AIR QUALITY IMPACT ASSESSMENT
JOHNS RIVER QUARRY

Boral Resources (NSW) Pty Ltd

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Job Number 24021688

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Air Quality Impact Assessment
Johns River Quarry Extension

DOCUMENT CONTROL

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Boral Resources (NSW) Pty Ltd (Boral) for the proposed extension of the Johns River Quarry at Johns River, New South Wales (NSW) (hereafter referred to as the proposed modification). The report presents an assessment of potential air quality impacts associated with the proposed modification.

The existing operations include the extraction of hard rock resources using standard drill and blast methods with processing via a mobile plant at a rate of approximately 300,000 tonnes per annum (tpa) with the capacity to process up to 450,000 tpa for special projects. The proposed modification is seeking to extend the approved extraction area to the northeast of the quarry to allow for the extraction of up to 2.3 million tonnes (Mt) of material and extend the life of the quarry by approximately 15 years.

This air quality impact assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

To assess the potential air quality impacts associated with the proposed modification, this report comprises:

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

2 BACKGROUND

2.1 Setting

Boral Resources (Country) Pty Ltd (Boral) owns and operates the Johns River Quarry at Bulleys Road, Johns River (the quarry or the site), a long-standing hard rock quarry that extracts and transports high quality hard rock aggregates for use as road base and in the construction industry. The quarry operates under development consent no. DA 93/31 (as amended) from the (former) Greater Taree Council. DA 93/31 is due to expire in July 2026.

The quarry is located at the northern end of Bulleys Road, approximately 2 kilometres (km) north of the village of Johns River and 500 metres (m) north-west of the Pacific Highway. The regional city of Taree is located approximately 38km south-west of the quarry. The area surrounding the site is predominantly comprised of bushland, and semi-rural land with scattered dwellings identified in the surrounding area.

The nearest identified residential dwelling is located approximately 500m east of the site. **Table 2-1** identifies the nearest residential receptors considered as assessment locations.

Figure 2-1 presents the location of the site with reference to each of assessment locations the proposed extension area.

Table 2-1: Assessment locations

Assessment location ID	Easting (m)	Northing (m)	Description	Approximate distance to site (km)
R1	471871	6491636	Residential	0.6
R2	472358	6491025	Residential	0.5
R3	472383	6491438	Residential	0.7
R4	473130	6491641	Residential	1.4
R5	473323	6491690	Residential	1.6
R6	472608	6490961	Residential	0.8
R7	472749	6491073	Residential	0.9
R8	472441	6491945	Residential	1.1
R9	470151	6490679	Residential	1.7
R10	470249	6490101	Residential	1.9
R11	470868	6489971	Residential	1.5
R12	471014	6490281	Residential	1.1
R13	471551	6490027	Residential	1.1
R14	471796	6489900	Residential	1.2
R15	471458	6490306	Residential	0.8
R16	472116	6490176	Residential	0.9
R17	472331	6490080	Residential	1.1
R18	473011	6490560	Residential	1.3

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the site. The site is located at the southeastern edge of the Middle Brother Mountain, with terrain decreasing towards the south and southeast towards the coast. The South Brother Mountain is the peak located southwest of the site.

Figure 2-1: Site setting

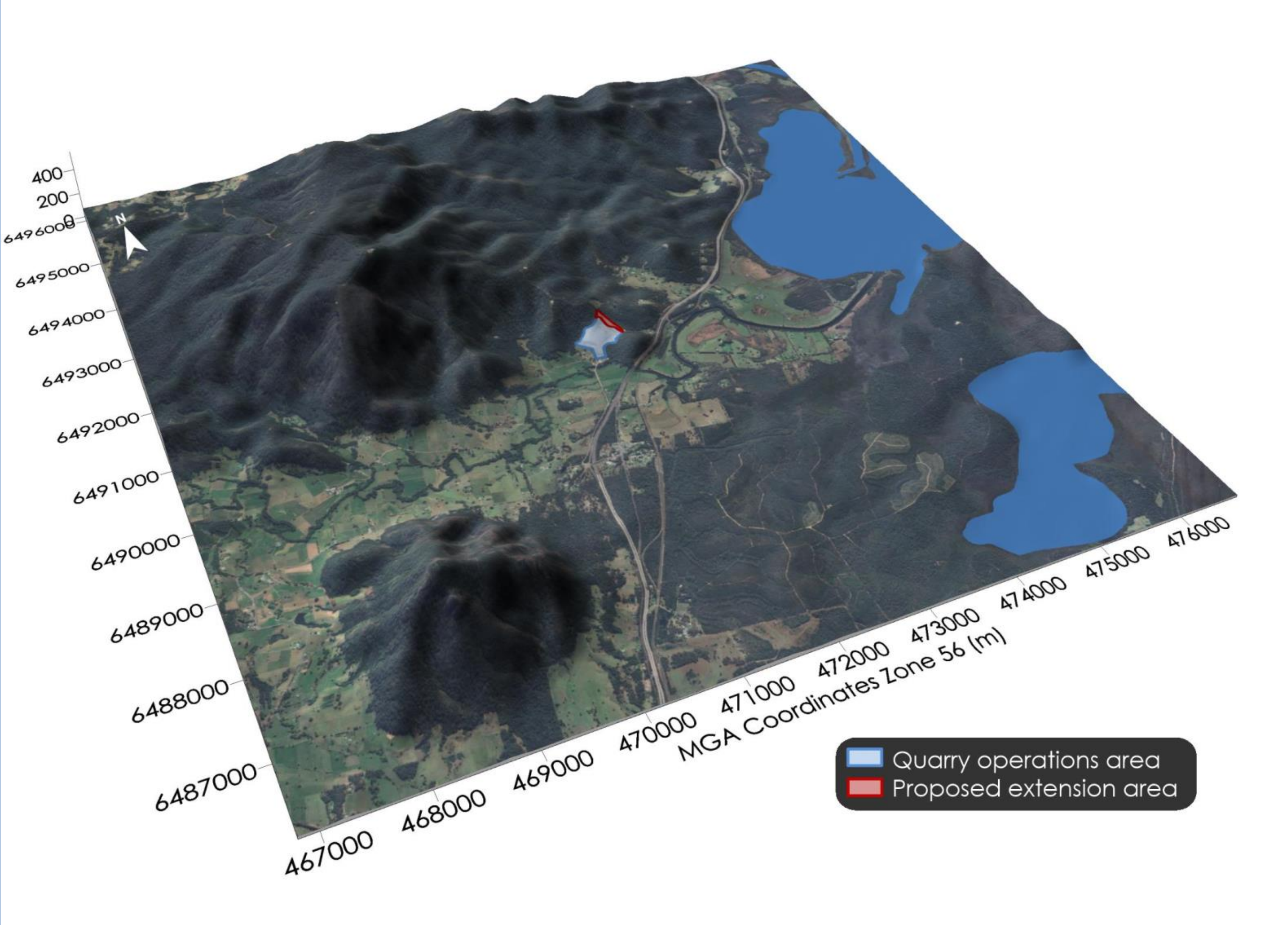

Figure 2-2: Representative visualisation of topography in the area surrounding the site

2.2 The proposed modification

2.2.1 Existing operations

The existing quarry operations area is approximately 16.46 hectares (ha) and incorporates the extraction area, haul roads, plant area, stockpile and loading area, weighbridge and truck staging area, noise bunds and water management structures, car parking and amenities.

The existing layout of the quarry is shown in **Figure 2-3**.

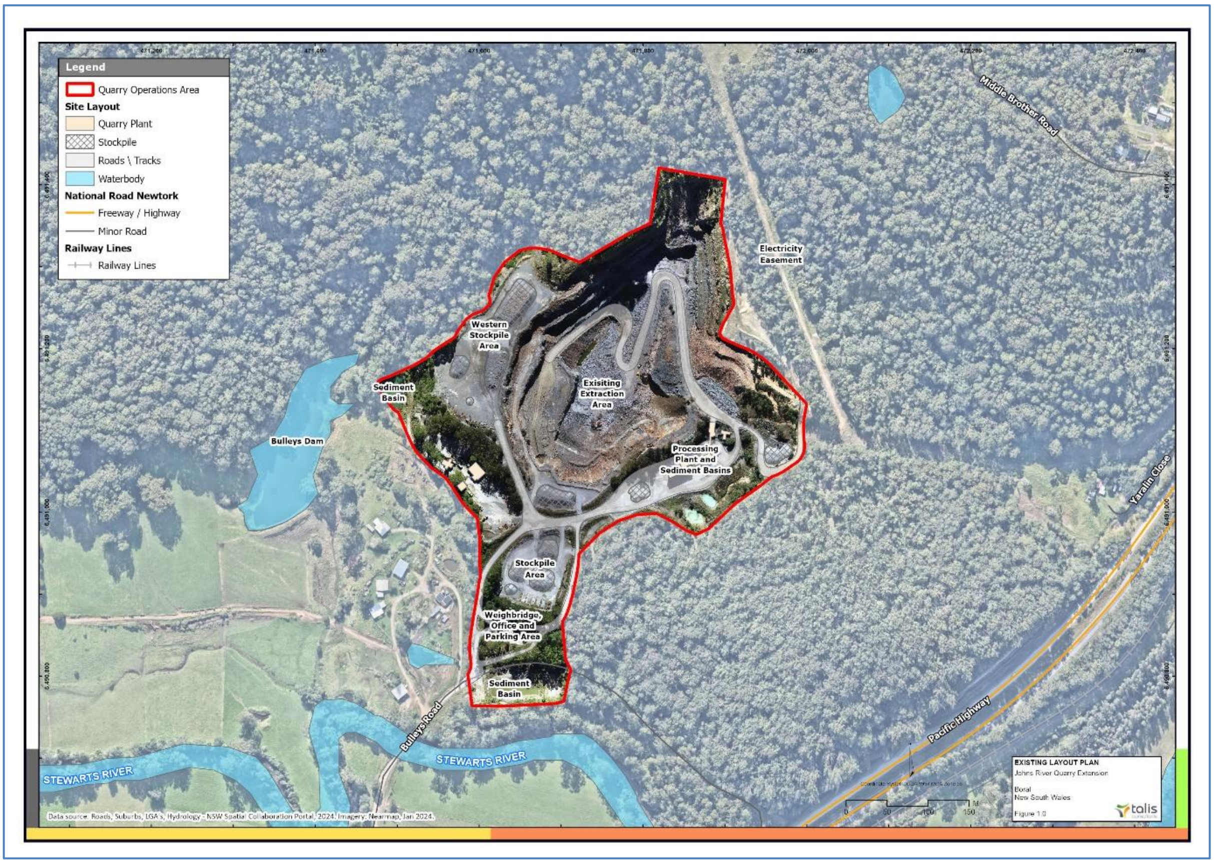

Figure 2-3: Existing site layout

2.2.2 Proposed operations

Due to the ongoing demand for high quality hard rock quarry products, Boral is seeking consent from the MidCoast Council to modify DA 93/31 to extend the life of the quarry through a minor extension of the quarry operations area.

