AIR QUALITY IMPACT ASSESSMENT
252 COAL ROAD MUSWELLBROOK

Muswellbrook Shire Council

19 December 2024

Job Number 24061736

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Air Quality Impact Assessment
252 Coal Road Muswellbrook

DOCUMENT CONTROL

Report Version	Prepared by	Reviewed by
FINAL - 001	KT & PH	EA

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Muswellbrook Shire Council (the Proponent). It presents an assessment of the potential air quality impacts on the proposed Community Infrastructure Depot (CID) at 252 Coal Road Muswellbrook, New South Wales (NSW) (hereafter referred to as the Project).

The Project involves the construction of a new building and associated CID infrastructure at the Muswellbrook Shire Council Waste and Recycling Management Facility (WRMF). Features of CID will include facilities for 82 operational staff and parking, parking facilities for Council's operational vehicles, store office, nursery and mechanical workshop.

The purpose of this assessment is to evaluate the potential for odour impacts on the CID building and conversely to ensure the new CID building does not impact on the operation of the landfill and waste management facility, its licence requirements and the ability to carry out landfilling operations to the full extent shown in the long-term filling plan.

This assessment has been prepared in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**) using a methodology based on a Level 2 / 3 Odour Impact Assessment as described in the *Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW* (**NSW DEC, 2006**).

This report comprises:

- A background to the Project and description of the site activities;
- A review of the existing meteorological environment surrounding the site;
- A description of the dispersion modelling approach and emission estimation used to assess potential air quality impacts at the Project; and,
- Presentation of the predicted results and discussion of the potential air quality impacts and associated mitigation and management measures.

2 PROJECT BACKGROUND

2.1 Local setting

The Project is located approximately 2.7 kilometres (km) from the Muswellbrook town centre. **Figure 2-1** presents the location of the Project. The local land use surrounding the site is a mixture of rural, suburban residential and a former open cut coal mining operation.

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the proposal location. The general area can be characterised as undulating with a gentle depression to the west of the proposal site along the flood plain. There is steeper, mountainous terrain further afield to the northeast of the Project site.

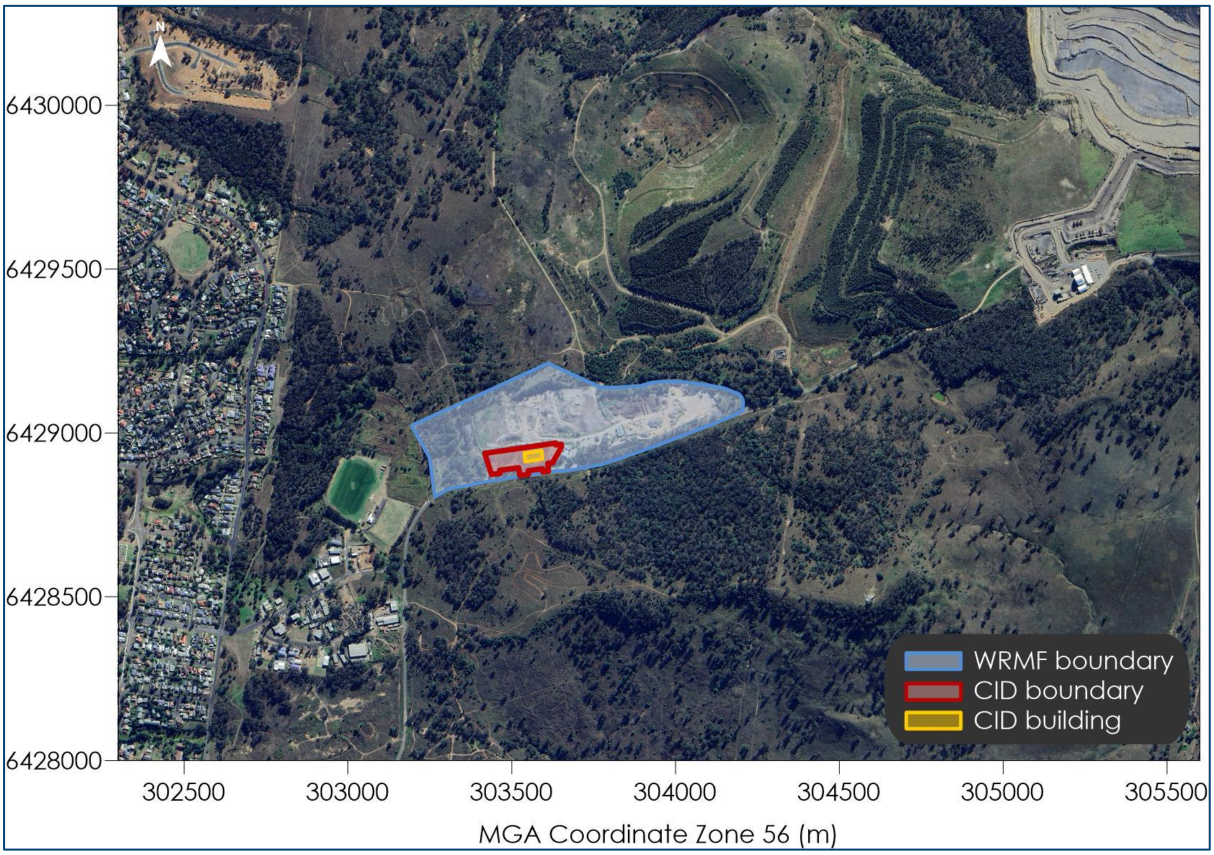

Figure 2-1: Project setting

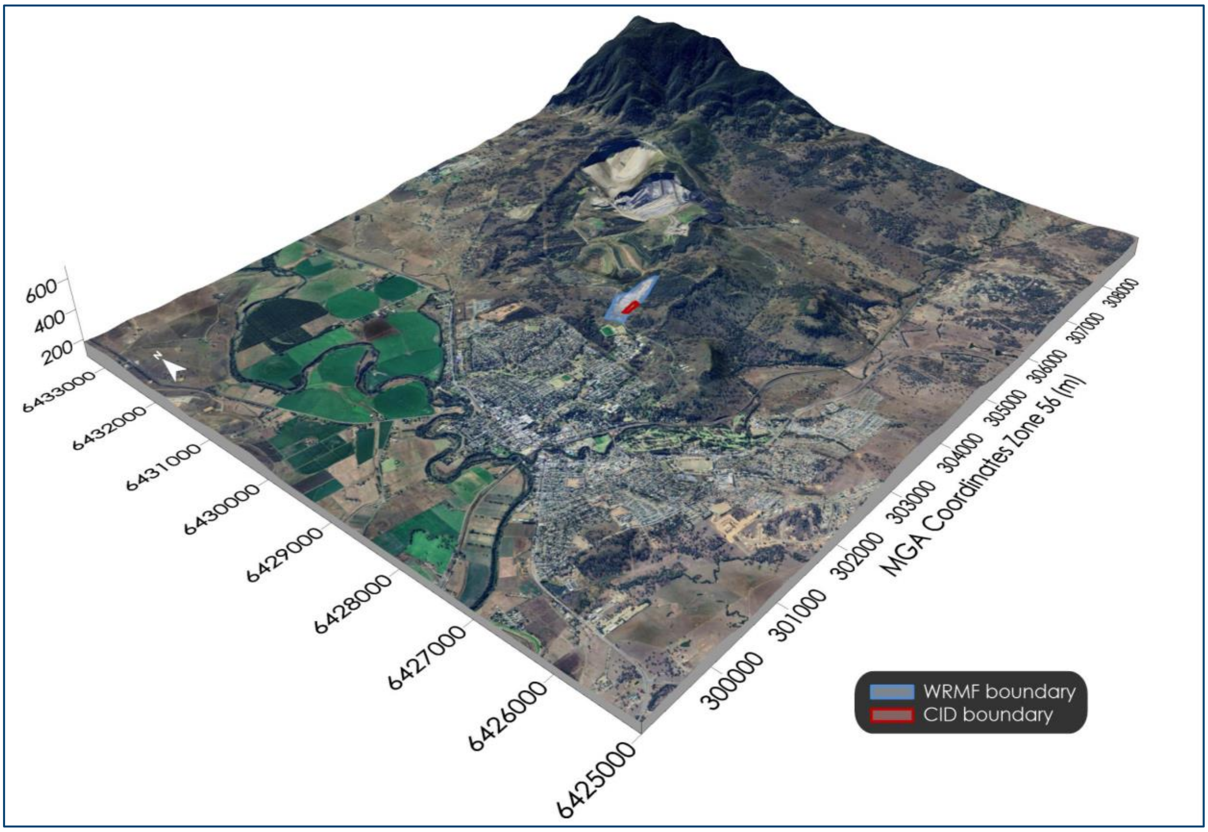

Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Site description

2.2.1 WRMF operations

The WRMF encompasses a total area of approximately 19.4 hectares (ha). The existing operations which occur within the WRMF comprise of recycling, composting, landfilling and associated services including a small vehicle waste transfer station, materials storage area, second-hand shop, weighbridge, staff facilities and community recycling centre. The WRMF operates 8:00am to 4:00pm, seven days a week (with consideration of public holidays).

