as follows:

- the access road and roads around the ARRC will be sealed;
- a water cart will operate on the sealed access road;
- all material handling, processing and storage will be within the enclosed warehouse;
- water sprays would be applied directly to the crusher and screens; and
- misting water sprays to operate at each exit point of the warehouse.

Other control measures not explicitly applied as a reduction factor in the emission inventory include:

- double handling of material will be avoided wherever possible;
- vehicle speed limits (40 kph on sealed roads) will be applied;
- wheel wash/cattle grid before exit; and
- a street sweeper will be used on the access roads when silt levels accumulate or as required.

These dust controls will be formally documented in an air quality management plan, prepared following approval of the ARRC, and are expected to be effective for eliminating potential exceedances of the impact assessment criteria at adjacent receptors. To demonstrate that the site would operate in accordance with best practice, a Best Management Practice (BMP) Determination is made with reference to best practice dust measures outlined in:

- Sustainability Victoria's *Guide to Best Practice at Resource Recovery Centres* (Sustainability Victoria 2009); and
- NSW EPA guidance document Environmental Guidelines: Solid Waste Landfills, Second edition 2016 (NSW EPA 2016).

The results of the BMP determination is presented in Table 7.1 and Table 7.2. It can be seen that, wherever applicable, the dust-control methods in place at the site are consistent with documented best practice dust control measures for the resource recovery and waste industry.

Table 7.1 Comparison of site dust-control measures with Sustainability Victoria *Guide to Best Practice at Resource Recovery Centres*

Dust-control method (Sustainability Victoria 2009)	Measure implemented at site
Minimise the area of exposed soils	Yes – all material storage, including soils, will be within the warehouse building and the remainder of the site will be concrete hardstand. There are therefore no exposed soils onsite.
Stabilise exposed areas (eg through revegetation) and stockpiles of dusty materials as soon as practicable	N/A – all stockpile storage will be within the warehouse building and the remainder of the site will be concrete hardstand.
Revegetate completed areas as soon as practicable	N/A - there will be no exposed soils onsite.
Water sprinklers at crushing/screening plant	Yes – water sprays will operate on the crusher and screens.
Paving of all operating, storage, unloading and loading areas	Yes – all storage and handling will be within the warehouse building and the remainder of the site will be concrete hardstand.
Sealing of roads if dust is considered likely to be an issue	Yes – all access roads will be sealed.
Minimising areas of exposed earth through suitable landscaping	N/A - there will be no exposed soils onsite.
Utilising dust suppressants (eg light water spray)	Yes – a misting system will operate at each exit of the warehouse building.
Installing windbreaks to prevent particulates becoming airborne	Yes – all stockpile storage will be within the warehouse building.
Regular cleaning/sweeping of paved surfaces	Yes – a street sweeper will operate when silt builds up on the access roads/paved surfaces.

Note: N/A – not applicable

Table 7.2 Comparison of site dust-control measures with NSW EPA *Environmental Guidelines: Solid Waste Landfills, Second edition 2016*

Dust-control method (NSW EPA 2016)	Measure implemented at site
Minimise the area of exposed soils	Yes – all material storage, including soils, will be within the warehouse building and the remainder of the site will be concrete hardstand. There are therefore no exposed soils onsite.
Stabilise exposed areas (eg through revegetation) and stockpiles of dusty materials as soon as practicable	N/A – all stockpile storage will be within the warehouse building and the remainder of the site will be concrete hardstand.
Revegetate completed areas as soon as practicable	N/A - there will be no exposed soils onsite.
Use sealed or gravel roads, particularly from the public roadway to the gatehouse or waste reception section of the landfill	Yes – all access roads will be sealed.
Reduce drop heights, where applicable	Yes – material drop heights during truck unloading and loading operations will minimised as much as practicable.
Spray water for dust suppression, particularly over exposed surfaces, at key material transfer points, and on unsealed haul roads to minimise wheel-generated dust	Yes – a misting system will operate at each exit of the warehouse building.
Appropriately modify excavation works and operations on dry, windy days or when the wind is blowing towards sensitive receptors	N/A – all storage and handling will be within the warehouse building and therefore unaffected by windy days. Additional watering of the access road will be used on windy days.
Enforce speed limits to minimise wheel-generated dust	Yes – the site will enforce a speed limit.
Cover loads of dusty material transported by road in open-topped trucks	Yes – all in-coming and out-going truck loads will be covered.
Minimise dirt tracked from the site to external roads; measures include visual inspection of trucks leaving the site, use of wheel-wash and shaker grids, and construction of sealed haul roads	Yes – a wheelwash/shaker grid will be installed.
Install wind barriers and enclosures (where practicable) to deflect wind from erodible areas and to minimise exposure of falling dusty materials to winds	Yes – all storage and handling will be within the warehouse building.

Note: N/A – not applicable

7.2 Monitoring

An *Air Quality Monitoring Programme* was developed in 2009 for the operation of the quarry (Golder 2009) and will be reviewed and augmented following approval for the reactivation of the quarry. It is anticipated that if the ARRC is also approved, a combined or complementary Air Quality Management Plan can be developed for the site, whereby an air quality monitoring programme is shared for the operation of the quarry and ARRC.

The combined Air Quality Management Plan would outline the monitoring requirements, including equipment type, locations, frequency and duration.

Development of a combined Air Quality Management Plan for both the quarry and ARRC site would enable management of operations across the entire site and allocation of the appropriate additional controls to the most relevant area of the site.

The existing quarry monitoring programme, comprising four dust deposition gauges, would also continue (existing locations will be reviewed based on the revised quarry plan if the reactivation is approved).

In addition, daily visual monitoring of activities would be undertaken to monitor the effectiveness of dust controls and allow for reactive and corrective measures to be implemented. The inspections will focus on the following key issues:

- inspect the sealed roads for high silt loading and clean surface using water cart/street sweeper if required;
- inspect and report on water cart activity and effectiveness; and
- inspect and report on dust leaving the warehouse building and effectiveness of water misting sprays at exit points.

8 Greenhouse gas assessment

8.1 Introduction

The estimation of GHG emissions for the project was based on the Commonwealth Department of the Environment and Energy (DoEE) National Greenhouse Accounts Factors (NGAF) workbook (DoEE 2019). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoEE 2019). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

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

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 project. GHG emissions from the project are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1, 2 and 3 emission factors for diesel and electricity use in NSW.

Table 8.1 Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel) by onsite plant and equipment	Indirect emissions associated with the consumption of purchased electricity	Indirect upstream emissions from the extraction, production and transport of diesel and from electricity lost in delivery in the transmission and distribution network

8.3 Activity data

The estimated diesel consumption is derived based on the proposed equipment, estimated utilisation and published fuel consumption for similar equipment (see Table 8.2). The electricity consumption for the ARRC has been estimated based on the electricity consumption from a similar facility at Camellia, which has an average daily consumption of 405 kWh, scaled according to the relative annual throughput for the ARRC.

Table 8.2 Estimated diesel consumption

Equipment	Number in operation	Load factor[1]	Utilisation factor	Fuel consumption (L/hour)[2]	Fuel consumption (L/annum)
Loader	2	0.6	80%	15	126,144
14-t Excavator	2	0.6	80%	10	84,096
30-t excavator	1	0.6	80%	20	84,096
Sweeper	1	0.6	80%	2	8,410
Water cart	1	0.6	80%	2	8,410
Total					**311,155**

Note:[1] Based on commercial off-road vehicles load factors for excavators, loaders, other construction equipment (NSW EPA 2012)
Note:[2] Indictive fuel consumption rates taken from the Caterpillar Performance Handbook for medium activity (ie light industrial/construction activity) and is equivalent to load factors of between 30%-60%.

8.4 Emission estimates

The estimated annual GHG emissions for each emission source are presented in Table 8.3. The significance of project GHG emissions relative to state and national GHG emissions is made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (AEGIS (2015) for calendar year 2017) for NSW (128,870 kt CO_2-e) and Australia (530,841 kt CO_2-e). Annual average GHG emissions (Scope 1 and 2) generated by the project represent approximately 0.001% of total GHG emissions for NSW and 0.0003% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

Table 8.3 Estimated annual GHG emissions

Scope 1 (t CO_2-e/year)	Scope 2 (t CO_2-e/year)	Scope 3 (t CO_2-e/year)	
Diesel	**Electricity**	**Diesel**	**Electricity**
843	575	43	13

8.5 Emission management

GHG emissions from the project are principally associated with on-site energy consumption, specifically diesel combustion and consumption of purchased electricity. Measures and practices designed to improve energy efficiency, will assist with the management of project GHG emissions, for example:

- regular maintenance of plant and equipment to minimise fuel consumption;
- efficient site operations planning (eg minimising rehandling and haulage of material) to minimise fuel consumption; and
- consideration of energy efficiency in the plant equipment selection phase.