The key components of the Johns River Quarry Extension – Modification 3 (the proposed modification) include:

- Continuing existing operations for an additional 15 years (until 2041); and,
- Extending the quarry operations area by 2.03 ha to the north-east to provide access to approximately 2.3 million tonnes (Mt) of additional resource.

There would be no other changes, noting that the proposed modification does not seek to modify:

- The approved rate of extraction;
- The depth of extraction;
- The type of product being extracted;
- Existing drill and blast extraction methods;
- Truck types or the number of movements;
- Hours of operation;
- The number of employees;
- Existing site office, amenities, weighbridge and parking area; and,
- Existing stockpile areas, crushing and screening plant, and mobile machinery.

The proposed layout of the quarry is shown in **Figure 2-4**.

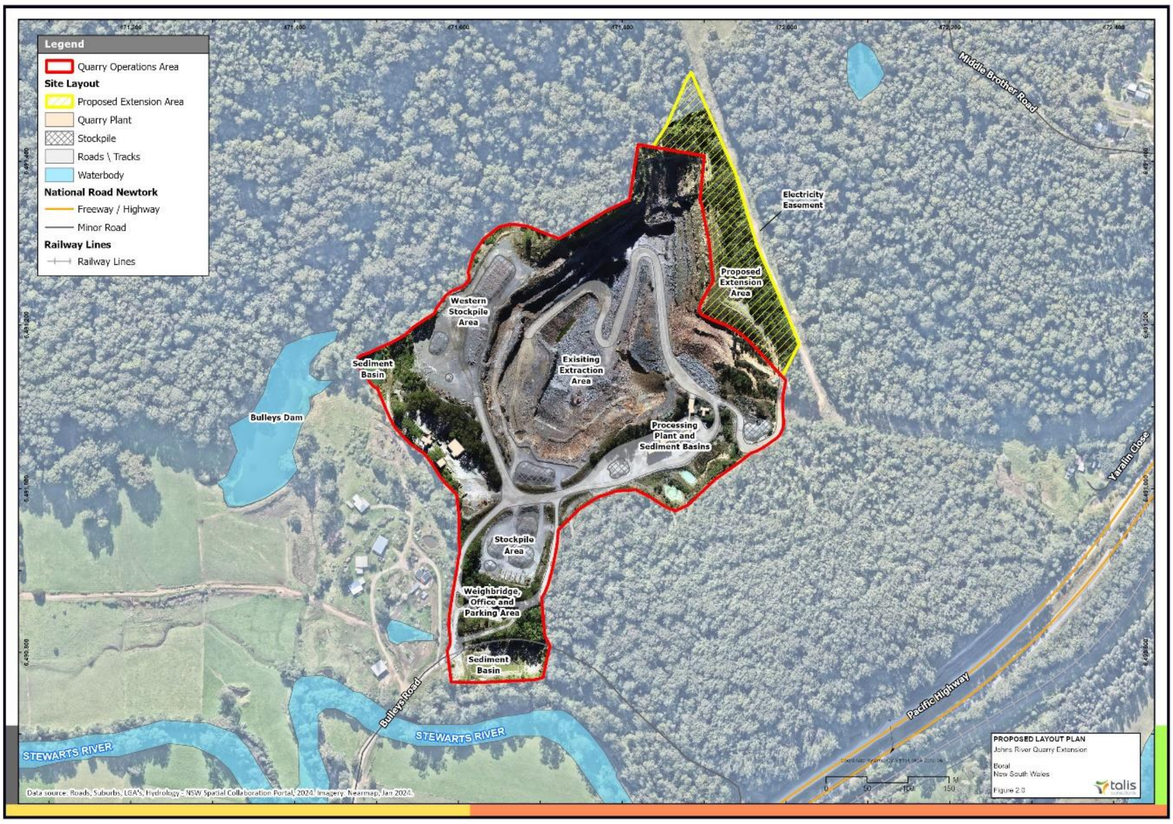

Figure 2-4: Proposed site layout

Table 2-2 provides a comparison of the main components of the proposed modification with the original and existing (as modified) consents.

Table 2-2: Comparison of the main components of the proposed modification

Component	Original consent	Existing (as modified) consent	The proposed modification
Life of the quarry	July 2018	July 2026	July 2041
Quarry operations area	15 ha	16.46 ha	18.49 ha
Depth of extraction	RL 35 m	RL 0 m	No change
Approved annual production	100,000 tpa	300,000 tpa[1]	No change
Truck routes	Southbound through Johns River Village and Northbound on Pacific Highway via Bulleys Road / Stewarts River interchange	No change	No change
Truck movements	60 per day	120 per day (60 each way)	No change
Operating hours (including stockpiling, processing, truck loading and dispatch)	Monday to Friday: 6.30 am to 5.30 pm Saturday: 6.30 am to 1.30 pm Sunday: No works	Monday to Friday: 7 am to 6 pm Saturday: 7 am to 1.30 pm Sunday: No works	No change
Blasting hours	Monday to Friday: 11 am to 3 pm	Monday to Friday: 9 am to 3 pm Saturday: 9 am to 1.30 pm	No change

Note 1: DA 93/31 allows for an increase in the annual production rate to 450,000 tpa for approved special projects.

3 AIR QUALITY CRITERIA

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

3.2 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

The air quality goals for total impact relate to the total pollutant burden in the air and not just the contribution from the proposed modification. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month

Source: **NSW EPA, 2022**
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

4 EXISTING ENVIRONMENT

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

4.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) automatic weather station (AWS) at Taree Airport AWS (Site No. 060141) were analysed to characterise the local climate in the proximity of the site. Taree Airport AWS is located approximately 26.2km southwest of the site.

Table 4-1 and **Figure 4-1** present a summary of data from the Taree Airport AWS collected over a 13 to 27 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 29.0 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 6.7°C.

Rainfall decreases during the cooler months, with an annual average rainfall of 1182.2 millimetres (mm) over 100.9 days. The data indicate that March is the wettest month with an average rainfall of 198.7mm over 10.8 days and August is the driest month with an average rainfall of 45.3mm over 5.4 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 63% in October to 86% in March. Mean 3pm relative humidity levels range from 50% in August to 63% in February.

Wind speeds exhibit variability over the day and seasonal fluctuations with a greater spread in wind speeds between 9am and 3pm in the warmer months compared to the cooler months. Mean 9am wind speeds range from 9.1 kilometres per hour (km/h) in February to 11.7km/h in October. Mean 3pm wind speeds range from 13.3km/h in June to 21.5km/h in January.

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

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	29.0	28.3	26.8	24.4	21.5	18.9	18.6	20.2	23.0	24.7	26.0	27.7	24.1
Mean min. temp. (°C)	18.4	18.2	16.8	13.7	10.1	8.0	6.7	6.8	9.4	12.0	15.0	16.7	12.6
Rainfall													
Rainfall (mm)	94.3	153.5	198.7	98.4	81.8	96.5	65.4	45.3	49.3	81.8	106.3	90.0	1182.2
No. of rain days (≥1mm)	9.6	10.1	10.8	9.4	7.7	8.4	6.5	5.4	6.1	7.9	9.8	9.2	100.9
9am conditions													
Mean temp. (°C)	23.3	22.5	20.4	18.9	15.3	12.6	11.8	13.3	17.3	19.8	20.5	22.6	18.2
Mean R.H. (%)	74.0	81.0	86.0	79.0	78.0	80.0	77.0	70.0	65.0	63.0	73.0	71.0	75.0
Mean W.S. (km/h)	10.0	9.1	9.2	10.4	11.2	10.7	11.1	11.4	10.9	11.7	10.9	10.2	10.6
3pm conditions													
Mean temp. (°C)	27.1	26.7	25.2	22.6	20.0	17.8	17.2	18.6	20.9	22.3	23.5	25.7	22.3
Mean R.H. (%)	60.0	63.0	62.0	62.0	58.0	59.0	56.0	50.0	53.0	55.0	62.0	60.0	58.0
Mean W.S. (km/h)	21.5	19.9	17.8	15.4	13.7	13.3	14.5	16.6	19.4	20.8	20.8	20.9	17.9