The WRMF facility handles a total of approximately 30,000 tonnes of waste annually and is approved to process up to approximately 10,000tpa of food organics and green organics (FOGO) and uses a covered aerated static pile (CASP) technology for the composting process.

Figure 2-3 presents the landfill staging plan. As of December 2023, the landfill had a remaining capacity of approximately 593,341 metres cubed (m^3) and by June 2024 the remaining capacity of the landfill was projected to be 583,203m^3. The landfill progression for Stages 1 to 4 is from west to east with subsequent landfilling on top of these areas in Stages 5 and 6. It is understood at the time of writing this assessment the active face is in Stage 3.

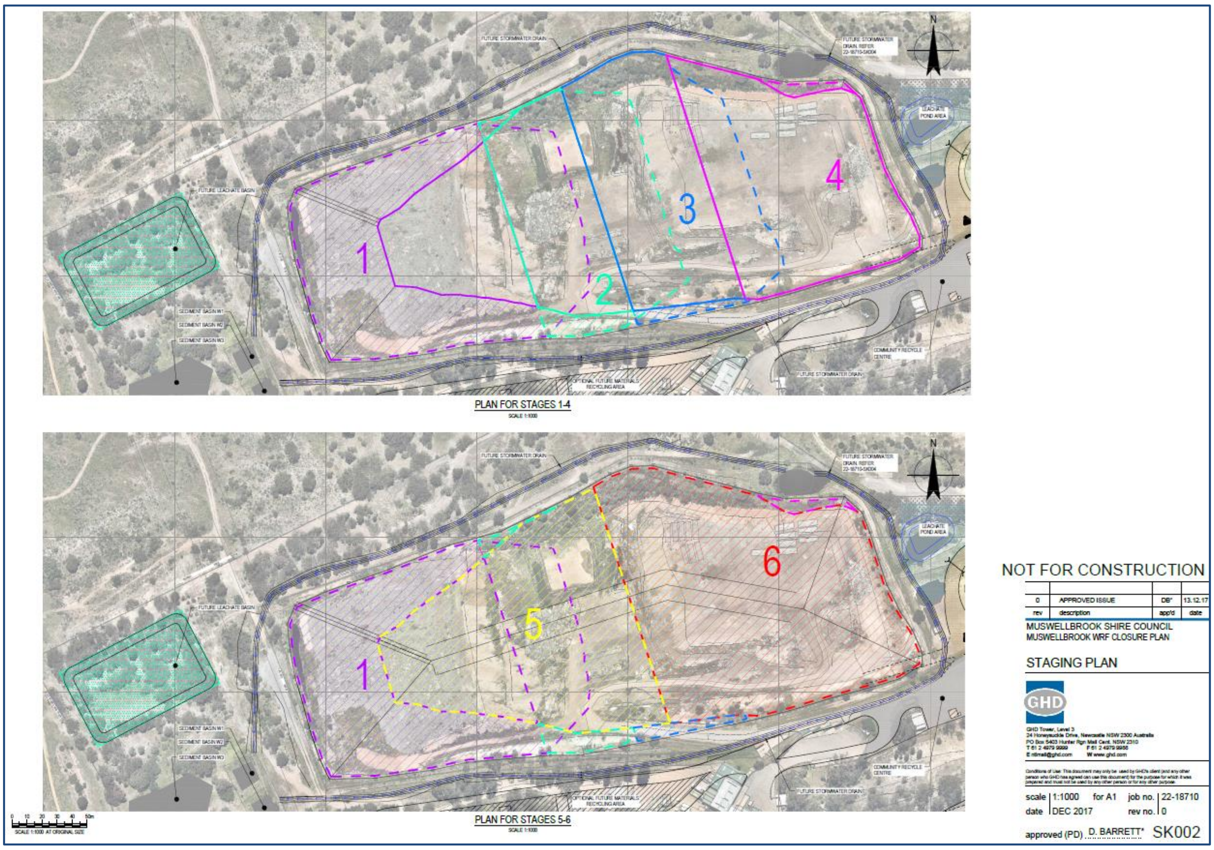

Figure 2-3: Landfill staging plan (GHD, 2022)

2.2.2 Proposed CID

The new CID building and associated infrastructure would accommodate all technical, professional, administrative, and operational staff from various sections of Council in one location.

This proposed CID is planned accommodate the following:

- Operational staff (82) and provide parking facilities for their vehicles;
- Parking facilities for council's operational vehicles, both heavy and light;
- A store office to provide storage of tools and construction materials, including chemicals;
- A nursery including storage of plant and equipment; and,
- A mechanical workshop for servicing and repairing vehicles.

Approximately 1.9ha of the WRMF is designated for the construction of the CID. An indicative site layout is show in **Figure 2-4.** The CID is located immediately south of the landfilling operations.

The proposed standard operating hours for the CID are 7:30am to 4:30pm.

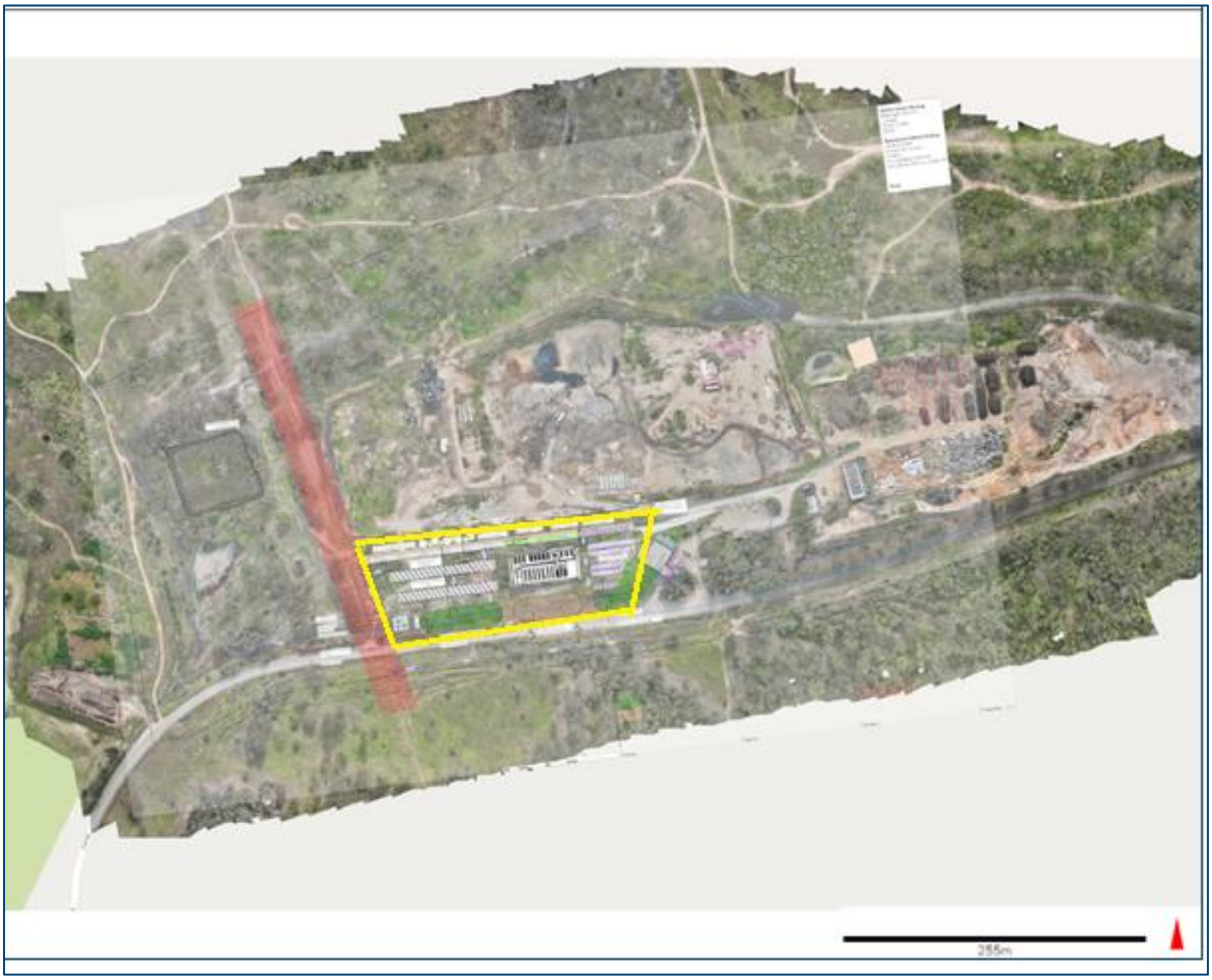

Figure 2-4: Indicative site layout for CID

3 AIR QUALITY CRITERIA

3.1 Odour

3.1.1 Introduction

NSW legislation (*Protection of the Environment Operations Act, 1997)* prohibits emissions that cause offensive odour to occur at any off-site receptor. Offensive odour is evaluated in the field by authorised officers, who are obliged to consider the odour in the context of its receiving environment, frequency, duration, character and so on and to determine whether the odour would interfere with the comfort and repose of the normal person unreasonably.