Opportunities to improve energy efficiency will be investigated on an ongoing basis throughout the life of the project.

9 Conclusion

The air quality impacts of the ARRC proposal were assessed with atmospheric dispersion modelling, using the regulatory dispersion model AERMOD. Predicted project increment and cumulative GLCs for key pollutants were presented for each assessment location and compared against the NSW EPA's impact assessment criteria. To determine compliance with impact assessment criteria, consideration of cumulative impact is required to assess how the project will interact with existing and future sources of emissions. Two potential cumulative scenarios are were assessed:

- Scenario 1 – concurrent operation of the ARRC with the Luddenham Quarry and construction phase of the WSA for approximately 3-4 years (from ~2022 to 2025); and
- Scenario 2 – concurrent operation of the ARRC with the operation of the WSA, from the completion of quarry rehabilitation.

It is noted that the quarry will be rehabilitated (filled) following the completion of quarrying, however this would be subject to separate development consent and is not explicitly modelled in this assessment. Subject to approval, this will include filling the quarry void will with unrecyclable material from the ARRC. The details of filling the void are not yet known, however, the equipment required, and the intensity of the activity are expected to be less than the quarry operations. Therefore, Scenario 1 can be taken to be representative of a cumulative scenario up to completion of quarry rehabilitation, noting that there will be a lower cumulative contribution from WSA, as it moves from construction to operational phase. Modelling results are summarised as follows:

- annual average PM_{10} - there are no exceedance of the impact assessment criterion at any receptor;
- 24-hour average PM_{10} - at receptor R3, there are 6 additional days over the impact assessment criterion for Scenario 1 and two additional days over the impact assessment criterion for Scenario 2;
- annual average $PM_{2.5}$ - for both cumulative assessment scenarios, there is an exceedance of the impact assessment criterion at R3, while for scenario 1 only, there is an exceedance of the impact assessment criterion at R6, primarily due to the high background concentrations;
- 24-hour average $PM_{2.5}$ - there are two additional days over the impact assessment criterion for both scenarios at R3 only;
- annual average TSP – for scenario 1, there is an exceedance of the impact assessment criterion at R3; and
- annual average dust deposition - there are no exceedances of the impact assessment for dust deposition and nuisance dust impacts will be contained within the site boundary (ie no impact to airport operations).

The most effective way to control potential exceedances will be to control wheel generated dust from trucks entering and exiting the site, which is the largest contributing source. This will be achieved though the installation of a wheel wash (which has not been incorporated into emission reduction measures for modelling) and through deployment of a street sweeper twice a day. Both measures will act to reduce the silt loading of the road surface and will significantly reduce dust emissions from truck movements. The risk of exceedance is significantly higher during Scenario 1 (the concurrent construction phase of the WSA and operation of the quarry), which is expected to relatively short-lived (ie limited to the first 3–4 years of operation of the ARRC). It is noted that the quarry will be rehabilitated (filled) following the completion of quarrying, however the intensity of this activity is expected to be less than the quarry operations and impacts are expected to the lower than during these first 3–4 years.

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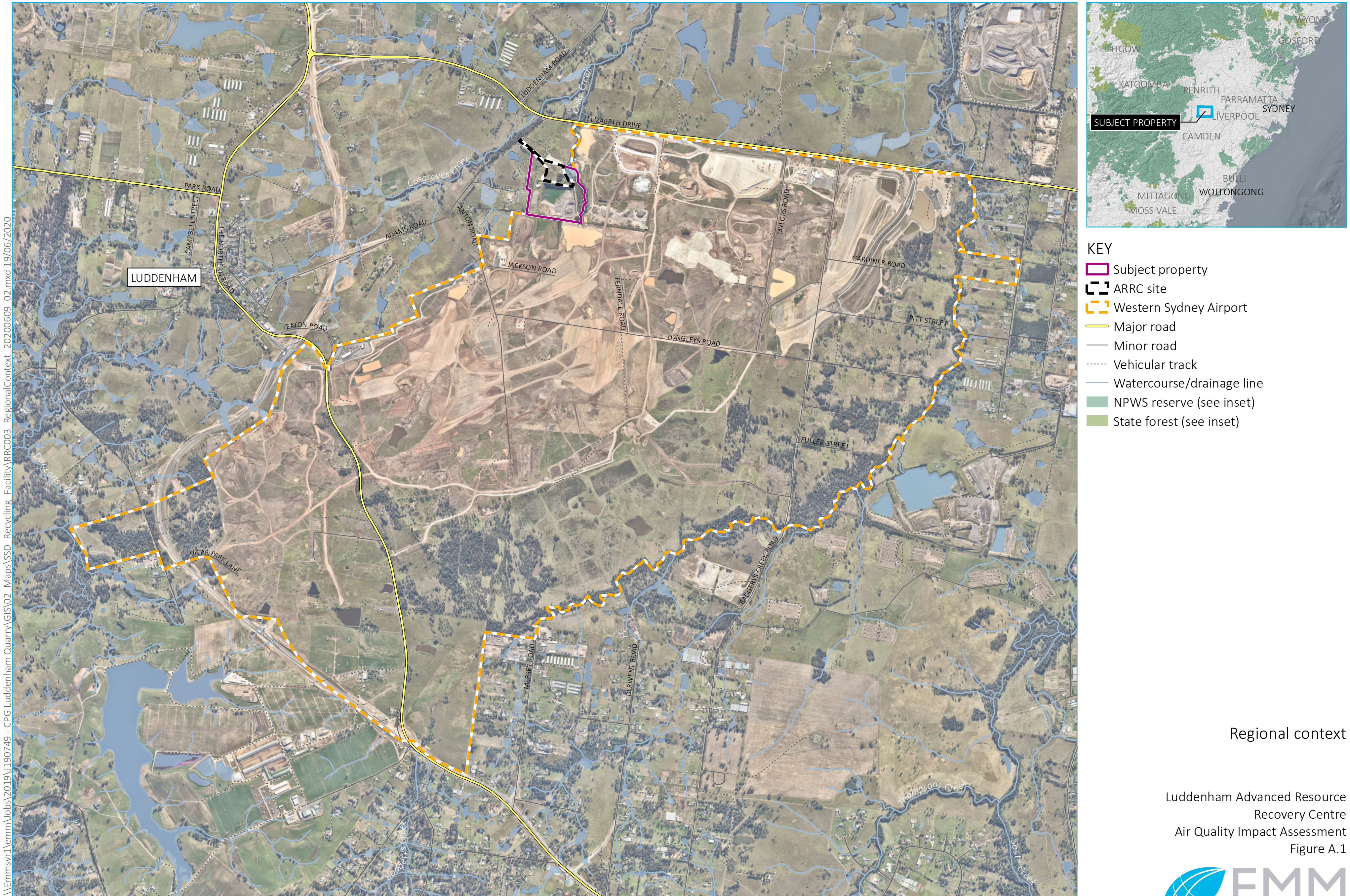
Abbreviations

Approved Methods for Modelling	*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
AQS	Air quality station
ARRC	Advanced resource recovery centre
AWS	Automatic weather station
BoM	Bureau of Meteorology
CO	Carbon monoxide
CO_2-e	Carbon dioxide equivalent
CPG	Coombes Property Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoEE	Department of the Environment and Energy
DPIE	Department of Planning, Industry and Environment
EMM	EMM Consulting Pty Ltd
EPA	Environment Protection Authority
FEL	Front end loader
GHG	Greenhouse gas
GLC	Ground level concentrations
KLF	KLF Holdings Pty Ltd
kWh	Kilo watt hour
NGAF	National Greenhouse Accounts Factors
NOx	Oxides of nitrogen
PM	Particulate matter
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
SO_2	Sulphur dioxide
TAPM	The Air Pollution Model
The site	275 Adams Road, Luddenham NSW
TSP	Total suspended particulates

US-EPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
WSA	Western Sydney Airport

