Report

Air Quality Impact Assessment

Meppem Quarry

Regional Group Australia

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Endorsements

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APPENDICES

1. INTRODUCTION

Advitech Pty Limited (trading as Advitech Environmental) was engaged by Groundwork Plus Pty Ltd (GroundworkPlus) on behalf of Regional Group Australia to undertake an Air Quality Impact Assessment (AQIA) on the proposed hard rock quarry site located north east of Bellata on the land formally identified as Lot 10 DP 751753 and Lot 110 DP 257328. Regional Group Australia propose to operate the quarry for the land owner and proponent, John Meppem. This Air Quality Impact Assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) dated 24 August, 2018. This report aims to provide an assessment of air quality impacts of the proposed hard rock quarry against the criteria set out in the SEARS.

It should be noted that this report was prepared by Advitech Pty Limited for Regional Group Australia ('the customer') in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

2. BACKGROUND AND OBJECTIVES

2.1 Site Location and Surrounding Land Uses

The proposed Meppem Quarry is located along Manamoi Road, approximately 10 kilometres north east of the township of Bellata, midway between Narrabri and Moree in northern New South Wales. The proposed quarry lies on Lot 10 DP751753 and Lot 110 DP 257328 within the Moree Plains Local Government Area on land zoned RU1 Primary Production. The lots comprise about 143 hectares, although the footprint of the quarry would be 8.34 hectares, with an additional approximate 1.6 hectares for the haul road (see **Figure 1**). The haul road connects to the Newell Highway via Manamoi Road and Boo Boo Road. A water dam is located to the east of the footprint and will be created for the proposed quarry.

The locality of the proposal site is considered to be rural in nature, with farming (cropping) making up the predominant land use within the region. It is proposed that the hard rock quarry will extract and process a maximum of 490,000 tonnes per annum over a five year period. The material extracted from the quarry will comprise overburden and hard rock, which will be processed through a mobile crushing and screening plant before being stockpiled. The quarry will produce a number of products suitable for the needs of the Inland Rail Project. Upon completion of supply of material to the project, the area of operation of the quarry would be rehabilitated to a suitable landform for continuing rural activities.

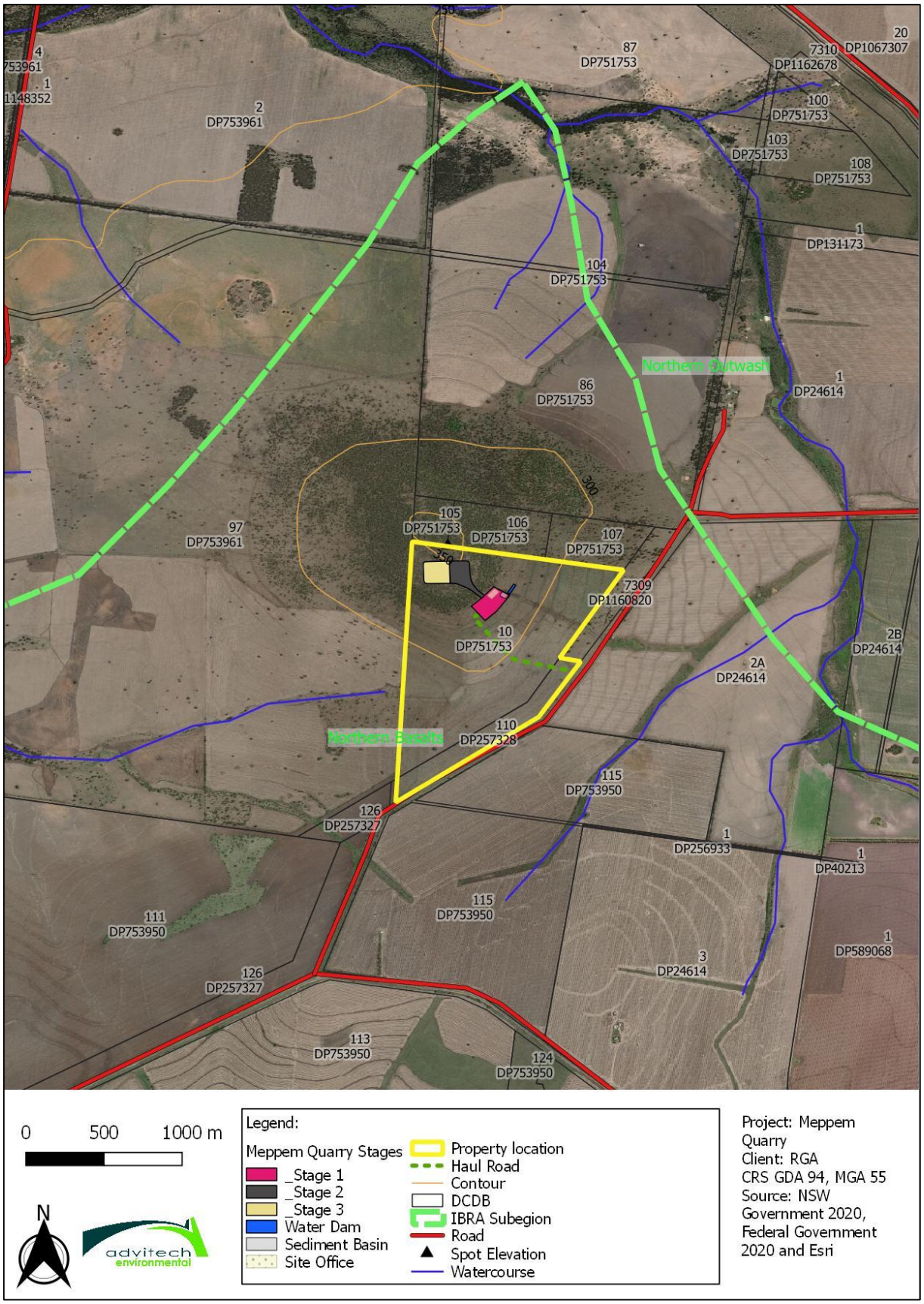

Figure 1: Site Location (Regional Context)

2.2 Project Description

The proposed quarry/extraction operations are as follows:

1. The internal access road from the Meppem quarry site down to the main road, that is Manamoi Road, will undergo its initial formation stage (the road will be cleared and formed to an all-weather gravel road standard);
2. The quarry site will undergo its preliminary construction phase which consists of establishing the crushing area platform within the site as well as performing preliminary clearing of the quarry face;
3. The crushing equipment will be delivered and installed on to the platform as well as the water supply and onsite buildings; and
4. The quarry will be subject to typical daily and weekly extraction activities such as blasting, winning, crushing and stockpiling of material as well as removing prepared product and transporting it using the access road and onto the Manamoi Road. The extracted material will be delivered off-site.

The facility proposes to have capacity to operate six days per week excluding Sundays and public holidays. The operating hours will be between 6 am – 6 pm on weekdays, between 6 am – 1 pm on Saturdays, and will be closed on Sundays and Public Holidays. The process is such that, aside from mined basalt material, no other material will need to be removed from the site. The site layout and indicative quarry extraction area is presented in **Figure 1**.

2.3 Sensitive receivers

The nearest potentially affected residences are provided in **Table 1** and shown on **Figure 2**. The residences are located in Bellata, along Manamoi Road and Berrigal Road. The area surrounding the development site can be described as an established rural setting.

Table 1: Sensitive Receivers.

Receiver ID	Easting UTM (m)	Northing UTM (m)	Address	Receiver Type
R1	780632	6693864	425 Manamoi Road Gurley 2398	Private Residence
R2	776013	6694359	207 Wilgaroi Road Bellata 2397	Private Residence
R3	782558	6689070	1499 Berrigal Creek Road Bellata 2397	Private Residence
R4	781405	6687849	1396 Berrigal Creek Road Bellata 2397	Private Residence
R5	784838	6690528	1733 Boo Boo Road Bellata 2397	Private Residence
R6	779748	6689142	1215 Berrigal Creek Road Bellata 2397	Private Residence
R7	773811	6693743	79 Wilgaroi Road Bellata 2397	Private Residence

Figure 2: Sensitive Receivers

3. AIR QUALITY GUIDELINES

The NSW Environment Protection Authority (EPA) specify the impact assessment criteria in the publication *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, 2016 (refer to **Section 11**, Reference 6). The relevant sections from this publication are reproduced below in **Table 2** which presents the ground level concentration (GLC) criteria for each applicable air pollutant.

Table 2: NSW EPA Impact Assessment Criteria.

Pollutant	NSW EPA Design Criteria	Units	Averaging Time
TSP[a]	90	µg/m^3	Annual
PM_{10}[b]	50	µg/m^3	24 hours
	25	µg/m^3	Annual
$PM_{2.5}$[c]	25	µg/m^3	24 hours
	8	µg/m^3	Annual
Deposited Dust[d]	2[e]	g/m2/month	Annual
	4[f]		

[a] Total suspended particulates.
[b] Particulate materials with an aerodynamic diameter less than 10 µm.
[c] Particulate materials with an aerodynamic diameter less than 2.5 µm.
[d] Dust is assessed as insoluble solids as defined by AS 3580.10.1.
[e] Maximum increase in deposited dust level.
[f] Maximum total deposited dust level.

4. METEOROLOGICAL DATA

4.1 Bureau of Meteorology Data

To determine the most representative 12 month calendar period required for modelling air emissions from the Meppem Quarry, historical Bureau of Meteorology (BOM) climate data at the Moree Airport Automatic Weather Station (AWS) (053115) was reviewed in **Table 3**. Historical BOM wind roses at Moree Airport from 2012 – 2017 have been presented in **Appendix III.**

Table 3: Bureau of Meteorology (BoM) Climate Data History for Moree Airport (053115).

Year	Temperature (°C)				Rainfall (mm)	
	Maximum year average	Difference from long term average	Minimum year average	Difference from long term average	Yearly total	Percentage of long term average
2012	26.4	-0.4	11.9	-0.6	633.2	109%
2013	27.6	+0.8	12.5	0.0	499.4	86%
2014	28.1	+1.3	13.7	+1.2	354.8	61%
2015	27.1	+0.3	13.1	+0.6	521.8	90%
2016	27.1	+0.3	13.5	+1.0	527.2	90%
2017	28.2	+1.4	13.4	+0.9	512.4	88%

A review of BOM climate and wind rose data suggests the years with the least deviation from long term average climate statistics are years 2012 and 2015. As a result of the review of climatic data (refer to **Table 3**) and wind rose data (refer to **Appendix III**), this report has adopted the 2015 year for air dispersion modelling purposes.

4.2 CALMET

Air dispersion modelling requires the creation of a three dimensional (3D) CALMET meteorological data file that represents the weather and climate for the region (domain) modelled. In brief, CALMET is a meteorological model that develops hourly (or sub-hourly) wind and other meteorological fields on a 3D gridded modelling domain. Associated two dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The final time varying wind field thus reflects the influences of local topography and land uses.

Compilation of a 2015 three dimensional (3D) meteorological data file for the Bellata area representative of the proposed site was obtained from the following data sources:

- Fifth-Generation NCARIPenn State Mesoscale Prognostic Model (MM5) for 2015;
- Bureau of Meteorology (BoM) automatic weather stations at Moree and Narrabri;
- Local weather stations (Tookey, Lochearn, Fairview) sourced from ozforecast.com.au (refer to Section 11, Reference 12);
- NSW DECC 2007 Land Use NSW; and
- Terrain data set with SRTM1 30 m resolution topography data.

MM5 is a widely-used 3D numerical meteorological model which contains non-hydrostatic dynamics and a variety of physics options. Extensive comparison between MM5 outputs and observed weather data has validated its use for application in the preparation of 3D CALMET weather files (refer to **Section 11**, Reference 9). MM5 is capable of simulating a variety of meteorological phenomena such as tropical cyclones, severe convective storms, sea-land breezes, and terrain forced flows such as mountain valley wind systems.

