Air Quality Impact and Greenhouse Gas Assessment

Appendix F

Appendix F — Air Quality Impact and Greenhouse Gas Assessment

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BERRIMA RAIL PROJECT
AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

RAMBØLL ENVIRON

BERRIMA RAIL PROJECT
AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

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Introduction

Hume Coal Pty Limited (Hume Coal) is seeking approval for the construction and operation of a new rail spur and loop in the Southern Highlands region of New South Wales (NSW) (the Berrima Rail Project). Hume Coal is also seeking approval in a separate State significant development application to develop and operate the Hume Coal Project; an underground coal mine and associated mine infrastructure in the NSW Southern Coalfields. Coal produced by the Hume Coal Project will be transported to port for export or to domestic markets by rail via a new rail spur and loop, constructed as part of the Berrima Rail Project.

Ramboll Environ Australia Pty Ltd (Ramboll Environ) was commissioned by EMM Consulting Pty Limited (EMM) to conduct an air quality and greenhouse gas assessment of the project.

Input Meteorology

Meteorological conditions are recorded in the vicinity of the Berrima Rail project area by two Hume Coal owned meteorological stations. Meteorological monitoring resources in the surrounding area also include stations at the Berrima Cement Works and in Moss Vale (Bureau of Meteorology (BoM) operated). The review of data from all these resources has highlighted that the region experiences winds which are predominantly from the westerly, north-easterly and south-easterly quadrants.

Due to the variability in the recorded wind speeds across the region, a complete year of meteorological conditions from each of two different weather stations was utilised for the dispersion modelling study. This data was recorded during 2013 at the BoM Moss Vale and southern Hume Coal 1 monitoring stations. This is effectively double the quantity of weather data that would be normally used for similar exercises on other projects.

Existing air quality

A number of existing industrial operations are located in the surrounding area, including Boral's Berrima Cement Works, Ingham's Berrima Feed Mill and Omya's Southern Limestone facility. Emissions from neighbouring industrial facilities were quantified and modelled to predict spatially-varying impacts in the surrounding environment.

Additionally, air quality monitoring data from onsite, local and regional monitoring equipment was analysed to quantify baseline air quality conditions.

Air pollutant emissions and impacts

A qualitative assessment of the construction phase of the project was undertaken. The results of this analysis identified that through the implementation of appropriate dust mitigation measures, impacts to the surrounding environment will be minimised.

Emissions of particulate matter (TSP, PM_{10}, $PM_{2.5}$) and gaseous pollutants (NO_2 and VOCs) as a result of diesel combustion by locomotive engines were quantified for existing and future operations along the Berrima Branch Line. Fugitive emissions of coal dust from loaded and empty wagons will be mitigated by the use of covered wagons.

Emissions were applied to the AERMOD atmospheric dispersion model to predict ground level concentrations. The results of the atmospheric dispersion modelling identified that the air emissions resulting from the upgrading and increased use of the Berrima Branch Line will increase relative to train movements associated with the existing users along the line. However, the predicted project only air quality impacts at all receptors are well below the applicable air quality criteria for both existing and future Berrima Branch Line activities.

A study of the cumulative impacts associated with the combination of emissions from the project, the Hume Coal Project, neighbouring emission sources and existing ambient background concentrations was undertaken. The results of the cumulative air quality impact assessment also demonstrated that no exceedance of air quality criteria will occur at any receptor locations including with all emissions from the Berrima Rail Project.

Greenhouse gas emissions

A greenhouse gas quantification assessment was undertaken for the project. The maximum annual Scope 1 and Scope 3 emissions associated with the combustion of diesel fuel by locomotives represent approximately 0.0033% of total GHG emissions for NSW and 0.0008% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

1. INTRODUCTION

1.1 Overview

Hume Coal Pty Limited (Hume Coal) is seeking approval for the construction and operation of a new rail spur and loop, known as the Berrima Rail Project, in the Southern Highlands region of New South Wales (NSW) (the Berrima Rail Project). Hume Coal is also seeking approval in a separate State significant development application to develop and operate the Hume Coal Project; an underground coal mine and associated mine infrastructure in the NSW Southern Coalfields. Coal produced by the Hume Coal Project will be transported to port for export or to domestic markets by rail via a new rail spur and loop, constructed as part of the Berrima Rail Project.

Approval for the Berrima Rail Project (the project) is being sought under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). An environmental impact statement (EIS) is a requirement of the approval processes. This air quality and greenhouse gas report forms part of the EIS. It documents the methodology and results of the assessment, the measures taken to avoid and minimise impacts and the additional mitigation and management measures proposed.

Development consent for the Berrima Rail Project is one of three approvals required under the EP&A Act for the Hume Coal mine to operate. Hume Coal is therefore seeking:

- development consent for the mine and associated facilities (ie the Hume Coal Project) under Part 4, Division 4.1 of the EP&A Act;
- development consent for the construction and use of a new rail spur and loop (the rail project which is the subject of this report) under Part 4, Division 4.1 of the EP&A Act; and
- an activity approval for proposed electricity supply works under Part 5 of the EP&A Act.

All three projects are inextricably linked, in that one will not be developed without the other two. Approval for the three projects is therefore being sought simultaneously, and construction will occur concurrently.

The location of the project is shown in **Figure 1-1**, and the local context around the project area is illustrated in **Figure 1-2**.

1.2 Project Description

The Berrima Rail Project will enable the transportation of coal produced by the Hume Coal Project to various customers. The new rail spur and loop will be connected to the western end of the existing Berrima Branch Line; a privately owned line branching off the Main Southern Rail Line at the Berrima Junction approximately 2.5 km north of Moss Vale. The Berrima Branch Line is owned and used by Boral Cement Ltd (Boral) for the transportation of cement, limestone, coal and clinker to and from the Berrima Cement Works. It is also used by Inghams Enterprises Pty Limited (Inghams) for the transportation of grain to its feed mill east of the cement works, and by Omya (Australia) Pty Ltd (Omya) for the transportation of limestone to their Moss Vale plant at the Berrima Junction.

In addition to the construction of the new rail spur and loop, the project also involves upgrades to the Berrima Branch Line and the use of the rail infrastructure by Hume Coal and Boral. The rail project and the Hume Coal Project are the subject of two separate development applications as the rail project involves rail infrastructure used by users other than Hume Coal, as noted above.

Hume Coal will rail product coal primarily to Port Kembla terminal for export, and possibly to the domestic market depending on demand. Hume Coal will transport up to 3.5 Million tonnes per annum (Mtpa) of product coal which will require up to eight train paths per day (four in each direction), with an average of four to six paths per day.

In summary the project involves:

- upgrades to Berrima Junction (at the eastern end of the Berrima Branch Line) to improve the operational functionality of the junction, including extending the number 1 siding, installation of new turnouts and associated signalling on the branch line. This does not involve any work at or beyond the interface with ARTC-controlled track;

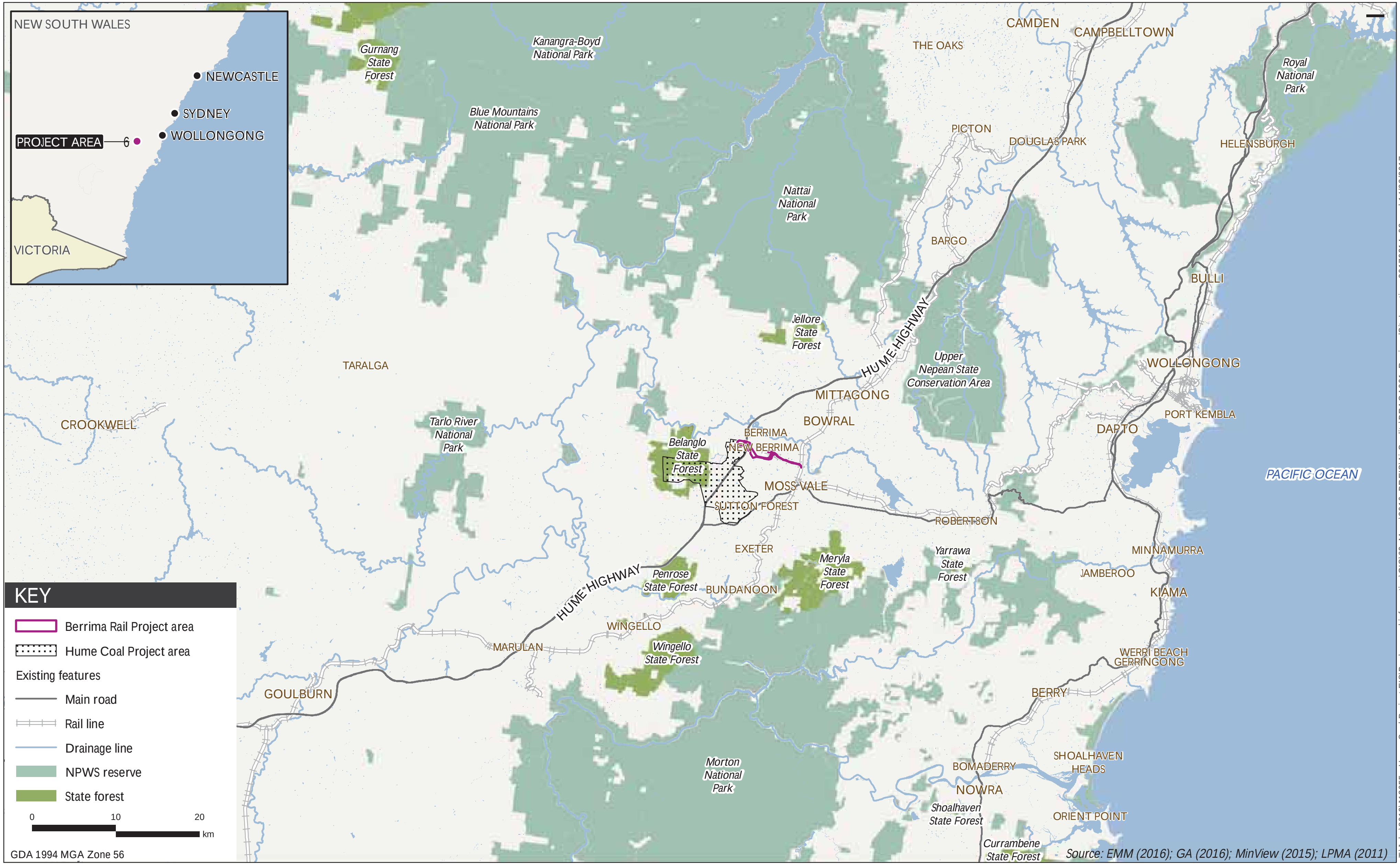
- construction and operation of a railway bridge over Berrima Road;
- construction and operation of a new rail connection into the Berrima Cement Works from the railway bridge;
- decommissioning of the existing rail connection into the Berrima Cement Works including the Berrima Road level rail crossing;
- construction and operation of a new rail spur line from the Berrima Branch Line connection to the Hume Coal Project coal loading facility;
- construction and operation of a grade separated crossing (railway bridge) over the Old Hume Highway;
- construction and operation of maintenance sidings, a passing loop and basic provisioning facility on the western side of the Old Hume Highway, including an associated access road, car parking and buildings;
- construction and operation of the Hume Coal rail loop within the Hume Coal Project Area, adjacent to Medway Road; and
- construction and operation of associated signalling, services (including water, sewerage drainage), access tracks, power and other ancilliary infrastructure.

The conceptual project layout is illustrated in **Figure 1-3**. As shown, approval is sought for two alignments of the new rail line where it will cross Berrima Road. The preferred option is the blue rail alignment shown in **Figure 1-3**, which includes construction of a railway bridge over Berrima Road as described in the points above. This preferred project design has been developed in consultation with Boral as the owner of the Berrima Branch Line.

The alternative option (orange alignment in **Figure 1-3**) accounts for a proposal by Wingecarribee Shire Council (WSC) to realign approximately 680 m of Berrima Road between Taylor Avenue and Stony Creek to replace the T-intersection at Berrima Road and Taylor Avenue with a roundabout, and to replace the existing rail level crossing into the Berrima Cement Works with a rail overbridge. If WSC relocates Berrima Road to the alignment shown in **Figure 1-3**, then the following project components would vary:

- the turnout for the new spur line to service the Hume Coal Project would be installed on the existing Berrima Branch Line approximately 1000 m east of the cement works. A short section of the existing Berrima Branch Line would be shifted north, within the rail corridor on Boral-owned land, to accommodate the spur line;
- the construction of a railway bridge over Berrima Road would be replaced by a railway underpass beneath the realigned Berrima Road, constructed through the elevated embankment for the road;
- the construction of a new rail connection into the Berrima Cement Works from the railway bridge would no longer be required, and the cement works access would remain unchanged; and
- the existing rail connection into the Berrima Cement Works and the Berrima Road level rail crossing would not be decommissioned, since the road would be realigned to pass over the existing rail alignment using a bridge.

From an air quality perspective, there is negligible difference in emissions and potential impacts at all of the surrounding receptors between the two alignment options. Therefore, the air quality and greenhouse gas assessment results presented in this report apply to both alignments.



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Locality plan
Berrima Rail Project
Air quality and GHG assessment
Figure 1.1

Local context

Berrima Rail Project

Air quality and GHG assessment

Figure 1.2

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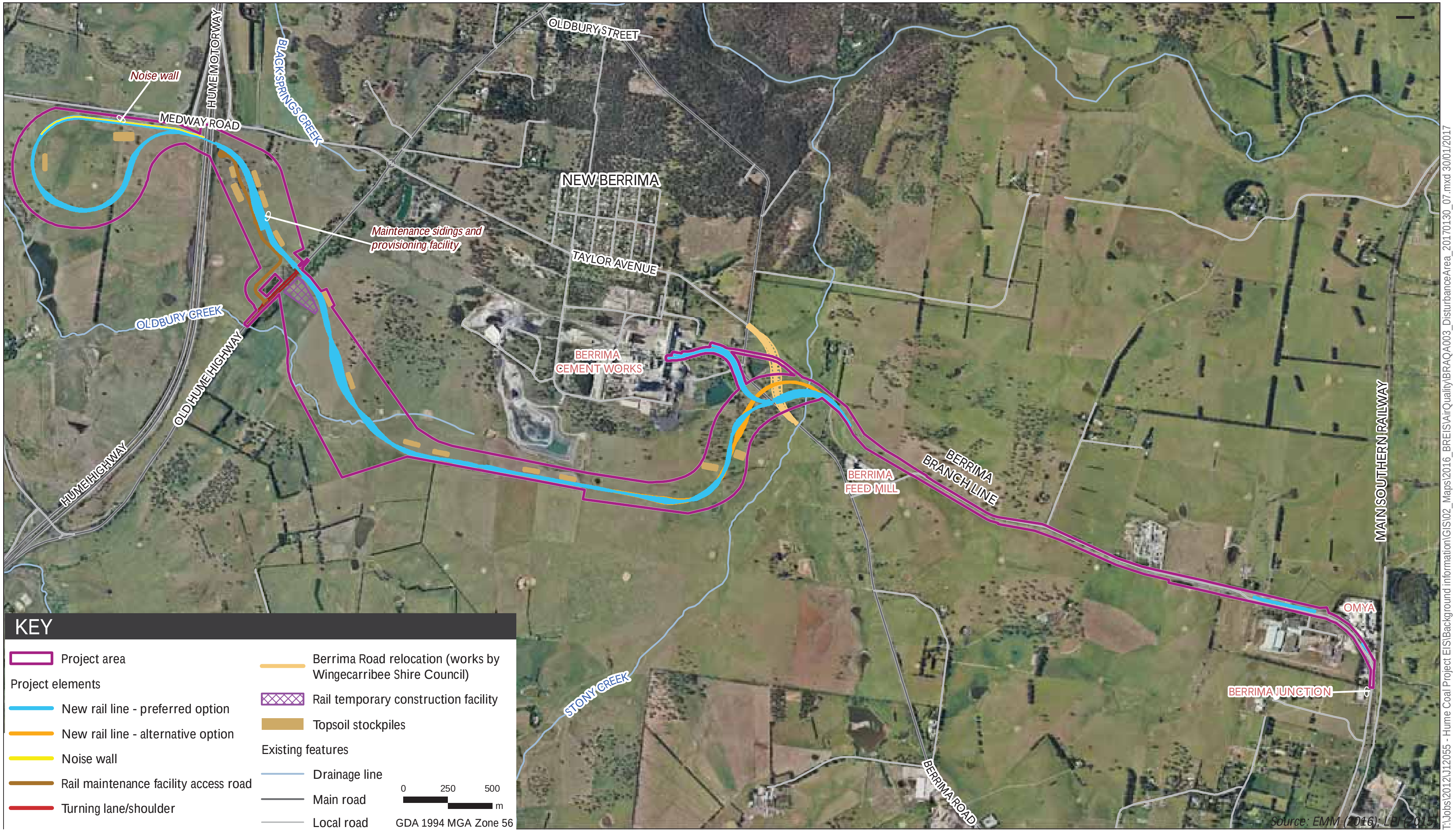


Conceptual project components

Berrima Rail Project
Air quality and GHG assessment

Figure 1.3

1.3 Project area

The project area is located in the Southern Highlands region of NSW in the Wingecarribee local government area, approximately 100 km south-west of Sydney. It occupies a corridor that is around 8 km long, stretching from the Berrima Junction on the outskirts of Moss Vale, heading west in parallel with Douglas Road past the Berrima Feed Mill, around the southern side of the Berrima Cement Works, across the Old Hume Highway and under the Hume Highway through an existing underpass into the Hume Coal Project area, south of Medway Road.