Appendix A

Figures



KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- NPWS reserve (see inset)
- State forest (see inset)

Source: EMM (2020); DFSI (2017); Nearmap (2020)

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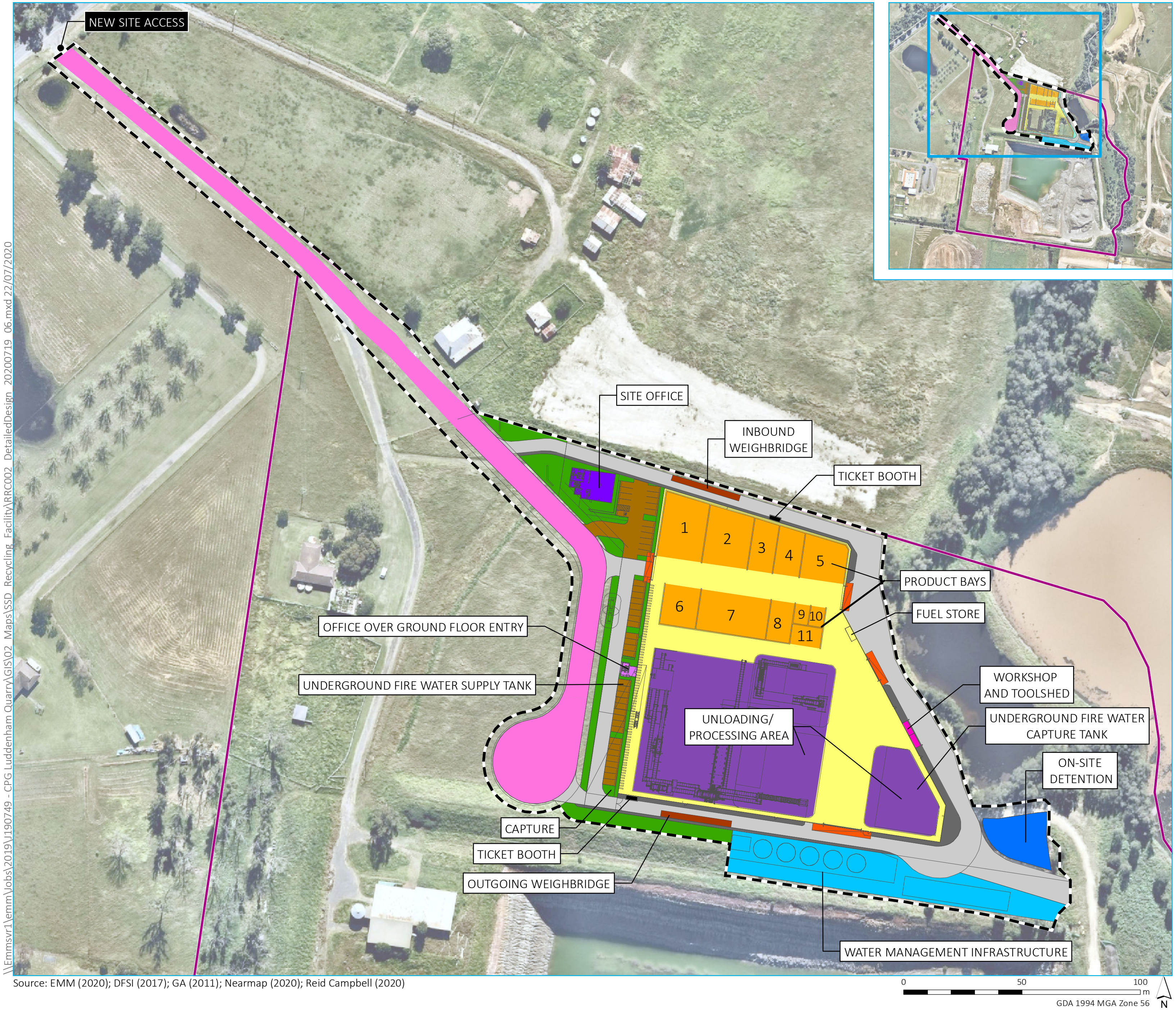
Regional context

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure A.1

EMM
creating opportunities



KEY

- Subject property
- ARRC site
- Indicative detailed layout

Proposed element

- Awning
- Carpark
- Hardstand
- ARRC access road
- Kerb/pedestrian area
- Landscaping
- Office over ground floor
- On-site detention
- ARRC warehouse
- Product bay
- Site office
- Ticketbooth
- Tool shed, workshop
- Unloading/processing
- Water management infrastructure, including treatment plant and storage
- Weighbridge

Product bays

1. Concrete/ rubble masonry
2. Clean timber
3. Rigid plastics
4. Paper/cardboard/film
5. Stumps/asphalt/metal
6. Heavy residual
7. Fines screened
8. Soil audit
9. Ferrous
10. Non-ferrous
11. Non-recyclables

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Reid Campbell (2020)

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Project overview

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Statement
Figure A.2

EMM
creating opportunities


Appendix B

Analysis of meteorology




B.1 Summary plot

Note: stlp = station level pressure and slp = sea level pressure. SigT = standard deviation of wind direction (sigma theta)

Figure B.1 Summary plot showing data availability for Badgerys Creek AWS – 2013–2018