The generated 3D meteorological file used in this report was developed using meteorological observations in the CALMET hybrid mode. The MM5 wind field was used as an initial guess in CALMET which was subsequently used to generate its wind. The initial wind was then adjusted to account for the kinematic and thermal effects of terrain and land use on wind.

Figure 3 shows the frequency of wind speed and direction for each season during the 2015 calendar year extracted from the CALMET generated file.

The CALMET seasonal wind roses predict that the predominant winds are from a northeast direction in summer months and a northeast and southwest direction in the autumn, winter and spring months.

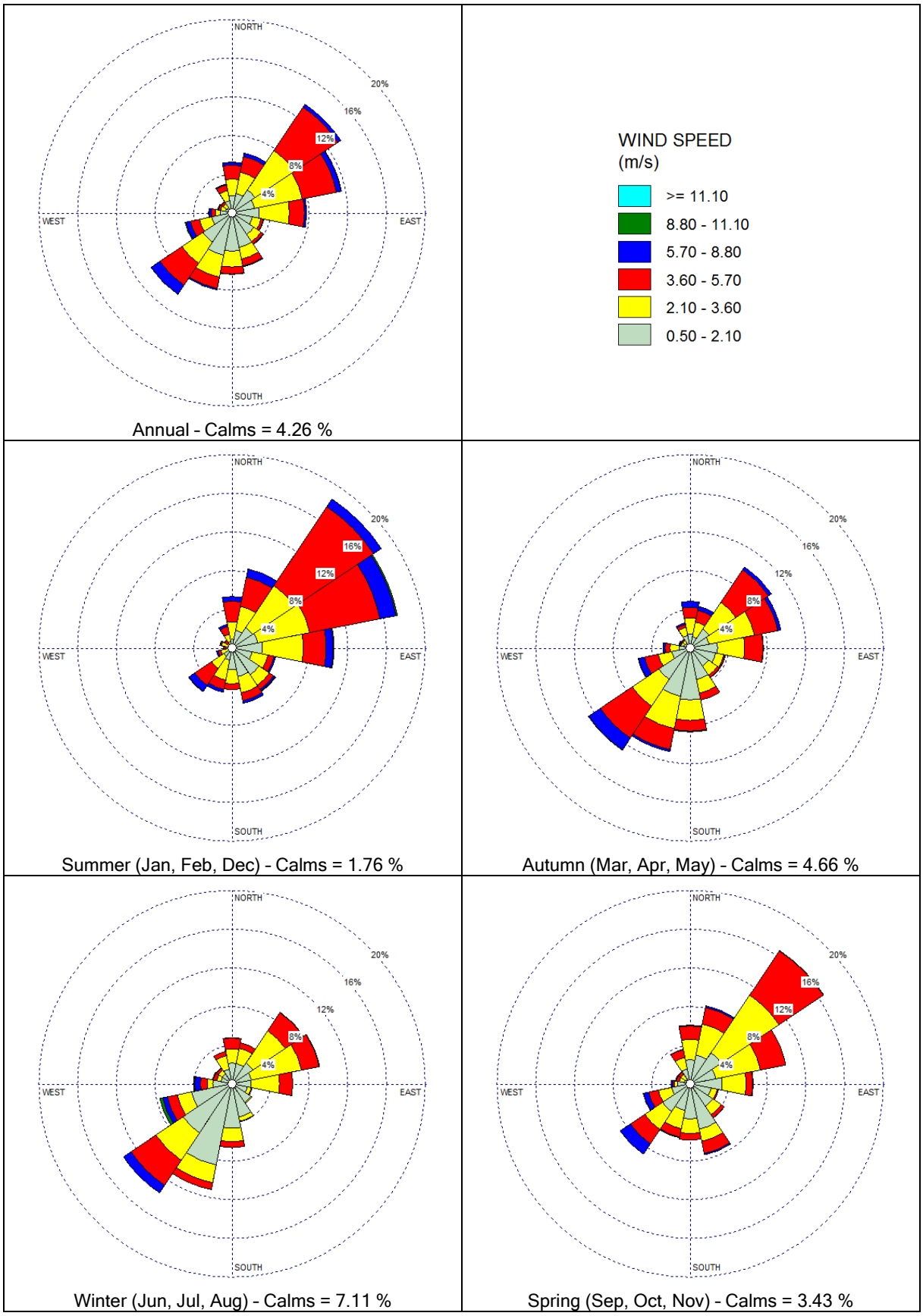

Figure 3: CALMET 2015 Meppem Quarry Site Seasonal Wind Roses.

5. MODELLING APPROACH/METHODOLOGY

5.1 Background Air Quality (Particulates)

Assessment of background air quality data has been undertaken for the airshed surrounding the proposed Meppem quarry operation.

The NSW Department of Environment, Energy and Science (DEES) operate an air quality monitoring program that collects accurate real-time measurements of ambient level pollutants at 28 monitoring sites within the air quality monitoring network (AQMN), located around the greater metropolitan area of Sydney, the Illawarra, the Lower Hunter and selected rural sites around NSW (refer to **Section 11**, Reference 8). Given the absence of background air quality data for 2015 in the Narrabri region, the nearest monitoring location at Tamworth was applied for the purpose of the assessment.

The Tamworth monitoring station commenced operation in 2000 and provides hourly meteorological data and particulate concentrations. It should be noted that $PM_{2.5}$ concentration monitoring began in August 2016 at the Tamworth monitoring station. In the absence of long term $PM_{2.5}$ monitoring measurements, this report has assumed a $PM_{2.5}$ to PM_{10} ratio of 0.5 (that is, 50% of PM_{10} is $PM_{2.5}$). A review of available $PM_{2.5}$ data (2016 - 2019) from the Tamworth station suggests the ratio is appropriate.

A Level 1 assessment of particulate background concentrations has been prepared for the pollutants listed in **Table 4** for the 2015 monitoring year to correspond with the meteorological data. The Level 1 assessment has assumed a worst-case background concentration by using the maximum reported value.

Table 4: Background Air Quality.

Pollutant	Background Concentration	Units	Averaging Time
TSP	28.2[a]	µg/m^3	Annual
PM_{10}	varies	µg/m^3	24 Hours
	14.1	µg/m^3	Annual
$PM_{2.5}$	varies[b]	µg/m^3	24 Hours
	7.1[c]	µg/m^3	Annual

[a] Assumed from annual average PM_{10} background concentration (TSP = 2 x PM_{10}).
[b] Assumed from 24 hour average PM_{10} background concentration ($PM_{2.5}$ = PM_{10} / 2).
[c] Assumed from annual average PM_{10} background concentration ($PM_{2.5}$ = PM_{10} / 2).

The maximum reported PM_{10} background concentration for the 2015 monitoring period was 52.7 µg/m^3 respectively, which is above the NSW EPA impact assessment criteria. As such, a Level 2 contemporaneous assessment of the PM_{10} background concentration is required to understand the cumulative impact of the proposed development. **Figure 4** displays the PM_{10} 24-hour average background concentrations for 2015 and indicates an exceedance of the NSW EPA impact assessment criteria.

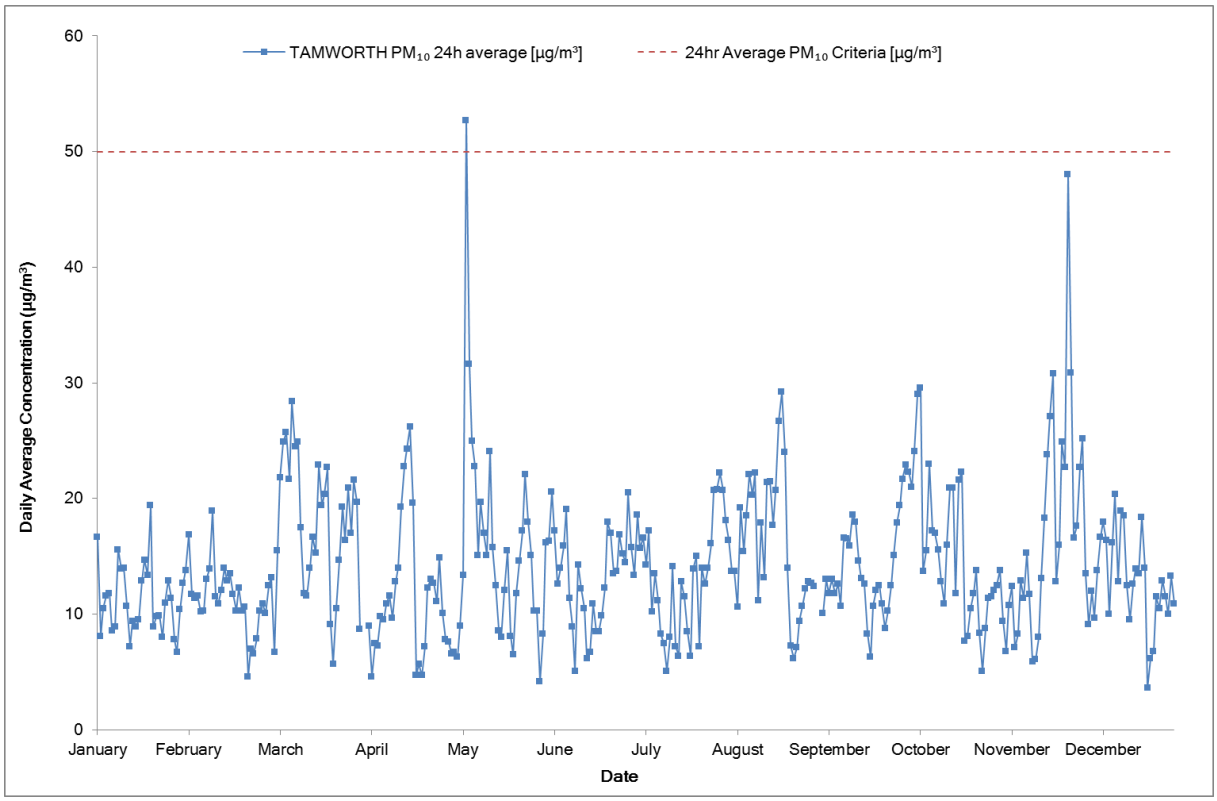

Figure 4: Daily Particulate Matter Concentrations for Tamworth 2015.

5.2 Meteorological Model Configuration

Table 5 details the parameters used in the meteorological modelling to drive the CALMET model. The nearest BOM observational station at Moree Airport AWS is 42 km north of the subject site. Additional data was obtained from three privately owned weather stations in the Bellata region. It is noted that the local stations use commercially available weather stations (Davis Instrument) and no maintenance history was available.

After comparison of the local observational data with regional observational data, Advitech considered the local data suitable for meteorological modelling. Therefore, the CALMET model was undertaken in 'Hybrid' mode using prognostic MM5 data with local and regional meteorological observations.

Table 5: CALMET Meteorological Parameters used in this Report.

Identifier	Descriptor	Comment
MM5	Grid spacing	4 km
	Year of analysis	2015
	Time step	hourly
CALMET (v 6.4.0)	Meteorological grid domain	20 km x 20 km
	Meteorological grid origin (SW corner)	768873 m, 6678165 m
	Meteorological grid resolution	0.16 km
	Surface meteorological stations	Moree AWS (053115) Tookey (Bellata) AWS Lochearn (Bellata) AWS Fairview (Bellata) AWS
	TERRAD value	5 km
	Cell Face Heights	0, 20, 40, 80, 160, 320, 700, 1300, 1700, 2300, 3000
	R1, R2, RMax1, RMax2	15 km, 15 km, 25 km, 25km

5.3 Dispersion Modelling Configuration

CALPUFF is an advanced non-steady-state meteorological and air quality modelling system. The model advects 'puffs' of material emitted from modelled sources, simulating the dispersion and transformation processes along the way. The model has been adopted by the US Environmental Protection Agency (US EPA) in its guideline on air quality models. CALPUFF uses the 3D wind fields generated by CALMET with the primary output files from CALPUFF processed in CALPOST to produce time based concentration or deposition fluxes evaluated at selected receiver locations.