The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The NSW Odour Policy (**NSW DEC, 2006**) sets out a framework specifically to deal with such issues.

It needs to be noted that the term odour refers to complex mixtures of odours, and not "pure" odour arising from a single chemical. Odour from a single, known chemical very rarely occurs (when it does, it is best to consider that specific chemical in terms of its concentration in the air). In most situations odour will be comprised of a cocktail of many substances which is referred to as a complex mixture of odour, or more simply odour.

Odour concentrations are used and are defined in odour units. The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose. Thus by definition, odour less than one odour unit (1 OU), would not be detectable to most people.

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point to where odour reaches surrounding receptors. This approach allows the air dispersion model to produce results in terms of odour units.

3.1.2 Complex Mixtures of Odorous Air Pollutants

To establish the criteria, the Equation 3.1 in the *Technical Notes - Assessment and Management of Odour from Stationary Sources in NSW* (**NSW DEC, 2006**) is applied as follows:

$$Odour\ assessment\ criterion\ (OU) = \frac{(log_{10}(population) - 4.5)}{-0.6}$$

The criteria for acceptable levels of odour range from 2 to 7 OU, with the more stringent 2 OU criteria applicable to densely populated urban areas and the 7 OU criteria applicable to sparsely populated rural areas.

Table 3-1 presents the assessment criteria as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2022**). This criterion is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 3-1: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Source: NSW EPA, 2022

The NSW odour goals are based on the risk of odour impact within the general population of a given area. In sparsely populated areas the criteria assume there is a lower risk that some individuals within the community would find the odour unacceptable, hence higher criteria apply.

3.1.3 Peak-to-mean factors

Peak-to-mean factors are applied to account for any odour fluctuation above and below the mean odour level of the 1-hour averaging time. The criteria in **Table 3-1** are compared with modelled results that include peaking factors to account for the time-averaging limitations of air dispersion models. The peak-to-mean factors developed by **Katestone Scientific Pty Ltd (1995, 1998)** for NSW EPA are applied to convert the modelled (1-hour) averaging time to 1-second peak concentrations which are appropriate.

A summary of the peak-to-mean values is provided in **Table 3-2**.

Table 3-2: Peak-to-mean values

Source Type	Pasquill-Gifford stability class	Near field P/M 60*	Far field P/M 60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A-F	6	6
Surface point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

*Ratio of peak 1-second average concentrations

3.2 Applicable odour criteria

At the Project location, higher odour levels are expected compared to residential areas due to the nature of activities in the surrounding area. The Project site includes workplaces where workers may be exposed to various odours or chemicals, making their sensitivity to odour different from that of residents in their homes.

Furthermore, workers typically spend only part of the day on-site, in line with standard working hours, and their exposure to odour may be lower depending on the time of day, such as during nighttime when the site is unoccupied. The WMRF can also accommodate higher odour levels, given the nature of its operations and visitors to the site are likely aware of these operations and may expect environmental conditions that differ from those in residential areas.

To account for the potential higher level of odour for the Project site, the anticipated number of operational staff was used to establish the applicable criteria per Equation 3.1 in the *Technical Notes - Assessment and Management of Odour from Stationary Sources in NSW* (**NSW DEC, 2006**).

Table 3-3 presents the calculated odour assessment criterion for the CID buildings.

Table 3-3: Calculated odour assessment criterion

Anticipated number of people at the CID	Odour assessment criterion (OU)
82	4

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

4.1 Local climate

Long term climatic data collected at the closest Bureau of Meteorology (BoM) weather station at Scone Airport Automatic Weather Station (AWS) (Station Number 061363) were analysed to characterise the local climate in the proximity of the Project. The Scone Airport AWS is located approximately 27km north of the Project.

Table 4-1 and **Figure 4-1** show climatic parameters which have been collected from the Scone Airport AWS over a 14 to 33 year period. These data assist in characterising the local climatic conditions based on the long-term meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 31.8 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 3.4°C.

Rainfall peaks during the summer months and declines during winter, with an annual average rainfall of 661.9 millimetres (mm) over 66.3 days. The data show November is the wettest month with an average rainfall of 77.9mm over 6.7 days and May is the driest month with an average rainfall of 34.7mm over 4.4 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity levels range from 62 per cent in October to 86 per cent in June. Mean 3pm relative humidity levels vary from 41 per cent in January to 58 per cent in June.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 7.0 kilometres per hour (km/h) in May and July to 12.7km/h in October and November. The mean 3pm wind speeds vary from 16.0km/h in June to 20.6km/h in November.

Table 4-1: Monthly climate statistics summary – Scone Airport AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	31.8	30.7	28.1	24.6	20.4	17.1	16.7	18.9	22.3	25.6	28.2	30.5	24.6
Mean min. temp. (°C)	17.2	16.7	14.3	10.0	6.5	4.7	3.4	3.7	6.7	9.7	13.0	15.4	10.1
Rainfall													
Rainfall (mm)	61.2	58.3	63.0	34.8	34.7	45.5	39.3	36.1	35.4	52.0	77.9	74.3	611.9
No. of rain days (≥1mm)	6.0	5.8	6.7	4.1	4.4	6.1	5.0	4.3	4.8	5.7	6.7	6.7	66.3
9am conditions													
Mean temp. (°C)	22.3	21.3	19.0	17.0	13.0	10.0	9.4	11.3	15.3	18.3	19.7	21.6	16.5
Mean R.H. (%)	70	77	82	77	81	86	83	73	66	62	66	67	74
Mean W.S. (km/h)	11.3	10.0	8.9	8.2	7.0	7.5	7.0	9.9	11.4	12.7	12.7	11.9	9.9
3pm conditions													
Mean temp. (°C)	29.9	28.9	26.7	23.4	19.4	16.1	15.6	17.7	20.8	23.6	26.0	28.4	23.0
Mean R.H. (%)	41	47	47	49	51	58	55	47	44	42	43	42	47
Mean W.S. (km/h)	19.2	18.7	18.6	18.0	16.1	16.0	16.5	18.7	18.9	19.1	20.6	20.0	18.4