The project area is in a semi-rural setting. It is surrounded by grazing properties, small-scale farm businesses, scattered rural residences, and large and small industries and is traversed by the Hume Highway. The project area contains predominately cleared agricultural land consisting of improved pasture for grazing, and over a third of the area comprises the existing Berrima Branch Line.

The villages of New Berrima, Berrima and Moss Vale are located in the general area. Medway is also located nearby while Bowral and Mittagong are located between 6 and 10 km north-east of the eastern end of the project area, respectively. There are also scattered homesteads, dwellings and other built structures associated with agricultural production surrounding the project area.

1.4 Assessment guidelines and requirements

This air quality and greenhouse gas assessment has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies. In particular, the following guidelines and policies were considered in this assessment:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2016); and
- National Greenhouse Accounts Factors (DoE, 2015).

The air quality and greenhouse gas assessment was prepared in accordance with the requirements of the NSW Department of Planning and Environment (DP&E). These were set out in the Secretary’s Environmental Assessment Requirements (SEARs) for the project, issued on 20 August 2015. A copy of the SEARs is attached to the EIS as Appendix B, while **Table 1-1** lists individual requirements relevant to this air quality impact and greenhouse gas assessment and where they are addressed in this report.

Table 1-1: Air Quality-related SEARs

Requirement	Section Addressed
An assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW	**Sections 3** to **10**
An assessment of the likely greenhouse gas impacts of the development	**Section 11**

2. SENSITIVE RECEPTORS

The project is surrounded by a mixture of regional villages, scattered rural residential properties, industrial facilities and agricultural land. In order to assess potential air quality impacts across the surrounding area, a sub-set of surrounding residences has been selected, considered to be representative of sensitive receptor locations in all directions from the project area. Additionally, single village representative receptors have been included for the following:

- Medway (receptor 1);
- Berrima (receptor 23);
- New Berrima (receptor 22);
- Bowral (receptor 31);
- Burradoo (receptor 30);
- Sutton Forest (receptor 33); and
- Moss Vale (receptor 32).

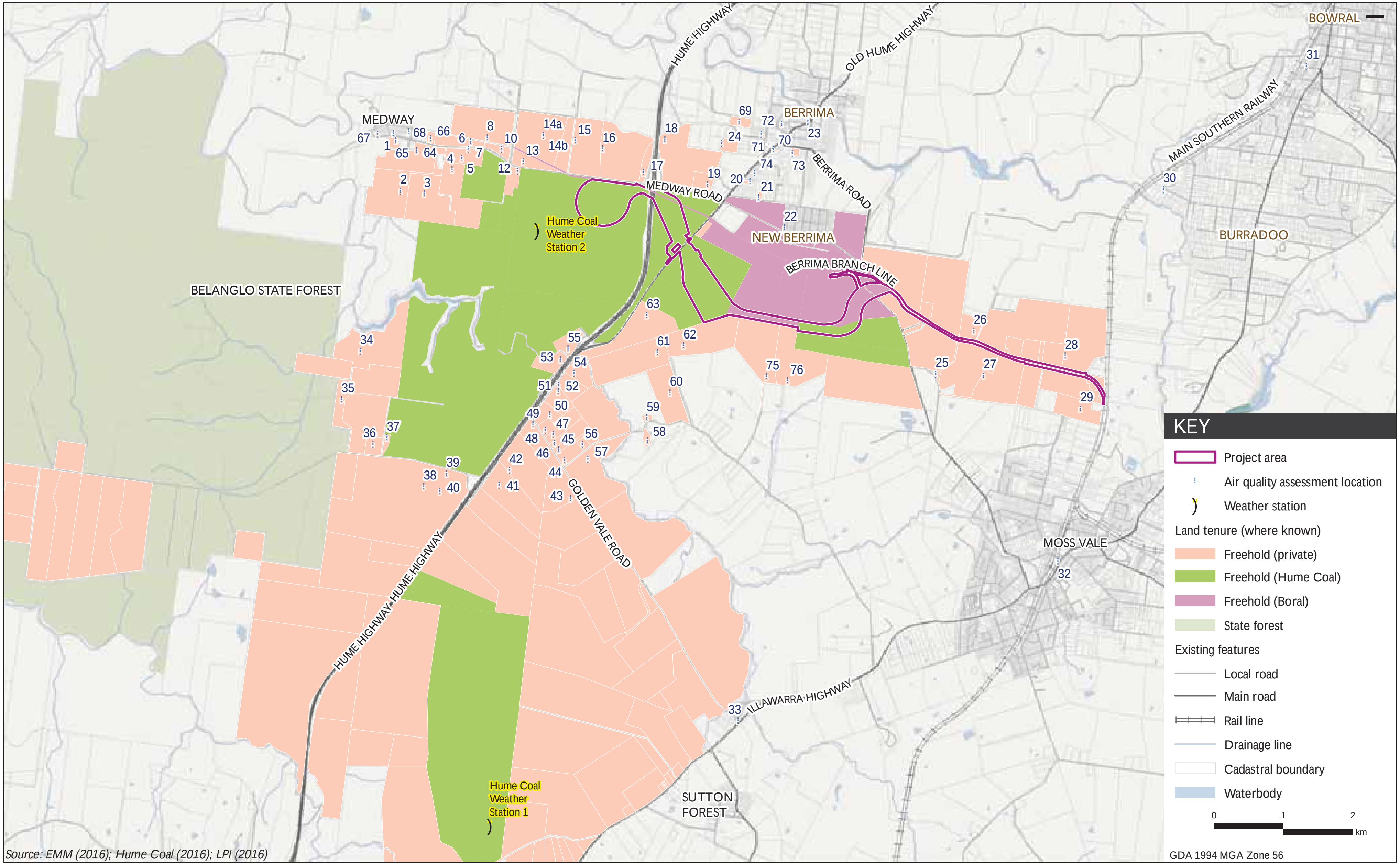
While air quality modelling results have not been explicitly reported for every residential location in the surrounding area, the modelling has been conducted for a 15km by 11km model domain with predictions made at 300m intervals. Therefore, air quality impact predictions have effectively been made for any location within the surrounding area of 165km^2. The selected representative receptor locations are presented in **Table 2-1** and illustrated in **Figure 2-1**.

Table 2-1: Selected Sensitive Receptor Locations Surrounding the project area

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)
	Easting	Northing	
1	249331	6180137	662
2	249437	6179316	631
3	249778	6179270	641
4	250179	6179619	660
5	250325	6179786	659
6	250411	6179920	660
7	250453	6180020	662
8	250691	6180085	663
10	250899	6179919	655
12	251130	6179599	660
13	251208	6179744	659
14a	251498	6180116	674
14b	251457	6180109	674
15	251961	6180040	675
16	252354	6179922	663
17	252944	6179582	661
18	253254	6180054	665
19	253868	6179400	671
20	254482	6179446	671
21	254600	6179219	684
22	254975	6178785	686
23	255316	6180322	662
24	254072	6180006	695
25	257161	6176673	687
26	257713	6177294	701
27	257854	6176648	713
28	259028	6176937	668
29	259248	6176172	678
30	260449	6179342	669
31	262512	6181117	672
32	258925	6173965	681
33	254309	6171667	655
34	248854	6177002	661
35	248589	6176305	674
36	249040	6175659	657
37	249239	6175753	654
38	249775	6175047	668
39	250105	6175232	647
40	250002	6174979	645
41	250860	6175067	651
42	251015	6175282	642
43	251889	6174874	649
44	251806	6175425	646
45	251721	6175576	647
46	251658	6175678	646
47	251644	6175801	646
48	251523	6175857	647
49	251349	6175937	653
50	251590	6176084	643
51	251712	6176412	641
52	251719	6176510	640
53	251747	6176878	638
54	251942	6176680	636
55	251855	6177038	635
56	252060	6175654	641

Table 2-1: Selected Sensitive Receptor Locations Surrounding the project area

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)
	Easting	Northing	
57	252144	6175446	640
58	253004	6175706	650
59	252990	6176040	649
60	253327	6176403	684
61	253141	6176981	677
62	253520	6177082	672
63	252992	6177520	677
64	249668	6179892	674
65	249372	6180036	660
66	249870	6180074	672
67	249105	6180133	662
68	249561	6180167	668
69	254321	6180310	680
70	254816	6179911	656
71	254641	6180129	663
72	254939	6180279	654
73	255094	6179859	675
74	254548	6179564	669
75	254720	6176633	688
76	255026	6176571	696



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Representative receptor locations

Berrima Rail Project

Air quality and GHG Assessment

Figure 2.1

3. AIR QUALITY ASSESSMENT CRITERIA

The project must demonstrate compliance with the impact assessment criteria outlined in the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (EPA, 2016 – hereafter the Approved Methods for Modelling). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

Relevant ambient air quality criteria applicable to the project are presented in the following sections.

3.1 Airborne particulate matter

When first regulated, airborne PM was assessed based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometres (µm) in diameter. As air sampling technology improved and the importance of particle size and chemical composition become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$[1].

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the Approved Methods for Modelling, gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

For the purpose of this report, predicted ground level concentrations (GLCs) are assessed against the NSW EPA's impact assessment criteria presented in **Table 3-1**.

The revised AAQ NEPM also establishes long-term goals for $PM_{2.5}$ to be achieved by 2025 (NEPC, 2015). It is noted that the purpose of the AAQ NEPM is to attain '*ambient air quality that allows for the adequate protection of human health and wellbeing*', and compliance with the AAQ NEPM is assessed through air quality monitoring data collected and reported by each state and territory. The long-term goals for $PM_{2.5}$ are therefore not applicable to the assessment of impacts of emissions sources on individual sensitive receptors, and are shown in **Table 3-1** for information only.

Table 3-1: Impact assessment criteria for PM

PM Metric	Averaging Period	Concentration (µg/m³)	Purpose of goal
TSP	Annual	90	NSW EPA impact assessment criteria
PM_{10}	24 hours	50	
	Annual	25	
$PM_{2.5}$	24 hours	25	
	Annual	8	
	24 hours	20	AAQ NEPM long term goal for 2025
	Annual	7	

The Approved Methods for Modelling specifies that the impact assessment criteria for PM are applied at the nearest existing or likely future off-site sensitive receptor and compared against

[1] Particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively.

the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (consideration of existing ambient background concentration is required).

3.2 Gaseous air pollutants

Emissions of gaseous pollutants will occur as a result of fuel combustion by the underground mining fleet and surface based vehicles.

For this assessment, the key combustion-related pollutants of interest are nitrogen dioxide (NO_2) and Volatile organic compounds (VOCs). While numerous VOC species are emitted during the combustion of diesel fuel, this assessment has focused primarily on benzene, ethylbenzene, toluene and total xylenes to assess the potential health impact of individual organic species. These species are quantifiable based on available emission factors, and may be used as markers of the relative toxicity of organic compounds from combustion.

Air quality impact assessment criteria issued by the NSW EPA applicable to these gaseous emissions are summarised in **Table 3-2**.

The air quality impact assessment criteria for NO_2 are applicable at the nearest existing or likely future off-site dwellings or establishments. In assessing compliance against the applicable criteria, the maximum total concentration (incremental plus background concentration) at each receptor must be reported as the 100th percentile concentration (i.e. maximum concentration).

The criteria specified for benzene and ethylbenzene is applicable at and beyond the boundary of the facility. For a Level 2 assessment, as is undertaken in the current study, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (EPA, 2016).

The impact assessment criteria given for toluene and xylenes are applicable at any existing or likely future off-site dwellings or establishments. The incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (EPA, 2016).

Table 3-2: Impact assessment criteria for Combustion Pollutants

Pollutant	Averaging Period	Concentration		Reference
		μg/m³	pphm[5]	
NO_2	1-hour	246	12	NSW EPA(1)
	Annual	62	3	NSW EPA(1)
Benzene	1-hour	29	9	NSW EPA(1)(2)(3)
Toluene	1-hour	360	90	NSW EPA(1)(2)(4)
Xylenes	1-hour	190	40	NSW EPA(1)(2)(4)
Ethylbenzene	1-hour	8,000	1,800	NSW EPA(1)(2)(3)

(1): Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016)

(2): For a Level 2 Assessment (defined within the Approved Methods for Modelling), expressed as the 99.9th percentile value. The current assessment constitutes a Level 2 Assessment

(3): Assessment criteria specified for toxic air pollutant

(4): Assessment criteria summarised for odorous air pollutants

(5): pphm: Parts per hundred million

4. CLIMATE AND METEOROLOGY

Meteorological mechanisms affect the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Dust generation rates are particularly dependent on wind energy, the moisture budget, which is a function of rainfall and evaporation rates, material movement, and activity.

The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the boundary layer (the general term for the layer of the atmosphere adjacent to the earth's surface) and other factors such as wind speed and direction.

Thermal turbulence is driven by incoming solar radiation and surface heating during the daylight hours. Mechanical turbulence is associated with wind speed, in combination with the surface roughness of the surrounding area. The stability of the atmosphere increases with a decrease in thermal and mechanical turbulence.

Air pollutant dispersion consists of vertical and horizontal components of motion. Vertical motion is defined by the stability of the atmosphere (e.g. a stable atmosphere has low vertical dispersion potential) and the depth of the surface-mixing layer (typically defined as the vertical distance between the earth's surface and a temperature inversion during the day).

The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field (i.e. wind speed and direction). The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The wind direction, and the variability in wind direction, determines the general path pollutants will follow and the horizontal spread of the plume.

Airborne particulate concentration levels, therefore, fluctuate in response to changes in atmospheric stability, mixing depth and winds (Oke, 2003; Sturman and Tapper, 2006; Seinfeld and Pandis, 2006).

In order to characterise the dispersion meteorology of the project region, long-term climate records, time-resolved meteorological monitoring data and meteorological modelling for the region was drawn upon, as documented in the following sections.