Particulate concentrations were simulated for a regular Cartesian receiver grid covering a 20 km by 20 km computational domain, set within the CALMET modelling domain and centred 3 kms north from the project site, with a grid resolution of 0.16 km.

Section 5.5 outlines the assumptions made for the AQIA. **Appendix I** contains example CALMET and CALPOST input files.

5.4 Air Dispersion Model

The Meppem quarry operations are to proceed as per the project description outlined in **Section 2.2.** The modelling scenario (a 'worst-case') has been undertaken on the assumption basis presented in **Section 5.5.**

Dispersion modelling has been undertaken for the entire 2015 calendar year. The modelling scenario was conservatively assumed to be operating at the maximum annual operating limit of 490,000 metric tonnes per annum.

5.5 Assumptions

Assumptions used in the computation of GLCs and deposition for particulates using the CALPUFF dispersion model are listed below.

5.5.1 General

The following assumptions have been applied to the dispersion modelling of the Meppem Quarry.:

- Options within CALPUFF modelling reflect the *NSW OEH Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System guidelines* (refer to **Section 11**, Reference 7).
- Appropriate emission factors from the EET Manual for Mining v3.1 have been applied to all quarry emission sources (refer to **Section 11**, Reference 3).
- *The operating times for Meppem Quarry are* as follows:
  - Monday to Friday: 6 am to 6 pm;
  - Saturday: 6 am to 1 pm; and
  - Sundays and Public Holidays: Closed;
- The Meppem Quarry extraction area is as per Conceptual Final Landform document provided by GroundWork Plus Pty Ltd (refer to **Figure 1**). The quarry area is estimated at 54,000 m^2;
- A $PM_{2.5}$ to PM_{10} ratio of 0.15 and 0.1 has been applied to material handling and wheel generated emission sources respectively (refer to **Section 11**, Reference 11);
- A $PM_{2.5}$ to PM_{10} ratio of 0.5 has been applied to background particulates in the air (refer to **Section 5.1**);
- For dust deposition modelling, a geometric mass mean diameter (GMMD) of 12.8 µm for TSP and 7 µm for PM_{10} with geometric standard deviation (GSD) of 1.7 µm for TSP and 1.3 µm for PM_{10} respectively was applied (refer to **Section 11**, Reference 5);
- Wheel generated dust from haul trucks within the quarry extraction area were modelled as multiple volume sources in CALPUFF. Each volume source has a separation distance of less than one quarter of the distance to the nearest residential receiver (that is, 150 m). Particulate emissions were equally divided between volume sources;
- The number of vehicle kilometres travelled (that is, 0.83 km per one way trip) is calculated on the unpaved haul route separating the extraction area and the main road; that is, Manamoi Road (refer to **Section 11**, Reference 10); and
- The entire aforementioned quarry extraction area is assumed to be blasted. The implemented blasting frequency was conservatively assumed at one hour of blasting per day. This assumption grants the blasting operators the flexibility to undertake blasting activities any day of the year rather than confining them to a particular day per week or per month. As advised by Groundwork Plus, the maximum blast frequency is likely to occur once per fortnight. The blasting parameters were based on the blast design parameters provided by Groundwork Plus (refer to **Section 11**, Reference 13).

5.5.2 Dispersion Modelling Scenario (Normal Operation)

The annual average extraction rate for the Meppem Quarry operation is 1,630 tonnes of material per day. To account for fluctuations, Advitech Environmental has conservatively modelled emissions-to-air on the basis of 1,818 metric tonnes of material per day over the hours of operations as outlined in **Section 5.5.1**.

Wheel generated dust from heavy vehicles travelling on the site were modelled at the same rate as the production rate (i.e. 1,818 tonnes per day). Control factors (for example, water sprays) were not modelled on any emission sources.

5.5.3 Dispersion Modelling Scenario (Worst Case)

The annual average extraction rate for the Meppem Quarry operation is 1,630 tonnes of material per day. To account for fluctuations, Advitech Environmental has conservatively modelled emissions-to-air on the basis of 1,818 metric tonnes of material per day over the hours of operations as outlined in **Section 5.5.1**.

Wheel generated dust from heavy vehicles travelling on the site were modelled at a proposed maximum transport rate of 5,000 tonnes per day to account for short term fluctuations in demand for quarries products. Control factors (for example, water sprays) were not modelled on any emission sources.

5.5.4 Dispersion Modelling Scenario (Worst Case with Controls)

The annual average extraction rate for the Meppem Quarry operation is 1,630 tonnes of material per day. To account for fluctuations, Advitech Environmental has conservatively modelled emissions-to-air on the basis of 1,818 metric tonnes of material per day over the hours of operations as outlined in **Section 5.5.1**.

Wheel generated dust from heavy vehicles travelling on the site were modelled at a proposed maximum transport rate of 5,000 tonnes per day to account for short term fluctuations in demand for quarries products. Water spray control factors were applied on the crushers (50 % control factor) and haul roads (Level 1 watering – 50 % control factor) to demonstrate the potential reduction to emissions during worst case operations.

5.6 Emission Sources

The activities associated with the proposed operations with the potential to generate dust are:

- Blasting and drilling operations within the proposed quarry extraction area;
- Operation of front-end loader and excavator within the extraction area;
- Operation of the grader, primary crusher, secondary crusher and screen;
- Wind erosion from stockpiled quarry materials; and
- Dust generated by haul truck movements along internal access road up to Manamoi Road.

Details of each emission source are given in **Table 6.** The emission factors and estimates are based on the *Emission Estimation Technique (EET) Manual for Mining - Version 3.1*. Emissions from the manual are based on typical emission for coal and metalliferous mining operations. The emission factors have been applied to the quarry operation and can be considered as a conservative estimate.

Table 6: Emission Sources (Normal Operations)

Emitter Identifier	Emitter Name	Emission Factor			Modelled days (Days)	Modelled Working hours (hours/day)[1]	Emission Rate(g/s)			Modelled Location[3]		
		TSP	PM_{10}	Units			TSP	PM_{10}	$PM_{2.5}$	Easting (m)	Northing (m)	Ground Elevation (m)
Grader	Grader	0.19	0.085	kg/VKT[4]	275	12	0.1	0.045	0.007	778923	6692802	353
Drill	Drill	0.59	0.31	kg/hole	275	12	0.04	0.019	0.003	778923	6692802	353
Excav	Excavator	0.03	0.012	kg/t	275	12	1.05	0.505	0.076	778923	6692802	353
FEL	Front end loader	0.03	0.012	kg/t	275	12	1.05	0.505	0.076	778923	6692802	353
Crush1	Jaw Crusher	0.2	0.02	kg/t	275	12	8.42	0.842	0.126	778923	6692802	353
Crush2	Secondary Crusher	0.6	0.06	kg/t	275	12	25.25	2.53	0.379	778923	6692802	353
Screen	Screen	0.08	0.06	kg/t	275	12	3.37	2.525	0.379	778923	6692802	353
Erosion	Wind Erosion from stockpiles	0.4	0.2	kg/ha/hr	365	24	0.6	0.3	0.045	778923	6692802	353
Blast[5]	Blasting	0.74	0.382	kg/blast	275	1	0.21	0.106	0.016	778923	6692802	353
HR1-HR7	Wheel generated dust from truck movements[2]	3.93	1.16	kg/VKT[4]	275	12	7.228	2.133	0.320	Varies	Varies	Varies

Notes:

[1] - Weekday operating hours based on 6 am to 6 pm. Saturday operating hours based on 6 am to 1 pm. No operations on Sunday.

[2] - Kilometres travelled by haul trucks estimated from Google Earth satellite imagery. Wheel generated dust from haul trucks were modelled as a volume source in CALPUFF. Each volume source has a separation distance of 100 metres. Emission rates are sum of haul road points.

[3] - Plant equipment location is based on the centre of the quarry extraction footprint.

[4] - Vehicle Kilometres Travelled.

[5] - Blasting is assumed to occur at 2 pm on every operational day to enable the flexibility of choosing any day of the month for blasting.

6. DISPERSION MODELLING RESULTS (NORMAL OPERATION)

6.1 Annual Average PM_{10}, $PM_{2.5}$, TSP

The predicted concentrations at selected sensitive receivers of the annual average PM_{10}, $PM_{2.5}$ and TSP for the Meppem Quarry are presented in **Table 7**.

Table 7: Predicted Annual Average PM_{10}, $PM_{2.5}$ and TSP at Sensitive Receivers (Normal Operation)

Receiver	Predicted Annual Average PM_{10} Increment +Background (µg/m^3)	Predicted Annual Average $PM_{2.5}$ Increment +Background (µg/m^3)	Predicted Annual Average TSP Increment +Background (µg/m^3)
Background[1]	14.1	7.1	28.2
R1	15.0	7.3	30.0
R2	14.2	7.1	22.5
R3	14.2	7.1	28.4
R4	14.2	7.1	28.4
R5	14.2	7.1	28.3
R6	14.3	7.2	28.7
R7	14.2	7.1	28.4

[1] - Background particulate concentrations obtained from the NSW DEES monitoring station at Tamworth

Table 7 presents the predicted cumulative 100th percentile annual average PM_{10}, $PM_{2.5}$ and TSP for sensitive receivers respectively. The annual PM_{10}, $PM_{2.5}$ and TSP impact assessment criteria are not exceeded at any sensitive receiver.

6.2 24 Hour Average PM_{10}

The predicted concentrations at selected sensitive receivers of the 24-hour average PM_{10} maximum increment for the Meppem Quarry are presented in **Table 8**.

Table 8: Maximum Impact of 24 Hour Average PM_{10} (Normal Operation)

Receiver	Meppem Quarry Maximum Predicted Increment (µg/m^3)	Maximum Background Concentration (µg/m^3)[1]	Total (µg/m^3)
R1	13.0	48.0 (26/11/2015)	**61.0**
R2	2.5		**50.5**
R3	4.2		**52.2**
R4	4.8		**52.8**
R5	1.6		**49.6**
R6	7.6		**55.6**
R7	1.7		49.7

Notes:
[1] - The background concentration of 52.7 µg/m^3 (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 48.0 µg/m^3 was used.

The exceedances at nearby sensitive receivers of the 24-hour average PM_{10} concentration presented in **Table 8** are likely a result of an elevated background PM_{10} concentration. A Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average PM_{10} contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 10**.

One exceedance displayed in **Table 10** has been discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour PM_{10} impact assessment criteria at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

6.1 24 Hour Average $PM_{2.5}$

The predicted concentrations at selected sensitive receivers of the 24-hour average $PM_{2.5}$ for the proposed operation are presented in **Table 9**. A maximum 24-hour $PM_{2.5}$ background concentration of 24.0 µg/m^3 has been applied (refer to **Table 4**) to determine if further assessment is required.

Table 9: Predicted Maximum 24 Hour Average $PM_{2.5}$ at Sensitive Receivers (Normal Operation)

Receiver	Subject Site Maximum Predicted Increment (µg/m^3)	Maximum Background Concentration (µg/m^3)[1]	Total (µg/m^3)
R1	2.7	24.0 µg/m^3 (26/11/2015)	**26.7**
R2	0.6		24.6
R3	0.9		24.9
R4	0.9		24.9
R5	0.4		24.4
R6	1.3		**25.3**
R7	0.6		24.6

Notes:
[1] - The background concentration of 26.3 µg/m^3 (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 24.0 µg/m^3 was used.