Source: **Bureau of Meteorology, 2024**

R.H. – Relative Humidity, W.S. – wind speed

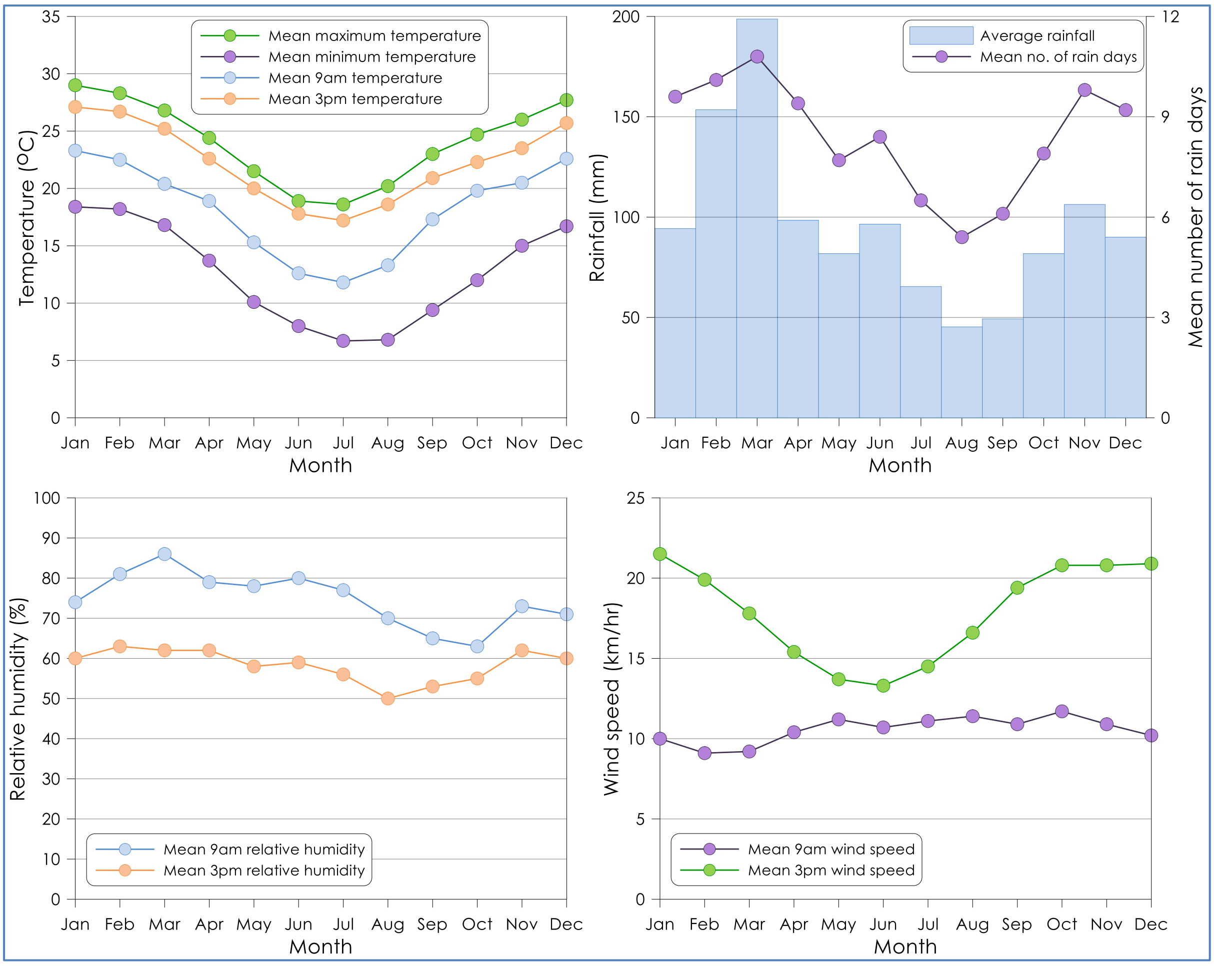

Figure 4-1: Monthly climate statistics summary – Taree Airport AWS

4.2 Local meteorological conditions

Annual and seasonal windroses for the Taree Airport AWS during the 2021 calendar period are presented in **Figure 4-2**.

The 2021 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 and appropriate monitoring data for the area as outlined in **Appendix A**.

Analysis of the windroses shows that the greatest proportion of winds are from the west with varied winds from other directions. The summer windrose shows wind directions are generally evenly spread with few winds from the north and north-northwest. The autumn and winter windrose follow a similar distribution as the annual windrose with winds predominately from the west. During spring, winds primarily from the west and northeast.

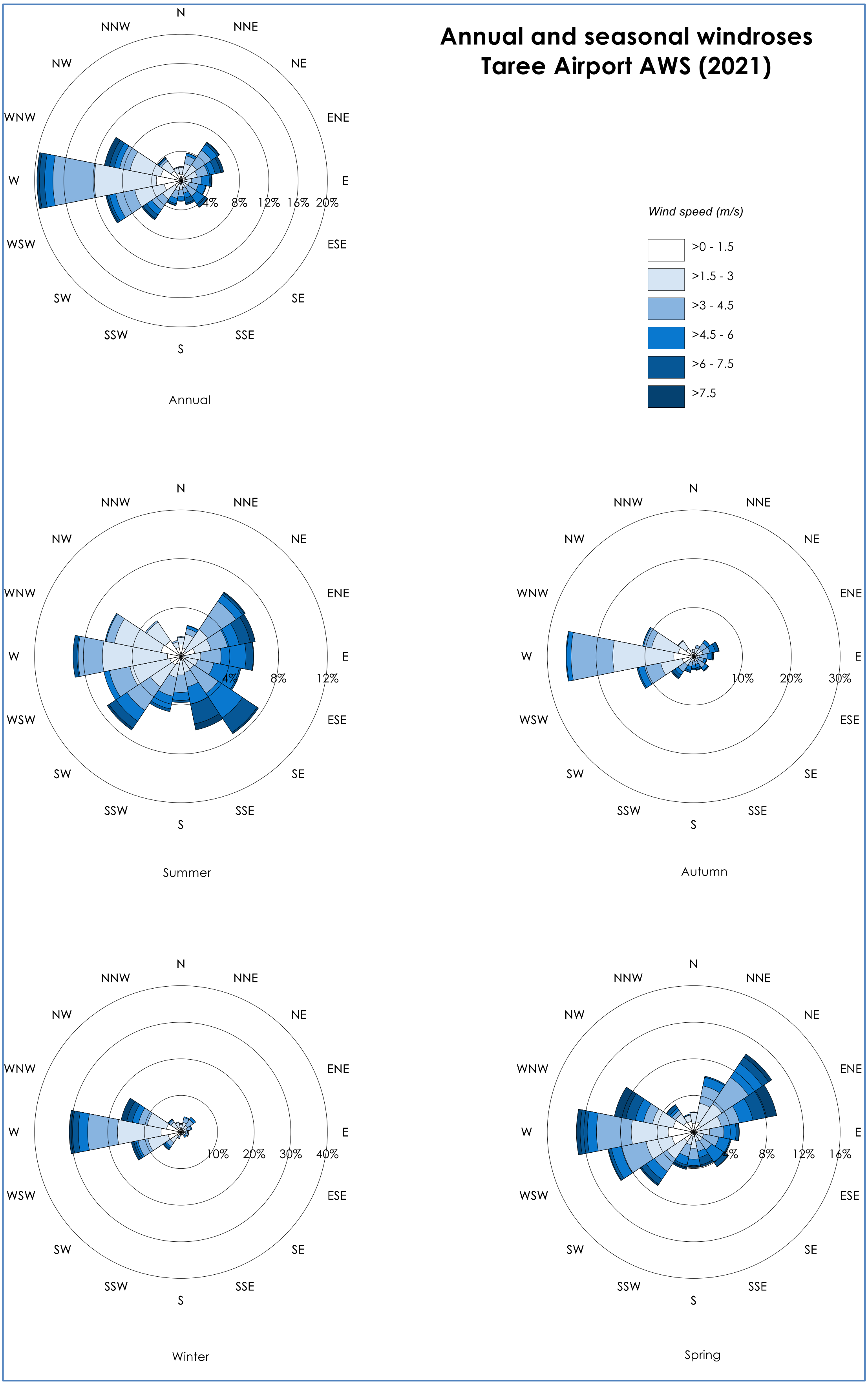

Figure 4-2 : Annual and seasonal windroses – Taree Airport AWS (2021)

4.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the site would include emissions from agricultural activities and other anthropogenic activities such as domestic wood heaters and motor vehicle exhaust.

The site operates four deposited dust gauges as outlined in the Environmental Protection Licence (EPL) 4812 and have been operational since 2019. Ambient air quality monitoring data for PM_{10} and $PM_{2.5}$ from the site are not available, however; is available from the air quality monitor operated by the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) at Port Macquarie were used to characterise the background levels for the site.

The Port Macquarie monitoring station is located approximately 33.8km northeast of the site and is located in a more urban setting which is subject to higher levels of particulate matter. Therefore, the Port Macquarie station is considered to be conservative as it would likely overestimate levels for the site area.

Figure 4-3 shows the approximate location of each of the monitoring stations that are part of the site air quality monitoring network. The NSW DCCEEW monitor at Port Macquarie is not shown in the figure.

Figure 4-3: Location of air quality monitors

4.3.1 Deposited dust

Table 4-2 and **Figure 4-4** shows the annual average dust deposition level at each gauge between 2019 and 2024.

The dust gauges recorded annual average insoluble solid deposition levels above the criterion of 4 grams per square metre per month (g/m²/month) on multiple occasions at EPA18 and EPA20. These monitors are located within active agricultural paddocks that are largely affected by general agricultural activities and not representative of dust from the site.

The other dust gauges, EPA21 and EPA22, are less influenced by intensive agricultural activities and would be more representative of the general background levels. The dust deposition levels at these monitors are below 4g/m²/month with the exception of EPA21 in 2023. An analysis of the monitoring results indicate that the elevated level may be attributed by localised farming activity near the monitor and potential contamination in the sample.