Source: **Bureau of Meteorology, 2024**

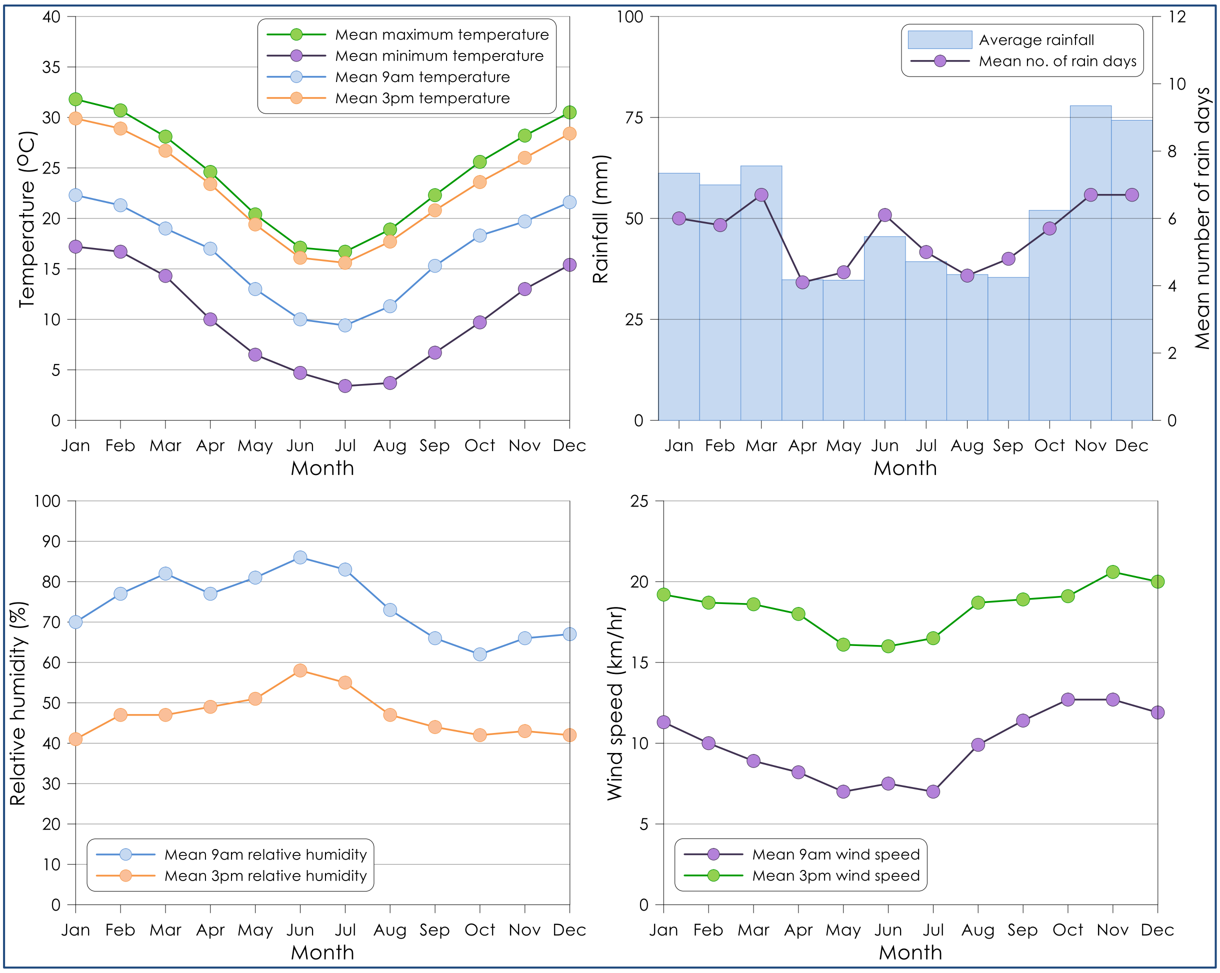

Figure 4-1: Monthly climate statistics summary – Scone Airport AWS

4.2 Local meteorological conditions

Annual and seasonal windroses for the Muswellbrook Department of Climate Change, Energy, the Environment and Water (DCCEEW) weather station during the 2015 calendar period are presented in **Figure 4-2**.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded for the area and wind patterns which reflect the patterns experienced in other years as outlined in **Appendix A**.

On an annual basis, winds typically occur along a southeast to northwest axis with the highest portion of winds from the southeast. In summer, strong winds are typically from the southeast. The autumn and spring distributions are similar to the annual distribution with dominant winds from southeast and south-southeast. For winter, the distribution is varied with a high proportion of winds originating from the west-northwest and northwest.

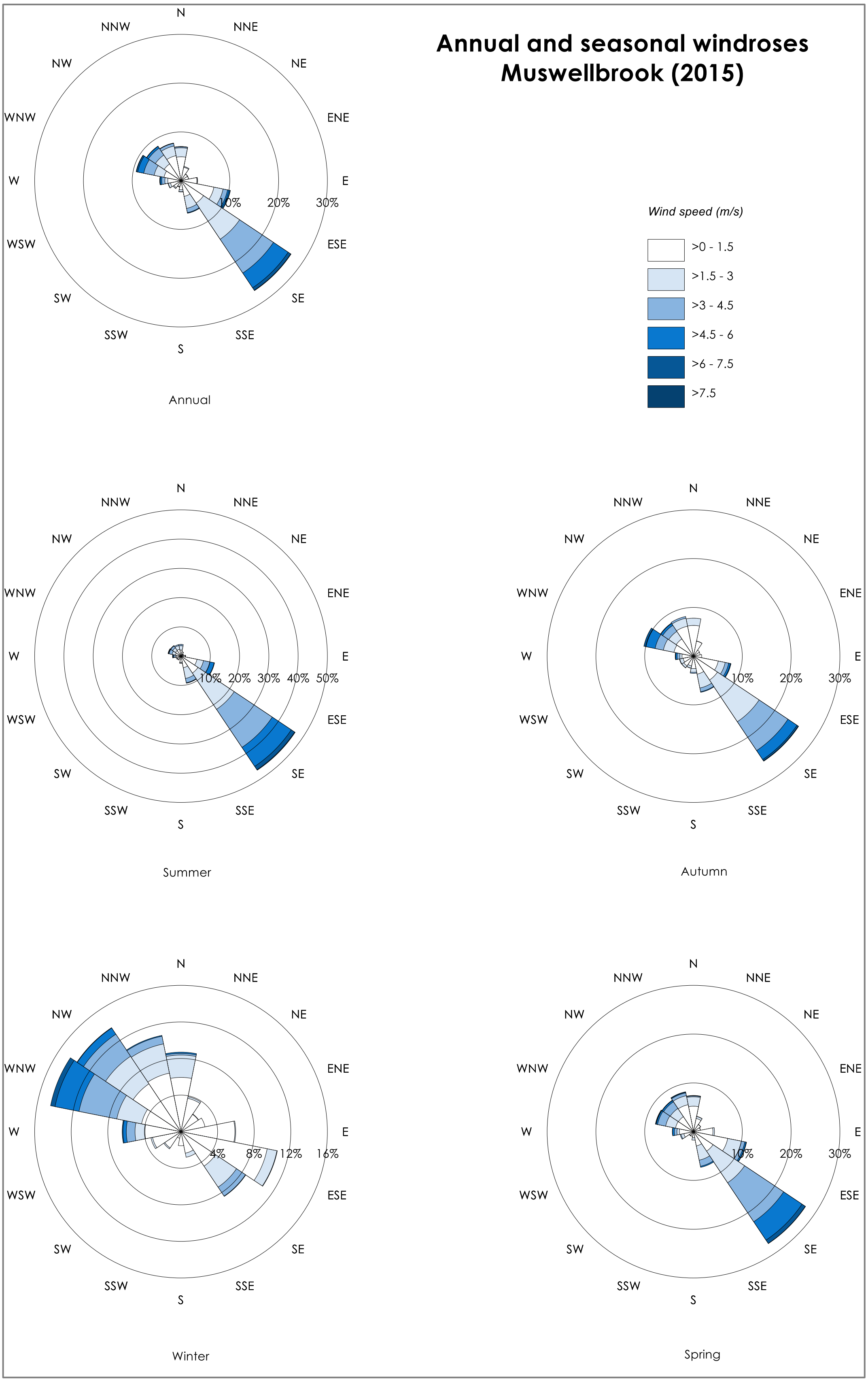

Figure 4-2: Annual and seasonal windroses – Muswellbrook (2015)

5 DISPERSION MODELLING APPROACH

5.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment. The CALPUFF is an advanced air dispersion model which can deal with the effects of complex local terrain on the dispersion meteorology over the modelling domain in a three-dimensional, hourly varying time step.

Modelling was undertaken using a combination of the CALPUFF Modelling System and the Weather Research and Forecasting model (WRF). The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets. WRF is a prognostic air model used to simulate meteorological data for input into CALMET.

The model was setup in general accord with the methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC**, **2011**).

5.2 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from WRF with surface observations.

The WRF model was applied to the available data to generate a three-dimensional upper air data file for use in CALMET. The centre of analysis for the WRF modelling used is 32.2479deg south and 150.824deg east.

The CALMET domain was run on a 10 x 10km grid with a 0.1km grid resolution. The available meteorological data for 1 January 2015 to 31 December 2015 from the Muswellbrook and the Muswellbrook NW DCCEEW monitoring stations were included in the simulation.

Local land use and detailed topographical information was included to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 5-1**.