The two exceedances at nearby sensitive receivers of the 24-hour average $PM_{2.5}$ concentration presented in **Table 9** are likely a result of an elevated background PM_{10} concentration. Therefore, a Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average $PM_{2.5}$ contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 11.**

One exceedance presented in **Table 11** was discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour $PM_{2.5}$ impact assessment criteria at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

Table 10: Summary of the 24 Hour Average PM_{10} Contemporaneous Impact and Background (Normal Operation)

Date	PM_{10} 24-hour average ($\mu g/m^3$)				Date	PM_{10} 24-hour average ($\mu g/m^3$)			
	Highest Background[1]	Predicted Increment - Meppem Quarry	Receiver	Total		Background	Highest Predicted Increment - Meppem Quarry	Receiver	Total
6/05/2015	**52.7**	1.8	R1	**54.5**	14/07/2015	8.0	13.0	R1	21.0
26/11/2015	48.0	0.7	R1	48.7	19/06/2015	8.5	13.0	R1	21.5
7/05/2015	31.6	1.1	R1	32.7	26/08/2015	7.1	8.4	R1	15.5
27/11/2015	30.9	1.5	R1	32.4	15/10/2015	10.9	7.6	R6	18.5
21/11/2015	30.8	1.3	R1	32.1	22/04/2015	7.2	6.2	R1	13.4
7/10/2015	29.6	0.7	R1	30.3	17/07/2015	6.4	5.6	R1	12.0
21/08/2015	29.2	0.4	R6	29.6	5/08/2015	13.7	5.6	R1	19.3
6/10/2015	29.0	0.6	R6	29.6	9/09/2015	12.6	5.5	R1	18.1
8/03/2015	28.4	0.1	R2	28.5	4/03/2015	21.8	5.4	R1	27.2
20/11/2015	27.1	1.9	R4	29.0	23/04/2015	12.3	5.3	R1	17.6
20/08/2015	26.7	0.6	R6	27.3	21/05/2015	8.1	5.1	R1	13.2
17/04/2015	26.2	0.0	R6	26.2	22/05/2015	6.5	4.8	R1	11.3
6/03/2015	25.7	1.0	R1	26.7	3/09/2015	0.0	4.8	R1	4.8
1/12/2015	25.2	0.3	R6	25.5	25/07/2015	14.0	4.8	R4	18.8
8/05/2015	25.0	1.7	R1	26.7	2/07/2015	13.4	4.8	R1	18.2

Notes:
[1] - Highlighted fields indicate predicted exceedance discounted as 24 hour average PM_{10} was already at the NSW EPA impact criteria.

Table 11: Summary of the 24 Hour Average $PM_{2.5}$ Contemporaneous Impact and Background (Normal Operation)

Date	$PM_{2.5}$ 24-hour average ($\mu g/m^3$)[1]				Date	$PM_{2.5}$ 24-hour average ($\mu g/m^3$)			
	Highest Background[1]	Predicted Increment - Meppem Quarry	Receiver	Total		Background	Highest Predicted Increment - Meppem Quarry	Receiver	Total
6/05/2015	**26.4**	0.3	R1	**26.7**	26/08/2015	3.6	2.7	R1	6.3
26/11/2015	24.0	0.1	R1	24.1	14/07/2015	4.0	2.1	R1	6.1
7/05/2015	15.8	0.2	R1	16.0	19/06/2015	4.3	2.0	R1	6.3
27/11/2015	15.5	0.3	R1	15.8	15/10/2015	5.5	1.3	R6	6.8
21/11/2015	15.4	0.3	R1	15.7	5/09/2015	6.5	1.3	R1	7.8
7/10/2015	14.8	0.1	R1	14.9	3/06/2015	8.2	1.0	R1	9.2
21/08/2015	14.6	0.1	R6	14.7	17/07/2015	3.2	1.0	R1	4.2
6/10/2015	14.5	0.1	R6	14.6	22/04/2015	3.6	1.0	R1	4.6
8/03/2015	14.2	0.0	R2	14.2	16/04/2015	12.2	1.0	R6	13.2
20/11/2015	13.6	0.3	R4	13.9	5/08/2015	6.9	1.0	R1	7.9
20/08/2015	13.4	0.2	R1	13.6	27/08/2015	4.7	1.0	R6	5.7
17/04/2015	13.1	0.0	R6	13.1	25/07/2015	7.0	0.9	R4	7.9
6/03/2015	12.9	0.2	R1	13.1	4/09/2015	5.1	0.9	R1	6.0
1/12/2015	12.6	0.1	R6	12.7	22/05/2015	3.3	0.9	R1	4.2
8/05/2015	12.5	0.3	R1	12.8	4/03/2015	10.9	0.9	R1	11.8

Notes:
[1] - Highlighted fields indicate predicted exceedance discounted as annual average of PM_{10} and $PM_{2.5}$ for R1 was already at the NSW EPA impact criteria.

6.2 Dust Deposition

The predicted annual average dust deposition rates at selected sensitive receivers for the proposed operation are presented in **Table 12**.

Table 12: Predicted Dust Deposition at Sensitive Receivers (Normal Operation)

Receiver	Subject Site Maximum Predicted Increment (g/m^2/month)	Impact Assessment Criteria
R1	0.1	2 g/m^2/month
R2	0.0	
R3	0.0	
R4	0.0	
R5	0.0	
R6	0.0	
R7	0.0	

Dispersion modelling indicates there are no exceedances of the maximum increase in deposited dust level criteria of 2 g/m^2/month at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

7. DISPERSION MODELLING RESULTS (WORST CASE SCENARIO)

7.1 Annual Average PM_{10}, $PM_{2.5}$, TSP

The predicted concentrations at selected sensitive receivers of the annual average PM_{10}, $PM_{2.5}$ and TSP for the Meppem Quarry are presented in **Table 13**.

Table 13: Predicted Annual Average PM_{10}, $PM_{2.5}$ and TSP at Sensitive Receivers (Worst Case)

Receiver	Predicted Annual Average PM_{10} Increment +Background ($\mu g/m^3$)	Predicted Annual Average $PM_{2.5}$ Increment +Background ($\mu g/m^3$)	Predicted Annual Average TSP Increment +Background ($\mu g/m^3$)
Background[1]	14.1	7.1	28.2
R1	15.3	7.3	31.8
R2	14.2	7.1	28.6
R3	14.2	7.1	28.5
R4	14.3	7.1	28.6
R5	14.2	7.1	28.4
R6	14.6	7.2	29.4
R7	14.2	7.1	28.5

[1] - Background particulate concentrations obtained from the NSW DEES monitoring station at Tamworth

Table 13 presents the predicted cumulative 100th percentile annual average PM_{10}, $PM_{2.5}$ and TSP for sensitive receivers respectively. The annual PM_{10}, $PM_{2.5}$ and TSP impact assessment criteria are not exceeded at any sensitive receiver.

7.2 24 Hour Average PM_{10}

The predicted concentrations at selected sensitive receivers of the 24-hour average PM_{10} maximum increment for the Meppem Quarry are presented in **Table 14**.

Table 14: Maximum Impact of 24 Hour Average PM_{10} (Worst Case)

Receiver	Meppem Quarry Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)[1]	Total (µg/m³)
R1	12.5	48.0 (26/11/2015)	**60.5**
R2	2.2		**50.2**
R3	6.1		**54.1**
R4	12.7		**60.7**
R5	6.9		**54.9**
R6	14.6		**62.6**
R7	2.2		**50.2**

Notes:
[1] - The background concentration of 52.7 µg/m³ (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 48.0 µg/m³ was used.

The exceedances at nearby sensitive receivers of the 24-hour average PM_{10} concentration presented in **Table 14** are likely a result of an elevated background PM_{10} concentration. A Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average PM_{10} contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 16**.

One exceedance displayed in **Table 16** has been discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour PM_{10} impact assessment criteria at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

7.3 24 Hour Average $PM_{2.5}$

The predicted concentrations at selected sensitive receivers of the 24-hour average $PM_{2.5}$ for the proposed operation are presented in **Table 15**. A maximum 24-hour $PM_{2.5}$ background concentration of 24.0 µg/m³ has been applied (refer to **Table 4**) to determine if further assessment is required.

Table 15: Predicted Maximum 24 Hour Average $PM_{2.5}$ at Sensitive Receivers (Worst Case)

Receiver	Subject Site Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)[1]	Total (µg/m³)
R1	2.1	24.0 µg/m³ (26/11/2015)	**26.1**
R2	0.4		24.4
R3	1.5		**25.5**
R4	2.5		**26.5**
R5	1.8		**25.8**
R6	3.4		**27.4**
R7	0.5		24.5

Notes:
[1] - The background concentration of 26.3 µg/m³ (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 24.0 µg/m³ was used.

The five exceedances at nearby sensitive receivers of the 24-hour average $PM_{2.5}$ concentration presented in **Table 17** are likely a result of an elevated background $PM_{2.5}$ concentration. Therefore, a Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average $PM_{2.5}$ contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 17.**

One exceedance presented in **Table 17** was discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour $PM_{2.5}$ impact assessment criteria at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

Table 16: Summary of the 24 Hour Average PM_{10} Contemporaneous Impact and Background (Worst Case)

Date	PM_{10} 24-hour average ($\mu g/m^3$)				Date	PM_{10} 24-hour average ($\mu g/m^3$)			
	Highest Background[1]	Predicted Increment - Meppem Quarry	Receiver	Total		Background	Highest Predicted Increment - Meppem Quarry	Receiver	Total
06/05/15	**52.7**	2.7	R1	**55.4**	16/04/15	24.3	14.6	R6	38.9
26/11/15	48.0	0.4	R1	48.4	25/07/15	14.0	14.4	R6	28.4
07/05/15	31.6	1.6	R1	33.2	14/07/15	8.0	12.5	R1	20.5
27/11/15	30.9	2.0	R1	32.9	27/08/15	9.4	12.0	R6	21.4
21/11/15	30.8	1.4	R1	32.2	28/05/15	15.1	10.4	R6	25.5
07/10/15	29.6	0.8	R1	30.4	15/10/15	10.9	10.4	R6	21.3
21/08/15	29.2	0.7	R6	29.9	05/05/15	13.4	9.3	R6	22.7
06/10/15	29.0	0.9	R6	29.9	19/06/15	8.5	8.9	R1	17.4
08/03/15	28.4	0.1	R6	28.5	29/08/15	12.2	8.7	R1	20.9
20/11/15	27.1	0.6	R4	27.7	09/06/15	19.1	8.3	R1	27.4
20/08/15	26.7	1.6	R6	28.3	10/10/15	23.0	8.0	R6	31.0
17/04/15	26.2	0.2	R6	26.4	27/06/15	16.9	7.9	R1	24.8
06/03/15	25.7	2.1	R1	27.8	28/04/15	10.1	7.8	R1	17.9
01/12/15	25.2	0.4	R6	25.6	24/07/15	7.2	7.3	R6	14.5
08/05/15	25.0	2.7	R1	27.7	26/08/15	7.1	7.2	R1	14.3

Notes:
[1] - Highlighted fields indicate predicted exceedance discounted as 24 hour average PM_{10} was already at the NSW EPA impact criteria.