4.1 Climate Records and Meteorological Data

This air quality impact assessment represents a Level 2 assessment in accordance with the NSW EPA Approved Methods for Modelling. The NSW EPA specifies in Section 4.1 of the Approved Methods for Modelling that for Level 2 assessments, meteorological data representative of a site should be used in the absence of actual onsite observations. The data should cover a period of at least one year with a percentage completeness of at least 90%. Site representative data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

The installation of a meteorological monitoring station was commissioned by Hume Coal in March 2012, approximately 8 km south of the Hume Coal Project surface infrastructure area. At the time of commencement of dispersion modelling and data analysis for this assessment, the most complete continuous 12-month period of monitoring data was the 2013 calendar year. Data capture for 2014 in the dataset is below the 90% requirement of the NSW EPA due to instrumentation issues between June and September 2014, while 2015 was not yet a complete calendar year. Placement of this weather station was undertaken prior to the location of the surface infrastructure area being determined and the relevant properties acquired.

In addition to Hume Coal's meteorological station, monitoring data was also collated from the following monitoring stations:

- Bureau of Meteorology (BoM) automatic weather station (AWS) at Moss Vale;
- BoM long-term climate station at Moss Vale (Hoskins Street); and

- Boral-owned meteorological station at the Berrima Cement Works.

Finally, a second weather station was commissioned by Hume Coal and installed in the vicinity of the proposed product coal stockpiling area of the Hume Coal Project in October 2015 (Hume 2). Data from the Hume 2 station was compared to data recorded by the southern Hume Coal meteorological station (Hume 1) to illustrate similarities across the two locations. Concurrent data recorded between October 2015 and July 2016 from the Hume 1, Hume 2, Boral's Berrima Cement Works and BoM Moss Vale weather stations was collated, with period wind roses generated (**Figure 4-1**).

The following points are noted from **Figure 4-1**:

- The general wind direction profile recorded at all four monitoring stations is similar, with dominant air flow from the northeast, southeast and west evident;
- The Hume 1 station typically records higher wind speeds than the concurrent wind speed recorded at the Hume 2 station;
- The BoM Moss Vale station records higher wind speeds than all other analysed sites.

It is considered that the comparison of concurrent wind speed and direction observations from the Hume 1, Hume 2, Berrima Cement Works and BoM Moss Vale AWS monitoring stations indicates that data from the Hume 1 weather station is representative of the conditions likely to be experienced in the northern area of the project area. Further discussion on the selection of meteorological data for modelling purposes is presented in **Section 4.3.3**.

The monitoring stations from which the data has been obtained in relation to the surface infrastructure area are illustrated in **Figure 4-2.**

A summary of meteorological parameters recorded at the four continuous monitoring stations is presented in **Table 4-1**. The BoM Moss Vale climate station only records measurements at 9am and 3pm and will be used to detail long term trends in climatic conditions.

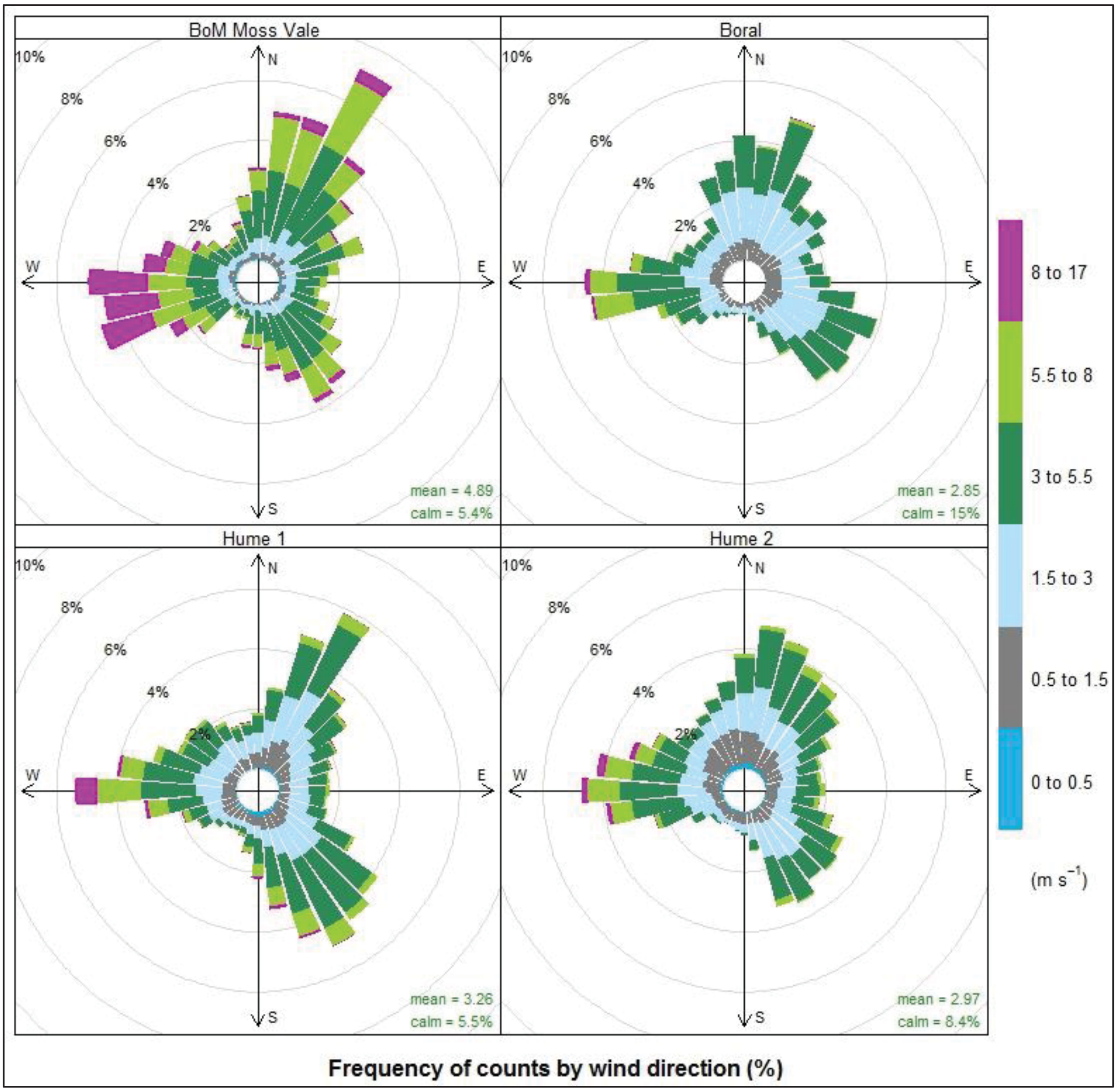
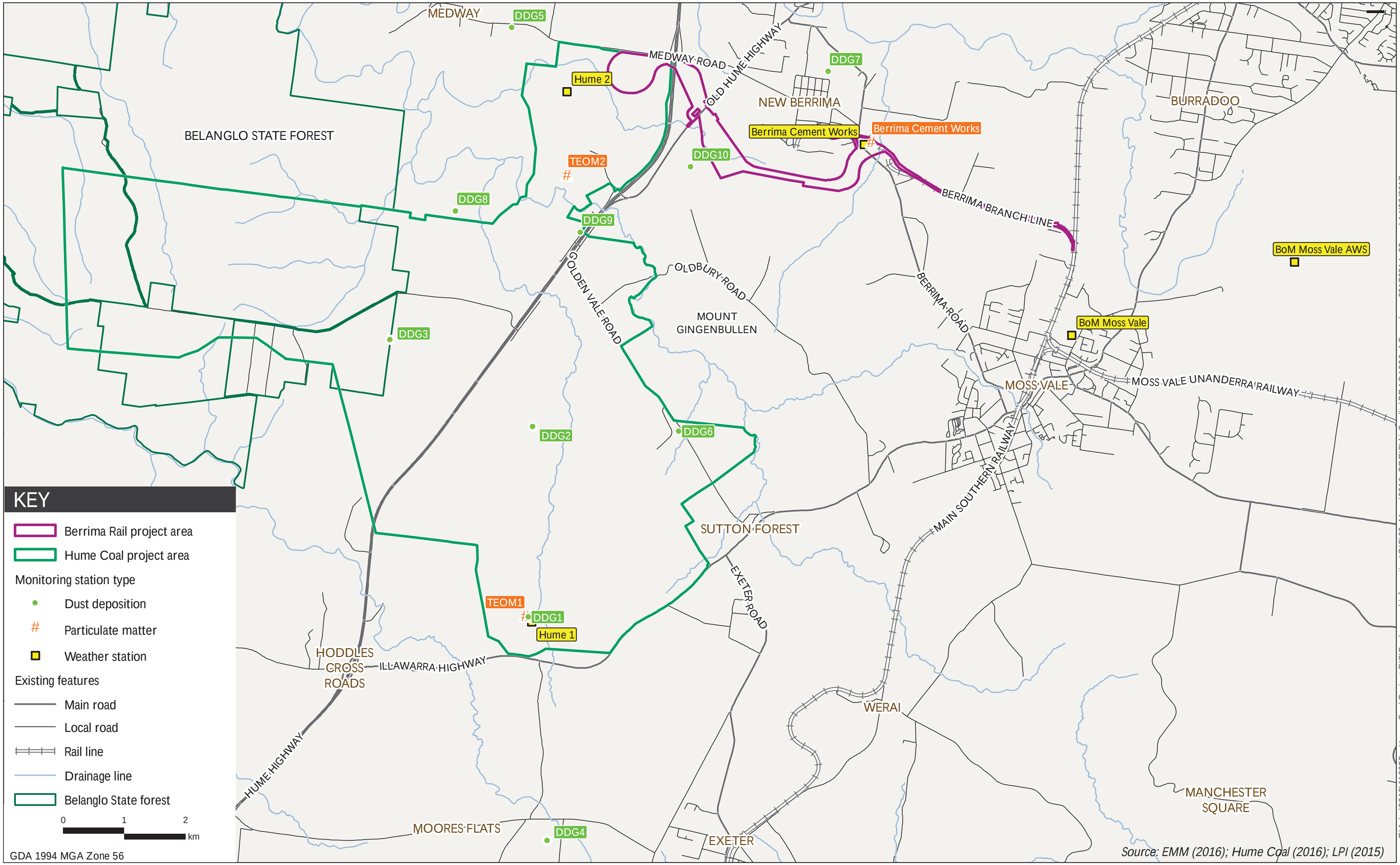


Figure 4-1: Comparison of concurrent wind data – October 2015 to July 2016



Location of local meteorological and air quality monitoring stations

Berrima Rail Project

Air quality and GHG assessment

Figure 4.2

Table 4-1: Meteorological parameters by monitoring station

Parameter	Hume Station 1	Hume Station 2	BoM Moss Vale	Boral Berrima Cement
Wind Speed and Direction	✓	✓	✓	✓
Air Temperature (2m above ground)	✓	✓		✓
Air Temperature (10m above ground)	✓	✓	✓	✓
Relative Humidity	✓	✓	✓	✓
Solar Radiation				✓
Rainfall	✓	✓	✓	✓
Cloud Cover			✓	

Of the reviewed monitoring locations, the BoM Moss Vale AWS returns the longest period of continuous monitoring data. Wind roses of wind speed and direction have been generated from recorded wind speed and direction data at the BoM Moss Vale AWS for the five year period between 2010 and 2014 inclusive. Wind rose diagrams illustrate the distribution of wind direction and speed, with the presented direction referring to the direction the wind is blowing from. These figures are presented within **Appendix 1** and indicate that minimal inter-annual variation in winds occurred across this period at Moss Vale.

As detailed above, the most complete 12-month period of monitoring data from the Hume 1 station at the commencement of the modelling assessment was the 2013 calendar year. On the basis of illustrated inter-annual consistency in recorded wind speed and direction at the BoM Moss Vale AWS, data recorded during the 2013 calendar year is the focus of this assessment.

4.2 Meteorological Modelling

To supplement the above meteorological observation datasets, the CSIRO meteorological model TAPM was used to generate parameters not routinely measured, specifically the vertical temperature and wind profile, and to substitute any data gaps in the monitoring datasets.

TAPM was configured for each monitoring station and run in accordance with Section 4.5 of the Approved Methods for Modelling (EPA, 2016), with the following refinements:

- Modelling to 300 m grid cell resolution (beyond 1 km resolution specified).
- Inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data).

The TAPM-generated vertical temperature profile at each monitoring station for every hour was adjusted by first substituting the predicted 10 m above ground temperature with hourly recorded temperature at 10 m. The vertical layer temperature difference predicted by TAPM was then adjusted relative to the 10 m observation temperature for each hour. This modified vertical profile was used in combination with the ambient air temperature throughout the day to calculate convective mixing heights between sunrise and sunset (see **Section 4.7**).

4.3 Wind Speed and Direction

4.3.1 Prevailing Annual Wind Regime

Wind rose diagrams showing wind speed and direction data recorded at the Hume 1, BoM Moss Vale AWS and Boral's Berrima Cement Works monitoring stations during 2013 is presented in **Figure 4-3**. The following points are noted with regard to the presented wind profiles:

- The dominant wind is westerly which is evident at all three monitoring stations;

- Air flow from the north to east quadrant also occurs at all three stations, however the alignment is closer north-northeast at the Hume 1 and BoM Moss Vale AWS locations and north at Boral's Berrima Cement Works station;
- Less defined air flow from the southeast is also evident across all three locations;
- Wind speeds are greater at the BoM Moss Vale AWS than the Hume 1 and Boral stations;
- Highest wind speeds are greatest from the westerly quadrant at all three locations.

A time series plot of hourly-varying 1-hour average wind speed is illustrated in **Figure 4-4**.