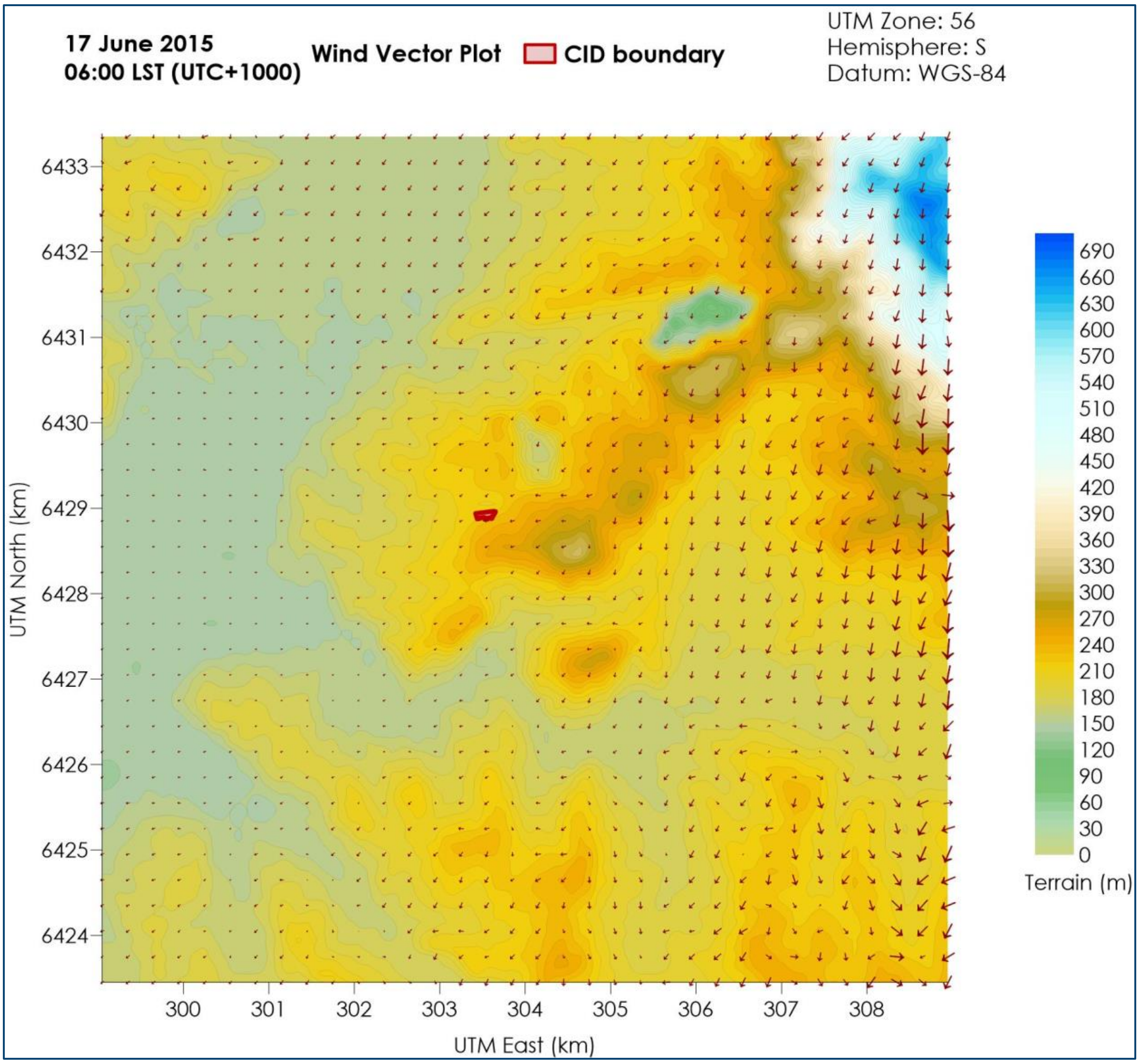

Figure 5-1: Representative 1-hour average snapshot of wind field for the proposal

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 5-2** and **Figure 5-3**.

Figure 5-2 presents annual and seasonal windroses extracted from one point in the CALMET domain. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 5-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

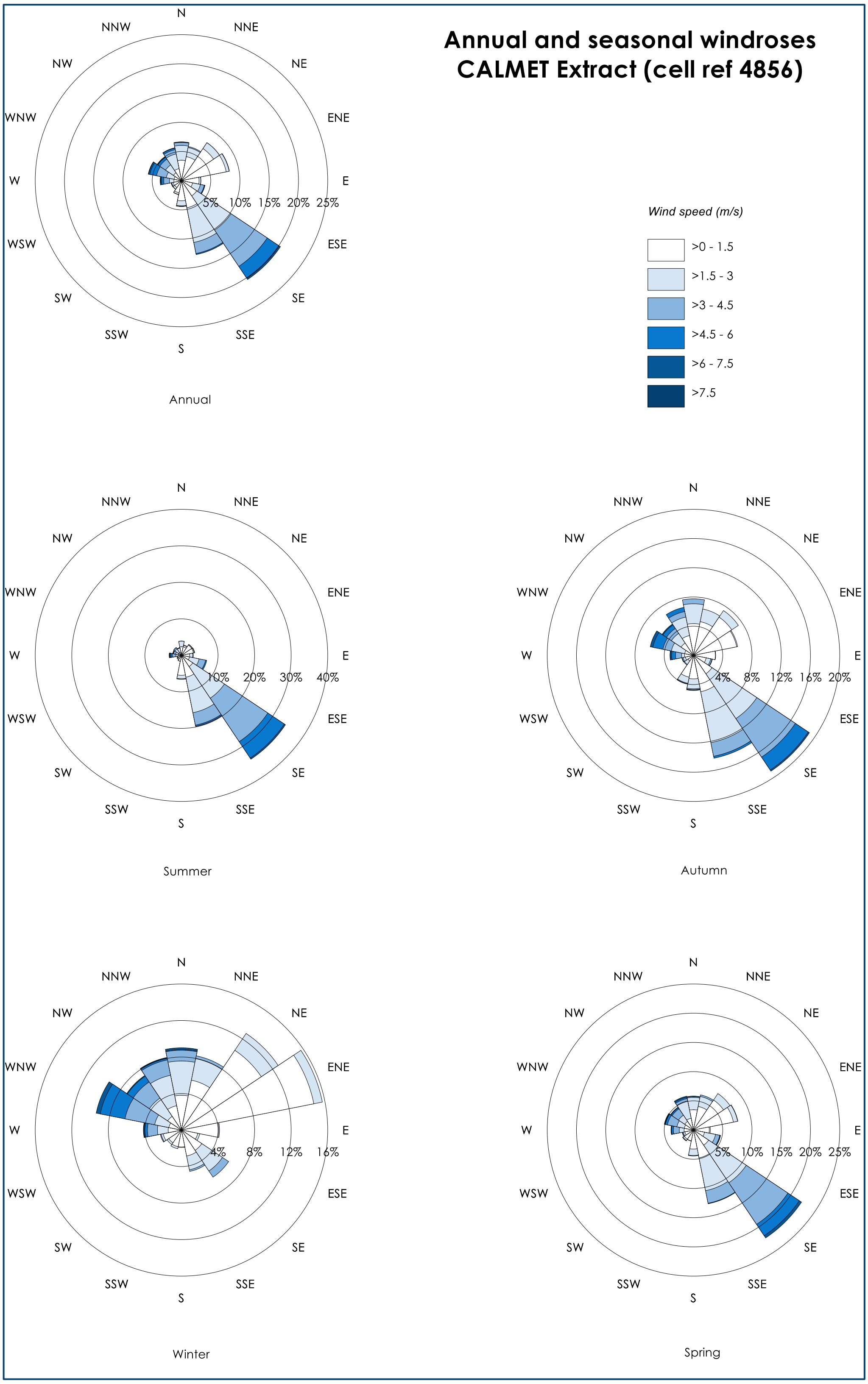

Figure 5-2: Annual and seasonal windroses from CALMET (Cell ref 4856)