Table 17: Summary of the 24 Hour Average $PM_{2.5}$ Contemporaneous Impact and Background (Worst Case)

Date	$PM_{2.5}$ 24-hour average (µg/m³)[1]				Date	$PM_{2.5}$ 24-hour average (µg/m³)			
	Highest Background[1]	Predicted Increment - Meppem Quarry	Receiver	Total		Background	Highest Predicted Increment - Meppem Quarry	Receiver	Total
06/05/15	**26.4**	0.5	R1	**26.9**	16/04/15	12.2	3.4	R6	15.6
26/11/15	24.0	0.1	R1	24.1	25/07/15	7.0	3.2	R6	10.2
07/05/15	15.8	0.3	R1	16.1	05/05/15	6.7	2.6	R6	9.4
27/11/15	15.5	0.4	R1	15.9	27/08/15	4.7	2.3	R6	7.0
21/11/15	15.4	0.2	R1	15.7	15/10/15	5.5	2.1	R6	7.6
07/10/15	14.8	0.1	R1	14.9	28/05/15	7.6	2.1	R6	9.7
21/08/15	14.6	0.1	R6	14.7	28/04/15	5.1	2.1	R1	7.2
06/10/15	14.5	0.1	R6	14.6	14/07/15	4.0	2.1	R1	6.1
08/03/15	14.2	0.0	R6	14.2	10/10/15	11.5	2.0	R6	13.5
20/11/15	13.6	0.1	R4	13.7	09/06/15	9.6	2.0	R1	11.6
20/08/15	13.4	0.3	R6	13.7	04/07/15	7.9	1.8	R5	9.7
17/04/15	13.1	0.0	R6	13.1	24/07/15	3.6	1.5	R6	5.1
06/03/15	12.9	0.4	R1	13.3	19/03/15	10.2	1.5	R1	11.7
01/12/15	12.6	0.1	R6	12.7	29/08/15	6.1	1.5	R1	7.6
08/05/15	12.5	0.4	R1	12.9	27/06/15	8.5	1.4	R1	9.9

Notes:
[1] - Highlighted fields indicate predicted exceedance discounted as annual average of PM_{10} and $PM_{2.5}$ for R1 was already at the NSW EPA impact criteria.

7.4 Dust Deposition

The predicted annual average dust deposition rates at selected sensitive receivers for the proposed operation are presented in **Table 18**.

Table 18: Predicted Dust Deposition at Sensitive Receivers (Worst Case)

Receiver	Subject Site Maximum Predicted Increment (g/m^2/month)	Impact Assessment Criteria
R1	0.1	2 g/m^2/month
R2	0.0	
R3	0.0	
R4	0.0	
R5	0.0	
R6	0.0	
R7	0.0	

Dispersion modelling indicates there are no exceedances of the maximum increase in deposited dust level criteria of 2 g/m^2/month at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

8. DISPERSION MODELLING RESULTS (WORST CASE W/ MITIGATION)

8.1 Annual Average PM_{10}, $PM_{2.5}$, TSP

The predicted concentrations at selected sensitive receivers of the annual average PM_{10}, $PM_{2.5}$ and TSP for the Meppem Quarry are presented in **Table 19**.

Table 19: Predicted Annual Average PM_{10}, $PM_{2.5}$ and TSP at Sensitive Receivers (Mitigation)

Receiver	Predicted Annual Average PM_{10} Increment +Background ($\mu g/m^3$)	Predicted Annual Average $PM_{2.5}$ Increment +Background ($\mu g/m^3$)	Predicted Annual Average TSP Increment +Background ($\mu g/m^3$)
Background[1]	14.1	7.1	28.2
R1	14.8	7.2	30.2
R2	14.2	7.1	28.4
R3	14.2	7.1	28.4
R4	14.2	7.1	28.4
R5	14.2	7.1	28.3
R6	14.4	7.1	28.8
R7	14.2	7.1	28.4

[1] - Background particulate concentrations obtained from the NSW DEES monitoring station at Tamworth

Table 13 presents the predicted cumulative 100th percentile annual average PM_{10}, $PM_{2.5}$ and TSP for sensitive receivers respectively. The annual PM_{10}, $PM_{2.5}$ and TSP impact assessment criteria are not exceeded at any sensitive receiver.

8.2 24 Hour Average PM_{10}

The predicted concentrations at selected sensitive receivers of the 24-hour average PM_{10} maximum increment for the Meppem Quarry are presented in **Table 20**.

Table 20: Maximum Impact of 24 Hour Average PM_{10} (Mitigation)

Receiver	Meppem Quarry Maximum Predicted Increment (µg/m³)[2]	Maximum Background Concentration (µg/m³)[1]	Total (µg/m³)
R1	8.2 (-35 %)	48.0 (26/11/2015)	**56.2**
R2	1.3 (-40 %)		49.3
R3	3.2 (-47 %)		**51.2**
R4	7.8 (-38 %)		**55.8**
R5	3.8 (-45 %)		**51.8**
R6	8.5 (-42 %)		**56.5**
R7	1.2 (-47 %)		49.2

Notes:
[1] - The background concentration of 52.7 µg/m³ (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 48.0 µg/m³ was used.
[2] - Precentage change between results presented in **Section 7**.

The exceedances at nearby sensitive receivers of the 24-hour average PM_{10} concentration presented in **Table 20** are likely a result of an elevated background PM_{10} concentration. No contemporaneous assessment was undertaken for this scenario since the worst case modelling presented in **Section 7** indicates that there are no additional exceedances of the 24 hour PM_{10} impact assessment criteria at nearby sensitive receivers.

The predicted increment from the quarry operations has reduced between 35 – 47 % as a result of water spray mitigation measures compared with the worst case scenario presented in **Section 7**.

8.3 24 Hour Average $PM_{2.5}$

The predicted concentrations at selected sensitive receivers of the 24-hour average $PM_{2.5}$ for the proposed operation are presented in **Table 21**.

Table 21: Predicted Maximum 24 Hour Average $PM_{2.5}$ at Sensitive Receivers (Mitigation)

Receiver	Subject Site Maximum Predicted Increment (µg/m³)[2]	Maximum Background Concentration (µg/m³)[1]	Total (µg/m³)
R1	1.0 (-54 %)	24.0 µg/m³ (26/11/2015)	**25.0**
R2	0.1 (-64 %)		24.1
R3	0.4 (-71 %)		24.4
R4	1.0 (-60 %)		**25.0**
R5	0.5 (-71 %)		24.5
R6	1.2 (-66 %)		**25.2**
R7	0.1 (-71 %)		24.1

Notes:
[1] - The background concentration of 26.3 µg/m³ (refer to **Figure 4**) has been discounted as it is above the impact assessment criteria. Therefore, the next highest value of 24.0 µg/m³ was used.
[2] - Precentage change between results presented in **Section 7**.

The two exceedances at nearby sensitive receivers of the 24-hour average $PM_{2.5}$ concentration presented in **Table 21** are likely a result of an elevated background $PM_{2.5}$ concentration. No contemporaneous assessment was undertaken for this scenario since the worst case modelling presented in **Section 7** indicates that there are no additional exceedances of the 24 hour $PM_{2.5}$ impact assessment criteria at nearby sensitive receivers.

The predicted increment from the quarry operations has reduced between 54 – 71 % as a result of water spray mitigation measures compared with the worst case scenario presented in **Section 7**.

9. DISCUSSION

The particulate dispersion modelling indicates that air quality impacts (i.e. airborne dust) from the Meppem Quarry is not likely to cause any additional exceedances of the PM_{10}, $PM_{2.5}$ or deposited dust impact assessment criteria at the identified nearby sensitive receivers.

Elevated background levels appear to be largely responsible for any predicted exceedances of the NSW EPA impact criteria. The exceedances only occurred when the background levels were above the assessment criteria. The operations of the Meppem Quarry did not cause any exceedances of the impact criteria. Additional modelling indicates that dust impacts can be reduced further as a result of water sprays on dust emissions from the crushers and vehicle movements on site.

10. CONCLUSIONS AND RECOMMENDATIONS

Advitech Environmental modelled a worst case scenario (i.e. 1,818 metric tonnes per day production and up to 5,000 metric tonnes per day transport) for the proposed Meppem Quarry to assess the potential particulate impacts to sensitive receivers. The results of the CALPUFF modelling indicate that operation of the Meppem Quarry will not result in incremental increases in particulate matter and dust deposition at surrounding sensitive receivers.

Any exceedances that may occur will be likely attributed to elevated background concentrations rather than a significant incremental contribution from the proposed development. To minimise potential impacts from the quarry operations, including minimising occurrences of predicted maximum increments, Advitech Environmental recommends implementation of the following measures:

- An air quality management plan (AQMP) be developed to ensure effective management and measurement of particulate emissions;
- Water sprays to be applied to dust generation sources when dust plumes are visible; and
- Enforcement of a maximum speed of 40 km/hr on unsealed haul and internal roads;

11. REFERENCES

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Appendix I

Example CALPUFF Input File

Table 22: Applied CALMET Modelling Parameters

Parameter	Value Used	Comment
Terrain radius of influence (TERRAD)	5 km	TERRAD can be estimated as the typical ridge-to-ridge distance divided by two, and usually rounded up. Typical values of TERRAD are between 5-15 km with an upper limit of about 20 km. The Mount Kapular National Park (NE adjacent to the site) is the only significant terrain feature in the area and the terrain is typically flat in all other directions.
Vertical extrapolation of surface wind observations (IEXTRP)	Similarity Theory	As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
Layer dependent weighting factor of surface vs. upper air wind observations in defining the Initial Guess Field (IGF) winds (BIAS)	Default (0)	As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
Weighting parameter for Step 1 wind field vs. observations in Layer 1 (R1)	15 km	Approximate distance from the Narrabri AWS to the base of the Mount Kaputar National Park.
Weighting parameter for Step 1 wind field vs. observations in Layer 2 and above (R2)	15 km	Approximate distance from the Narrabri AWS to the base of the Mount Kaputar National Park.
Maximum radius of influence for meteorological stations in layer 1 (RMAX1)	25 km	Typically values of RMAX1 and RMAX2 are smaller than R1 and R2, this way 'sharp' boundaries between the Step 1 wind field and the weighted observation station are prevented.
Maximum radius of influence for meteorological stations in layer 2 and above (RMAX2)	25 km	Typically values of RMAX1 and RMAX2 are smaller than R1 and R2, this way 'sharp' boundaries between the Step 1 wind field and the weighted observation station are prevented.
Modelling mode (NOOBS)	1 (Hybrid)	Using WRF data and one observational station dataset (BoM Narrabri AWS)
(ICLOUD)	4	As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
Minimum radius of influence used in the wind field interpolation (RMIN)	0.16 km	Default value. As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
No. of vertical layers (NZ)	10	
Cell face heights in arbitrary vertical grid (ZFACE) (m)	0, 20, 40, 80, 160, 320, 700, 1300, 1700, 2300, 3000	

Note: CALMET input parameters not listed in the table are set as default values.

Table 23: Applied CALPUFF Modelling Parameters

Parameter	Value Used	Comment
Dry deposition modelled (MDRY)	1	Dry deposition was modelled. Geometric mass mean diameters applied are presented in **Section 5.4.1**.
Chemical transformation	0	Chemical transformation was not modelled
Method used to compute dispersion coefficients (MDISP)	2 (dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables)	As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
Default minimum turbulence velocities sigma-v for each stability class over land and over water (m/s) (SVMIN)	0.2 m/s for all stability classes	As recommended by the NSW Generic Guidance and Optimum Model Settings for CALPUFF.
Emission Sources (Volume sources)	Variable emission file used (VOLEMARB)	External file generated.

Note: CALPUFF input parameters not listed in the table are set as default values.