B.2 Wind roses

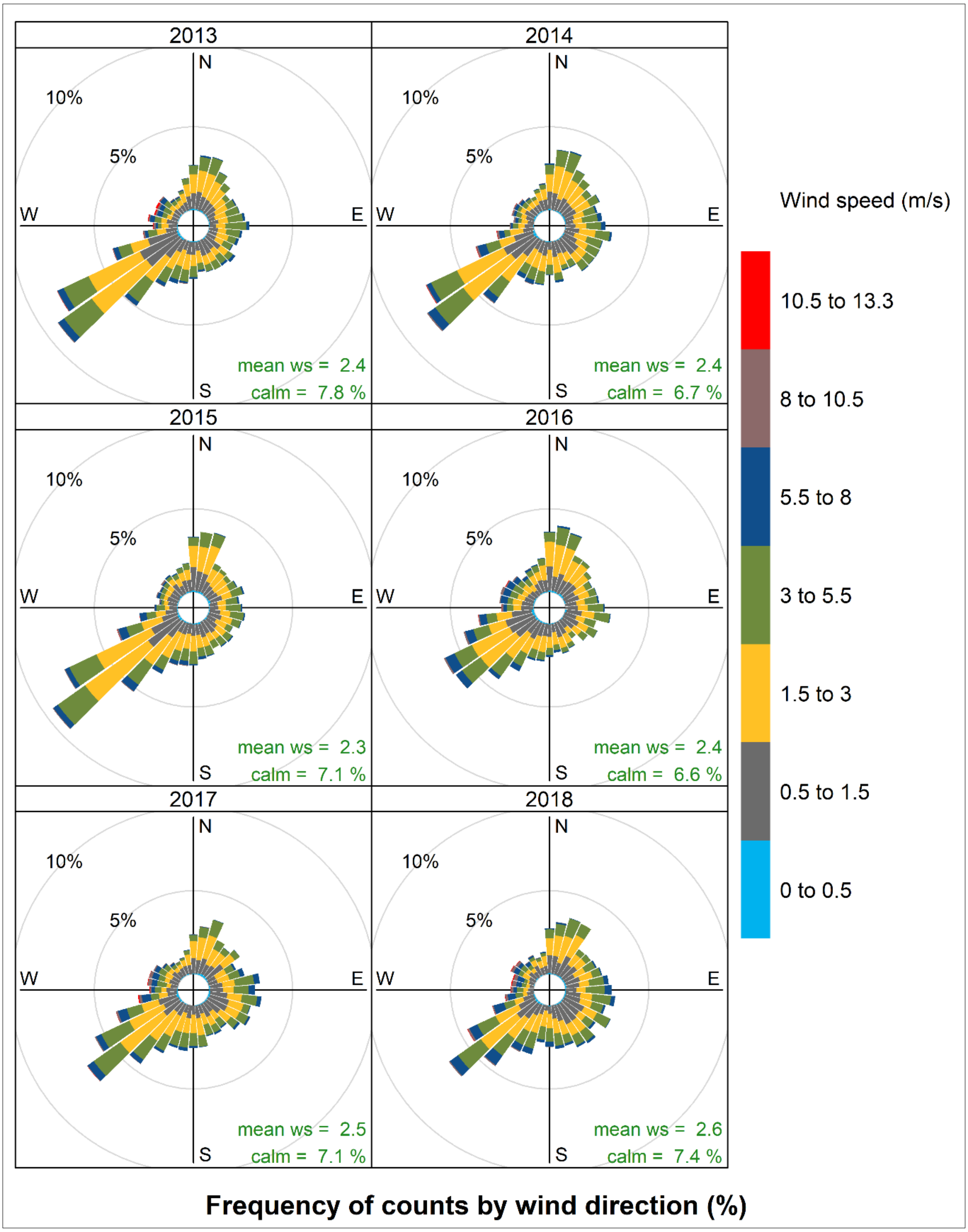


Figure B.2 Interannual wind roses for Badgerys Creek AWS – 2013–2018

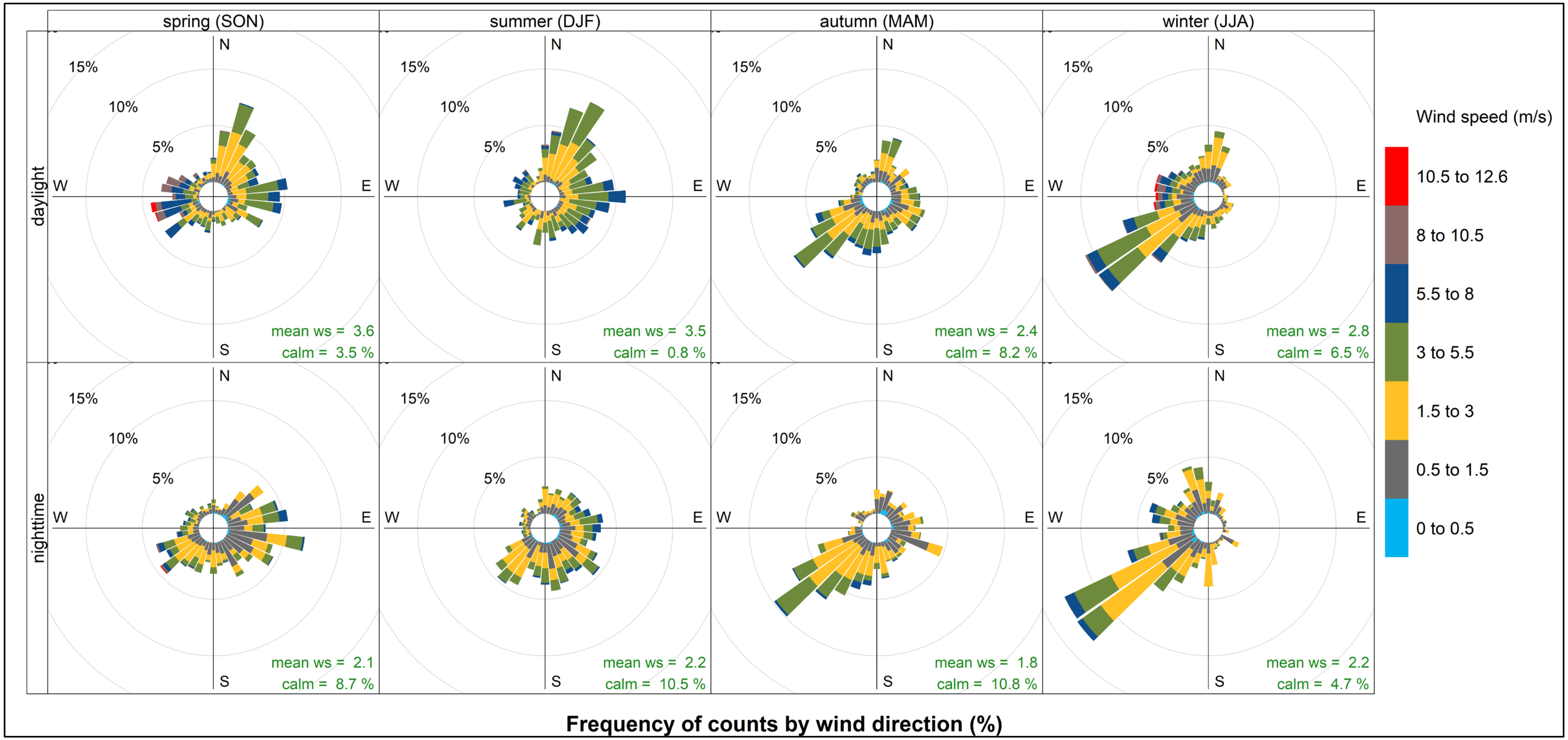


Figure B.3 Seasonal wind roses for Badgerys Creek AWS – 2017

B.3 Ambient temperature

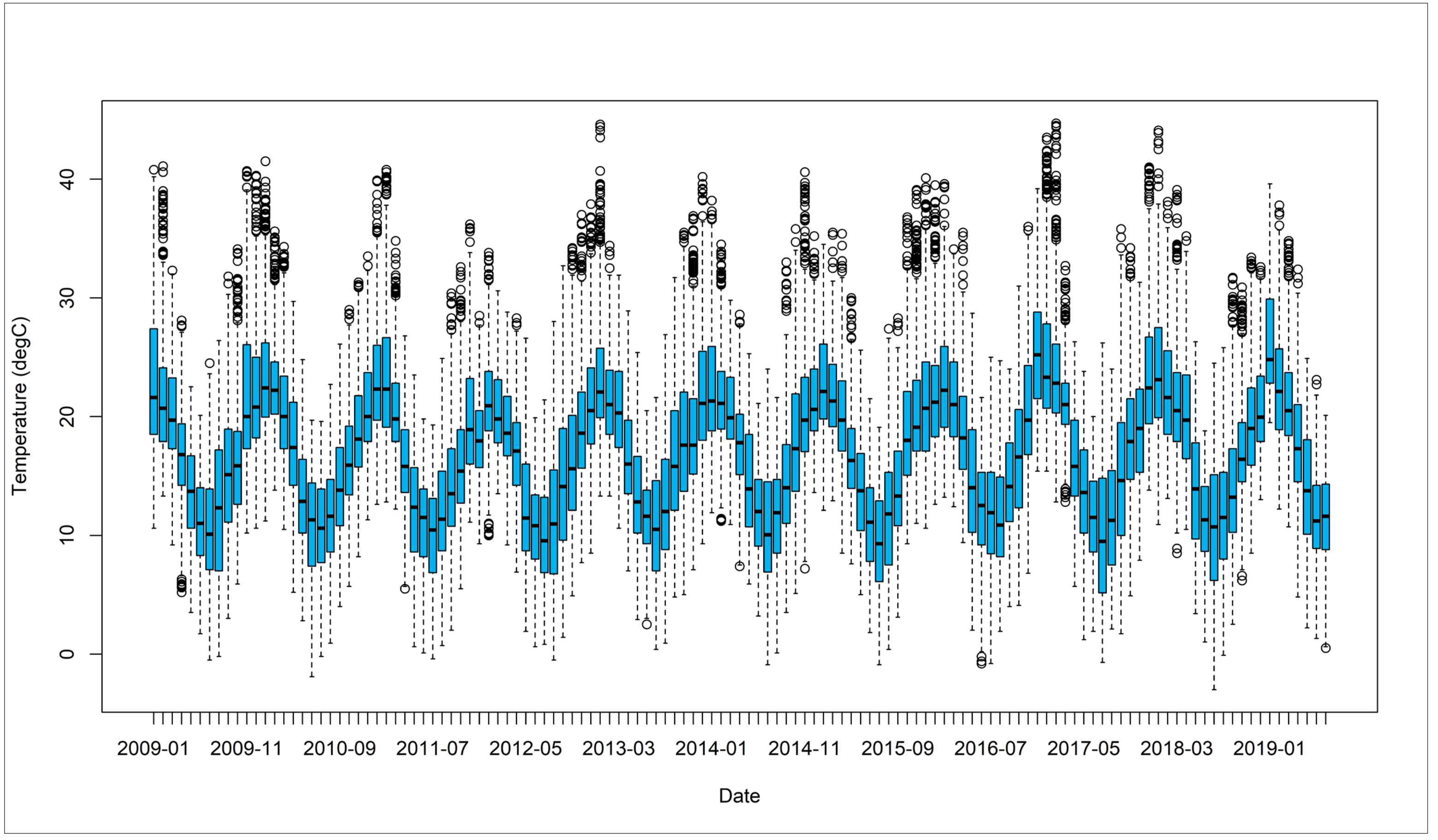


Figure B.4 Interannual variation in monthly temperature for Badgerys Creek AWS – 2009–2019

B.4 TAPM modelling

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

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

- TAPM version 4.0.5;
- Grid domains with cell resolutions of 30 km, 10 km, 3 km and 1 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; and
- TAPM defaults for advanced meteorological inputs.