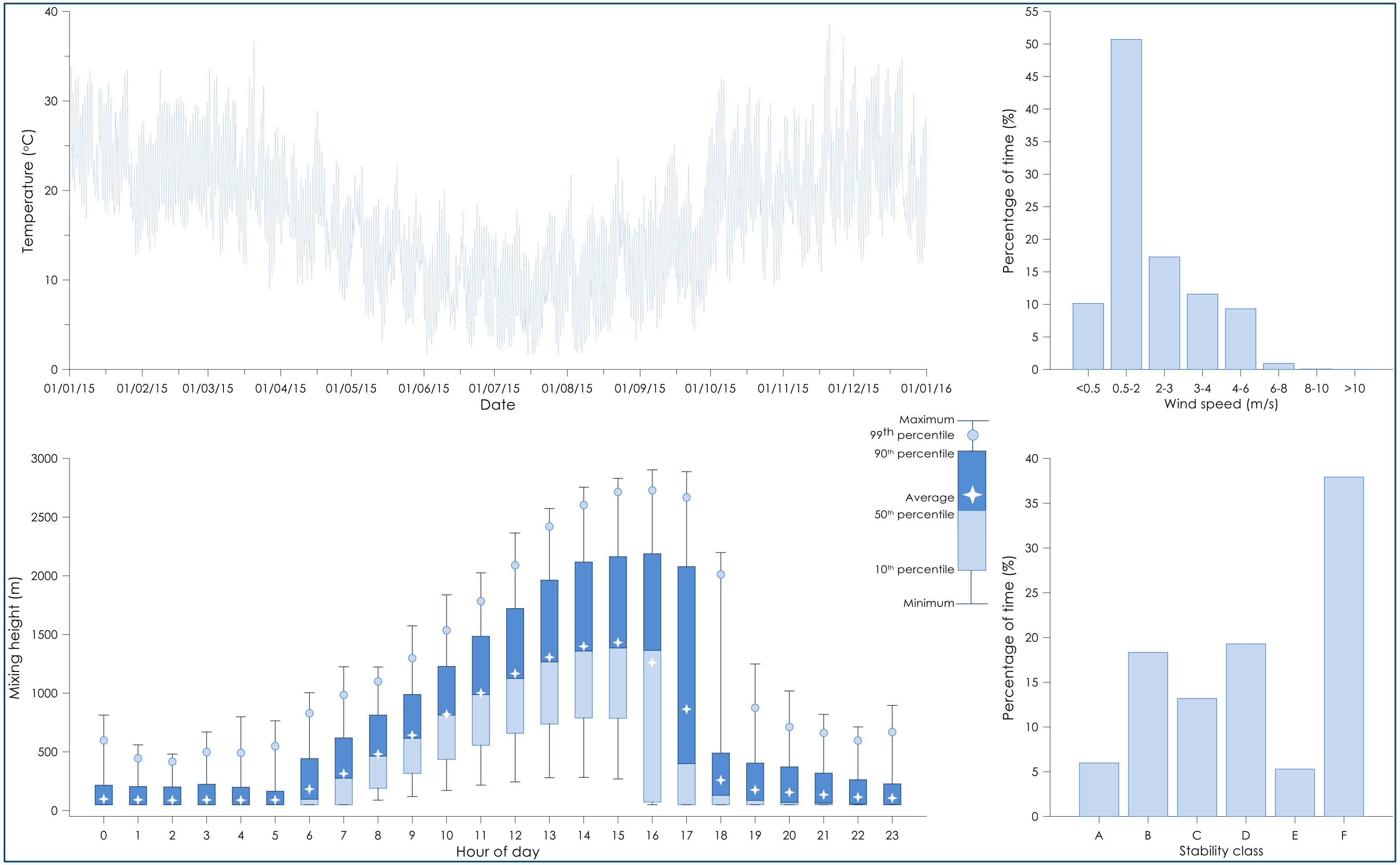

Figure 5-3: Meteorological analysis of CALMET (Cell Ref 4856)

5.3 Dispersion modelling

The CALPUFF air dispersion model has been used to predict the potential odour levels in the ambient air in the wider area.

Modelling of the key odour emission sources was conducted using the emissions rates and parameters outlined in the following section and utilising the meteorological data described in the previous section.

5.4 Emission estimation

While the expectation is that potential receivers would be able to determine whether the odour they may experience is coming from the landfill or composting odour (i.e. not considered to be additive), for the purposes of this assessment, we have examined cumulative odour impacts due to the odours from the composting and the landfill combined.

5.4.1 Landfill operations

In the absence of any site-specific odour measurements for the landfill operations, odour emissions were estimated based on odour measurements used in the *Air Quality Impact Assessment Albury Waste Management Centre* (**Todoroski Air Sciences, 2018**). A summary of the odour emission rates for these sources applied is outlined in **Table 5-1**.

Note that with the establishment of the new organics facility, up to 10,000tpa of FOGO would be diverted from landfill. The removal of a significant amount of organic waste from landfill would act to decrease the odour emission rates from landfill sources. To account for this, a reduction of 30% has been applied to the odour emission rates for the landfill active face.

During periods when landfilling is not occurring (i.e. during night time) odour emission rates from the active face have been scaled down to 20% outside of operational hours to account for covering of the active face.

Table 5-1: Summary of odour emission rates for landfill operations

Source	SOER ($OU.m^3/m^2/s$)
Active face	3.51
Intermediate cell	0.09
Capped area	0.02

5.4.2 Composting operations

Odour emissions from the compositing activities would potentially arise from a range of sources with varying rates of odour emissions at different times. The main sources of odour emissions from the composting activities are identified as being from the compost windrows, from the processing of the input material streams and other sources such as the on-site water storage and composting handling activities.

Composting emissions have been modelled identically as described in the *Air Quality Impact Assessment Muswellbrook Shire Council Organics Recycling Facility* (**Todoroski Air Sciences, 2020**). Further detail regarding the emission estimation can be found in the report.

5.5 Source locations

The modelled source locations for the landfilling operations are based on the proposed landfilling sequence (refer to **Figure 2-3**) and represents a potential worst-case for odour impacts at the CID building with the active face locations in close proximity to the CID building as would occur during Stage 5 of the landfill.

It has been advised by the Proponent the active face is to be maintained at 6 metres (m) wide and 12m long, giving a total area of 72m^2. It is noted that this is a significant decrease from the assumptions used in the previous modelling assessment (**Todoroski Air Sciences, 2020**) and odour impacts are expected to be less.

Figure 5-4 presents the locations of odour generating sources associated with the WRMF.

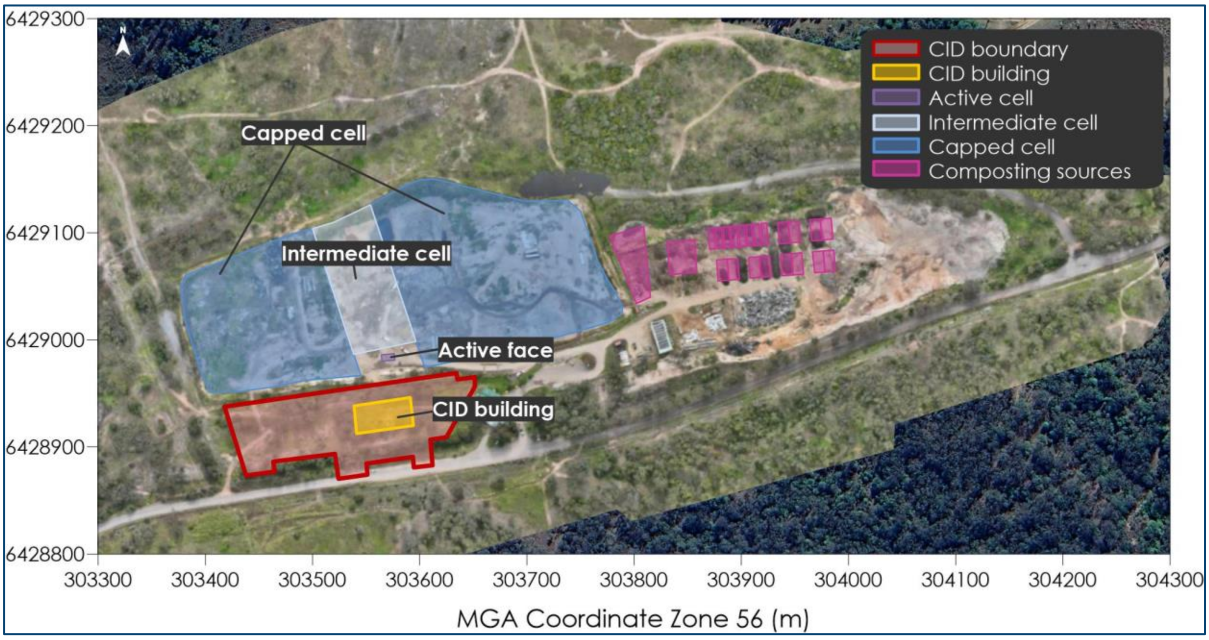

Figure 5-4: Modelled source locations

6 DISPERSION MODELLING RESULTS

The spatial distribution of the dispersion modelling predictions is presented as an isopleth diagram showing the 99th percentile nose-response ground level odour concentrations for all hours of the day in **Figure 6-1**. As people will not be present at the CID at all hours, the predicted 99th percentile nose-response ground level odour concentrations occurring from 7am to 5pm is presented in **Figure 6-2**.

Based on the isopleth shape, the largest source of odour at the WRMF is the composting operations.

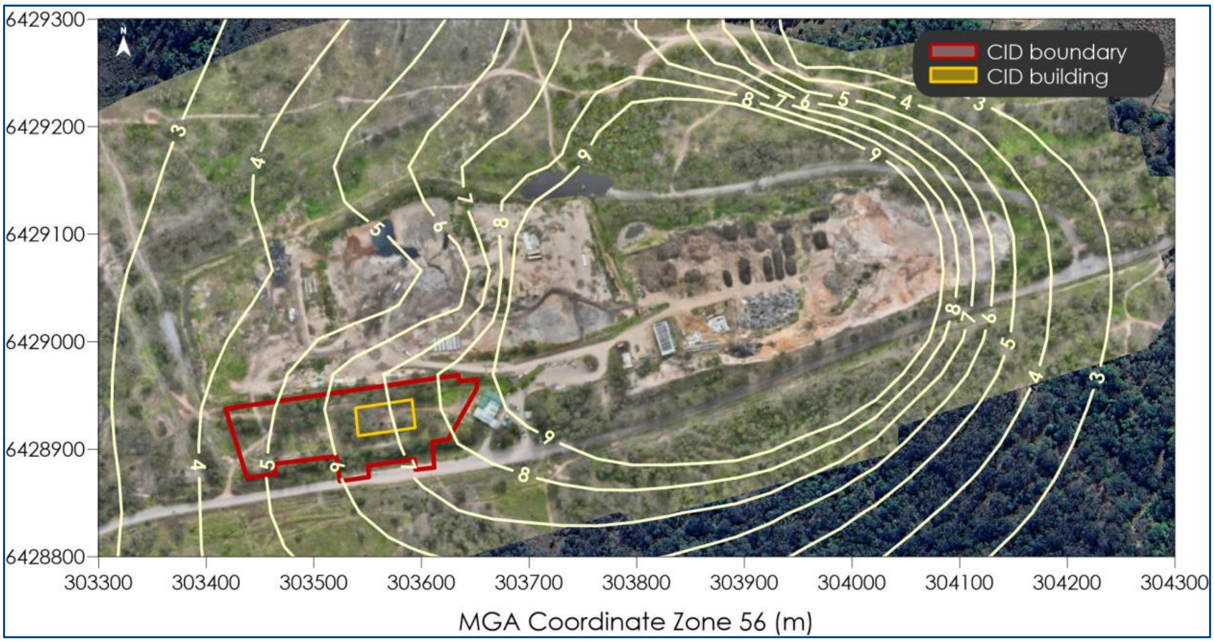

Figure 6-1: Predicted 99th percentile nose-response average ground level odour concentrations – all hours