Appendix II

Contour Plots (Normal Operation)

Figure 5: 100th Percentile Annual Average PM_{10} Concentration (Contour labels = 5, 10 µg/m^3)

Figure 6: 100th Percentile Annual Average $PM_{2.5}$ Concentration (Contour labels = 2, 10 µg/m^3)

Figure 7: 100th Percentile Annual Average TSP Concentration (Contour labels = 5, 10, 20 µg/m³)

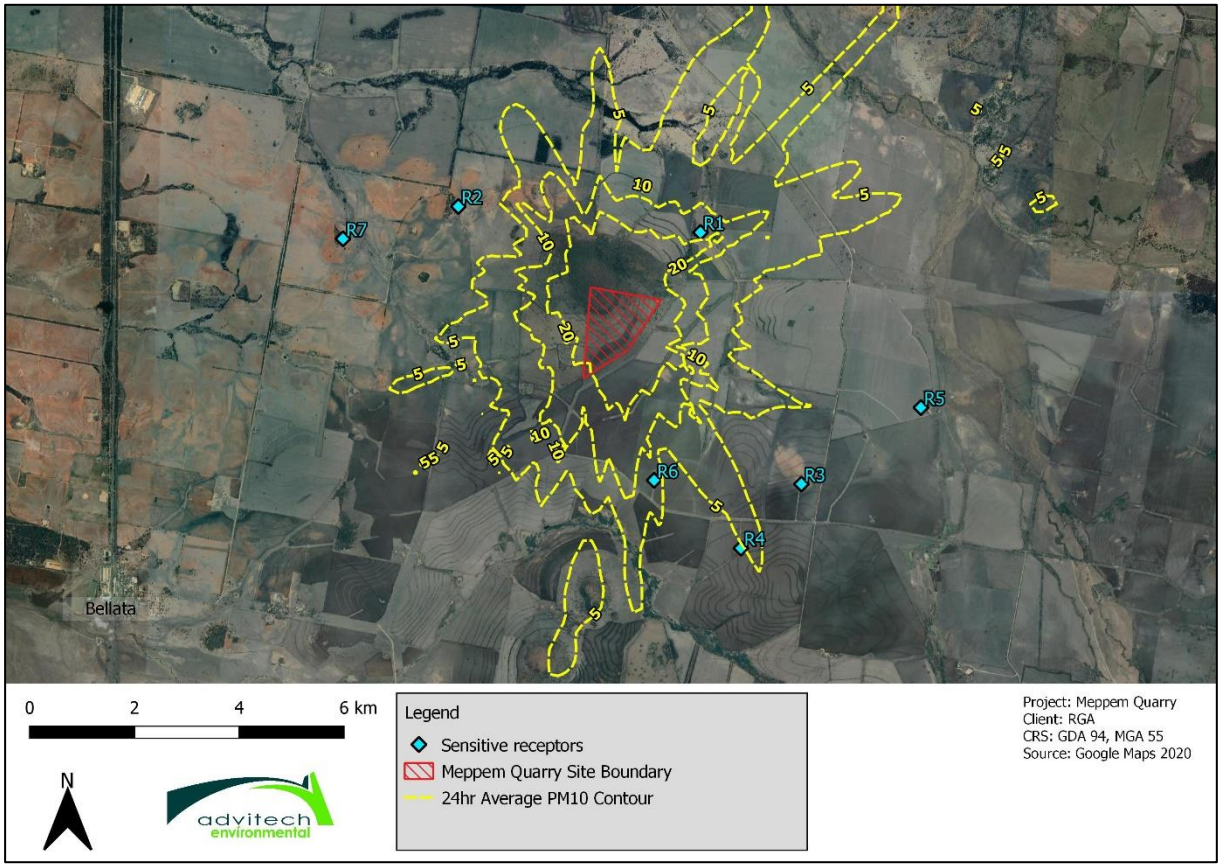


Figure 8: 100th Percentile 24-hr Average PM_{10} Concentration
(Contour labels = 5, 10, 20 µg/m³)

Figure 9: 100th Percentile 24-hr Average $PM_{2.5}$ Concentration
(Contour labels = 5, 15 µg/m^3)

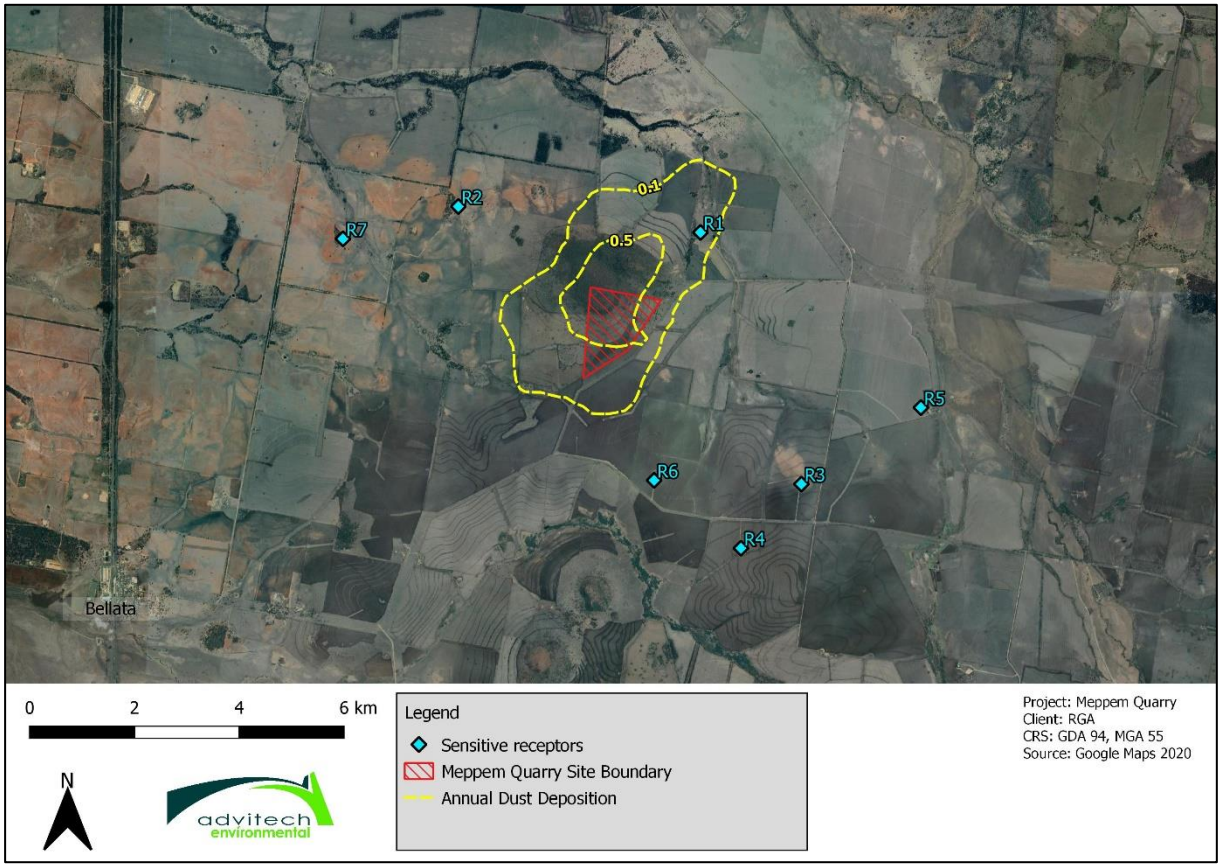
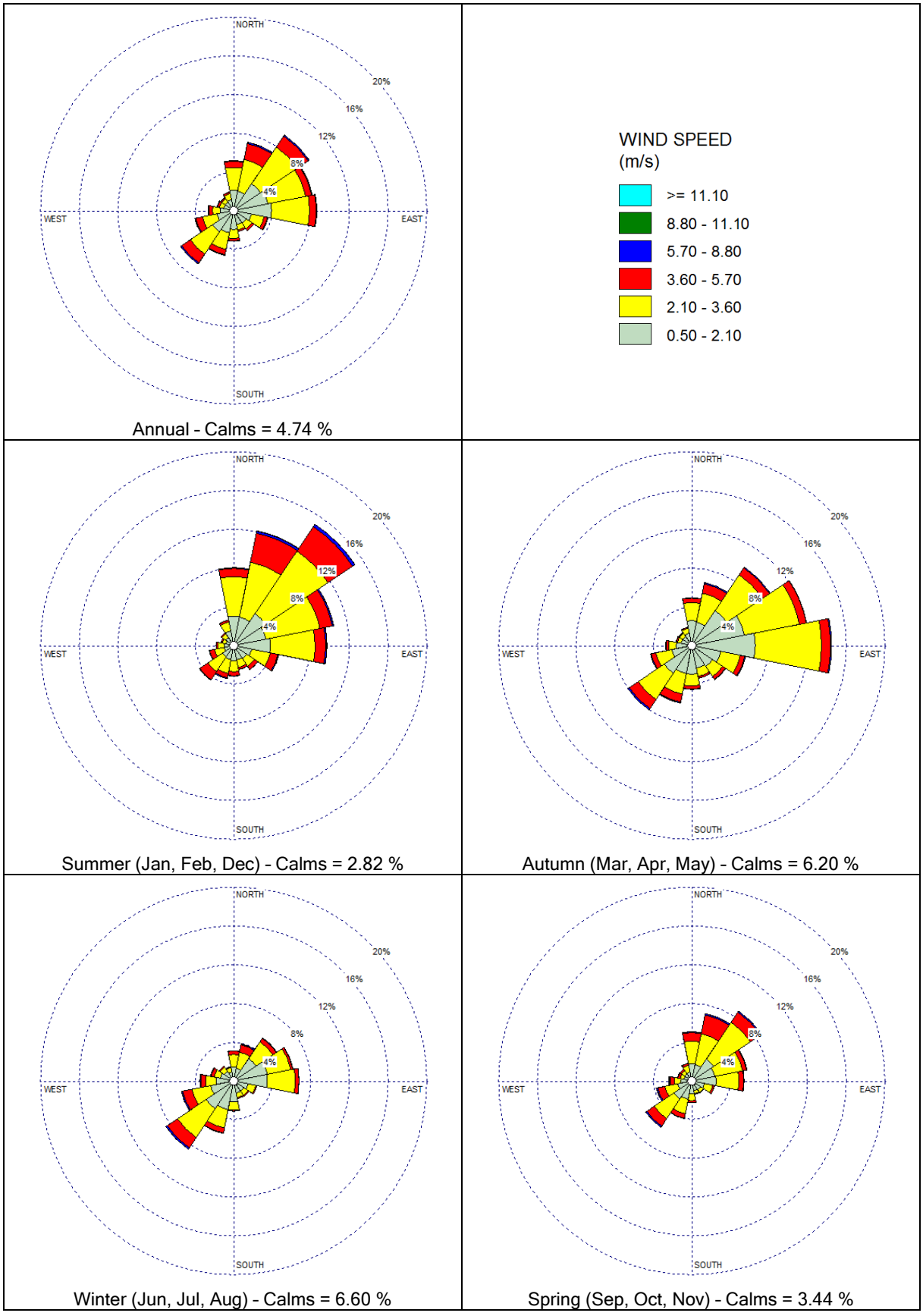


Figure 10: 100th Percentile Annual Average Incremental Dust Deposition Rate (Contour labels = 0.1, 0.5 g/m^2/month)