B.5 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.

B.5.1 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; and
- Bowen ratio.

As detailed by US-EPA (2013), the surface roughness length is related to the height of obstacles to the wind flow (eg 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 project was mapped (see Figure B.5). Using the AERSURFACE tool and following the associated guidance of US-EPA (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 US-EPA (2013).

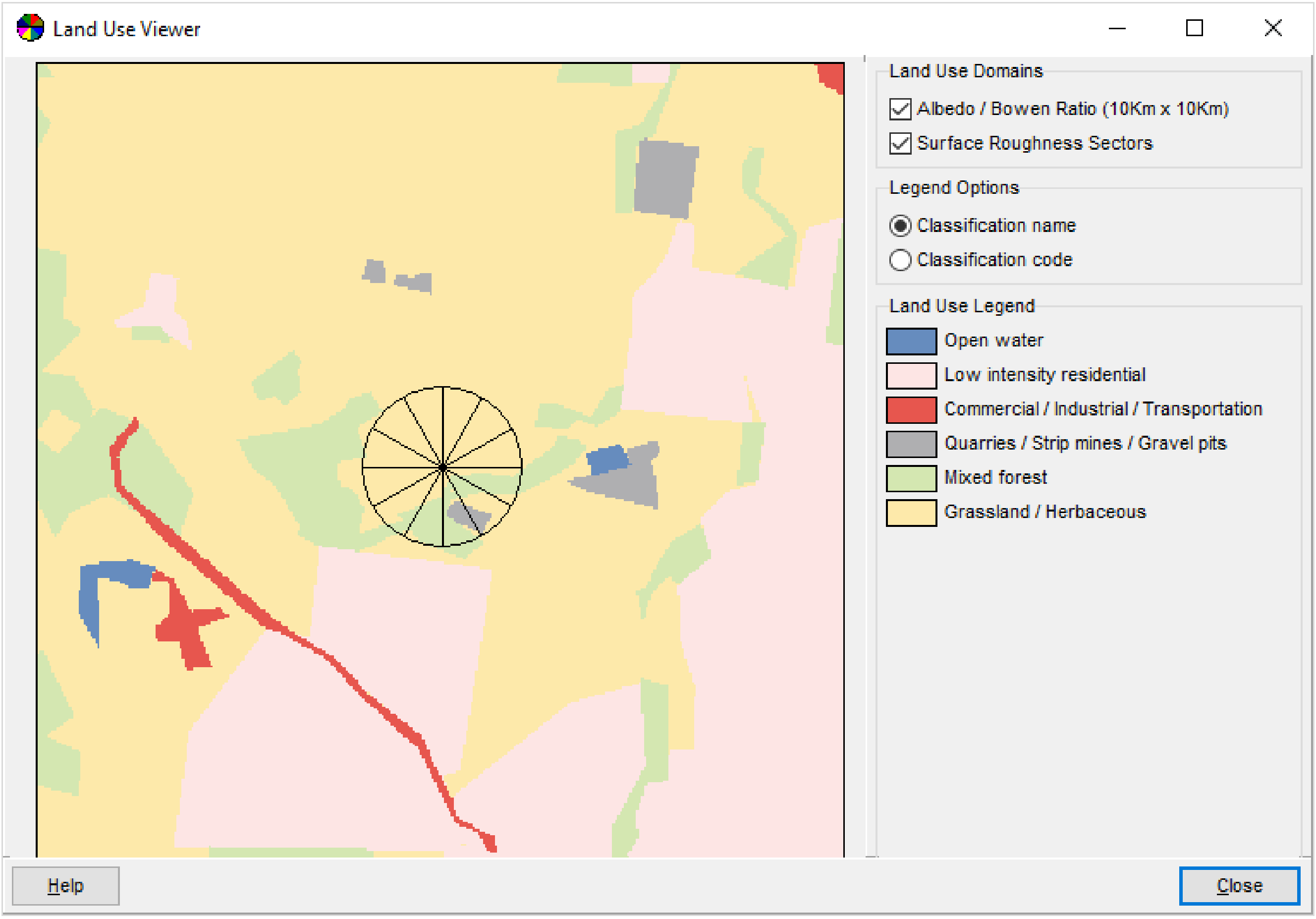


Figure B.5 Land use map for AERSURFACE processing

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)

B.5.2 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 direction – Badgerys Creek AWS;
- temperature (heights of 2 m and 10 m) – Badgerys Creek AWS;
- relative humidity – Badgerys Creek AWS;
- station level pressure – Badgerys Creek AWS;
- solar insolation – Bringelly DPIE station; and
- mixing depth – TAPM at on-site station.

The period of meteorological data input to AERMET was 1 January 2017 to 31 December 2017.

B.5.3 Upper air profile

Due to the absence of necessary local upper air meteorological measurements, the hourly profile file 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 C

Emissions inventory




C.1 Particulate matter emissions inventory

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

- *NPI Emission Estimation Technique Manual for Mining* (NPI 2012);
- AP-42 Chapter 11.9 – Western Surface Coal Mining (US-EPA 1998);
- AP-42 Chapter 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing (US-EPA 2004);
- AP-42 Chapter 13.2.1 – Paved Roads (US-EPA 2011); and
- AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles (US-EPA 2006).

Particulate releases were quantified for TSP, PM_{10} and $PM_{2.5}$ are shown in Table C.2.

C.2 Diesel combustion emissions

Diesel combustion emissions were calculated based on an estimated annual diesel consumption of 311 kL/annum and US EPA emission factors for off-road diesel equipment (Tier 2 for engines between 75-130 kW. The estimated diesel consumption is derived based on the proposed equipment, estimated utilisation and published fuel consumption for similar equipment (see Table C.1).

Table C.1 Estimated annual diesel consumption

Equipment	Number in operation	Load factor[5]	Utilisation factor	Fuel consumption (l/hour)[6]	Fuel consumption (l/annum)
Loader	2	0.6	80%	15	126,144
14 t Excavator	2	0.6	80%	10	84,096
30t excavator	1	0.6	80%	20	84,096
Sweeper	1	0.6	80%	2	8,410
Water cart	1	0.6	80%	2	8,410
Total					**311,155**

5 Based on reported load factors of commercial off-road diesel equipment in NSW EPA (2012).

6 Based on published fuel consumption in the Holt Cat handbook

Table C.2 TSP emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Haulage																	
Waste trucks in	2,028	58,636	VKT/y	0.12	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Waste trucks out	744	68,182	VKT/y	0.04	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.500	km/trip	1.8	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks in	880	7,701	VKT/y	0.38	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.430	km/trip	18	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks out	1,771	5,910	VKT/y	1.00	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.330	km/trip	46	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Material handling and processing in shed																	
Internal haul - waste trucks	1,014.0	58,636	VKT/y	0.1153	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Internal haul - product trucks	511.4	8,955	VKT/y	0.3807	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.500	km/trip	18	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Trucks unloading waste in warehouse	36.7	600,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Excavator sorting / picking	36.7	600,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Non-recyclable material - rehandle	3.7	60,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Recyclable material - conveyor/transfer	165.2	540,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3	5	transfer points					85	Enclosure and water sprays
Recyclable material - screening	89.1	540,000	t/y	0.0043	kg/t											85	Enclosure and water sprays
Recyclable material - rehandle	33.0	540,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays

Table C.2 TSP emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Crushing concrete/masonry	12.2	135,000	t/y	0.0125	kg/t											85	Enclosure and water sprays
Shredding timber	24.3	270,000	t/y	0.0125	kg/t											85	Enclosure and water sprays
Future processing - shredding tyres	1.8	20,000	t/y	0.0125	kg/t											85	Enclosure and water sprays
Future processing - sand screening at wash plant	16.5	100,000	t/y	0.0043	kg/t											85	Enclosure and water sprays
Future processing - rehandle	14.7	120,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3	2	times rehandle					85	Enclosure and water sprays
Rehandle processed material to stockpile bins	24.8	405,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
FEL wheel generated dust	22	7,500	VKT/y	0.0200	kg/VKT	600,000	t/y	4.0	t/load (wt ave)	0.050	km/trip	1.0	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Product - rehandle to truck	36.7	600,000	t/y	0.0004	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Wind erosion (shed)																	
Shed area	11.9	1.4	ha	850	kg/ha/yr											99	Enclosure
Miscellaneous																	
Onsite diesel consumption	308	311	kL/y	0.99	kg/kL												
Total (kg/yr)	**7,786**																