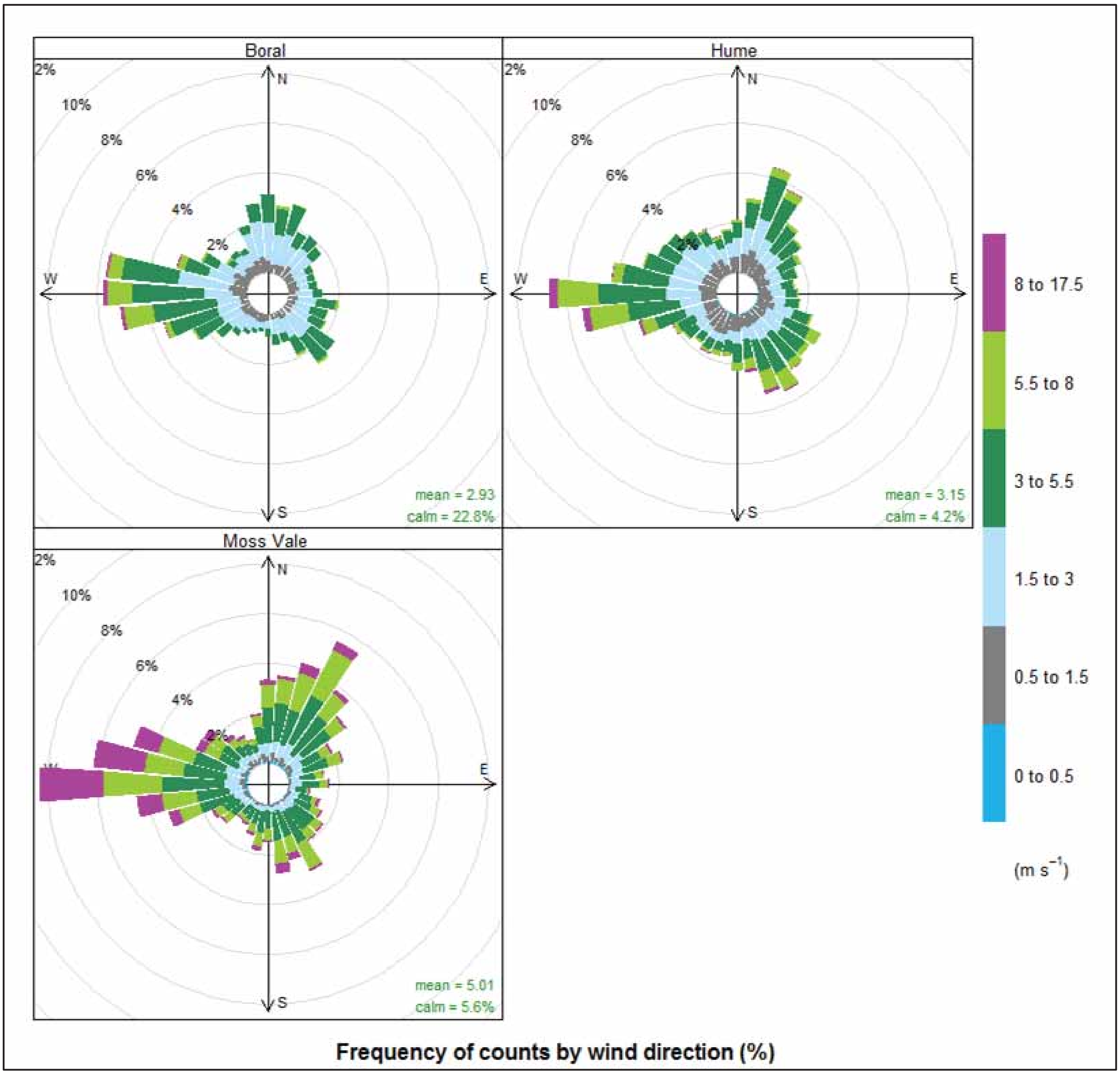


Figure 4-3: Annual wind rose – 2013 – Hume 1, BoM Moss Vale AWS and Boral Berrima monitoring stations

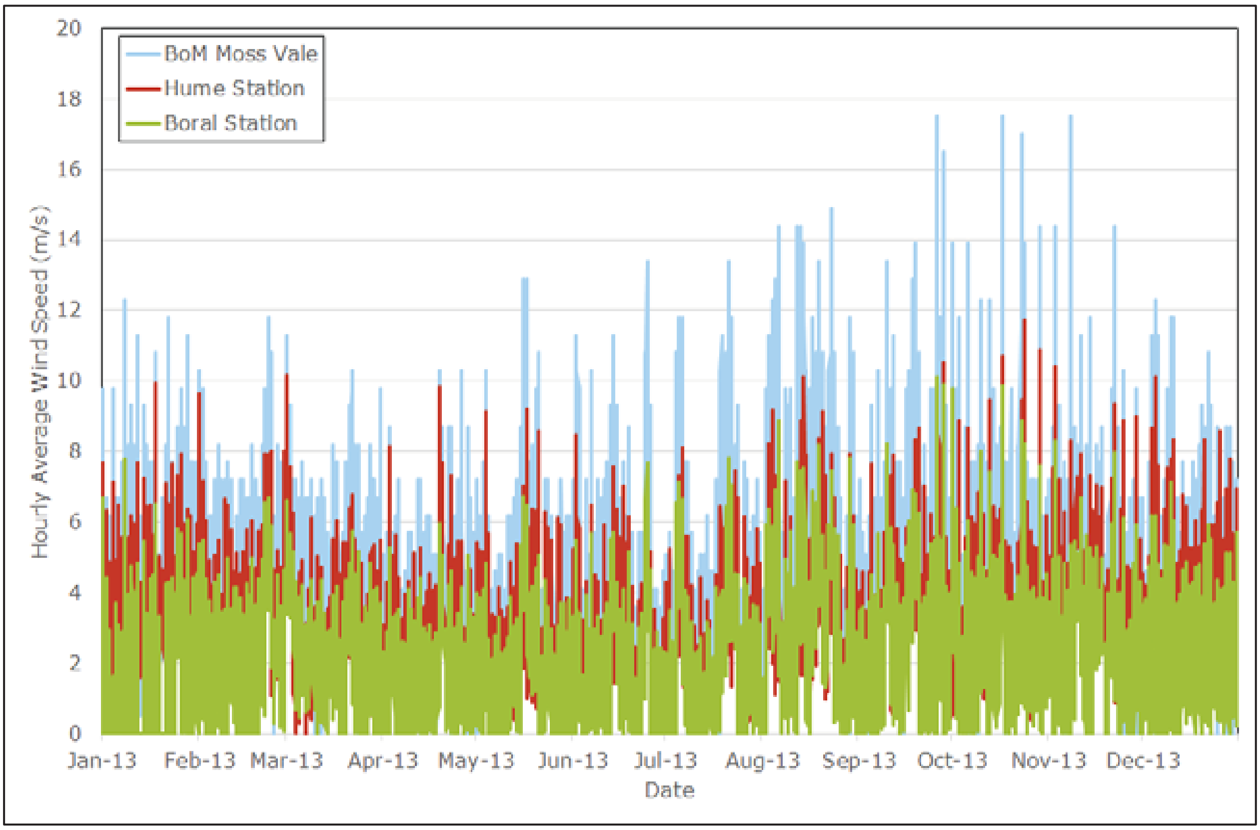


Figure 4-4: Time series of hourly average wind speed at local monitoring locations - 2013

Each 2013 meteorological monitoring dataset contains 12 months of 1-hour average observations derived from sub-hourly monitoring observations (10-minute data at Hume 1 and BoM Moss Vale AWS, 15-minute data at Boral's Berrima Cement Works).

A summary of hourly average and peak hourly gust wind speed conditions from the three monitoring stations is presented in **Table 4-2**. It is noted that during 2013, the data logger at the Hume 1 monitoring station was not configured to return peak gusts per 10-minute monitoring period. As a surrogate, the relationship between hourly average and peak gust at the Boral Berrima site was analysed, with the following linear relationship equation derived:

$$\text{hourly gust} = 1.574 * \text{hourly average wind speed} + 0.6722$$

To derive hourly peak gust data for the Hume 1 2013 dataset, the above equation was applied to each hourly average wind speed.

Table 4-2: Summary of average and peak wind speed conditions by monitoring station - 2013						
Parameter	**Hume 1**		**BoM Moss Vale AWS**		**Boral Berrima Cement**	
	m/s	**km/h**	**m/s**	**km/h**	**m/s**	**km/h**
Average Wind Speed	3.2	11.5	5.0	18.0	2.9	10.4
Maximum 1-hour Average Wind Speed	11.7	42.1	17.5	63.0	10.1	36.4
Average Gust	5.5	19.8	6.7	24.1	4.1	14.8
Maximum Gust	19.1	68.8	27.3	98.3	18.2	65.7
Frequency of Calm Conditions (%)	4.2		5.6		22.8	

4.3.2 Seasonal and Diurnal Wind Regime

Seasonal and diurnal (dividing the day into night and day) wind roses for the three meteorological monitoring datasets are presented within **Appendix 1**.

Seasonal variation in wind speed and direction is evident in the recorded data at all three monitoring stations. Wind speeds are greatest during the winter and spring months. The westerly air flow evident at all three sites is most dominant between autumn and spring, while north-easterly air flow is most common during the summer months.

Diurnal variation is most notable in recorded wind speed within all three monitoring datasets. The recorded wind speeds at each site are notably higher during the daylight hours. The westerly component is most dominant during the daylight hours, however is still evident during the night.

4.3.3 Data selection for modelling

This air quality impact assessment involves the prediction of ground level concentrations of particulate matter and gaseous pollutants emitted by the proposed project through the use of an appropriate atmospheric dispersion model. The AMS/US-EPA regulatory model (AERMOD) has been adopted for this assessment (further discussion in **Section 9.1**).

As demonstrated in the preceding sections, the wind direction experienced in the local area is relatively uniform based on the three meteorological monitoring stations analysed (BoM Moss Vale AWS, Hume 1 and Boral Berrima). However, there is spatial variance with regard to wind speed, in particular high wind speeds. This spatial variance in wind speed will result in a variation in dispersion predictions of ground level concentrations in the surrounding environment depending on the input dataset applied.

To understand the implications of different wind speed data, atmospheric dispersion modelling has been undertaken using two meteorological monitoring datasets (i.e. two complete years of modelling):

- the 2013 Hume 1 monitoring dataset; and
- the 2013 BoM Moss Vale AWS monitoring dataset.

The use of two complete meteorological monitoring datasets in the dispersion modelling (rather than a single year as per the requirements of the Approved Methods for Modelling) widens the range of dispersion meteorological conditions against which to assess potential air quality impacts in the surrounding environment.

Detailed analysis of ambient temperature, atmospheric stability and mixing depth, within the 2013 Hume 1 and BoM Moss Vale AWS monitoring datasets is presented in the following sections.

4.4 Ambient Temperature

A time series plot of hourly average recorded temperature during 2013 at the three monitoring stations is illustrated in **Figure 4-5**. It can be seen that the recorded temperature is similar at all three stations throughout 2013.

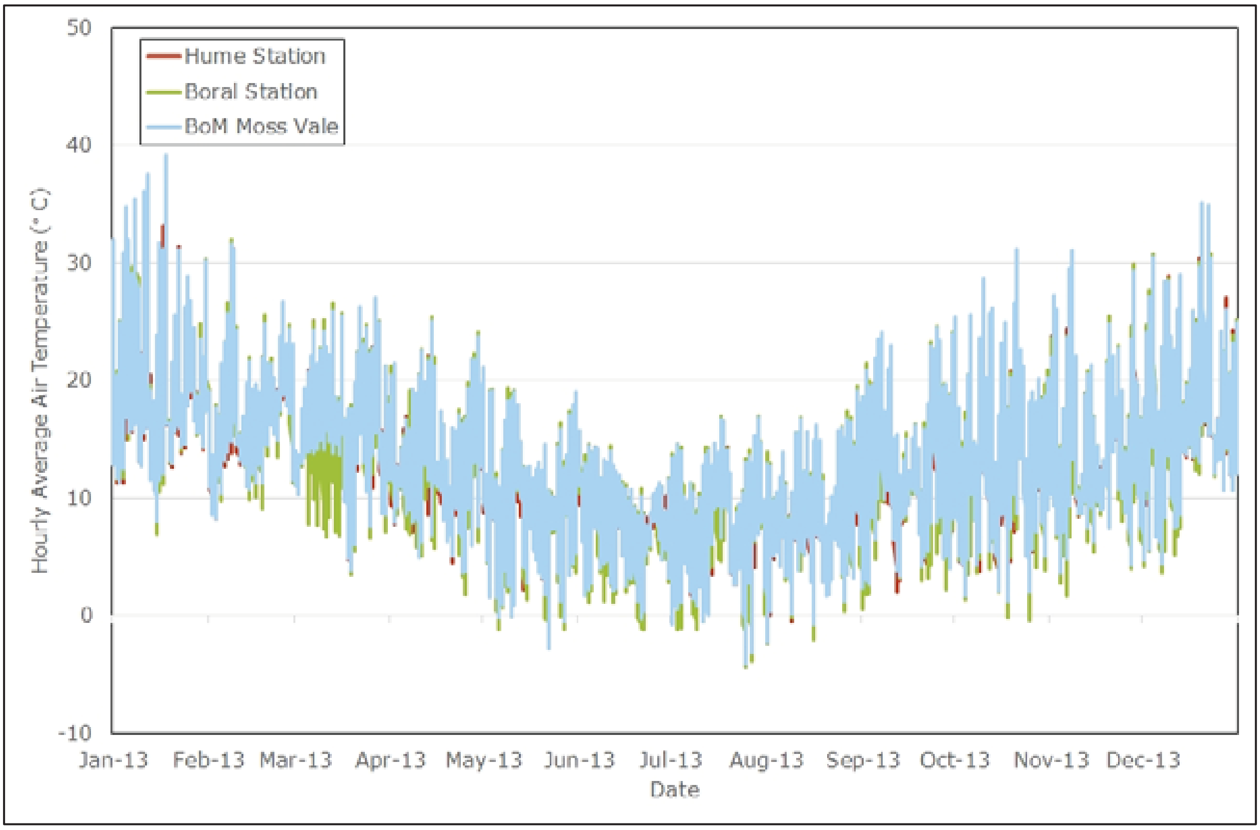
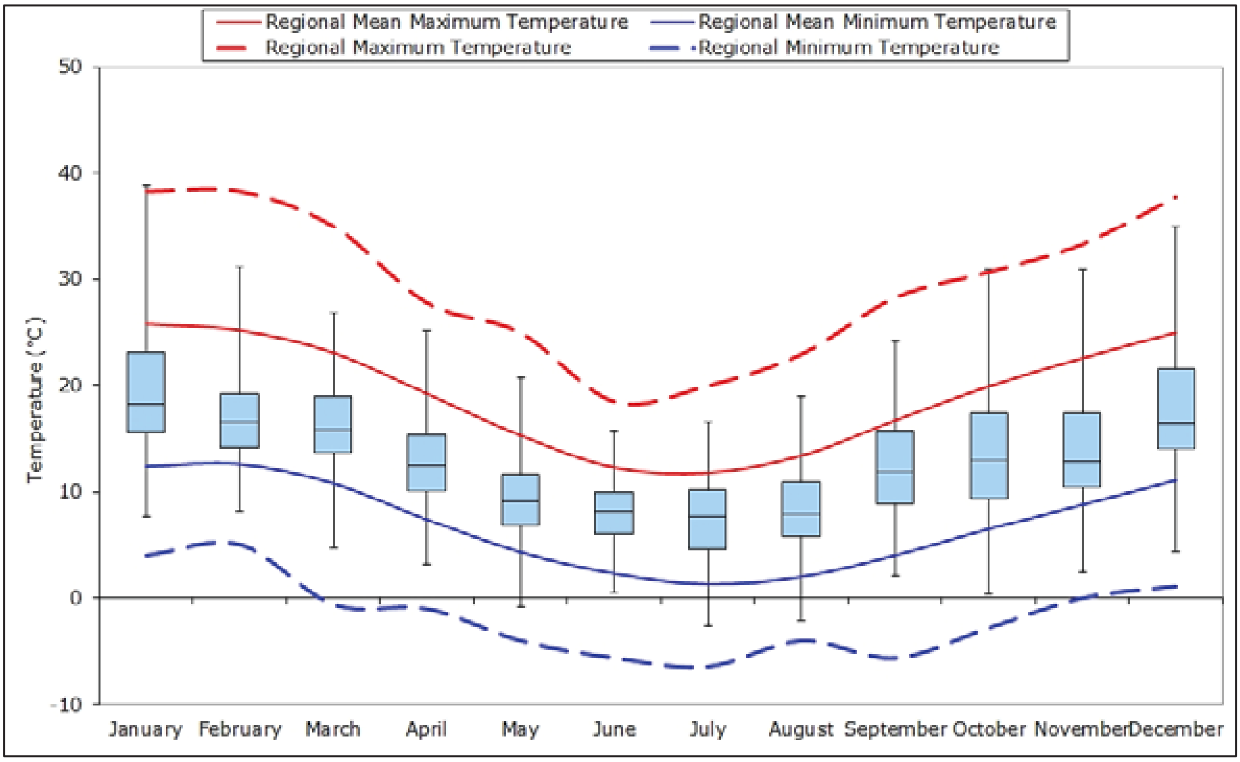


Figure 4-5: Time series plot of hourly average temperature – 2013 – Hume 1, BoM Moss Vale AWS and Boral Berrima stations

Based on the long term climate records from the BoM Moss Vale climate station, monthly mean minimum temperatures are in the range of 1°C to 13°C, with mean maxima of 12°C to 26°C. Peaks occur during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between June and August.