Appendix III

Moree Annual Wind Roses

Moree Airport AWS (053115) 2007 - 2017 Annual and Seasonal Wind Roses



Annual - Calms = 4.74 %

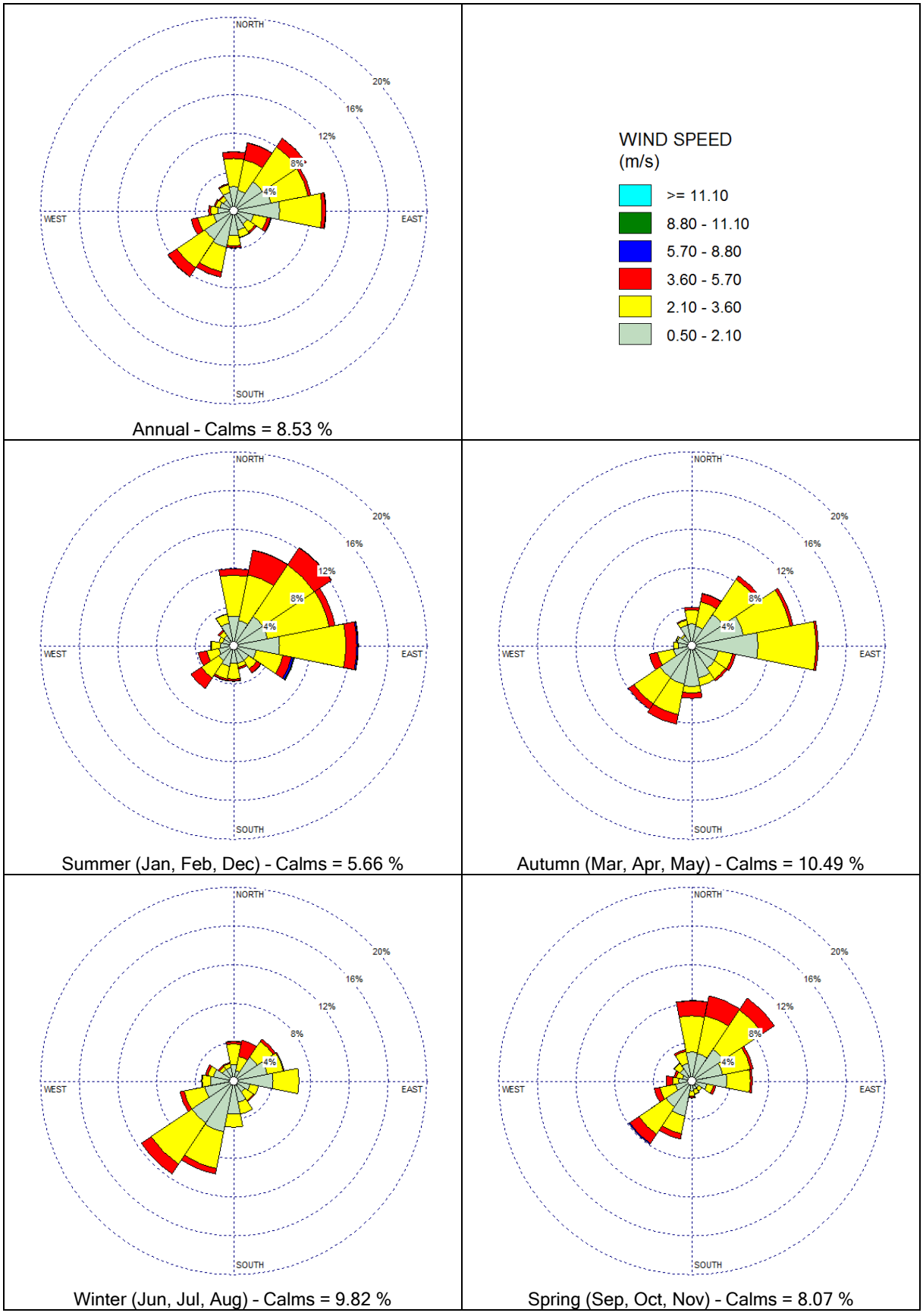
Summer (Jan, Feb, Dec) - Calms = 2.82 %

Autumn (Mar, Apr, May) - Calms = 6.20 %

Winter (Jun, Jul, Aug) - Calms = 6.60 %

Spring (Sep, Oct, Nov) - Calms = 3.44 %

Moree Airport AWS (053115) 2012 Annual and Seasonal Wind Roses



Annual - Calms = 8.53 %

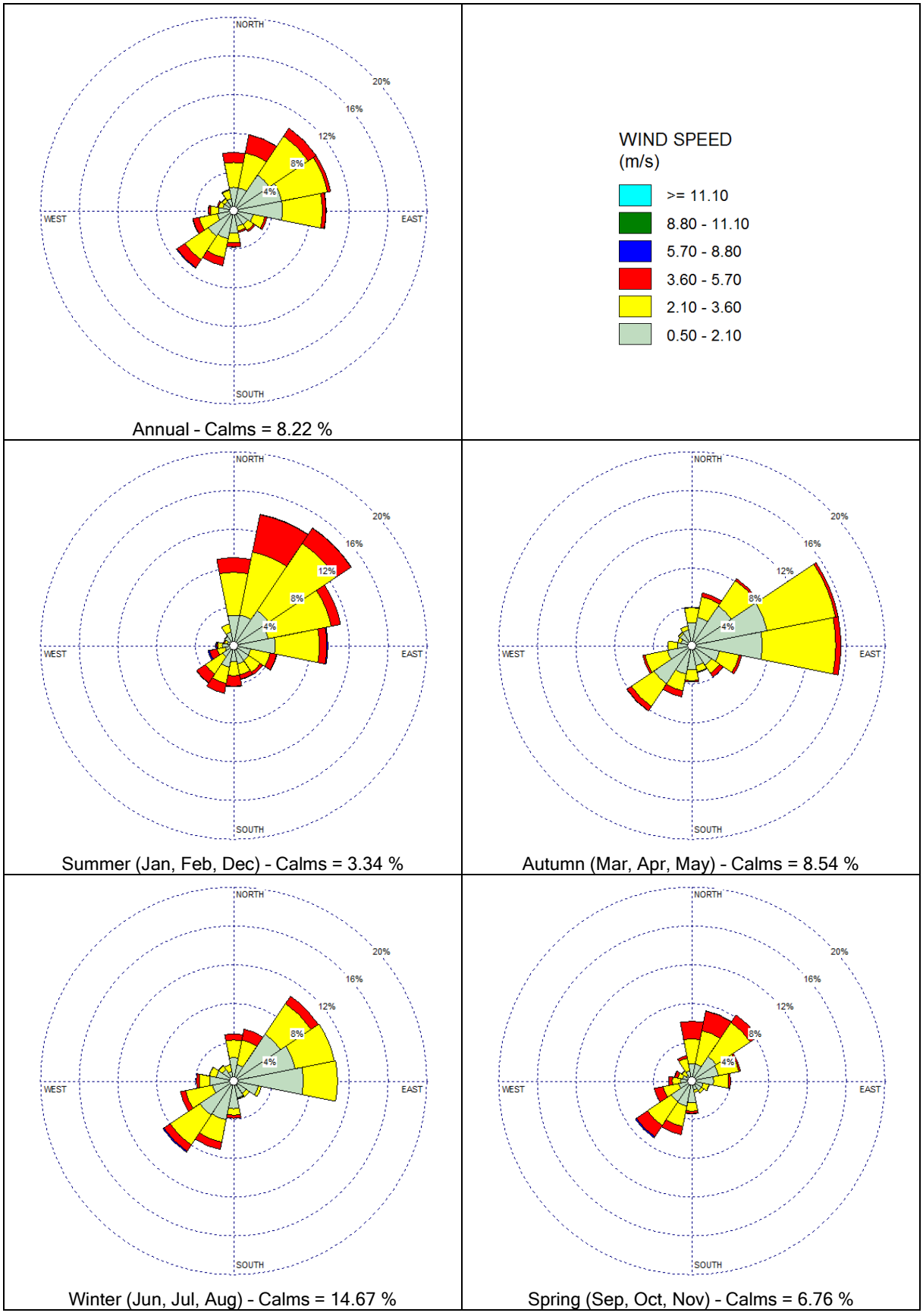
Summer (Jan, Feb, Dec) - Calms = 5.66 %

Autumn (Mar, Apr, May) - Calms = 10.49 %

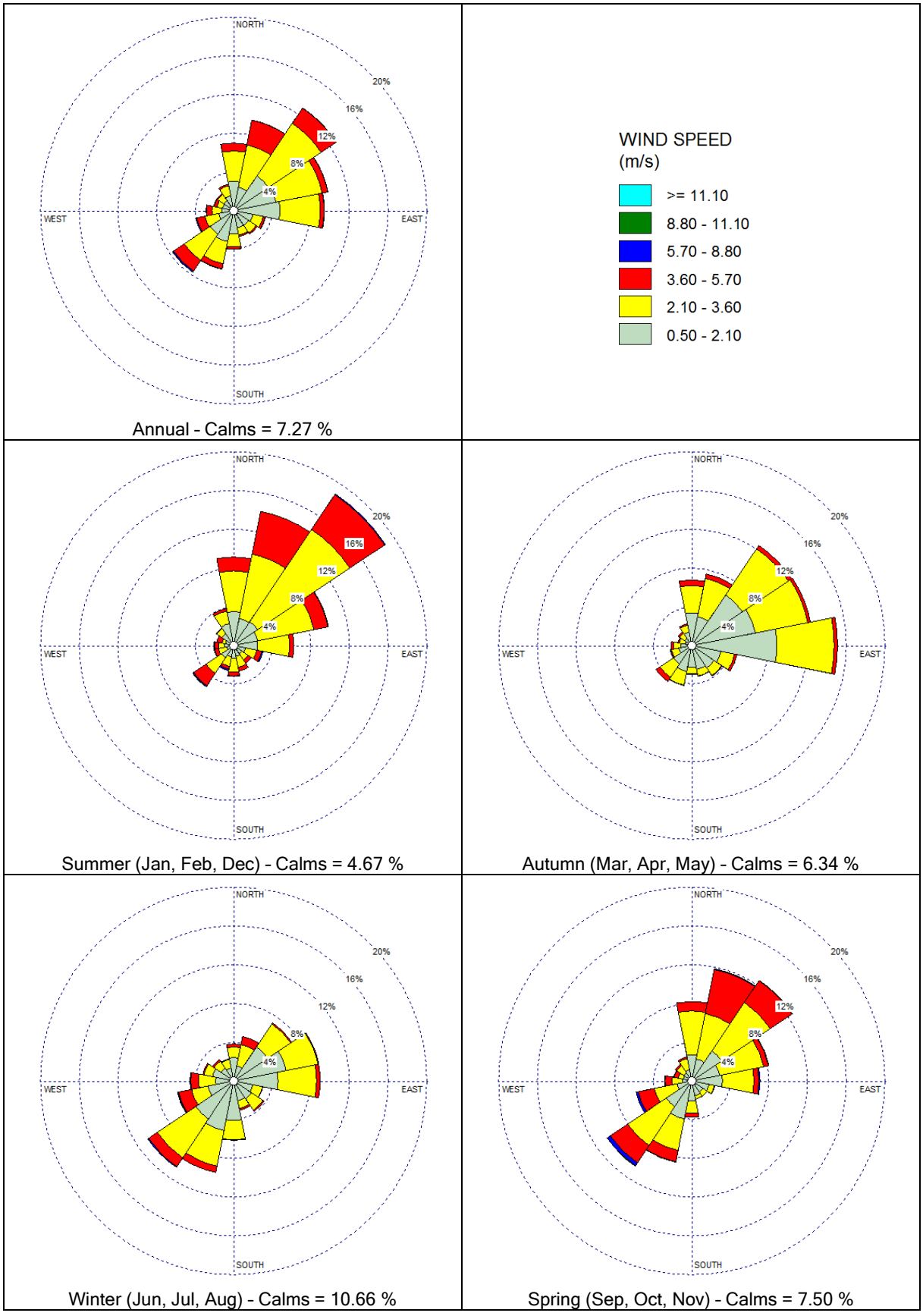
Winter (Jun, Jul, Aug) - Calms = 9.82 %

Spring (Sep, Oct, Nov) - Calms = 8.07 %

Moree Airport AWS (053115) 2013 Annual and Seasonal Wind Roses



Moree Airport AWS (053115) 2014 Annual and Seasonal Wind Roses



Annual - Calms = 7.27 %

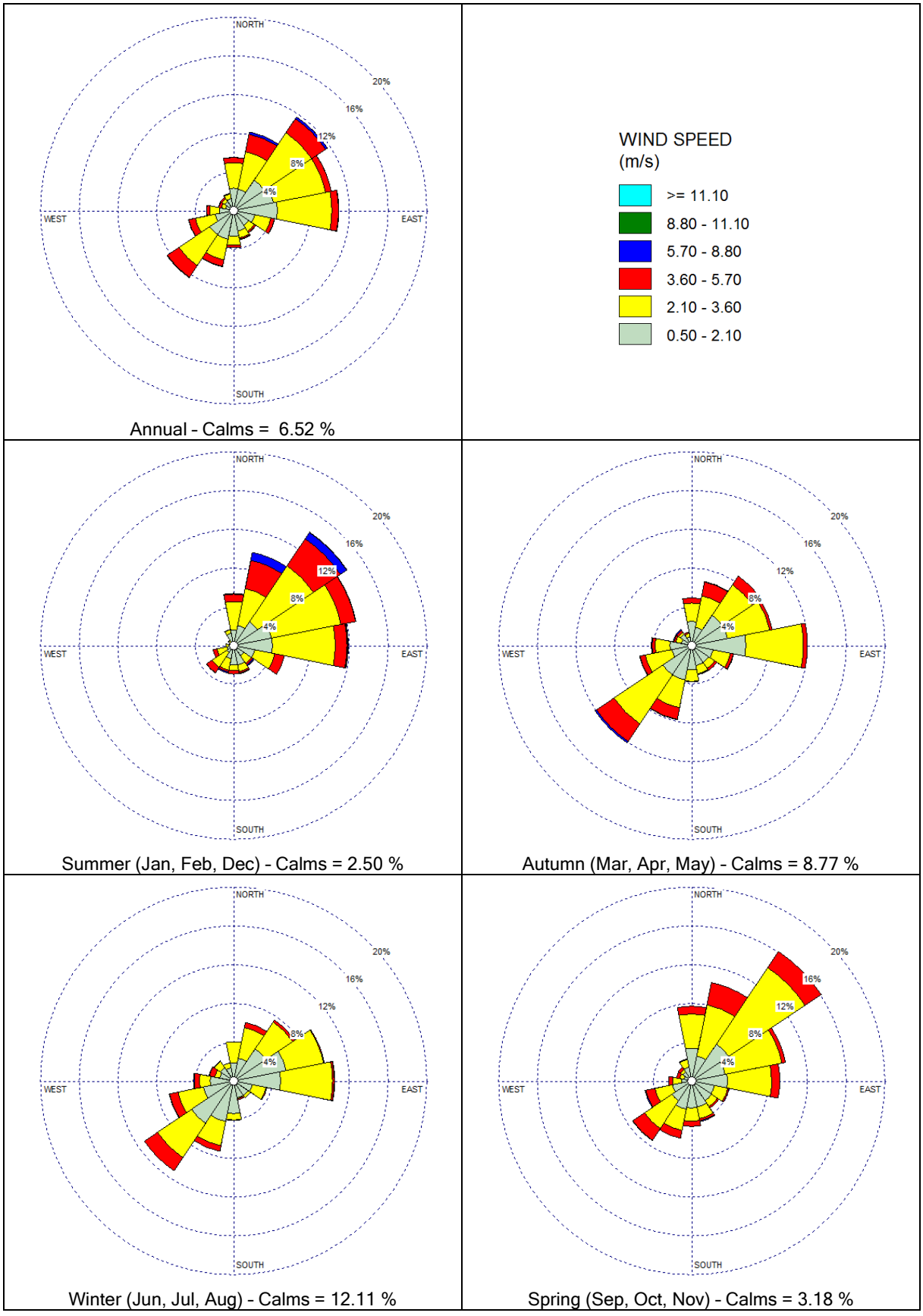
Summer (Jan, Feb, Dec) - Calms = 4.67 %

Autumn (Mar, Apr, May) - Calms = 6.34 %