Figure 6-2: Predicted 99th percentile nose-response average ground level odour concentrations – operational hours

Table 6-1 presents the dispersion modelling results at the CID boundary and building façade. The results indicate that when considering at all hours the predicted odour levels would be above the applicable odour criteria. During operational hours when workers would be at the CID, the odour is predicted to be within the acceptable odour criteria (refer to **Section 3.2**).

Table 6-1: 99th percentile nose-response average ground level odour concentrations – Incremental impact

Receiver ID	Predicted level (OU) (all hours)	Predicted level (OU) (CID operational hours)	Odour assessment criterion*(OU)
CID boundary	**9**	4	**4**
CID building façade	**7**	3	**4**

***** See **Section 3.2.**

Odour impacts at night are generally higher than during the day, due to a higher frequency of poor dispersion conditions, hence why the predicted odour levels during the CID operational hours are significantly lower than for all hours.

This is demonstrated in **Figure 6-3** which presents a diurnal profile of the frequency of odour concentrations above 4OU predicted at the most impacted point of the CID building façade. The data indicate that there is a much lower frequency of 4OU levels during the daytime and higher frequency during the nighttime. Note that the odour assessment criterion applies to the 99th percentile and thus for 1% of the time odour may be above this threshold.

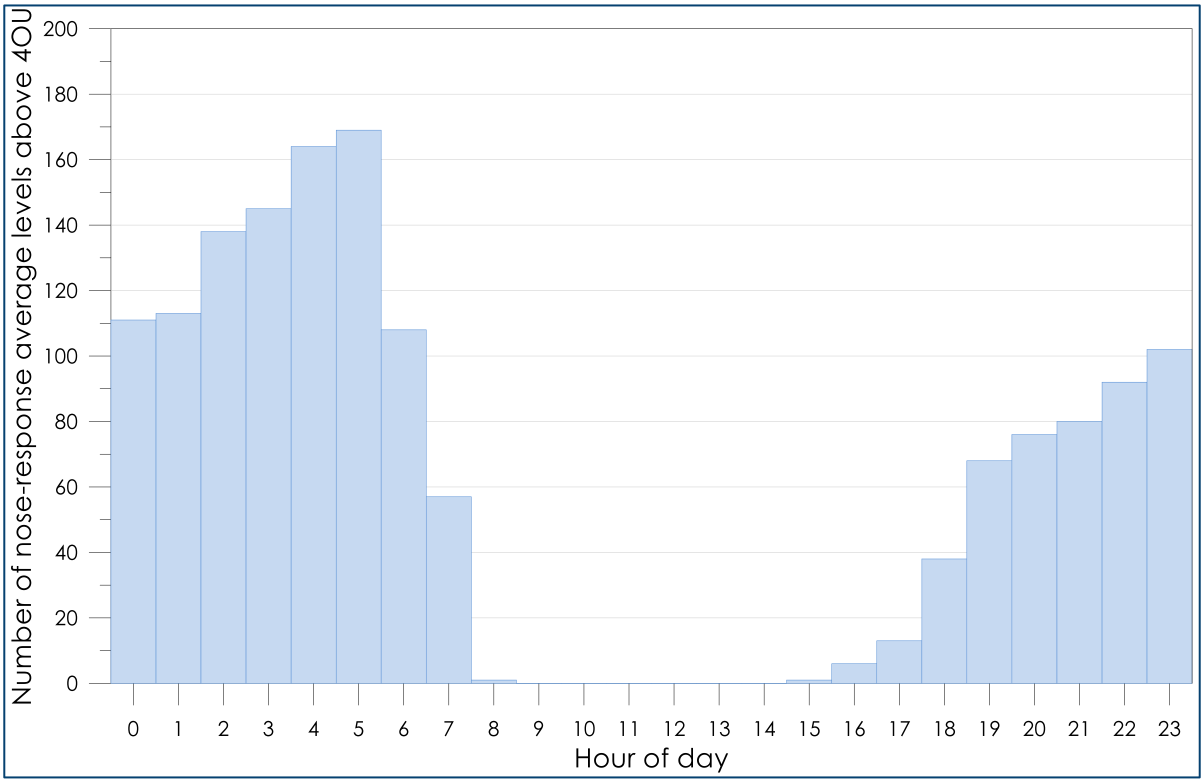

Figure 6-3: Diurnal profile showing frequency of predicted odour impacts at CID building façade

7 EVALUATION AND RECOMMENDATIONS

The modelling assessment indicates that predicted odour levels at the CID would be within the acceptable levels during standard operating hours. However, there is potential for odour levels above the criteria outside of the standard operating hours (as discussed in **Section 6**).

It should be noted that whilst the modelling indicates levels below the applicable criteria, there is still potential for odour to be observed, however would not be considered to be offensive as it is not expected to interfere with the comfort and repose of the normal worker at the CID unreasonably. The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour and how any particular odour is perceived by any individual. There is an expectation that the workers at the CID would be less sensitive to odour considering the context of its receiving environment, frequency, intensity, duration and character. That being said, there will be times at the CID when odour would be detectable from the composting and landfilling operations, therefore consideration of mitigation and management measures for both the CID building and WRMF operations to minimise the potential land use conflict is considered.

Recommendations to minimise the potential odour impacts at the CID building include:

- Ensure the building design provides adequate air flow and encourages flow in a particular direction away from doorways and intakes. Avoid dead-ends or long narrow spaces perpendicular to the wind where air can lay dormant and stagnate.
- Build continuous dense landscaping along the CID boundary between the landfill and composting operations. Tall vegetation will aid in dispersion and dilution for odour sources and also assist to minimise visual impacts and perception of odour sources.
- Consider positioning of air conditioning and ventilation intakes away from odorous sources. Have non-opening windows on the odorous side of the building and duct cleaner air into the building from along the south and west of the building and out to the odorous side. If necessary, consider the use of filtration to assist with odour removal.

To ensure odour emissions from the landfill and composting operations are minimise, the following is recommended:

- Ensure operations are managed in line with the existing odour mitigation and management measures.
- For the landfill operations, ensure the size of the active face is limited to 6m wide by 12m long in line with best practice.
- Any offensive odour observed at the CID by workers should be investigated to determine the nature of the odour and the cause. Identify any addition measures as necessary to ensure these can be managed or prevented from occurring in the future.

8 SUMMARY AND CONCLUSIONS

This report outlines an assessment of the potential air quality impacts associated with the operation of the Waste and Recycling Management Facility at 252 Coal Road Muswellbrook on the proposed CID.

Air dispersion modelling using the CALPUFF model was applied to predict the potential for odour impacts at the Project. The odour impact assessment indicates that odour from the WRMF would comply with the applicable odour criteria at the building façade during the CID standard operational times and would be above this during all hours.

Recommendations to minimise the potential for land use conflict between the CID and landfilling and composting operation are provided.

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Todoroski Air Sciences (2020)

"Air Quality Impact Assessment Muswellbrook Shire Council Organics Recycling Facility", prepared for Molino Stewart Pty Ltd by Todoroski Air Sciences, July 2020.

TRC (2011)

"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

Appendix A

Selection of Meteorological Year

The 2015 calendar year has been selected as the meteorological year for the dispersion modelling based on an analysis of the latest ten years of meteorological data.

A statistical analysis of the latest ten years of meteorological data from the DCCEEW Muswellbrook monitoring station is presented in **Table A-1**. The standard deviation of ten years of meteorological data spanning 2014 to 2023 was analysed against the mean wind speed, wind direction, temperature, and relative humidity data.

The analysis indicates that 2015 is closest to the average for wind speed, 2015 is closest to the average for wind direction, 2014 is the closest to the average for temperature and 2014 is closest to the average for relative humidity.