Table 4-2: Annual average dust deposition (g/m²/month)

Year	EPA18	EPA20	EPA21	EPA22	Criterion
2019	2.2	**4.7**	2.0	1.8	4
2020	**4.0**	**11.1**	1.8	2.4	4
2021	**6.3**	**11.5**	2.4	1.8	4
2022	**8.5**	**32.9**	1.1	1.4	4
2023	2.3	3.9	**4.1**	1.7	4
2024*	4.0	**5.6**	1.2	1.5	4

*Less than 75% available data (data available to March 2024)

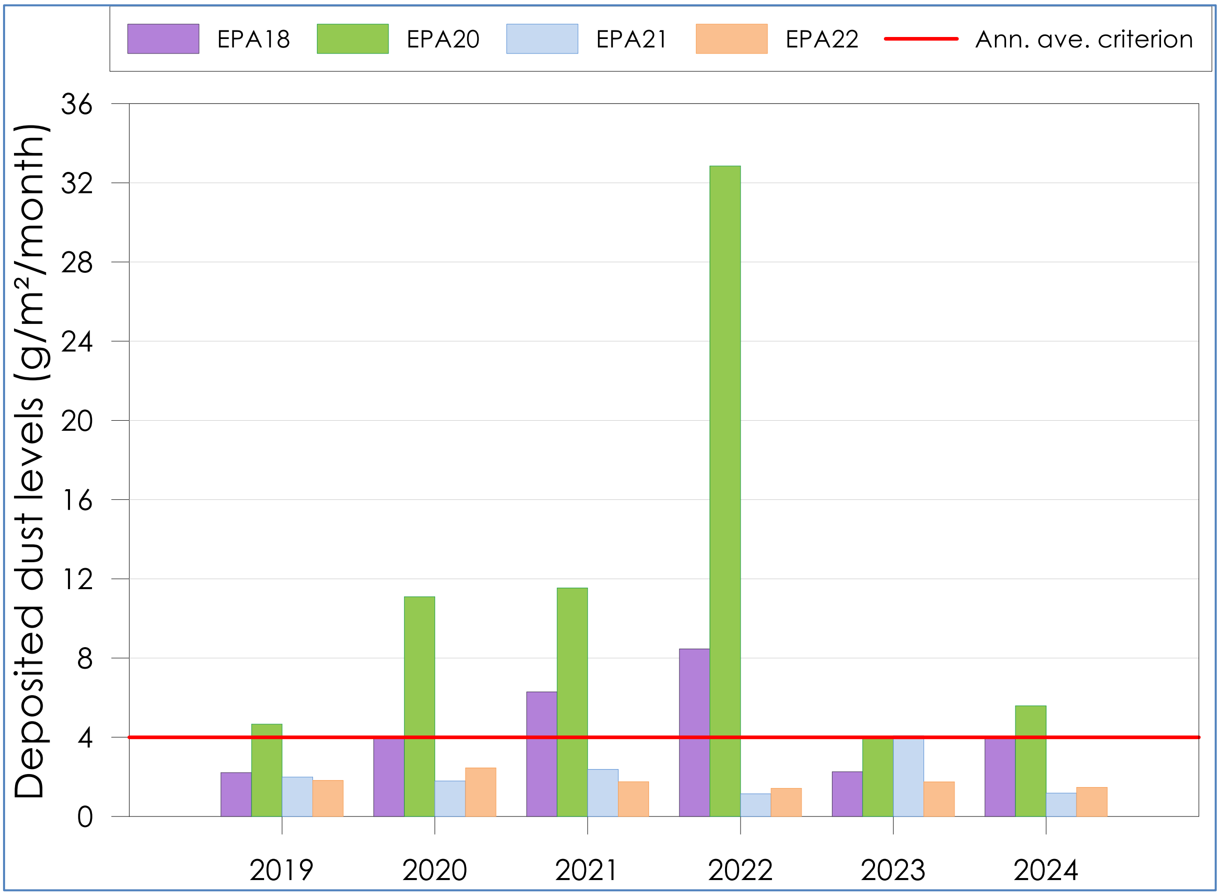

Figure 4-4: Annual average dust deposition (g/m²/month)

4.3.2 PM_{10} monitoring

A summary of the available PM_{10} data for the Port Macquarie monitoring station from 2019 to 2023 are presented in **Table 4-3**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-5**.

A review of **Table 4-3** indicates that the annual average PM_{10} concentrations at the monitoring station were below the relevant criterion of 25µg/m^3 for all years of the review period as per the criterion in **Table 3-1**. It should be noted that annual periods which contain less than 75% data are excluded for estimating an annual average in **Table 4-3**.

The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m^3 during 2019 and 2020. Anomalously high PM_{10} concentrations recorded in December 2019 and January 2020 in **Figure 4-5** are attributed to wildfires and the drought period (**NSW DPIE 2019 & NSW DPIE 2020**).

Table 4-3: Summary of PM_{10} levels from monitoring station (µg/m³)

Year	Annual average	Criterion
2019	-	**25**
2020	14.4	**25**
2021	10.8	**25**
2022	9.1	**25**
2023	11.9	**25**
Year	**Maximum 24-hour average**	**Criterion**
2019	**480.5**	**50**
2020	**249.9**	**50**
2021	31.9	**50**
2022	31.5	**50**
2023	36.2	**50**

- Less than 75% data

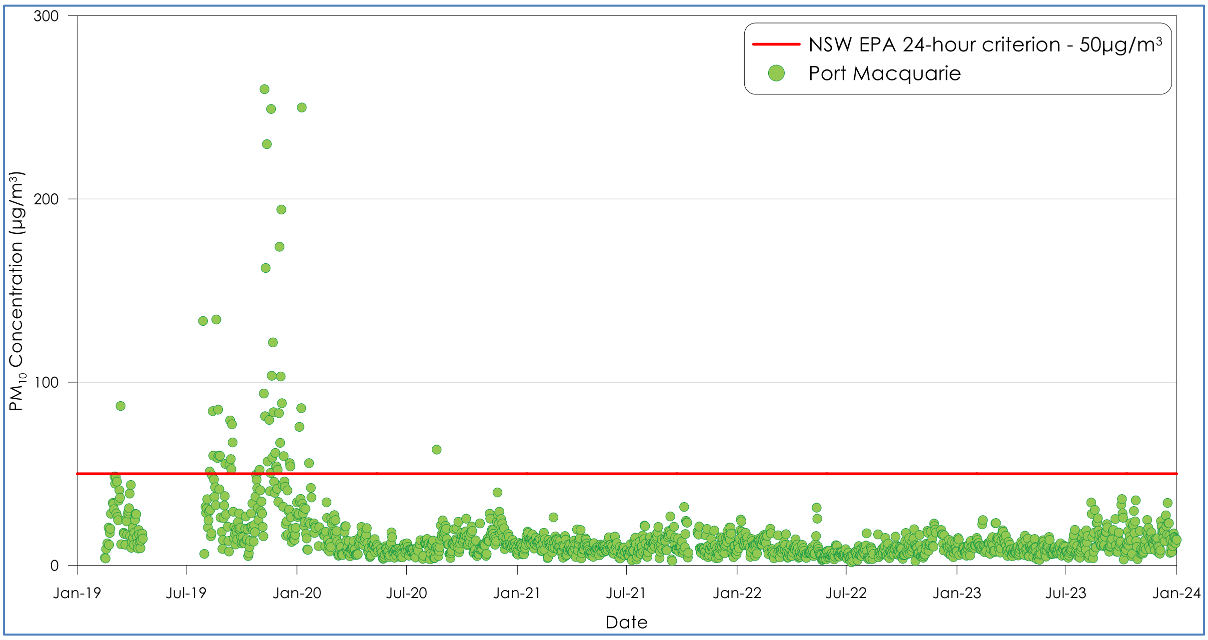

Figure 4-5: 24-hour average PM_{10} concentrations

4.3.3 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ data for the Port Macquarie monitoring station from 2019 to 2023 are presented in **Table 4-4**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-6**.

Table 4-4 indicates that the annual average $PM_{2.5}$ concentrations were below the relevant criterion of 8µg/m^3 for all years of the review period as per the criterion in **Table 3-1**. It should be noted that annual periods which contain less than 75% data are excluded for estimating an annual average in **Table 4-4**.

The maximum 24-hour average $PM_{2.5}$ concentrations were found to exceed the relevant criterion of 25µg/m^3 during 2019, 2020 and 2023. Similar to the PM_{10} monitoring data, the mass bushfires affecting NSW in 2019 and 2020 are seen in the $PM_{2.5}$ monitoring data in **Figure 4-6**.

Table 4-4: Summary of $PM_{2.5}$ levels from monitoring station (µg/m³)

Year	Annual average	Criterion
2019	-	**8**
2020	6.5	**8**
2021	4.6	**8**
2022	3.3	**8**
2023	5.1	**8**
Year	**Maximum 24-hour average**	**Criterion**
2019	**442.7**	**25**
2020	**220.5**	**25**
2021	14.7	**25**
2022	9.4	**25**
2023	**30.5**	**25**

- Less than 75% data

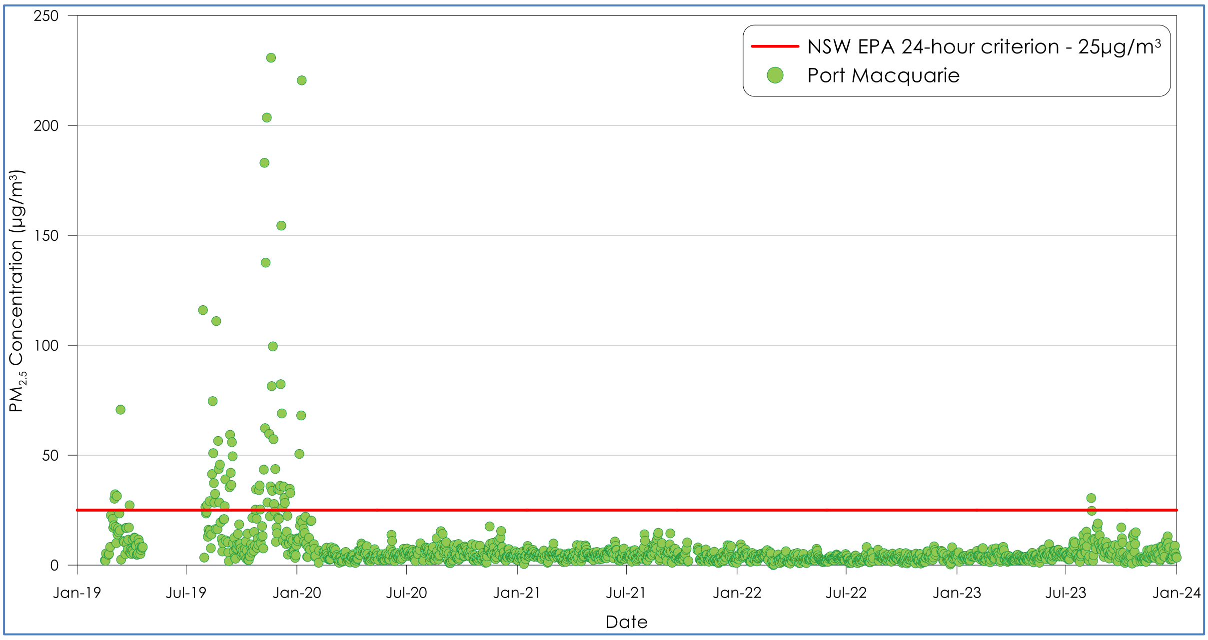

Figure 4-6: 24-hour average $PM_{2.5}$ concentrations

4.3.4 Estimated background levels

As outlined above, there are no readily available site-specific monitoring data for PM_{10} and $PM_{2.5}$, and therefore the background air quality levels from the closest DCCEEW monitoring station at Port Macquarie for the 2021 calendar year were used to represent background levels for the proposed modification. The deposited dust levels for the 2021 calendar year from the onsite EPA21 deposited dust gauge were used to represent deposited dust background levels for the proposed modification.