Table C.3 PM_{10} emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Haulage																	
Waste trucks in	389.3	58,636	VKT/yr	0.0221	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Waste trucks out	142.7	68,182	VKT/yr	0.0070	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.500	km/trip	1.8	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks in	168.8	7,701	VKT/yr	0.0731	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.430	km/trip	18.0	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks out	340.0	5,910	VKT/yr	0.1918	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.330	km/trip	46.4	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Material handling and processing in shed																	
Internal haul - waste trucks	15.7	13,636	VKT/yr	0.0221	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Internal haul - product trucks	15.7	1,433	VKT/yr	0.0731	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.500	km/trip	18	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Trucks unloading waste in warehouse	17.4	600,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Excavator sorting / picking	17.4	600,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Non-recyclable material - rehandle	1.7	60,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Recyclable material - conveyor/transfer	16	540,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3	5	transfer points					85	Enclosure and water sprays
Recyclable material - screening	30.0	540,000	t/y	0.0043	kg/t											85	Enclosure and water sprays

Table C.3 PM$_{10}$ emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Recyclable material - rehandle	15.6	540,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Crushing concrete/masonry	5.5	135,000	t/y	0.0012	kg/t											85	Enclosure and water sprays
Shredding timber	10.9	270,000	t/y	0.0012	kg/t											85	Enclosure and water sprays
Future processing - shredding tyres	0.8	20,000	t/y	0.0012	kg/t											85	Enclosure and water sprays
Future processing - sand screening at wash plant	5.6	100,000	t/y	0.0043	kg/t											85	Enclosure and water sprays
Future processing - rehandle	3.5	120,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3	2	times rehandle					85	Enclosure and water sprays
Rehandle processed material to stockpile bins	11.7	405,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
FEL wheel generated dust	4.3	7,500	VKT/annum	0.0038	kg/VKT	600,000	t/y	4.0	t/load (wt ave)	0.050	km/trip	1.0	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Product - rehandle to truck	17	600,000	t/y	0.0002	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Wind erosion (shed)																	
Shed area	6.0	1.4	ha	425	kg/ha/yr											99	enclosure
Miscellaneous																	
Onsite diesel consumption	308	311	kL/yr	0.99	kg/kL												
Total (kg/yr)	**1,573**																

Table C.4 $PM_{2.5}$ emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Haulage																	
Waste trucks in	94.2	58,636	VKT/yr	0.0054	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Waste trucks out	34.5	68,182	VKT/yr	0.0017	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.500	km/trip	1.8	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks in	40.8	7,701	VKT/yr	0.0177	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.430	km/trip	18.0	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Product trucks out	82.3	5,910	VKT/yr	0.0464	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.330	km/trip	46.4	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	70	Water flushing/street sweeping
Material handling and processing in shed																	
Internal haul - waste trucks	11.0	13,636	VKT/yr	0.0054	kg/VKT	600,000	t/y	4.4	t/load (wt ave)	0.430	km/trip	5.6	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Internal haul - product trucks	3.8	1,433	VKT/yr	0.0177	kg/VKT	600,000	t/y	33.5	t/load (wt ave)	0.500	km/trip	18.0	Wt ave vehicle gross mass (t) empty	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Trucks unloading waste in warehouse	2.6	600,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Excavator sorting / picking	2.6	600,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Non-recyclable material - rehandle	0.3	60,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Recyclable material - conveyor/transfer	2.4	540,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3	5	transfer points					85	Enclosure and water sprays
Recyclable material - screening	2.0	540,000	t/y	0.000025	kg/t											85	Enclosure and water sprays

Table C.4 $PM_{2.5}$ emissions inventory

Activity	Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Recyclable material - rehandle	2.4	540,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Crushing concrete/masonry	1.0	135,000	t/y	0.00022	kg/t											85	Enclosure and water sprays
Shredding timber	2.0	270,000	t/y	0.00022	kg/t											85	Enclosure and water sprays
Future processing - shredding tyres	0.2	20,000	t/y	0.00022	kg/t											85	Enclosure and water sprays
Future processing - sand screening at wash plant	0.4	100,000	t/y	0.000025	kg/t											85	Enclosure and water sprays
Future processing - rehandle	0.5	120,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3	2	times rehandle					85	Enclosure and water sprays
Rehandle processed material to stockpile bins	1.8	405,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
FEL wheel generated dust	0.0	7,500	VKT/annum	0.00000	kg/VKT	600,000	t/y	4.0	t/load (wt ave)	0.050	km/trip	1.0	Wt ave vehicle gross mass (t) loaded	7.4	road surface silt loading (g/m2)	85	Enclosure and water sprays
Product - rehandle to truck	2.6	600,000	t/y	0.00003	kg/t	5	mc %	1.2	(ws/2.2)^1.3							85	Enclosure and water sprays
Wind erosion (shed)																	
Shed area	0.9	1.4	ha	64	kg/ha/yr											99	enclosure
Miscellaneous																	
Onsite diesel consumption	299	311	kL/yr	0.96	kg/kL												
Total (kg/yr)	**587**																

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Reid Campbell (2020)

KEY

- Subject property
- ARRC site
- Indicative detailed layout
- Access road for vehicles in and out
- Building entry and exit points

Model source locations

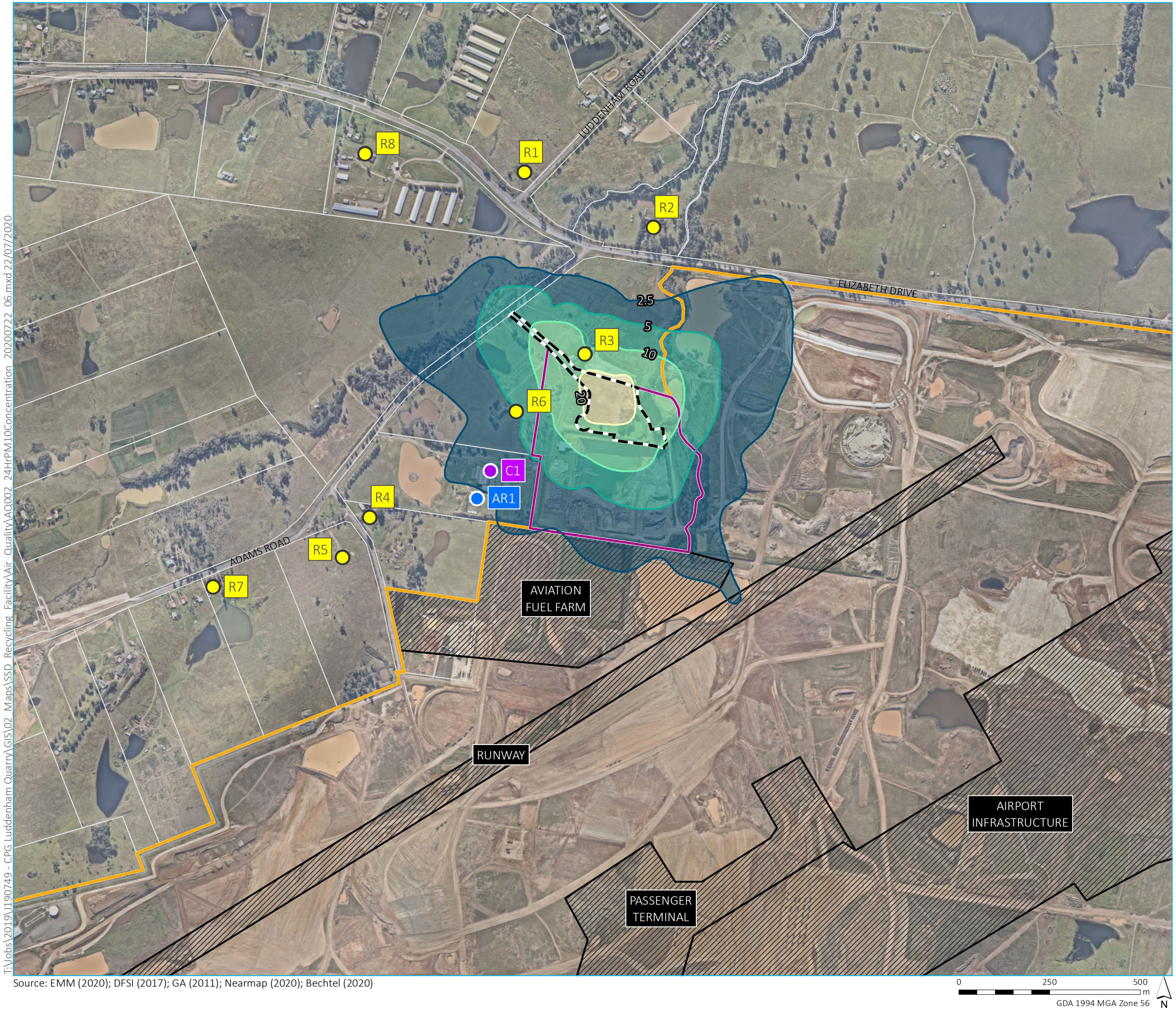
Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure C.1