Table A-1: Statistical analysis results of standard deviation for meteorological data at Muswellbrook

Year	Wind speed	Wind direction	Temperature	Relative humidity
2014	0.32	0.29	0.14	0.36
2015	0.27	0.13	0.20	0.55
2016	0.34	0.34	0.15	0.57
2017	0.46	0.21	0.27	0.57
2018	0.58	0.36	0.22	0.59
2019	0.55	0.37	0.33	0.85
2020	0.31	0.24	0.22	0.55
2021	0.42	0.20	0.29	0.53
2022	0.60	0.20	0.40	0.66
2023	0.64	0.25	0.20	0.43

Figure A-1 and **Figure A-2** present annual and seasonal wind roses for the DCCEEW Muswellbrook monitoring station for the 2014-2023 period and for the 2015 year, respectively. The figures indicate that the wind speed and directions recorded during the 2015 year generally align with the wind patterns of the latest ten year dataset.

Therefore, based on this analysis it was determined that 2015 is generally representative of the expected meteorological trends in the vicinity of the Project and is thus suitable for the purpose of modelling.

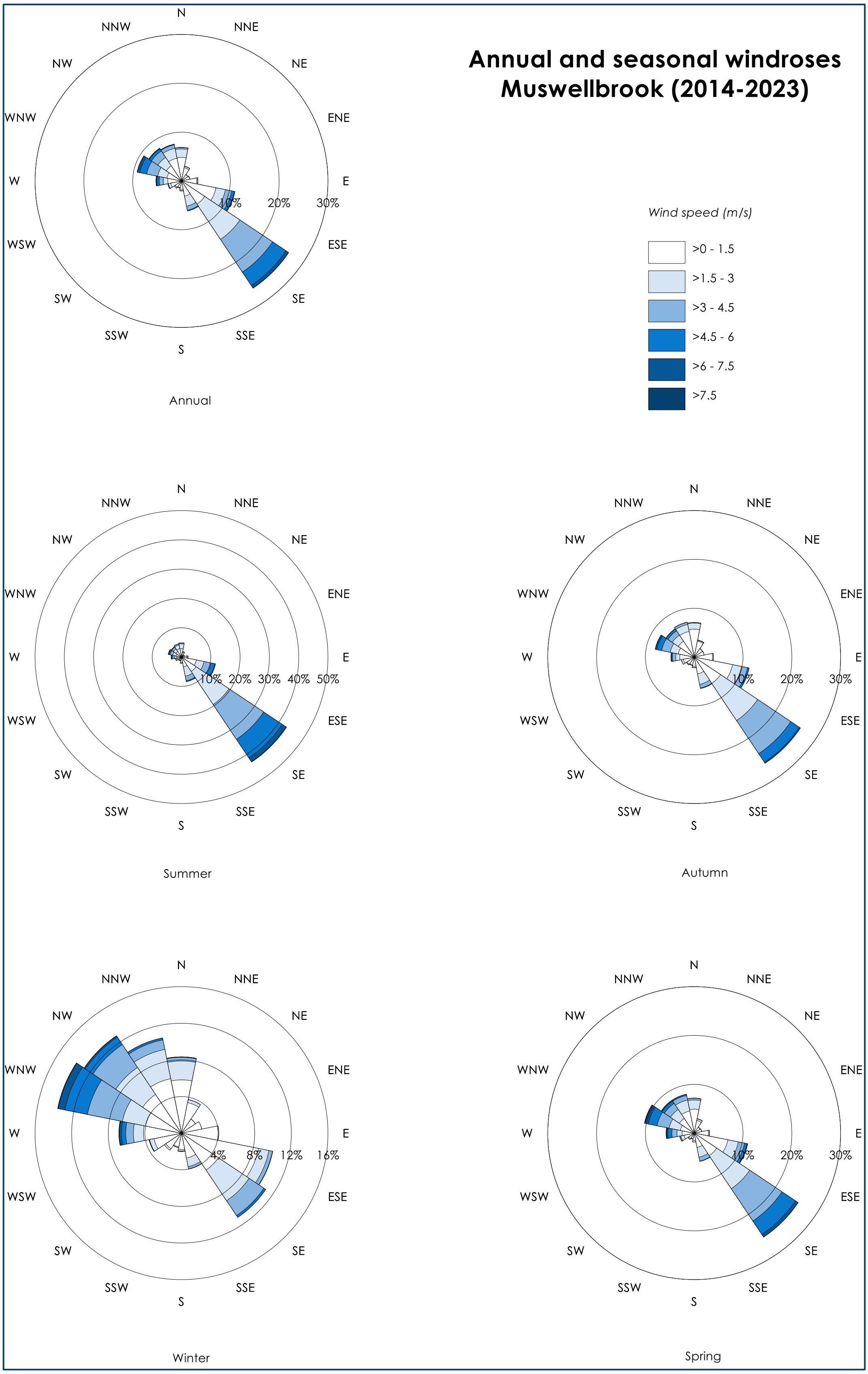

Figure A-1: Muswellbrook annual and seasonal windroses (2014 to 2023)

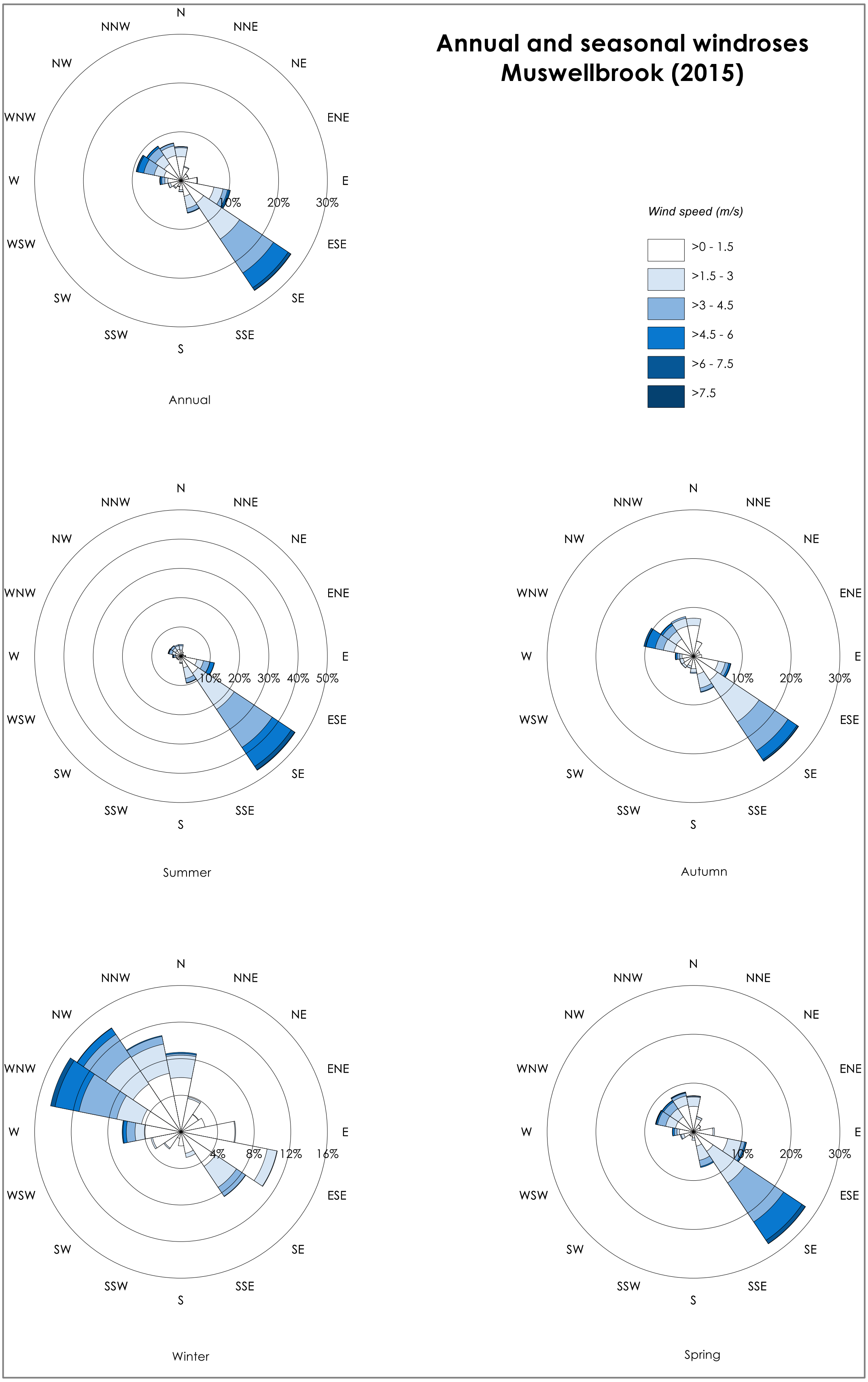

Figure A-2: Muswellbrook annual and seasonal windroses (2015)