In the absence of available data, estimates of the annual average background TSP concentrations can be determined from a relationship between PM_{10} and TSP concentrations and the measured PM_{10} levels. This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to an annual average TSP concentration of 90µg/m^3. This relationship is based on the NSW EPA air quality impact criteria as outlined in **Table 3-1**.

Applying this relationship with the measured annual average PM_{10} concentration of 10.8µg/m^3 indicates an approximate annual average TSP concentration of 38.8µg/m^3.

The background air quality levels applied in this assessment are summarised in **Table 4-5**.

Table 4-5: Summary of background levels

Pollutant	Background level	Units
Annual average TSP	38.8	µg/m^3
24-hour average PM_{10}	Daily varying	µg/m^3
Annual average PM_{10}	10.8	µg/m^3
24-hour average $PM_{2.5}$	Daily varying	µg/m^3
Annual average $PM_{2.5}$	4.6	µg/m^3
Annual average deposited dust	2.4	g/m^2/month

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.

The model was set up 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 Modelling methodology

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.

5.2.1 Meteorological modelling

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 31.72deg south and 152.72deg east. The simulation involved an outer grid of with 15km grid spacing, with two nested grids with 3km and 1km grid spacing.

The CALMET domain was run on a domain of 10 x 10km with a 0.1km grid resolution. The available meteorological data the year 2021 from the surrounding BoM Taree Airport AWS weather station were included in the simulation.

5.2.2 Meteorological modelling evaluation

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extract data.

Figure 5-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period (i.e., example only). The wind fields follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

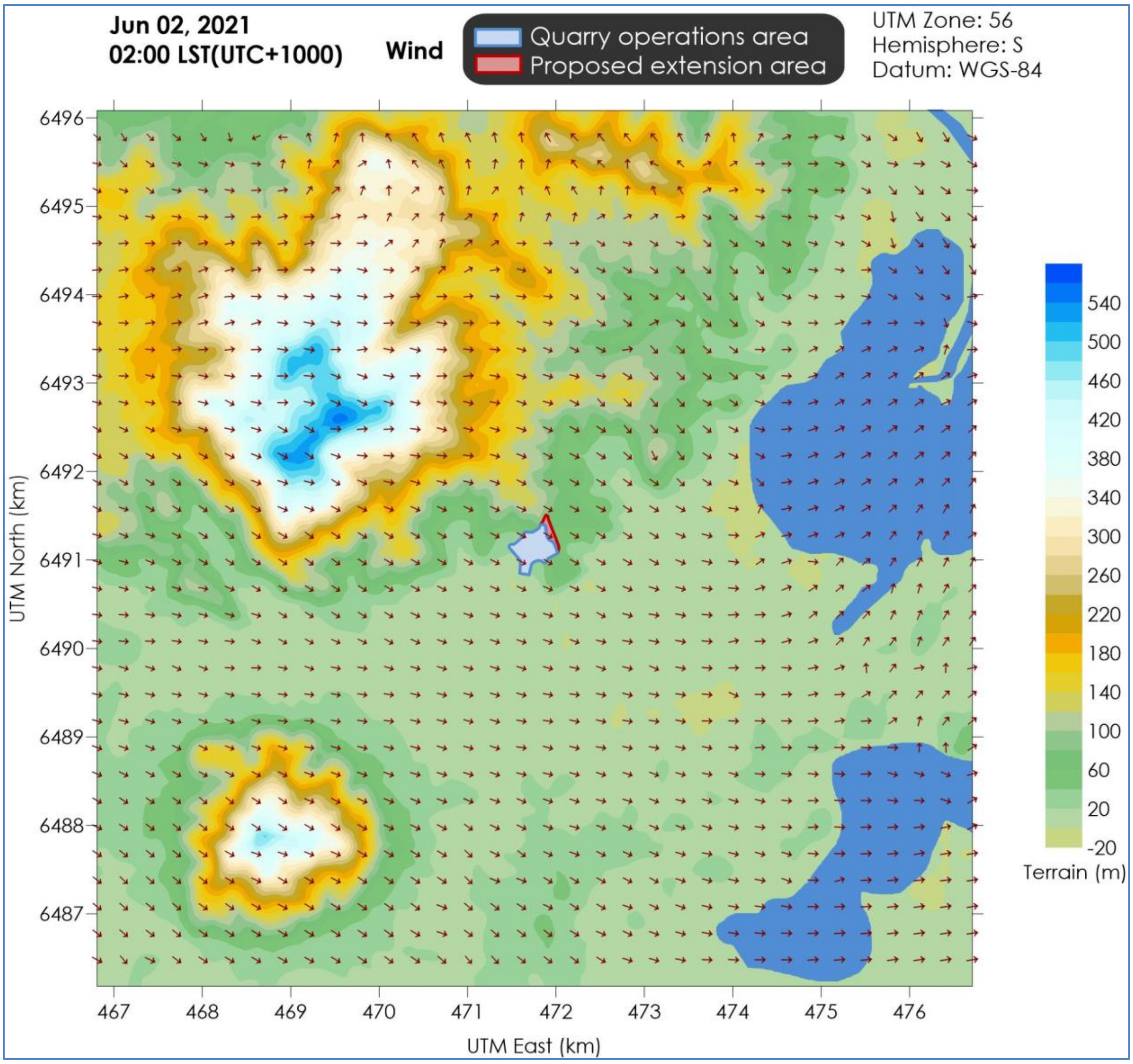

Figure 5-1: Representative 1-hour average snapshot of wind field for the site

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 the annual and seasonal windroses from the CALMET data. 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.

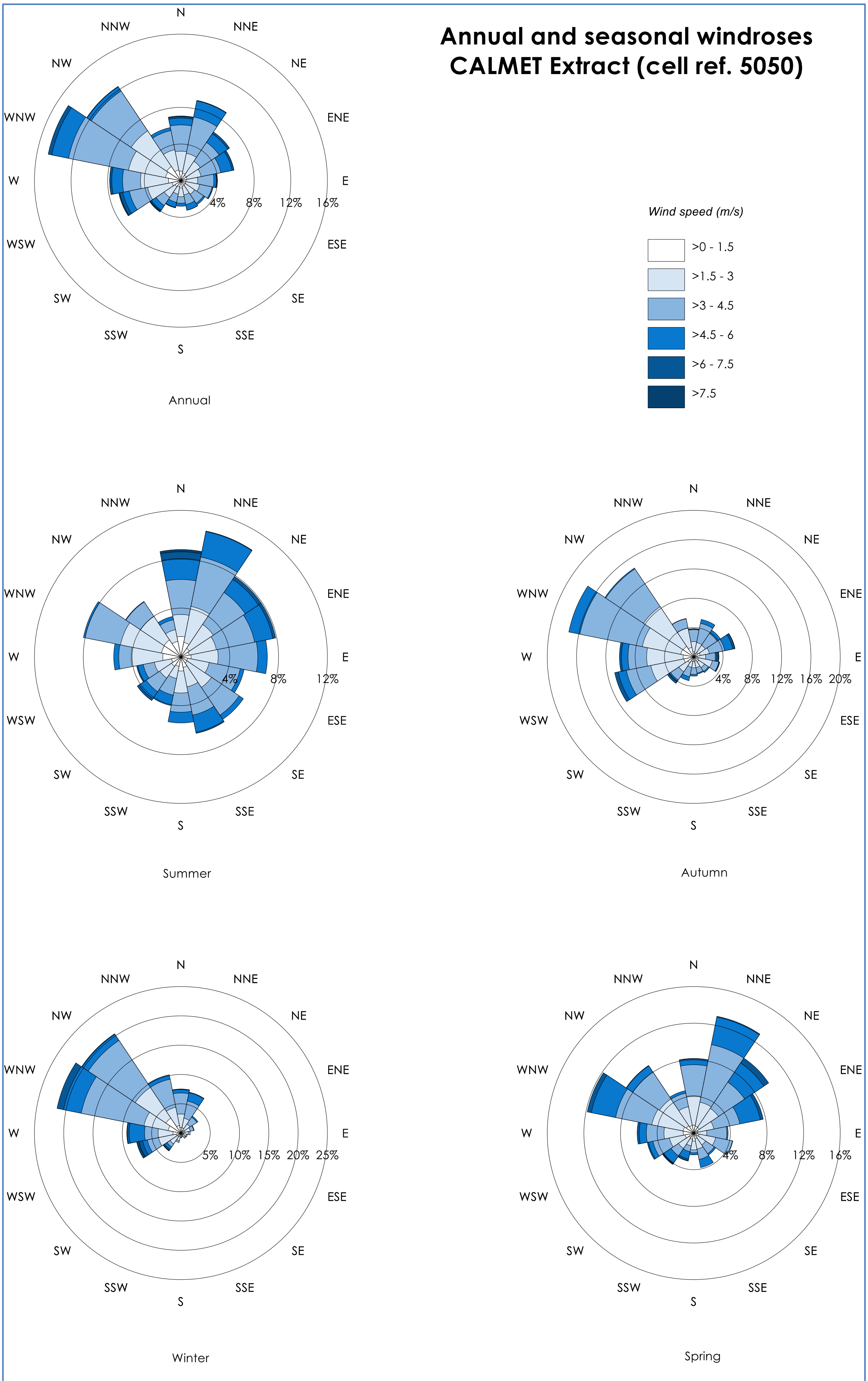

Figure 5-2: Annual and seasonal windroses from CALMET (Cell ref 5050)