EMM creating opportunities


Appendix D

Contour plots



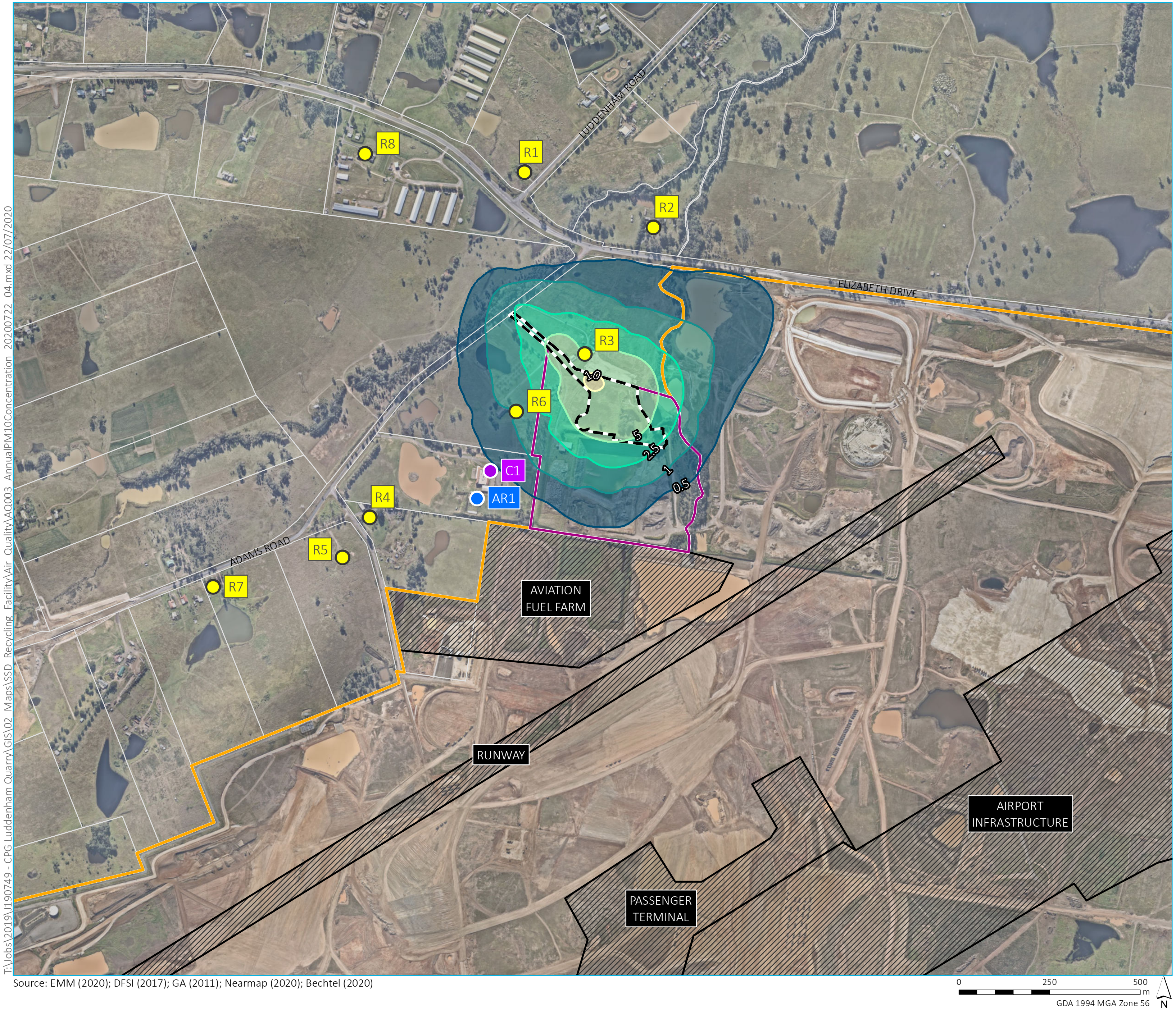
Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ002_24HrPM10Concentration_20200722_06.mxd 22/07/2020

Predicted incremental 24-hour average PM_{10} concentration (µg/m^3)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.1

creating opportunities



KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Western Sydney Airport infrastructure (indicative)
- Cadastral boundary

Assessment location

- Active recreation
- Commercial
- Residential

Annual PM_{10} concentration ($\mu g/m^3$)

- 0.5 - 1
- 1 - 2.5
- 2.5 -5
- 5 - 10
- over 10

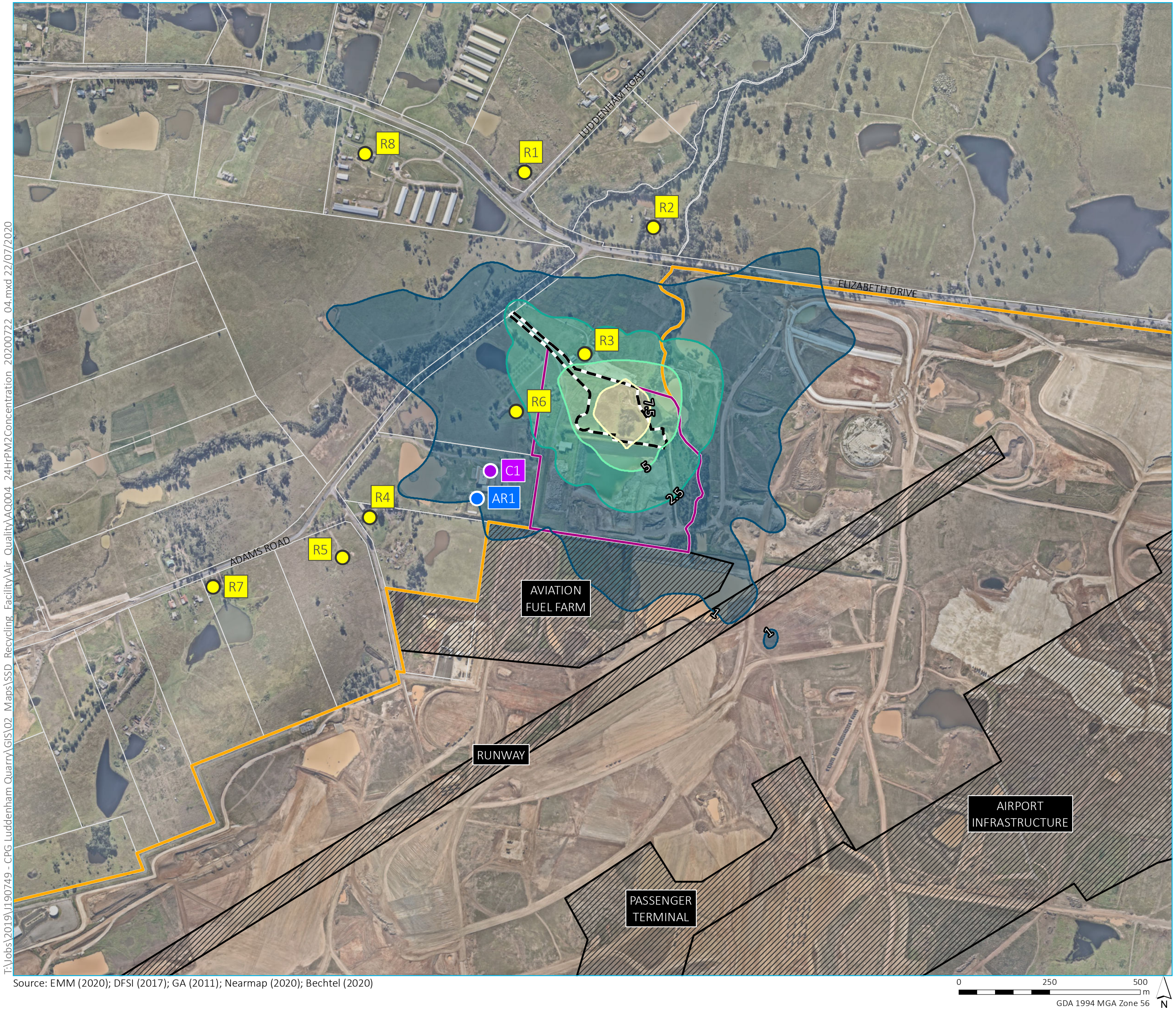
Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ003_AnnualPM10Concentration_20200722_04.mxd 22/07/2020