The 2013 Hume 1 and BoM Moss Vale AWS temperature datasets have been compared with the long-term trends recorded at the BoM Moss Vale climate station to determine the representativeness of these datasets. **Figure 4-6** presents the monthly variation in recorded temperature during 2013 compared with the recorded long-term climate station mean, minimum and maximum temperatures. There is good agreement between temperatures recorded during 2013 and the recorded historical trends, indicating that both datasets are representative of conditions likely to be experienced in the region.

Hume 1 Station



BoM Moss Vale

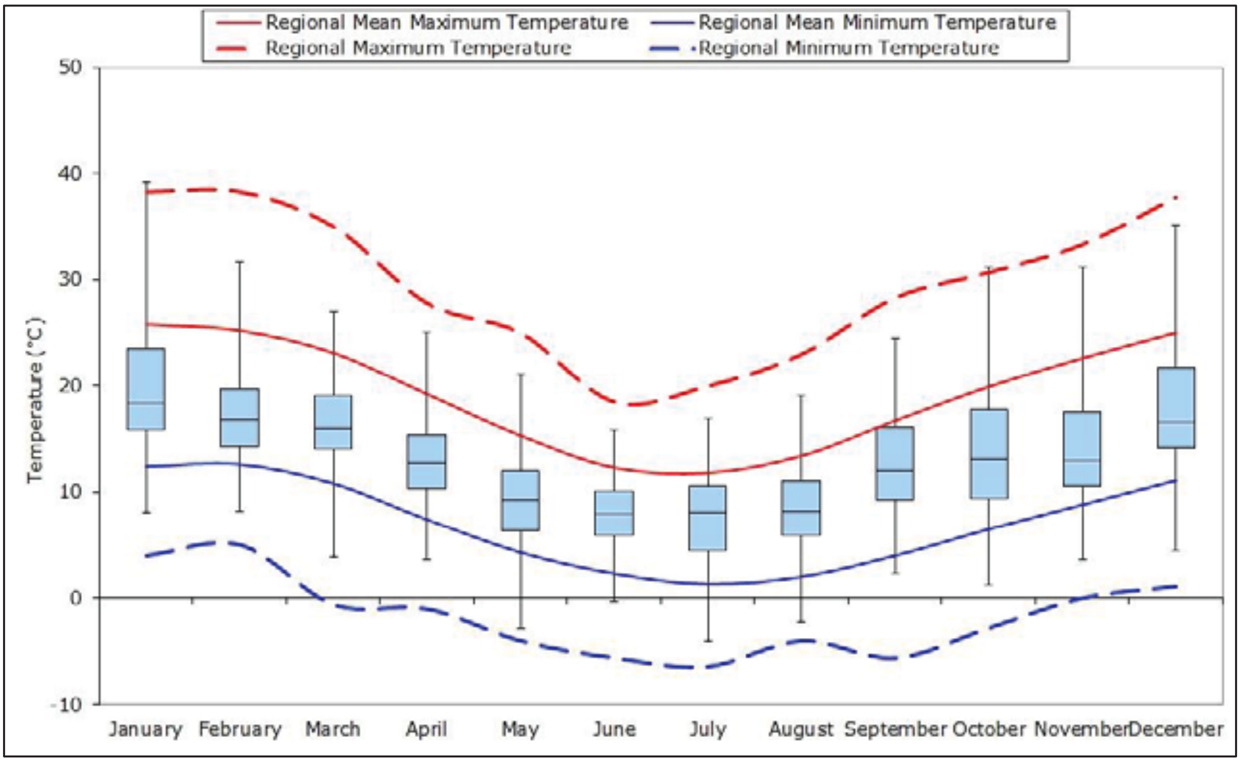


Figure 4-6: Temperature comparison between BoM Moss Vale (Hoskins Street) long term records and 2013 temperature monitoring datasets – Hume 1 Station (top) and BoM Moss Vale (bottom)

Note: 2013 data is illustrated by the 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at BoM Moss Vale climate station are depicted as line graphs.

4.5 Rainfall

Precipitation is important to air pollution studies since it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants.

Based on historical data recorded at the BoM Moss Vale climate station, the area is characterised by moderate to high rainfall, with a mean annual rainfall of approximately 970 mm, and an annual rainfall range between 370 mm and 1,850 mm. Rainfall is quite evenly distributed throughout the year, with monthly average rainfall totals varying from slightly lower rainfall experienced between August and December than the remainder of the year. According to the long term records, an average of 120 rain days occurs per year.

To provide a conservative (upper bound) estimate of the airborne particulate matter concentrations occurring due to the project, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this study.

4.6 Atmospheric Stability

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

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

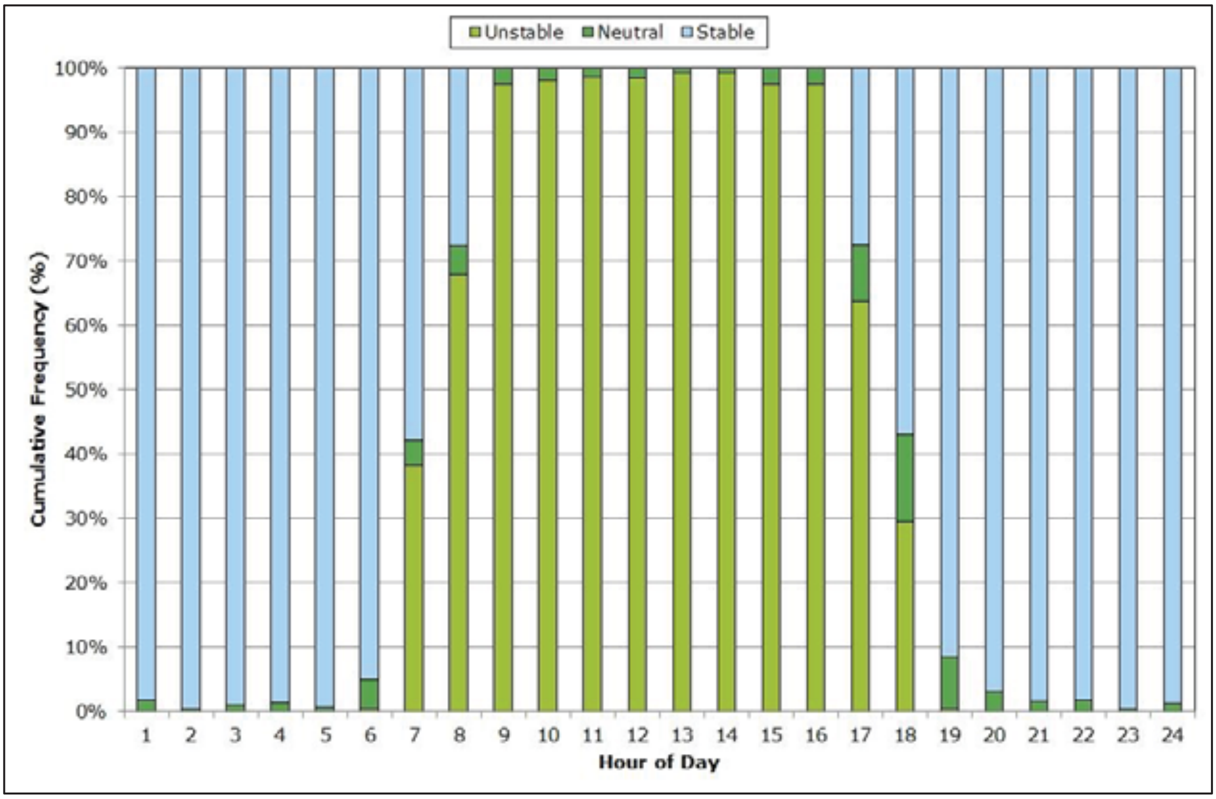
Figure 4-7 illustrates the seasonal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET for both the Hume 1 and BoM Moss Vale AWS monitoring stations. Each diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. Both profiles indicate that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

4.7 Mixing Depth

Hourly-varying atmospheric boundary layer depths were generated for each monitoring dataset by AERMET, the meteorological processor for the AERMOD dispersion model (see **Section 9.1** for further information), using a combination of surface observations from each station, sunrise and sunset times and adjusted TAPM-predicted upper air temperature profile.

The variation in average boundary layer depth by hour of the day for the Hume 1 and BoM Moss Vale AWS monitoring locations is illustrated in **Figure 4-8**. It can be seen that greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increase the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

Hume 1 Station



BoM Moss Vale

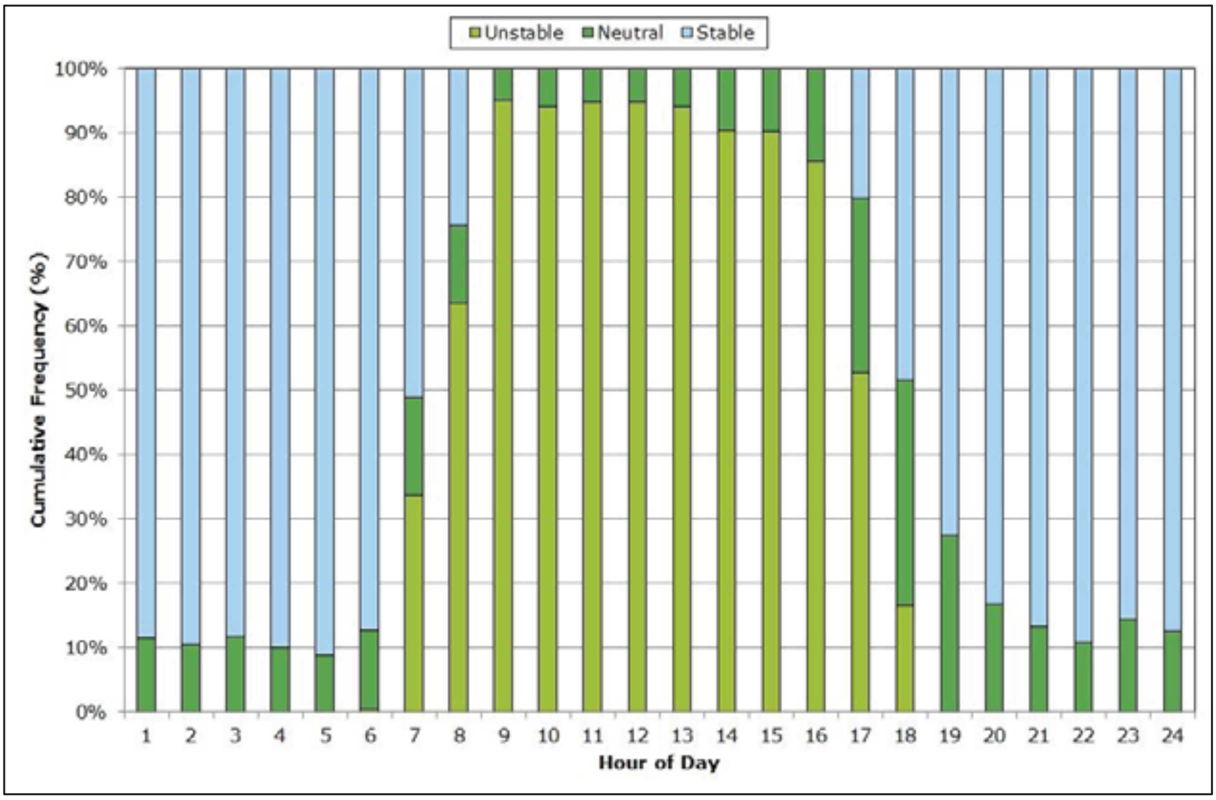
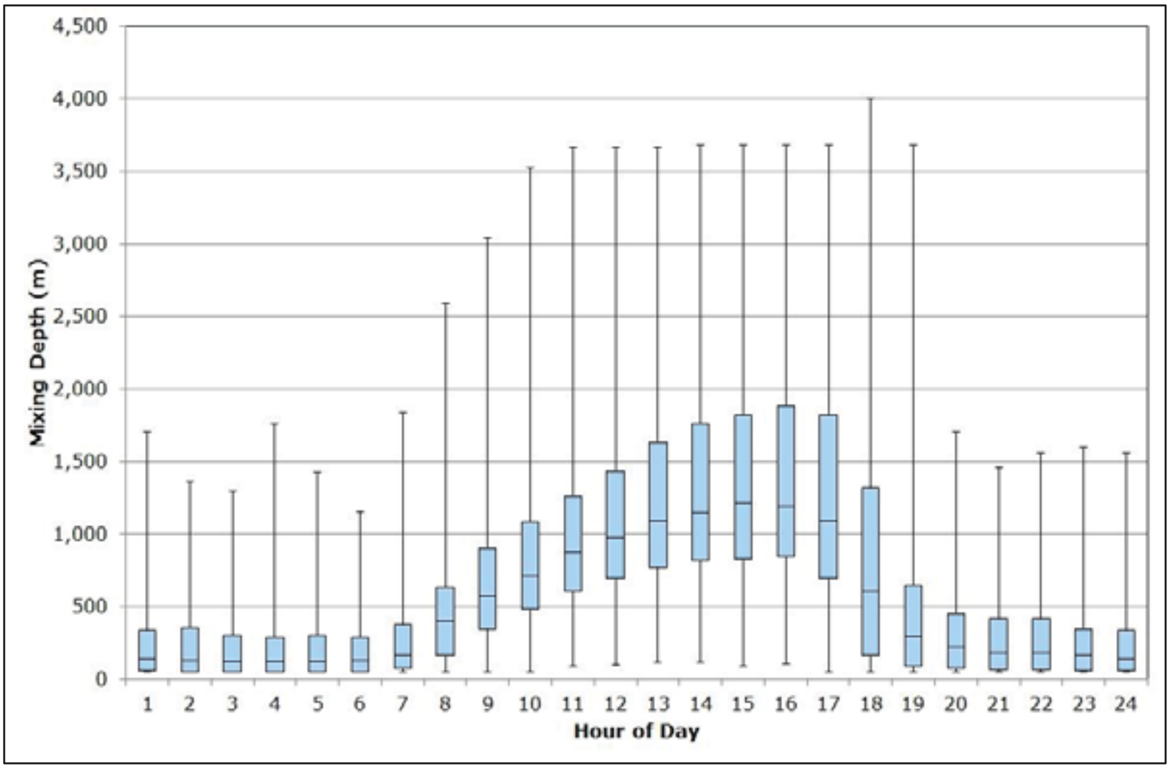


Figure 4-7: AERMET-Calculated Diurnal Variation in Atmospheric Stability– Hume 1 Station (top) and BoM Moss Vale AWS (bottom)

Hume 1 Station



BoM Moss Vale

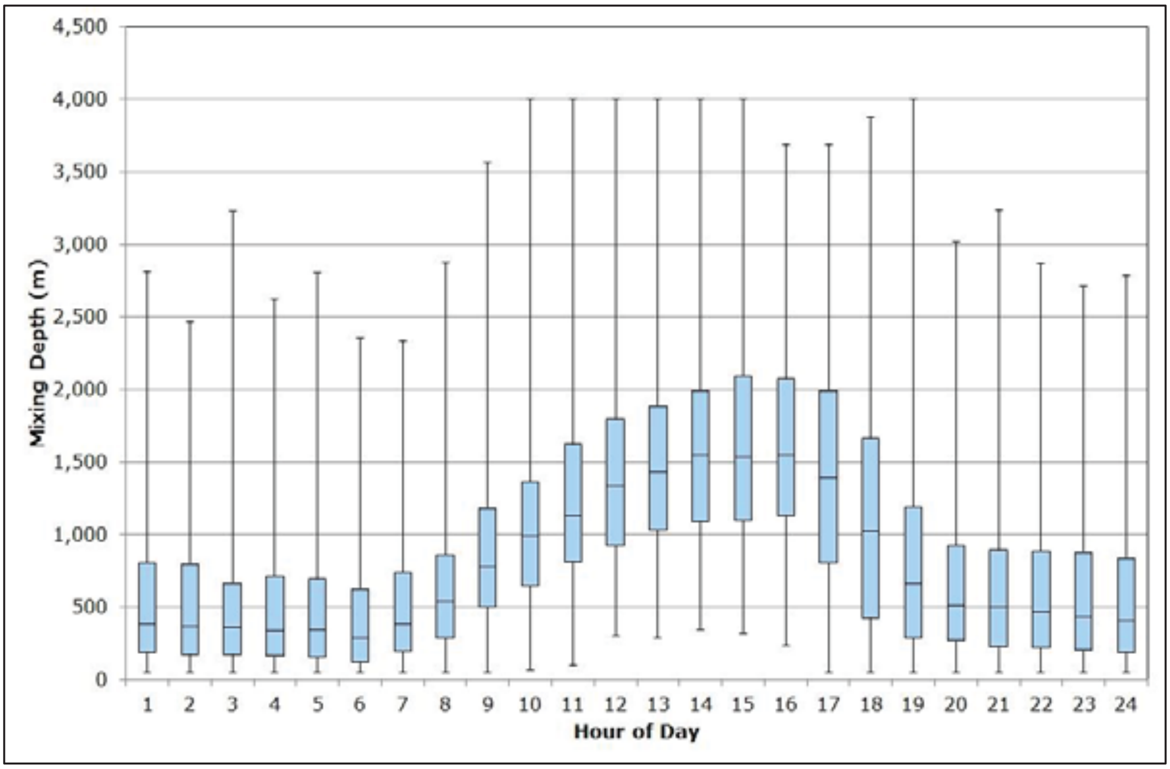


Figure 4-8: AERMET-Calculated Diurnal Variation in Mixing Depth– Hume 1 Station (top) and BoM Moss Vale AWS (bottom)

Note: Boxes indicate 25th, Median and 75th percentile of AERMET-calculated mixing height data while upper and lower whiskers indicate maximum and minimum values.