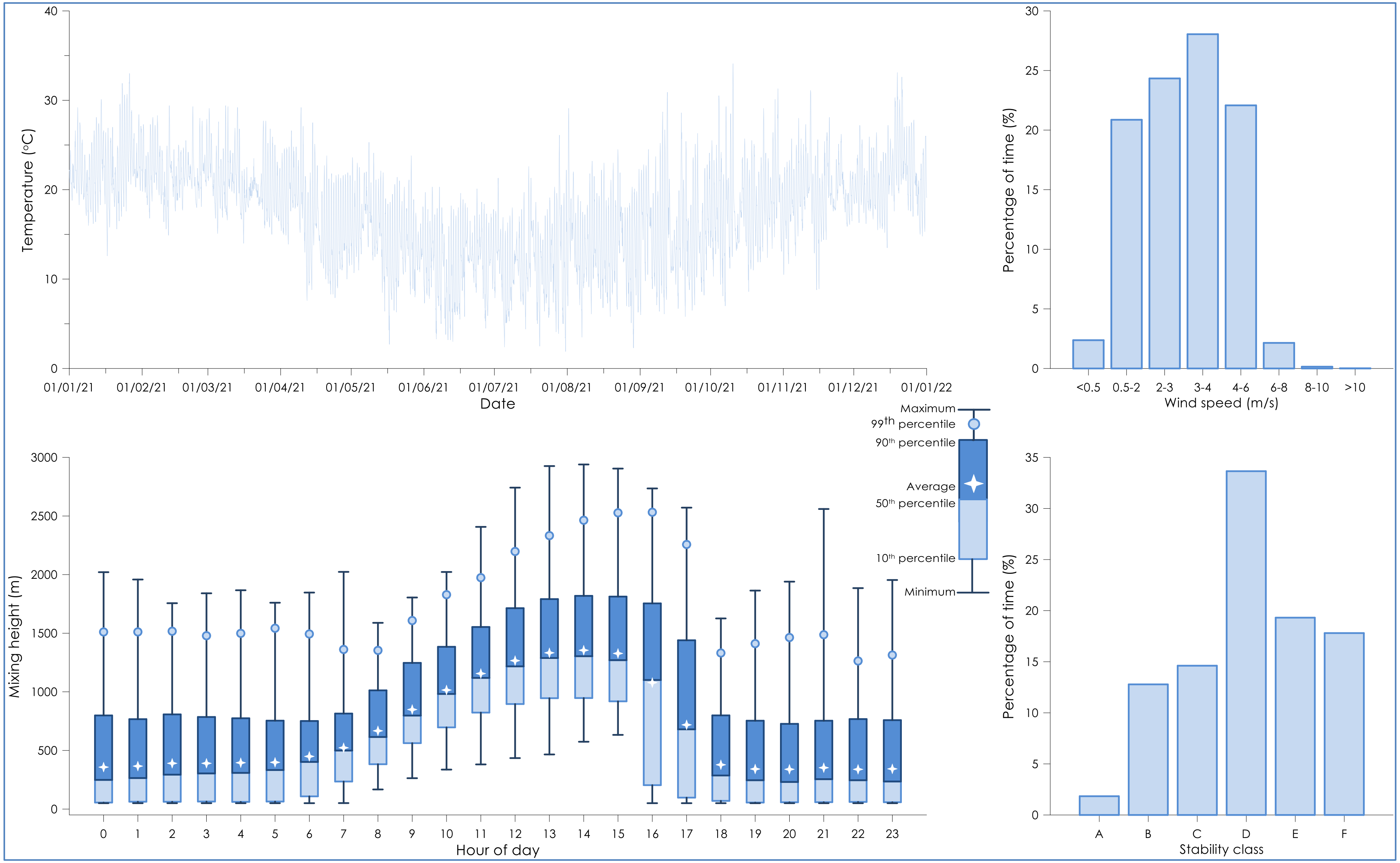

Figure 5-3: Meteorological analysis of CALMET (Cell Ref 5050)

5.3 Dispersion modelling

Dust emissions from each operational activity of the proposed modification were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

5.4 Emission estimation

The main dust generating activities associated with operation of the proposed modification are identified as the loading/unloading of material, vehicles travelling on-site and off-site, crushing and screening processes, drilling and blasting, and windblown dust from exposed areas and stockpiles. The on-site plant equipment also has the potential to generate particulate emissions from the diesel exhaust.

Bulleys Road used to transport the product material from the site is a sealed road. Potential hauling emissions along Bulleys Road have been accounted for in the emission estimates.

Similar emission factors and dust controls to those used in the *Johns River Quarry Modification Air Quality Impact* Assessment (**Environ, 2015**) were applied for the proposed modification and adjusted to reflect quarrying in the proposed extension area.

A summary of the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions is presented in **Table 5-1**. Full emission inventories and associated calculations are presented in **Appendix B**.

Table 5-1: Summary of estimated annual dust emissions for the proposed modification (kg/year)

Activity	TSP	PM_{10}	$PM_{2.5}$
Overburden loading	12	6	1
Overburden hauling (unpaved)	164	47	5
Overburden unloading	12	6	1
Truck loading in pit	237	112	17
Raw material haulage (unpaved)	4,619	1,313	131
Truck unloading to hopper	993	469	71
Crushing (uncontrolled)	608	270	45
Screening (uncontrolled)	2,813	968	135
Loading to stockpiles from processing	237	112	17
Loading to trucks	237	112	17
Product haulage to storage stockpiles (unpaved)	2,029	577	58
Unloading to storage stockpiles	237	112	17
Loading to product trucks	237	112	17
Haulage - stockpiles to exit (unpaved)	6,863	1,951	195
Product transportation (paved)	4,280	822	199
Drilling	18	9	1
Blasting	307	160	9
Wind erosion - exposed surfaces and stockpiles	8,745	4,373	656
Exhaust emissions	966	966	937
Total emissions	**33,613**	**12,497**	**2,529**

6 DISPERSION MODELLING RESULTS

The dispersion model predictions presented in this section include those for the operation of the proposed modification in isolation (incremental impact) and the operation of the proposed modification with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) during the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

Table 6-1 presents the predicted incremental and cumulative particulate dispersion modelling results at each of the assessed residential receptor locations. The cumulative (total) impact is defined as the modelling impact associated with the operation of the proposed modification combined with the estimated ambient background levels in **Section 4.3.4**.

The predicted incremental results show that minimal incremental effects would arise at the receptor locations due to the proposed modification. The predicted cumulative results indicate that all of the assessed receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 6-1: Dust dispersion modelling results for residential receptors

Receptor ID	Incremental maximum concentrations						Cumulative			
	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R1	1.5	0.1	6.1	0.6	1.3	0.1	4.7	11.4	40.1	2.5
R2	0.6	0.1	2.8	0.6	1.3	0.2	4.7	11.4	40.1	2.6
R3	0.8	0.1	3.4	0.5	1.1	0.1	4.7	11.3	39.9	2.5
R4	0.2	<0.1	1.0	0.1	0.3	<0.1	4.6	10.9	39.1	2.4
R5	0.2	<0.1	0.8	0.1	0.2	<0.1	4.6	10.9	39.0	2.4
R6	0.4	<0.1	2.0	0.4	0.8	<0.1	4.7	11.2	39.6	2.5
R7	0.4	<0.1	2.3	0.4	0.8	<0.1	4.7	11.2	39.6	2.5
R8	0.3	<0.1	1.1	0.1	0.3	<0.1	4.6	10.9	39.1	2.4
R9	0.2	<0.1	0.9	0.1	0.2	<0.1	4.6	10.9	39.0	2.4
R10	0.2	<0.1	1.0	0.1	0.3	<0.1	4.6	10.9	39.1	2.4
R11	0.6	0.1	1.7	0.4	0.8	<0.1	4.7	11.2	39.6	2.4
R12	0.4	<0.1	2.1	0.4	0.8	<0.1	4.7	11.2	39.6	2.4
R13	0.7	0.1	2.2	0.5	1.2	<0.1	4.7	11.3	40.0	2.5
R14	0.5	<0.1	1.4	0.3	0.7	<0.1	4.7	11.1	39.5	2.4
R15	1.4	0.3	4.5	1.2	2.9	0.1	4.9	12.0	41.7	2.5

Receptor ID	Incremental maximum concentrations						Cumulative			
	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R16	0.4	<0.1	1.4	0.3	0.7	<0.1	4.7	11.1	39.5	2.4
R17	0.3	<0.1	1.0	0.2	0.4	<0.1	4.6	11.0	39.2	2.4
R18	0.3	<0.1	1.2	0.2	0.3	<0.1	4.6	11.0	39.1	2.4

*Deposited dust

6.1 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

The results for incremental 24-hour average $PM_{2.5}$ and PM_{10} concentrations indicate there are no predicted exceedances of the relevant criteria at the receptors for the assessed scenario.

When assessing the total (cumulative) 24-hour average impacts based on model predictions an assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA**, **2022**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts for $PM_{2.5}$ and PM_{10}. In simple terms, the Level 2 assessment involves matching one year of ambient air quality monitoring data with meteorological data representing the same period.

Table 6-2 provides a summary of the findings from the Level 2 assessment for the most impacted residential receptor (R1) for both $PM_{2.5}$ and PM_{10}. The results in **Table 6-2** indicate that the proposed modification does not increase the number of days above the 24-hour average criterion at the assessed receptors for $PM_{2.5}$ and PM_{10}. Based on this result it can be inferred that the proposed modification does not increase the number of days above the 24-hour average $PM_{2.5}$ and PM_{10} criterion at any of the receptor locations surrounding the site.