Winter (Jun, Jul, Aug) - Calms = 10.66 %

Spring (Sep, Oct, Nov) - Calms = 7.50 %

Moree Airport AWS (053115) 2015 Annual and Seasonal Wind Roses



Annual - Calms = 6.52 %

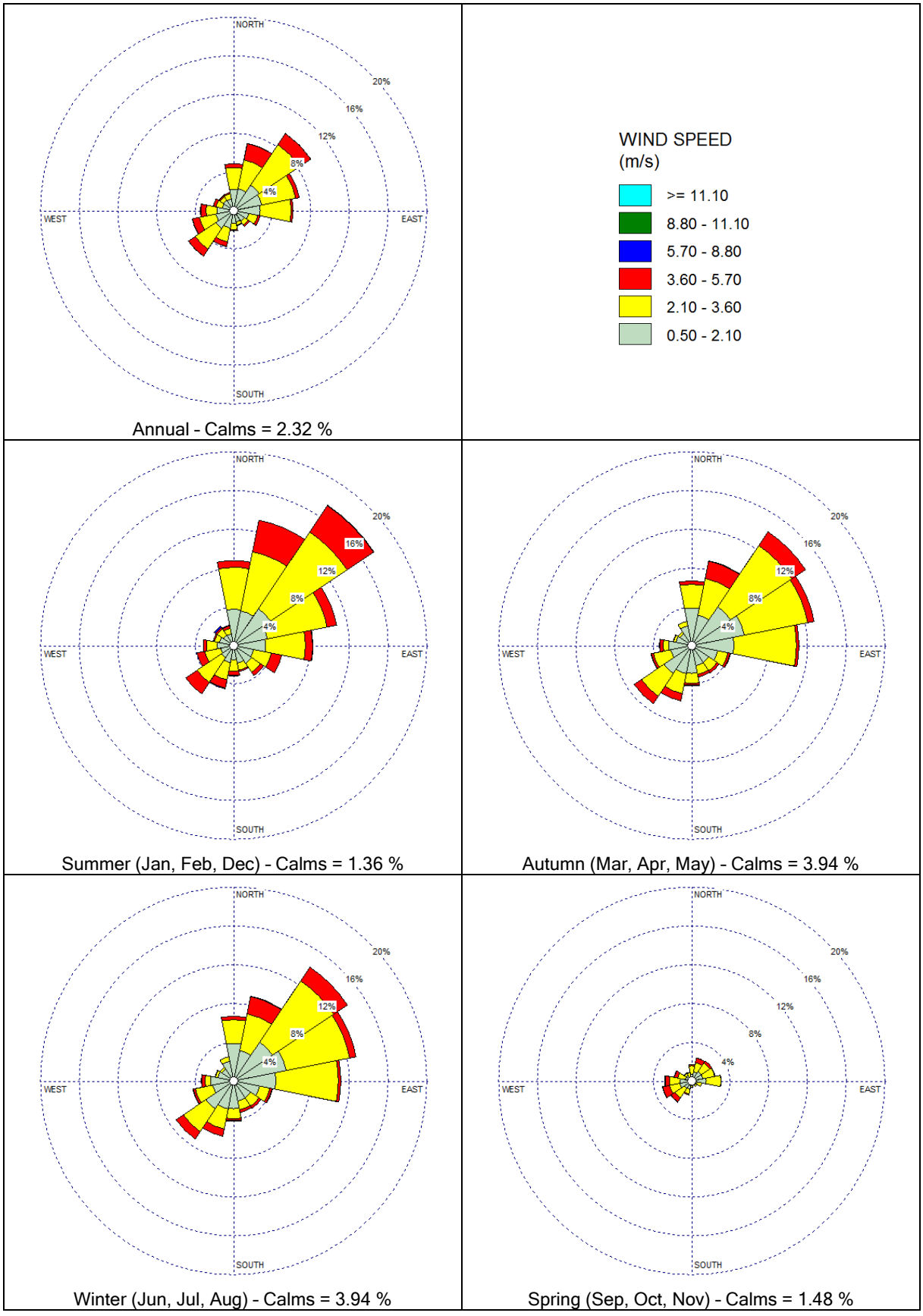
Summer (Jan, Feb, Dec) - Calms = 2.50 %

Autumn (Mar, Apr, May) - Calms = 8.77 %

Winter (Jun, Jul, Aug) - Calms = 12.11 %

Spring (Sep, Oct, Nov) - Calms = 3.18 %

Moree Airport AWS (053115) 2016 Annual and Seasonal Wind Roses



Annual - Calms = 2.32 %

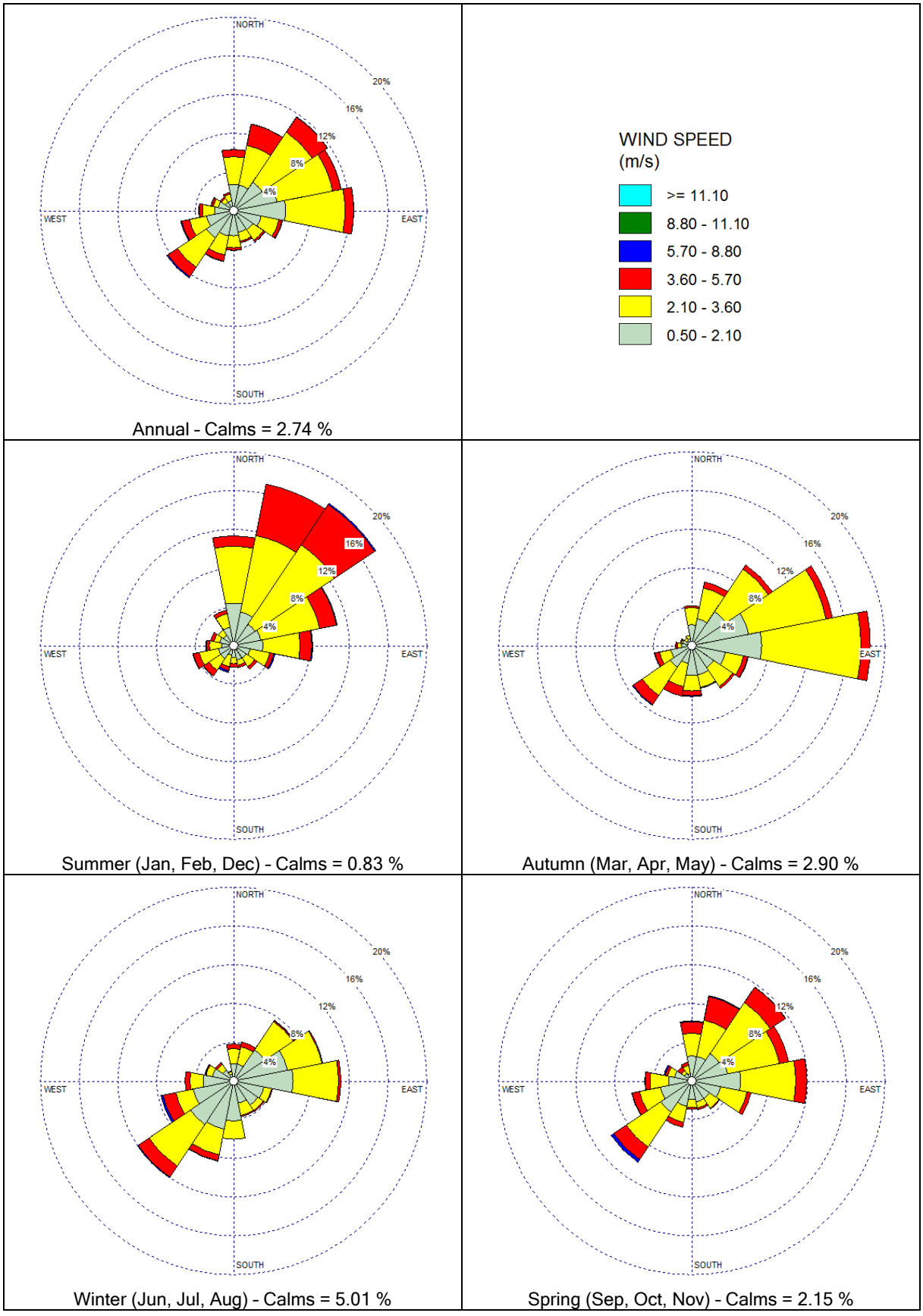
Summer (Jan, Feb, Dec) - Calms = 1.36 %

Autumn (Mar, Apr, May) - Calms = 3.94 %

Winter (Jun, Jul, Aug) - Calms = 3.94 %

Spring (Sep, Oct, Nov) - Calms = 1.48 %

Moree Airport AWS (053115) 2017 Annual and Seasonal Wind Roses



Annual - Calms = 2.74 %

Summer (Jan, Feb, Dec) - Calms = 0.83 %

Autumn (Mar, Apr, May) - Calms = 2.90 %

Winter (Jun, Jul, Aug) - Calms = 5.01 %

Spring (Sep, Oct, Nov) - Calms = 2.15 %