5. BASELINE AIR QUALITY ENVIRONMENT

5.1 Existing sources of air emissions

The quantification of the cumulative air pollution concentrations and the assessment of compliance with ambient air quality criteria necessitate the characterisation of baseline air quality. It is therefore pertinent to review existing sources of air pollutants in the local environment to be considered for cumulative assessment.

The National Pollutant Inventory (NPI) database lists the following sources of air pollution emissions in the surrounding 10km from the project:

- Berrima Cement Plant, New Berrima – clinker and cement manufacture;
- Inghams Feed Mill, Berrima – stock feed manufacture;
- Dux Manufacturing, Moss Vale – manufacture of gas, electric, heat pump and solar hot water heaters;
- Rail Corporation NSW Refuelling Facility, Moss Vale – rolling stock refuelling;
- Moss Vale Sewage Treatment Plant - sewage treatment, intermittent extended aeration; and
- Bowral Sewage Treatment Plant - sewage treatment utilising intermittent extended aeration and pasveer channel aeration systems.

The NSW EPA Environment Protection Licence (EPL) register lists the following activities within the surrounding 10km from the project:

- Berrima Colliery – underground coal mine (not currently operational, scheduled for closure)
- Omya Southern Limestone, Moss Vale – material processing facility;
- Southern regional livestock exchange, Moss Vale - Animal accommodation;
- Resource Recovery Centre, Moss Vale - waste recycling, collection and transfer facility; and
- Berrima Sewage Treatment Plant, New Berrima - Sewage treatment processing by small plants.

Finally, it is noted that a proposed shale quarry at New Berrima has received planning approval for development. It is understood that initial site preparation and exploration activities for this quarry are underway, however operational activities are yet to commence. In addition to the above existing and approved operations, it is considered that the following sources contribute to particulate matter emissions in the vicinity of the project:

- Dust entrainment due to vehicle movements along unsealed and sealed public roads;
- Petrol and diesel emission from vehicle movements along public roads;
- Wind generated dust from exposed areas within the surrounding region;
- Episodic emissions from local vegetation burning (e.g. grass and bushfires);
- Seasonal emissions from household wood burning fires.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Whereas dust storms predominately contribute primary particulates from mechanical attrition, bushfires are a source of fine particulates including both primary particulates and secondary particulates formed by atmospheric gas to particle conversion processes.

In order to account for these existing sources of air pollution emissions in the cumulative assessment of project impacts, a combination of air quality monitoring datasets (**Section 5.2**) and publicly available air emissions data (see **Section** 6) have been utilised.

5.2 Monitoring Data Available for Baseline Air Quality Characterisation

5.2.1 Monitoring Stations

The following monitoring resources have been collated for this study:

- Hume-owned Tapered Element Oscillating Microbalance (TEOM), located within the Hume Coal Project area (approximately 8km south of the Hume Coal surface infrastructure area and around 8 km from the Berrima Rail Project Area) – referred to as TEOM1. Continuous concentrations of particulate matter (PM_{10} and $PM_{2.5}$) recorded;

- Boral's Berrima Cement Works Air Quality Monitoring station – one-in-six day 24-hour average concentrations of TSP and PM_{10}, located within the Berrima Rail Project area, and approximately 4.5 km east of the Hume Coal surface infrastructure area;
- NSW OEH air quality monitoring stations, located at Bargo and Camden, approximately 33 km and 62km to the northeast of the Hume Coal surface infrastructure area respectively. Continuous concentrations of particulate matter and gaseous pollutants recorded; and
- ACT Government air quality monitoring station at Monash, approximately 150 km southwest of the surface infrastructure area. Continuous concentrations of particulate matter and gaseous pollutants recorded.

While spatially distant from the project area, the inclusion of data from the ACT Government Monash air quality monitoring station is considered useful to assist with understanding particulate matter concentrations beyond the influence of the Greater Sydney Metropolitan area and identify any regional elevated events.

The location of the Hume Coal and Boral-owned monitoring stations are illustrated in **Figure 4-2**.

5.2.2 TSP (Total Suspended Particulates)

Concentrations of TSP are recorded by Boral at the air quality monitoring station to the immediate east of the Berrima Cement Works on a one-in-six day basis via high volume air sampler (HVAS), in accordance with applicable environmental licence conditions. TSP data recorded since 2010 by Boral has been collated for use in this assessment in the absence of TSP monitoring at the project area. Annual average TSP concentrations recorded between 2010 and 2014 are presented in **Figure 5-1**.

It can be seen from the presented annual average TSP concentrations that all years are lower than the applicable NSW EPA assessment criterion of 90µg/m^3. The average TSP concentration is 37.6 µg/m^3.

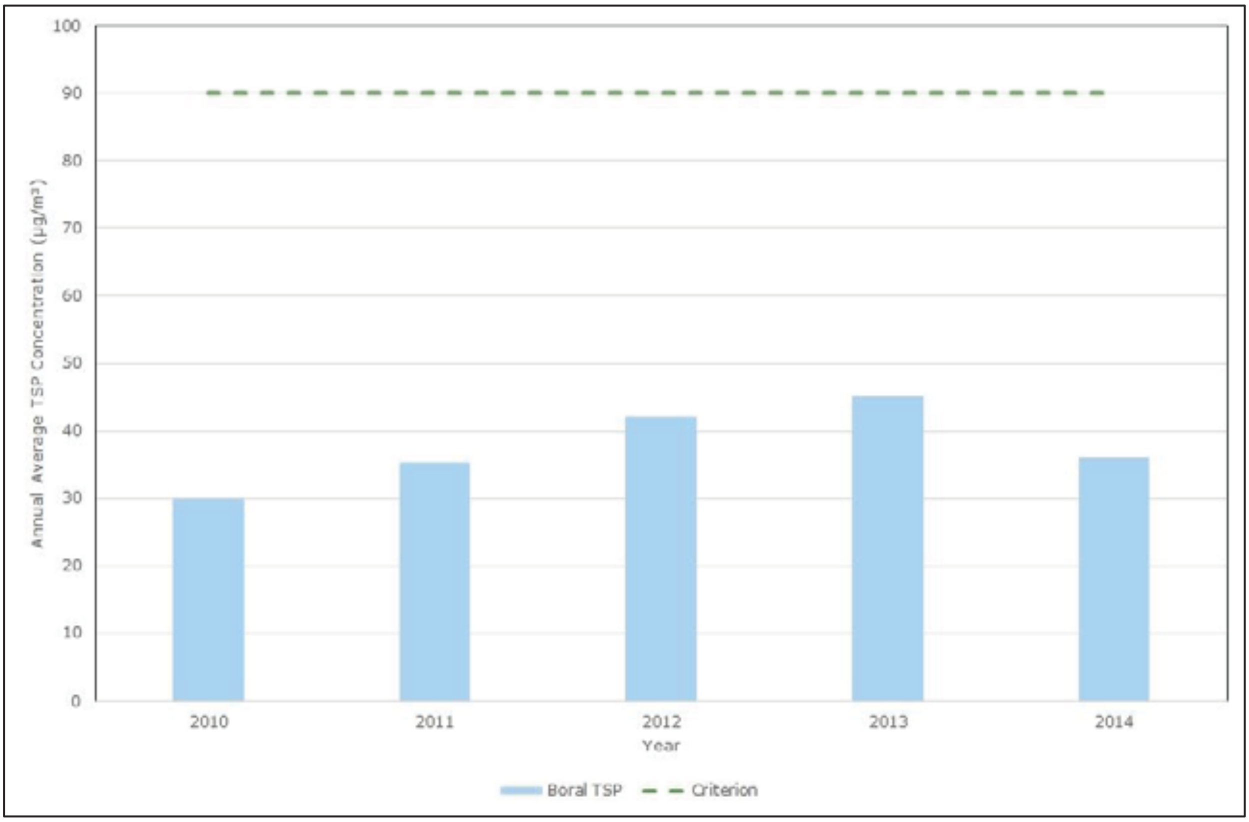


Figure 5-1: Annual average TSP concentrations – Boral's Berrima Cement Works monitoring station - 2010 to 2014

5.2.3 PM_{10}

Concentrations of PM_{10} are recorded by a number of sources both on a local and regional scale surrounding the project. A daily-varying time series plot of 24-hour average PM_{10} concentrations at the Hume TEOM1 station, Boral Berrima station, NSW OEH Camden and Bargo stations and ACT Government Monash station is illustrated in **Figure 5-2**.

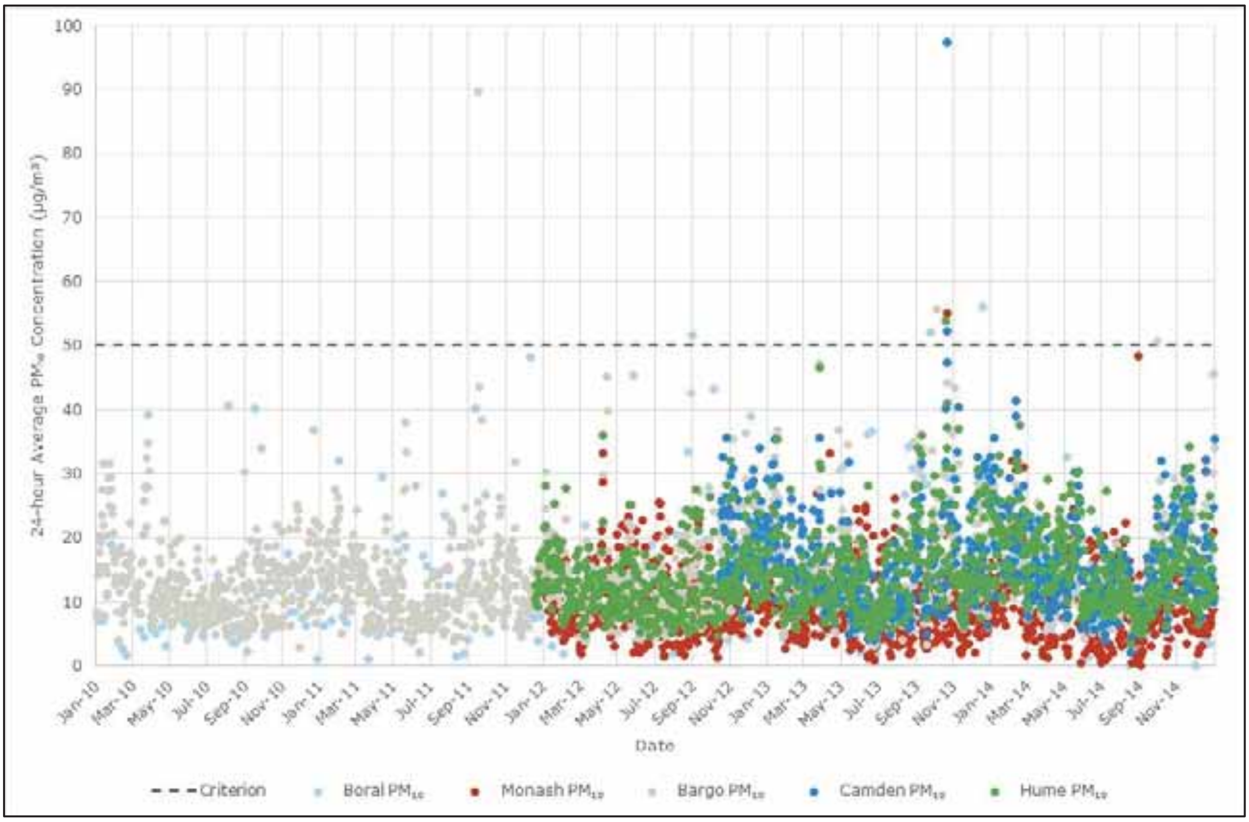


Figure 5-2: Time series plot of daily varying 24-hour average PM_{10} concentrations – January 2010 to December 2014

It can be seen that the recorded 24-hour average PM_{10} concentrations at all locations fluctuate throughout the period presented. Exceedances of the 24-hour average NSW EPA assessment criterion (50 µg/m³) occur at all monitoring locations. The most notable grouping of recorded criteria exceedance is evident in late October/early November 2013, which was a period of extensive bushfires across NSW.

There is good agreement between the local stations (Hume TEOM1 and Boral Berrima) with stations located further afield (Bargo, Camden and Monash), indicating that the Hume TEOM1 PM_{10} dataset is appropriate for the representation of ambient concentrations in the local area and regional influences are notable to ambient particulate matter concentrations.

The frequency distribution of derived and recorded PM_{10} concentrations between January 2010 and December 2014 are illustrated in **Figure 5-3**. It can be seen that the majority of PM_{10} concentrations recorded at the Hume TEOM1 station are below 20 µg/m³. The Boral Berrima station shows a higher occurrence of elevated PM_{10} concentrations (>30 µg/m³) and is considered reflective of the localised influence of emissions from the cement works.