Detailed tables of the contemporaneous assessment results are provided in **Appendix D**.

Table 6-2: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for the receptor R1 are presented in **Figure 6-1** to **Figure 6-2**.

The orange bars in the figures represent the contribution from the proposed modification and the blue bars represent the applied background levels. It is clear from the figures that the proposed modification has a small influence at the assessed receptor locations and in most cases would be difficult to discern beyond the existing background level. It is to be noted, where data are unavailable in the monitoring datasets for the contemporaneous period, the 90th percentile of the monitoring dataset has been applied to substitute for these gaps. This approach provides a reasonable indication of the potential background level on days where data are unavailable.

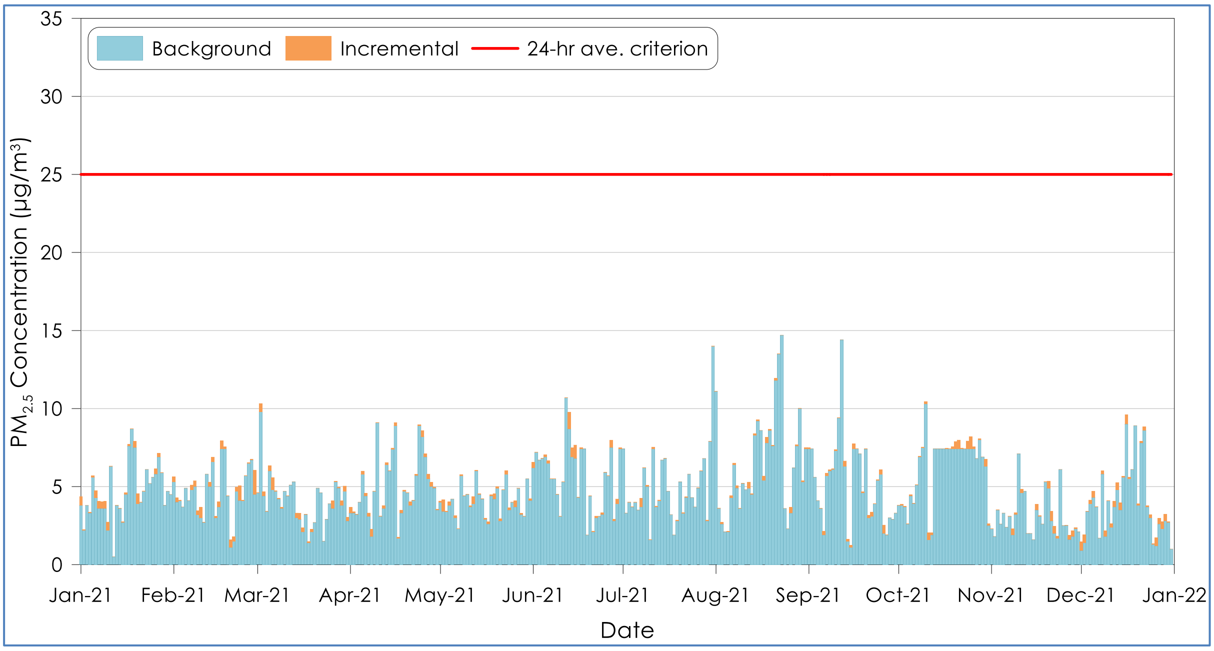

Figure 6-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R1

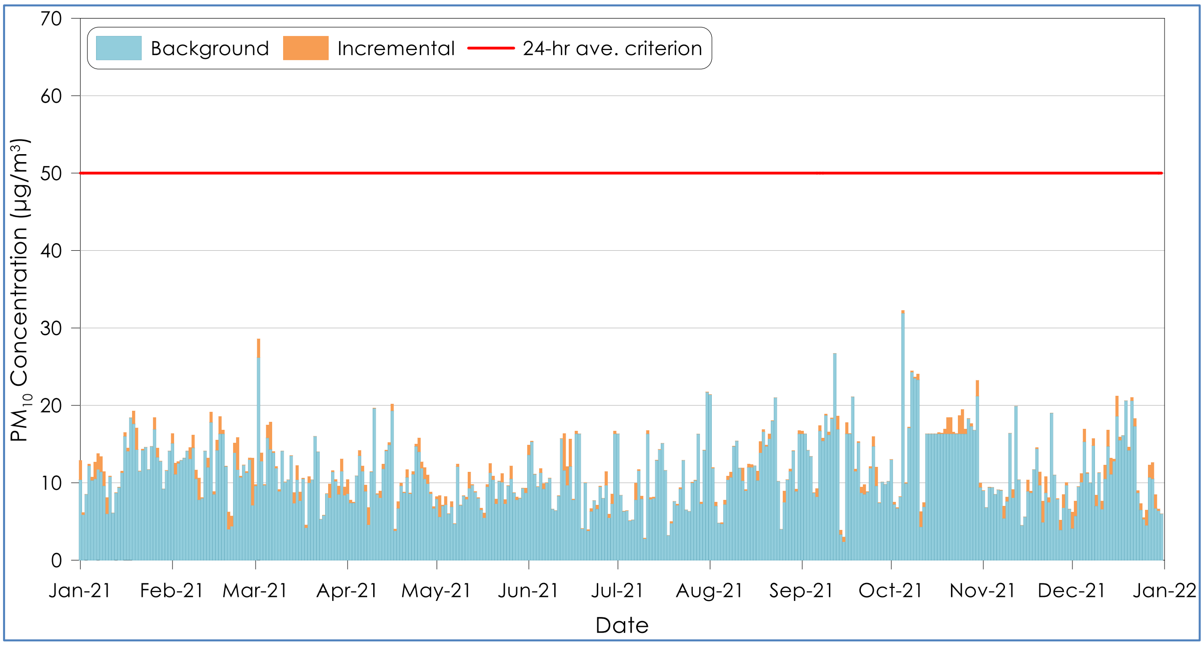

Figure 6-2: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R1

7 DUST MITIGATION AND MANAGEMENT

The operations of the proposed modification have the potential to generate dust emissions. To ensure that activities associated with the proposed modification have a minimal effect on the surrounding environment, it is recommended that all reasonable and practicable dust mitigation measures be utilised.

Boral currently employ a number of air quality control measures at the Johns River Quarry that are included within the site's Environmental Management Plan (EMP) (**Boral, 2018**). The objective in the EMP is to minimise dust generation through appropriate dust management measures. These are outlined below:

- Ensure the use of a mobile water tanker and fixed sprays is adequately controlling dust generation;
- All areas in or on the premises must be maintained in a condition that prevents or minimises the emission into the air of dust;
- Any activity carried out in or on the premises must be carried out by such practical means as to prevent dust or minimise the emission of dust to the air;
- Any plant operated in or on the premises must be operated by such practical means to prevent or minimise dust or other air pollutants;
- Trucks entering and leaving the premises that are carrying loads of dust generating materials must have their loads covered at all times, except during loading and unloading;
- Contain the crushing plant within a colourbond housing;
- Water sprays are used on all material change over points;
- Conveyors are covered on tops and one side;
- Wet down stockpiles, loading pads and roads in dry and/or windy conditions. Spray truck loads prior to dispatch;
- Minimise stripping of overburden;
- Progressively rehabilitate disused quarry benches;
- Vegetate and stabilise bund walls and overburden stockpiles with grass;
- Schedule overburden stripping during the best climatic conditions; and,
- Reduction in vehicle travel speeds on site.

It is recommended that existing air quality control measures continue to be applied and the EMP updated to incorporate the proposed modification.

8 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the proposed extraction area increase at Johns River Quarry, Johns River.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the proposed modification. The estimated emissions of dust applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the operation of the proposed modification would comply with the applicable NSW EPA air quality assessment criteria at the assessed receptors and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the site can operate without causing any significant air quality impact at residential receptors in the surrounding environment.

9 REFERENCES

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Climate statistics for Australian locations, Bureau of Meteorology website, accessed May 2024. http://www.bom.gov.au/climate/averages

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

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"Dustwatch Report November 2019", prepared by NSW Department of Planning, Industry and Environment, November 2019.

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TRC (2011)

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

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"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

Appendix A

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Taree Airport AWS weather station, is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2019 to 2023 was analysed against the available measured wind speed, temperature and relative humidity. The analysis indicates that 2020 and 2021 dataset is closest to the mean for wind speed, and 2021 is closest to the long term mean for wind direction and relative humidity. On the basis of a score weighting analysis, 2021 was found to be most representative.

Table A-1: Statistical analysis results for Taree Airport AWS

Year	Wind speed	Temperature	Relative humidity	Score
2019	0.5	0.9	7.0	8.4
2020	0.2	0.6	3.4	4.2
2021	0.2	0.5	2.9	3.7
2022	0.3	0.7	5.8	6.8
2023	0.3	0.9	3.8	5.0

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2015 year compared with the mean of the 2019 to 2023 data set. The 2021 year data appear to be well aligned with the mean data.