Predicted incremental annual average PM_{10} concentration ($\mu g/m^3$)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.2

EMM
creating opportunities



T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ004_24HrPM2Concentration_20200722_04.mxd 22/07/2020

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Western Sydney Airport infrastructure (indicative)
- Cadastral boundary

Assessment location

- Active recreation
- Commercial
- Residential

24hr $PM_{2.5}$ concentration (µg/m^3)

- 1 - 2.5
- 2.5 -5
- 5 - 7.5
- over 7.5

Predicted incremental 24-hour average $PM_{2.5}$ concentration (µg/m^3)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.3

EMM creating opportunities

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

0 250 500 m

GDA 1994 MGA Zone 56

N

T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ005_AnnualPM2Concentration_20200722_04.mxd 22/07/2020

Predicted incremental annual average $PM_{2.5}$ concentration ($\mu g/m^3$)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.4

EMM
creating opportunities

KEY
- Subject property
- ARRC site
- Western Sydney Airport
- Western Sydney Airport infrastructure (indicative)
- Cadastral boundary

Assessment location
- Active recreation
- Commercial
- Residential

Annual TSP concentration (µg/m^3)
- 0.5 - 1
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- over 50

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

0 250 500 m

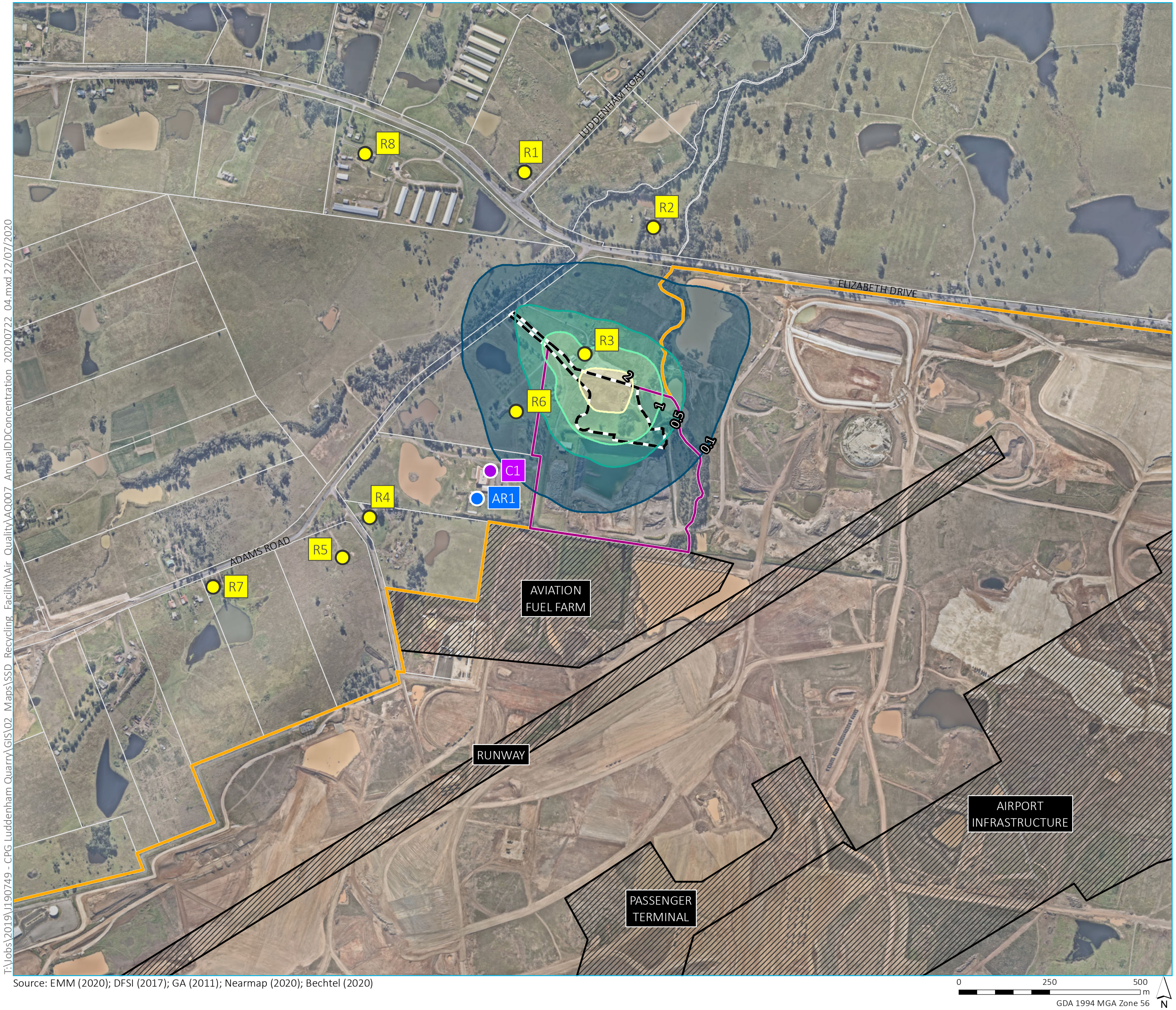
GDA 1994 MGA Zone 56

T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ006_AnnualTSPConcentration_20200722_04.mxd 22/07/2020

Predicted incremental annual average TSP concentration (µg/m^3)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.5

EMM
creating opportunities



Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Bechtel (2020)

T:\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02_Maps\SSD_Recycling_Facility\Air_Quality\AQ007_AnnualDDConcentration_20200722_04.mxd 22/07/2020

KEY
- Subject property
- ARRC site
- Western Sydney Airport
- Western Sydney Airport infrastructure (indicative)
- Cadastral boundary

Assessment location
- Active recreation
- Commercial
- Residential

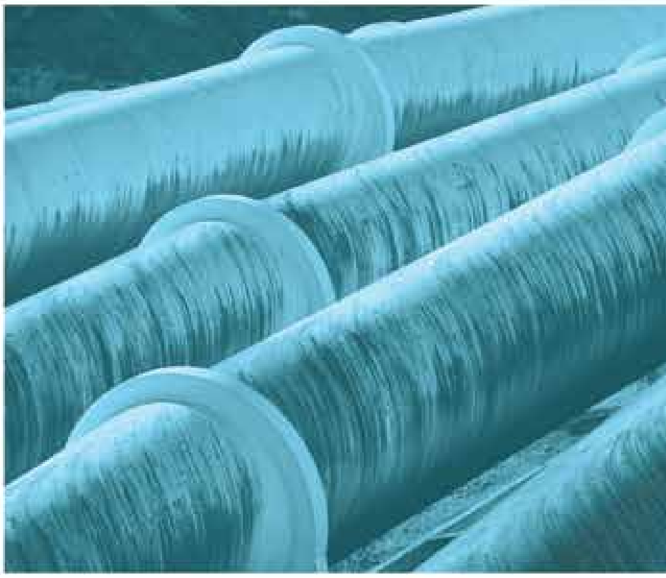
Annual dust deposition (µg/m^3)
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- over 2

Predicted incremental annual average dust deposition concentration (g/mg^s/month)

Luddenham Advanced Resource Recovery Centre
Air Quality Impact Assessment
Figure D.6

EMM
creating opportunities



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