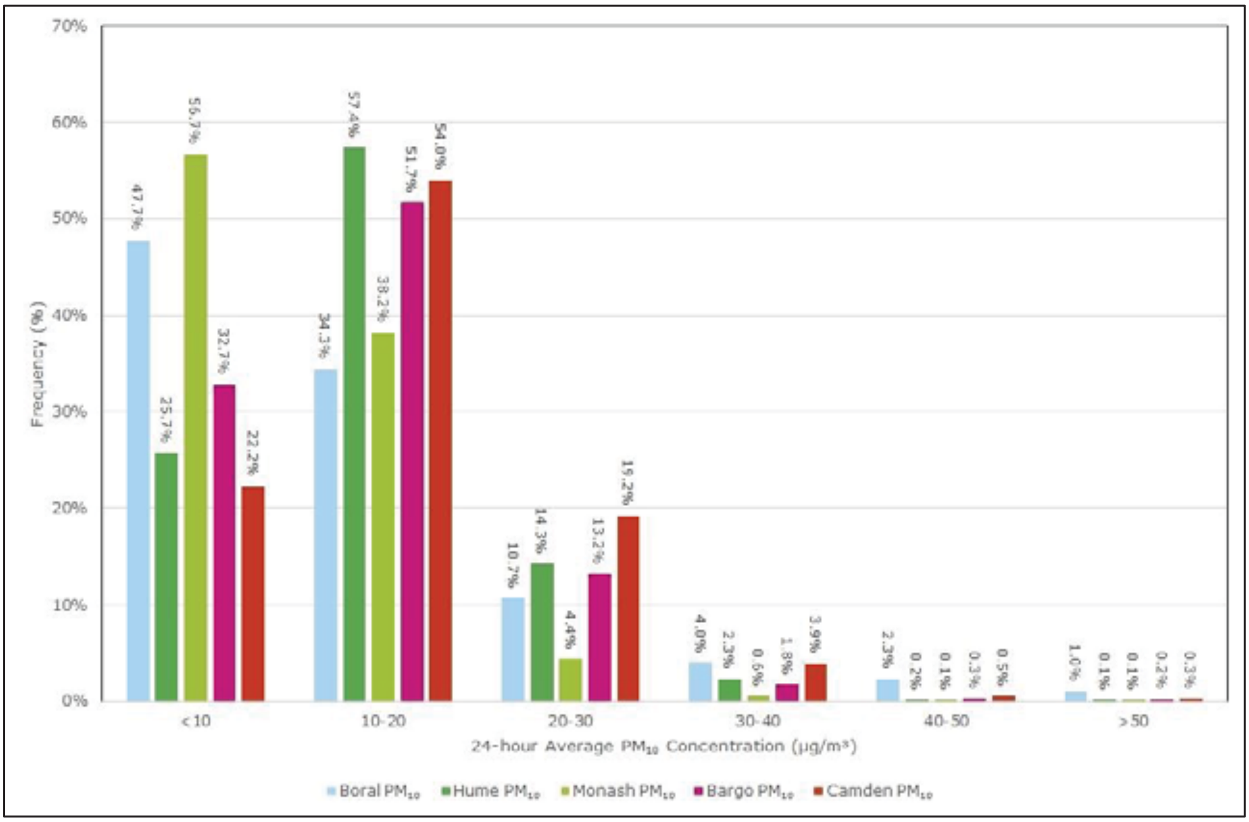


Figure 5-3: Frequency distribution of 24-hour average PM_{10} concentrations – January 2010 to December 2014

Annual average PM_{10} concentrations for 2010 through to 2014 are presented in **Figure 5-4**. For each year of data, it can be seen that the annual average PM_{10} concentrations at the Hume TEOM1 station are comparable with the concentrations recorded by the Boral Berrima, Bargo and Camden monitoring stations. The average concentrations for all years at all locations are below the NSW EPA assessment criterion of 25 µg/m³. The average PM_{10} concentration across the Hume TEOM1 PM_{10} dataset is 14.3 µg/m³.

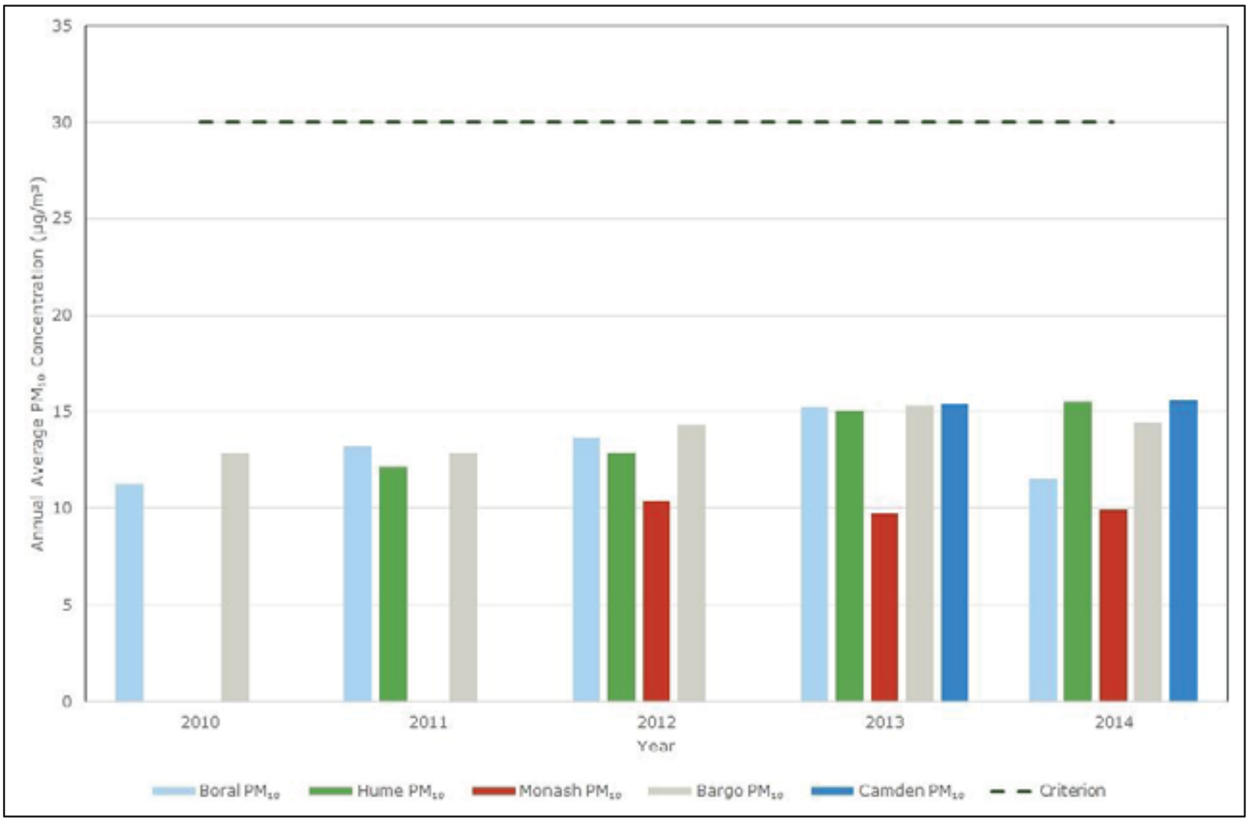


Figure 5-4: Annual average PM_{10} concentrations – local and regional monitoring locations - 2010 to 2014

5.2.4 $PM_{2.5}$

As stated previously, the Hume-owned TEOM1 records continuous concentrations of PM_{10} and $PM_{2.5}$. In analysing the $PM_{2.5}$ monitoring data, the average ratio of recorded $PM_{2.5}$ to corresponding PM_{10} concentrations by the TEOM1 station was calculated to be approximately 0.8. For the same period of time, the average ratio of $PM_{2.5}$ to PM_{10} across all NSW OEH monitoring stations where PM_{10} and $PM_{2.5}$ concentrations are co-recorded (including stations across the Sydney Metropolitan, Illawarra and Hunter Valley regions) ranged from 0.3 to 0.5. The Hume TEOM1 $PM_{2.5}/PM_{10}$ ratio is considered questionable for the following reasons:

- A high $PM_{2.5}/PM_{10}$ ratio is reflective of the influence of combustion sources to the monitoring station. While the Hume TEOM 1 station is located in proximity of some scattered rural residential properties, analysis of concurrent wind direction data from the Hume 1 station with recorded concentrations did not return any directional footprint of recorded concentrations (i.e. recorded concentrations were evenly distributed across all directions); and
- The ratio at the Hume TEOM1 station is much higher than the ratio recorded by NSW OEH monitoring stations in significantly more urbanised (Sydney Metropolitan) and mining-intensive (Hunter Valley) regions – locations with an abundance of combustion emission sources.

The issue of the elevated $PM_{2.5}/PM_{10}$ ratio for the Hume TEOM1 station was raised with the monitoring consultant and Hume Coal. In response, a second TEOM (TEOM2) was commissioned by Hume Coal and installed in the vicinity of the surface infrastructure area in July 2015. Analysis of data from TEOM2 showed agreement for both PM_{10} (across all stations) and $PM_{2.5}$ (for regional stations only, indicating that the original Hume TEOM1 $PM_{2.5}$ station concentrations are indeed erroneously high).

A range of further investigation studies on concurrent data recorded at TEOM1 and TEOM2 was conducted by Hume Coal and Ramboll Environ, including physically swapping the TEOM1 and TEOM2 stations to either location. These investigation studies highlighted the following:

- PM_{10} concentrations recorded by TEOM1 were comparable with concurrent TEOM2 and regional monitoring station data, indicating that the total incoming less than 10 micron sample was reliable; and
- The ratio of less than 2.5 micron to less than 10 micron sample was much higher at TEOM1 in comparison with concurrent TEOM2 and regional monitoring station data. This indicates that TEOM1 was apportioning too high of a percentage of the less than 10 micron total sample to the less than 2.5 micron internal recording channel.

Due to the uncertainty with the $PM_{2.5}/PM_{10}$ ratio recorded at the Hume TEOM1 station, the $PM_{2.5}/PM_{10}$ ratio of the closest NSW OEH $PM_{2.5}/PM_{10}$ monitoring station (Camden) has been adopted. The referencing of the $PM_{2.5}/PM_{10}$ ratio from the Camden dataset is considered appropriate and consistent with Section 4.2 of the Approved Methods for Modelling to conservatively derive existing $PM_{2.5}$ concentrations in the project area in the absence of a reliable onsite dataset.

The average $PM_{2.5}/PM_{10}$ ratio recorded at Camden between October 2012 (commencement of monitoring at station) and December 2014 was 0.41. The daily varying $PM_{2.5}/PM_{10}$ ratio was applied to the corresponding 24-hour average PM_{10} concentrations recorded at the Hume TEOM1 station to derive a background $PM_{2.5}$ dataset for the study area. A daily-varying time series plot of 24-hour average $PM_{2.5}$ concentrations at the Hume TEOM1 station (derived), NSW OEH and ACT Government Monash station is illustrated in **Figure 5-5**.

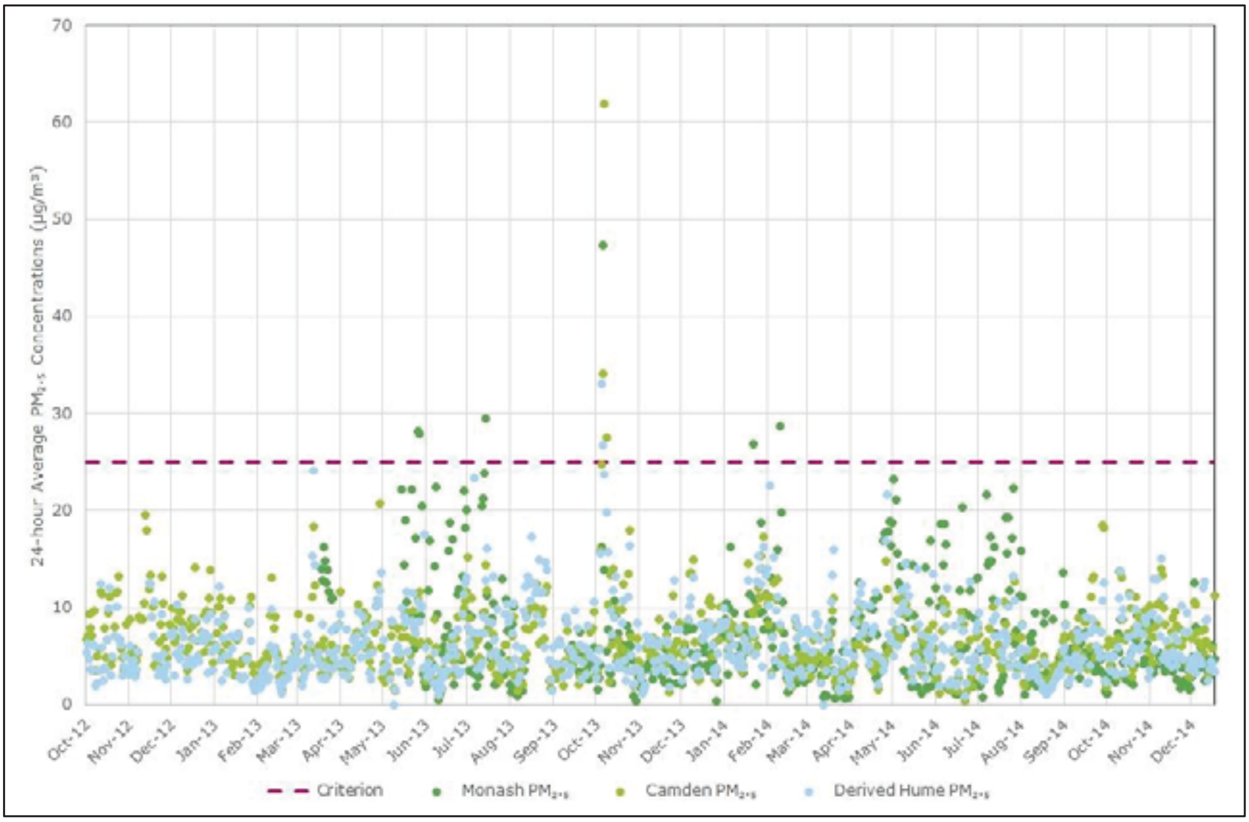


Figure 5-5: Time series plot of daily varying 24-hour average $PM_{2.5}$ concentrations – October 2012 to December 2014

Like the PM_{10} concentrations, it can be seen that the recorded 24-hour average $PM_{2.5}$ concentrations at all locations fluctuate throughout the period presented. Exceedances of the 24-hour average NSW EPA assessment criterion (25 µg/m³) occur in all three datasets, with the most notable coinciding with the widespread October/November 2013 bushfire event that affected NSW.

The frequency distribution of derived and recorded $PM_{2.5}$ concentrations between December 2012 and December 2014 are illustrated in **Figure 5-6**. It can be seen that the majority of $PM_{2.5}$

concentrations at all locations are below 10 µg/m³. It is noted that the Monash dataset experiences a higher frequency of greater than 12.5 µg/m³ concentrations due to the proximity of that monitoring station to residential wood fire heater emission sources.