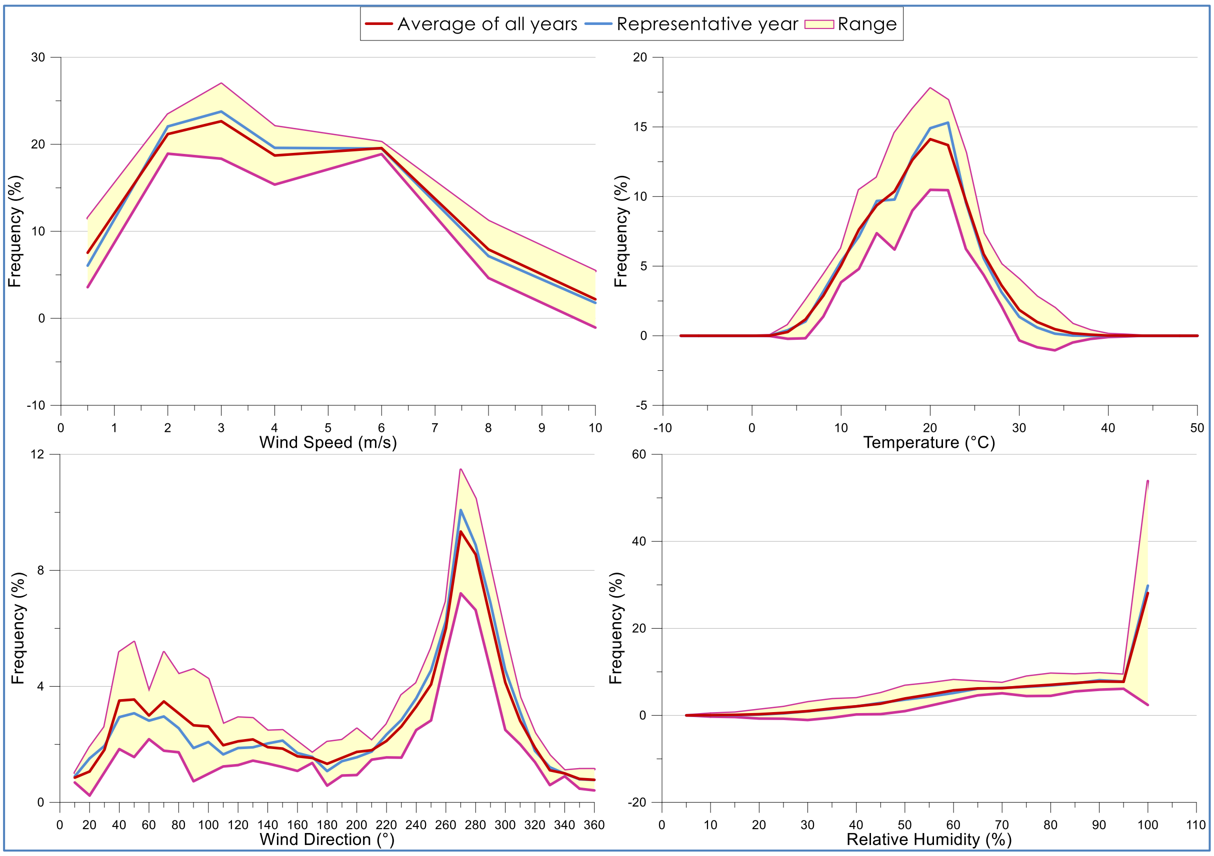

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Emission Calculations

Emission Calculation

The dust emissions from the proposed modification have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**NSW EPA, 2015**).

The emission factor equations used for each dust generating activity are outlined in **Table B-1** below. A detailed dust emission inventory for the modelled scenario is presented in **Table B-2**.

Control factors applied in the emission estimates are identical to those applied in the latest air quality impact assessment (**Environ, 2015**) and include the following:

- Hauling on unpaved surfaces – 75% control for watering of trafficked areas and 44% control for travel speeds;
- Crushing and screening activities – 50% watering applied; and,
- Wind erosion from exposed areas – 50% control for watering of exposed areas.

Table B-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Hauling on sealed surfaces	$EF = 3.23 \times s.L.^{0.91} \times (1.1023 \times W)^{1.02} kg/VKT$	$EF = 0.62 \times s.L.^{0.91} \times (1.1023 \times W)^{1.02} kg/VKT$	$EF = 0.15 \times s.L.^{0.91} \times (1.1023 \times W)^{1.02} kg/VKT$
Drilling	0.59	$0.30 \times TSP$	$0.04 \times TSP$
Blasting	$0.00022 \times A^{1.5}$	$0.52 \times TSP$	$0.03 \times TSP$
Crushing (uncontrolled)	0.0027	0.0012	0.0002
Screening (uncontrolled)	$EF = 0.0125\, kg/tonne$	$EF = 0.0043\, kg/tonne$	$EF = 0.0006\, kg/tonne$
Wind erosion on exposed areas, stockpiles	$EF = 850\, kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

A = horizontal area (m^2) with blasting depth ≤ 21m, EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), s.L. = silt loading (g/m^2), W = average weight of vehicle (tonne), VKT = vehicle kilometres travelled (km), s.L. = silt loading (g/m^2).

Table B-2: Dust Emissions Inventory

Proposed Modification	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var 1	Units	Var 2	Units	Var 3 - TSP	Var 3 - PM10	Var 3 - PM25	Units	Var 4	Units	Var 5	Units	Var 6	Units
Overburden loading	12	6	1	22,320	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Overburden hauling (unpaved)	164	47	5	22,320	t/yr	0.05237	0.0149	0.00149	kg/t	30	t/load	0.50	km/return	3.14	0.89	0.09	kg/VKT	8.3	S.C. %	30	Ave weight (t)	86	% C
Overburden unloading	12	6	1	22,320	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Truck loading in pit	237	112	17	450,000	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Raw material haulage (unpaved)	4,619	1,313	131	450,000	t/yr	0.07331	0.0208	0.00208	kg/t	30	t/load	0.70	km/return	3.14	0.89	0.09	kg/VKT	8.3	S.C. %	30	Ave weight (t)	86	% C
Truck unloading to hopper	993	469	71	450,000	t/yr	0.00221	0.00104	0.00016	kg/t	1.61	ave. wind speed (m/s)	1.8	M.C. %										
Crushing (uncontrolled)	608	270	45	450,000	t/yr	0.0027	0.0012	0.0002	kg/t													50	C %
Screening (uncontrolled)	2,813	968	135	450,000	t/yr	0.0125	0.0043	0.0006	kg/t													50	C %
Loading to stockpiles from processing	237	112	17	450,000	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Loading to trucks	237	112	17	450,000	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Product haulage to storage stockpiles (unpaved)	2,029	577	58	450,000	t/yr	0.032	0.009	0.001	kg/t	30	t/load	0.31	km/return	3.14	0.89	0.09	kg/VKT	8.3	S.C. %	30	Ave weight (t)	86	% C
Unloading to storage stockpiles	237	112	17	450,000	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Loading to product trucks	237	112	17	450,000	t/yr	0.00053	0.00025	0.00004	kg/t	1.61	ave. wind speed (m/s)	5	M.C. %										
Haulage - stockpiles to exit (unpaved)	6,863	1,951	195	450,000	t/yr	0.109	0.031	0.003	kg/t	30	t/load	1.04	km/return	3.14	0.89	0.09	kg/VKT	8.3	S.C. %	30	Ave weight (t)	86	% C
Product transportation (paved)	4,280	822	199	450,000	t/yr	0.00951	0.00183	0.00044	kg/t	32	t/load	3.96	km/return	0.0769	0.015	0.004	kg/VKT	0.6	S.L (g/m2)	32	Ave weight (t)		
Drilling	18	9	1	30	holes/yr	0.59	0.30	0.04	kg/hole														
Blasting	307	160	9	24	blasts/yr	12.8	6.6	0.4	kg/blast	1500	area of blast (m2)												
Wind erosion - exposed surfaces and stockpiles	8,745	4,373	656	21	ha	850	425	64	kg/ha/year													50	% C
Exhaust emissions	966	966	937																				
Total TSP emissions (kg/yr.)	**33,613**	**12,497**	**2,529**																				

Appendix C

Isopleth Diagrams

Figure C-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

Figure C-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

Figure C-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

Figure C-5: Predicted incremental annual average TSP concentrations (µg/m³)

Figure C-6: Predicted incremental annual average dust deposition levels (g/m²/month)

Figure C-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

Figure C-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

Figure C-9: Predicted cumulative annual average TSP concentrations (µg/m³)

Figure C-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

Appendix D

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 50 to 51 of the Approved Methods.

The background level is the ambient level at the Port Macquarie monitoring station for $PM_{2.5}$ and PM_{10}.

The predicted increment is the predicted level to occur at the R1 receptor due to the proposed modification.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Table D-1 to **Table D-2** assesses receptor R1 and shows the predicted maximum cumulative levels at the receptor. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the proposed modification.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m^3 or above the PM_{10} criterion of 50µg/m^3 is in **bold red.**

Table D-1: Cumulative 24-hour average $PM_{2.5}$ concentration ($\mu g/m^3$) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/10/2021	31.9	0.4	32.3	28/02/2021	7.1	6.1	13.2
12/09/2021	26.7	0.0	26.7	13/06/2021	11.6	4.7	16.3
2/03/2021	26.2	2.4	28.6	23/02/2021	11.7	4.2	15.9
8/10/2021	24.3	0.2	24.5	15/06/2021	12.1	3.5	15.6
9/10/2021	23.5	0.1	23.6	6/03/2021	14.3	3.5	17.8
10/10/2021	23.3	0.7	24.0	25/10/2021	16.3	3.2	19.5
31/07/2021	21.7	0.1	21.8	10/02/2021	7.8	2.8	10.6
1/08/2021	21.4	0.0	21.4	20/01/2021	14.3	2.8	17.1
30/10/2021	21.2	2.1	23.3	2/05/2021	5.6	2.8	8.4
18/09/2021	21.1	0.0	21.1	21/11/2021	4.9	2.7	7.6

Table D-2: Cumulative 24-hour average PM_{10} concentration ($\mu g/m^3$) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
23/08/2021	14.7	0.0	14.7	28/02/2021	4.5	1.5	6.0
12/09/2021	14.4	0.0	14.4	13/06/2021	8.7	1.1	9.8
31/07/2021	14.0	0.0	14.0	23/02/2021	4.1	0.9	5.0
22/08/2021	13.5	0.0	13.5	15/06/2021	6.8	0.9	7.7
21/08/2021	11.8	0.1	11.9	6/03/2021	4.8	0.8	5.6
1/08/2021	11.1	0.0	11.1	25/10/2021	7.4	0.8	8.2
12/06/2021	10.7	0.0	10.7	2/05/2021	3.4	0.7	4.1
10/10/2021	10.3	0.2	10.5	10/02/2021	3.0	0.7	3.7
29/08/2021	10.0	0.0	10.0	20/01/2021	3.9	0.7	4.6
2/03/2021	9.8	0.5	10.3	21/11/2021	2.8	0.6	3.4