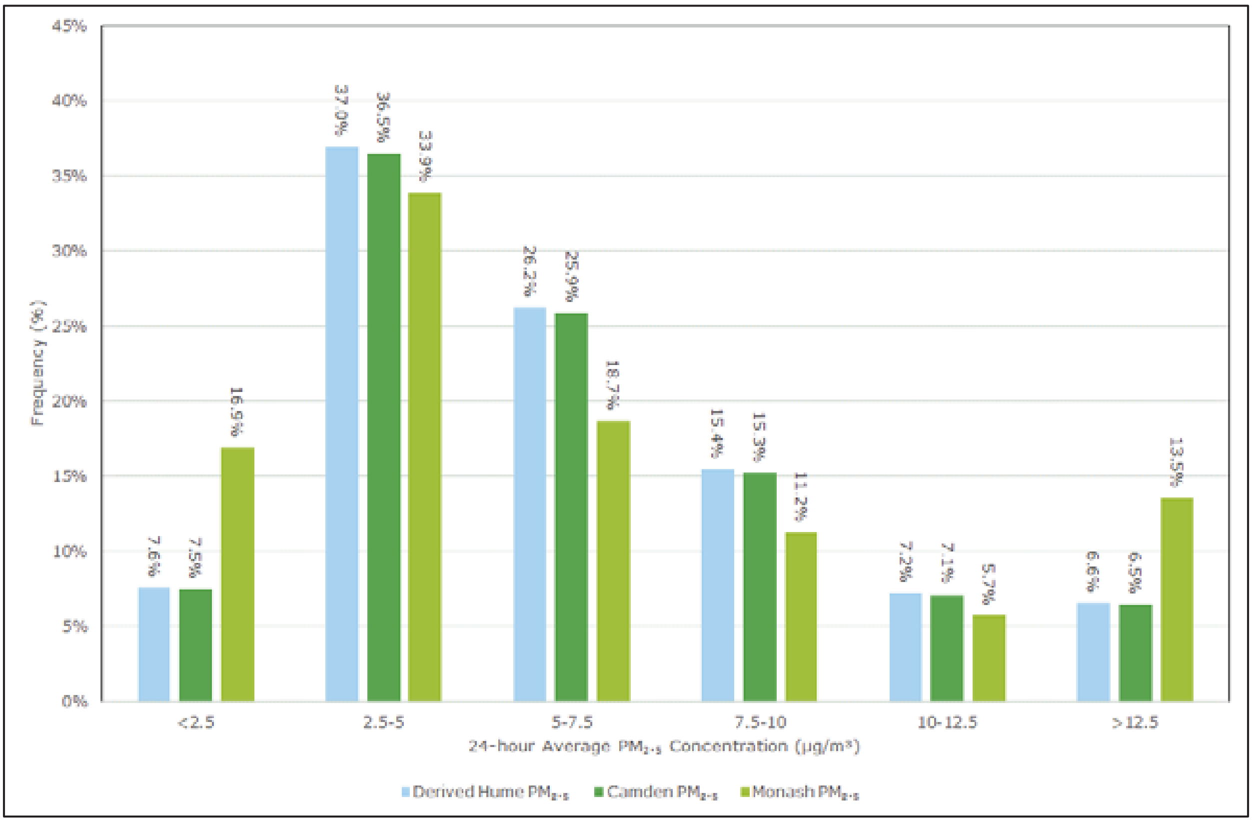


Figure 5-6: Frequency distribution of 24-hour average $PM_{2.5}$ concentrations – October 2012 to December 2014

Annual average $PM_{2.5}$ concentrations for 2013 and 2014 are presented in **Figure 5-7**. The 2013 datasets are higher than the 2014 datasets at all three locations, attributable to the extensive bushfire events that occurred in that year. The average concentrations for both years at all locations are below the NSW EPA assessment criterion of 8 µg/m³. The average $PM_{2.5}$ concentration across the derived Hume $PM_{2.5}$ dataset is 6.3 µg/m³.

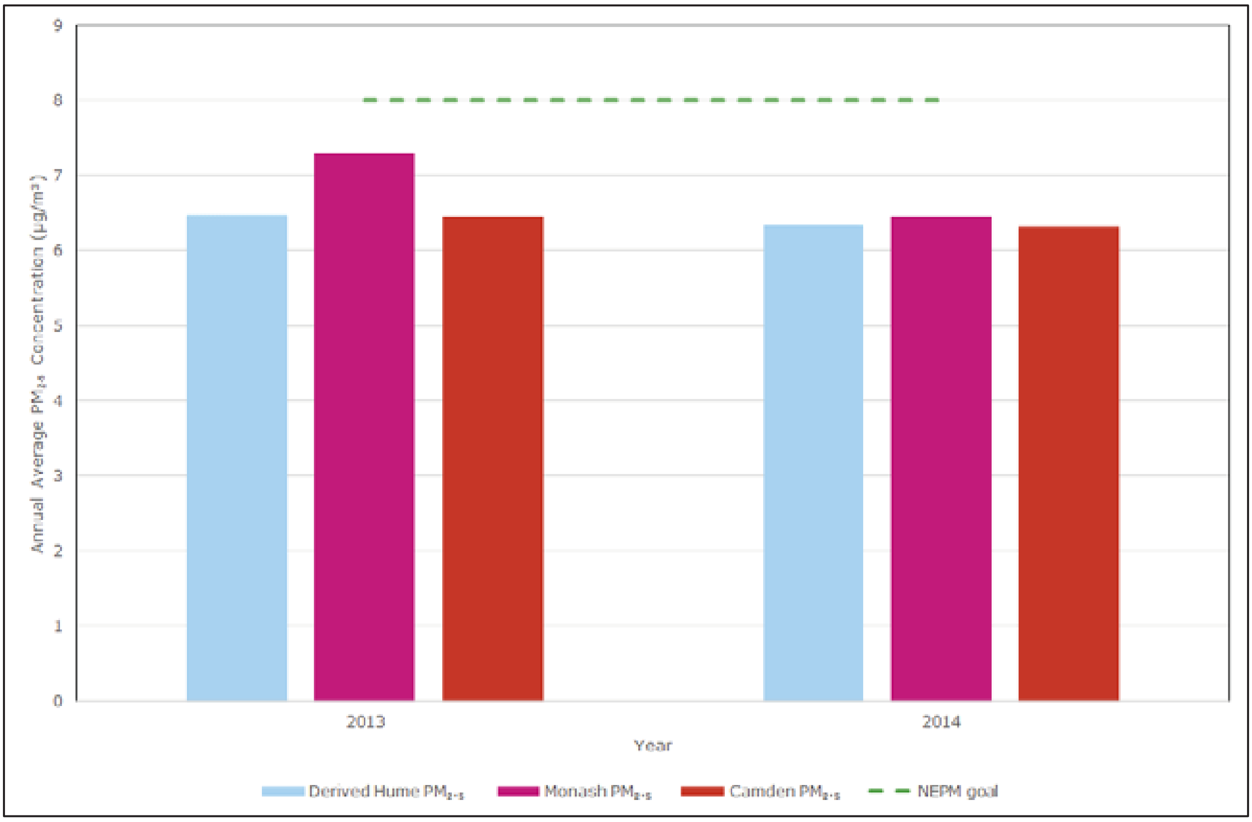


Figure 5-7: Annual average $PM_{2.5}$ concentrations – local and regional monitoring locations - 2013 to 2014

5.2.5 Gaseous Air Pollutants

This assessment will quantify and assess impacts from nitrogen dioxide and the individual VOC species benzene, ethylbenzene, toluene and xylenes.

Of the above pollutants, only NO_2 has a cumulative impact assessment criterion, with individual VOC species assessed as increment only. To convert predicted concentrations of oxides of nitrogen (NO_x) to NO_2, the ozone limiting method (OLM) prescribed in Section 8.1.2 of the NSW EPA Approved Methods for Modelling (EPA, 2016) has been applied. While further detail relating to this approach is presented in **Section 9**, the OLM requires background concentrations of NO_2 and ozone (O_3).

No monitoring of ambient gaseous pollutants is conducted in the immediate vicinity of the project. The closest available resource of such monitoring data is the NSW OEH Bargo station. A summary of maximum and average concentrations recorded since 2010 is presented in **Table 5-1**. Hourly varying NO_2 and O_3 concentrations, concurrent with the meteorological datasets (2013), have been adopted for this assessment.

Table 5-1: Summary of NO_2 and O_3 concentrations – NSW OEH Bargo monitoring station – 2010 to 2015

Year	NO_2 (µg/m³)		O_3 (µg/m³)	
	Max 1-hr	**Average**	**Max 1-hr**	**Average**
2010	111	9	216	41
2011	86	9	247	37
2012	83	9	178	37
2013	128	9	186	39
2014	68	9	206	41
2015	90	9	163	37
Average	**94**	**9**	**199**	**39**
Criterion	**246**	**62**	**214**	**-**

5.2.6 Ambient baseline air quality for cumulative impact assessment

Drawing on the information presented in the preceding sections, the ambient baseline air quality for cumulative impacts for the project comprise of the following:

- Annual average TSP - 37.6 µg/m^3;
- 24-hour PM_{10} – the frequency distribution profile of all 24-hour average PM_{10} monitoring measurements from Hume, Boral, NSW OEH Bargo and Camden stations and ACT EPA Monash station;
- Annual average PM_{10} – 14.3 µg/m^3;
- 24-hour $PM_{2.5}$ – the frequency distribution profile of all 24-hour average $PM_{2.5}$ monitoring measurements from Hume (derived), NSW OEH Camden station and ACT EPA Monash station;
- Annual average $PM_{2.5}$ – 6.3 µg/m^3;
- NO_2 – hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous OLM analysis with modelling period predictions; and
- O_3 – hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous OLM analysis with modelling period predictions.

6. NEIGHBOURING EMISSION SOURCES

As discussed in **Section 5.1**, a number of existing and approved industrial sources of air pollution emissions are located in the area surrounding the project. The location of these sources in relation to the project is illustrated in **Figure 6-1**.

Due to the spatial distribution of these industrial operations, the potential for cumulative impact at individual receptors may vary. The following sections detail emissions from neighbouring industrial operations and resultant predicted ground level concentrations in the surrounding environment.

Annual emissions from the neighbouring industrial emission sources have been quantified based on the following resources:

- Boral's Berrima Cement Works - *Boral Cement Berrima Works Use of Solid Waste Derived Fuels in Kiln 6 - Air Quality Impact Assessment* (Air Quality Professionals, 2015) – point and fugitive emission sources;
- New Berrima Shale Quarry – *New Berrima Shale Quarry, S75W Modification, Air Quality Impact Assessment* (SLR, 2015) – fugitive emission sources;
- Dux Manufacturing Moss Vale – NPI annual reporting totals, 2013-2014 – fugitive emission sources;
- Ingham's Berrima Feed Mill – NPI annual reporting totals, 2013-2014 – fugitive emission sources;
- Omya Southern Limestone, Moss Vale – emission calculations based on EPL limit of processing of 500,000tpa – fugitive emission sources;
- Southern Regional Livestock Exchange – emission calculations based on EPL limit of cattle accommodation of 25,000 heads of cattle – fugitive emission sources; and
- Wingecarribee Resource Recovery Centre – emissions derived based on air quality impact assessment conducted by Ramboll Environ for the Widemere Recycling Facility a similar operation in Western Sydney (Environ, 2015) – fugitive emission sources.

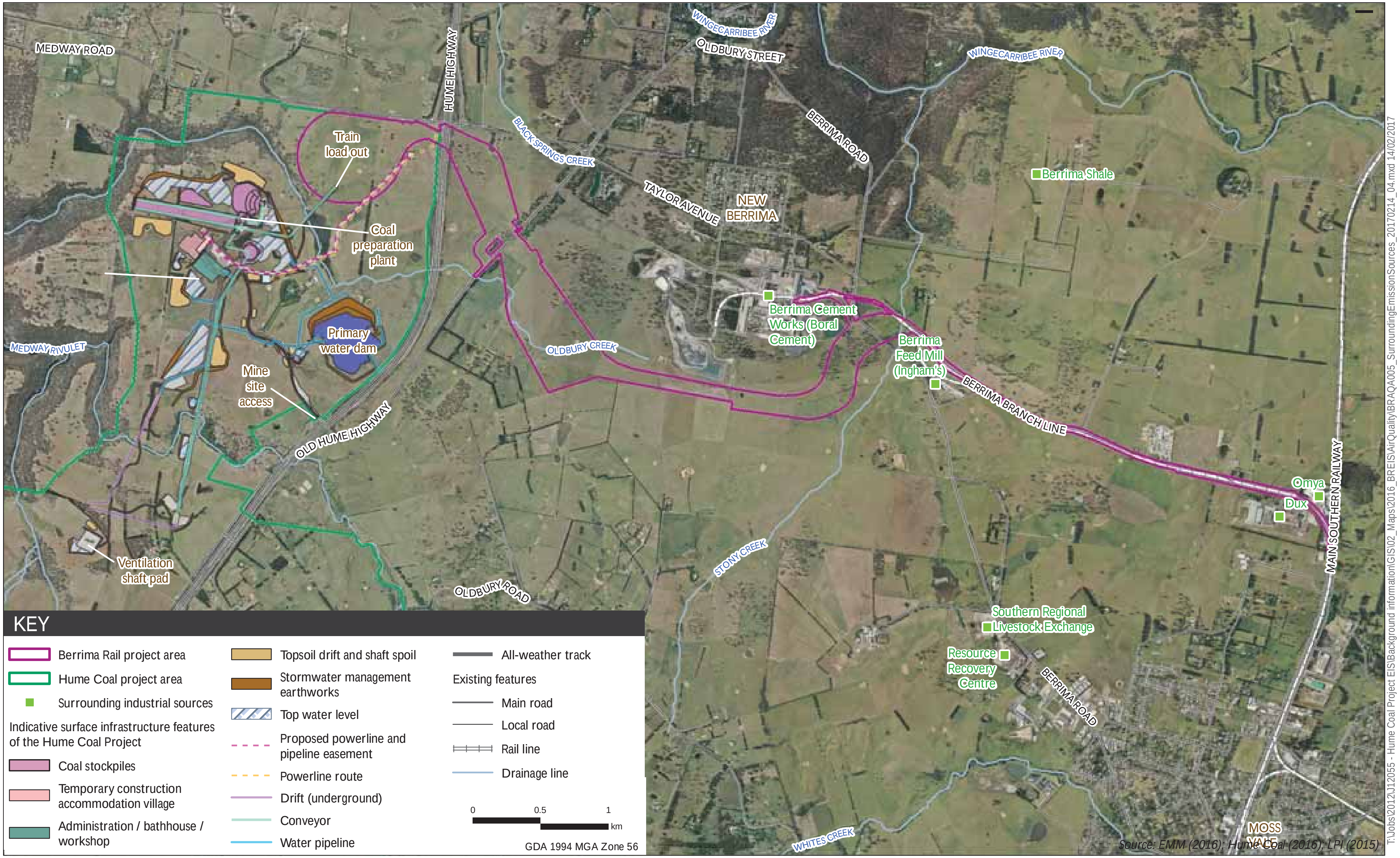
Additionally, emissions from the proposed Hume Coal Project have been incorporated into the neighbouring emission sources calculations. Emissions have been comprehensively presented in the air quality impact assessment for that project (Ramboll Environ, 2017). Peak operational emissions from that report have been adopted in this assessment.

Annual emission totals for neighbouring emission sources are presented in **Table 6-1**. A detailed breakdown of emission calculations and assumptions for the above emission sources is presented in **Appendix 2**.

Table 6-1: Summary of annual average emissions from neighbouring emission sources

Emissions Source	Annual Emissions (kg/annum)			
	TSP	PM_{10}	$PM_{2.5}$	NO_x
Berrima Cement Works	706,974	455,607	187,024	4,975,750
New Berrima Shale Quarry	136,674	40,555	4,947	n/a
Dux Manufacturing Moss Vale	356	237	100	3,400
Ingham Berrima Feed Mill	10,125	6,750	148	3,441
Omya Southern Limestone	11,642	3,578	471	n/a
Southern Regional Livestock Exchange	66,477	43,875	6,581	n/a
Wingecarribee Resource Recovery Centre	21,708	5,175	668	n/a
Hume Coal Project – peak operational emissions	161,532	65,276	15,919	12,906

Note: n/a – no emissions data available. Assumed to be minor



Surrounding emission sources
Berrima Rail Project
Air quality and GHG Assessment
Figure 6.1

7. CONSTRUCTION DUST IMPACTS

In order to assess the air quality impact potential of the construction phase of the project, a qualitative impact assessment was undertaken. While no specific methodology for such an assessment is available in Australia, the United Kingdom-based Institute of Air Quality Management (IAQM) has prepared the Guidance on the Assessment of Dust from Demolition and Construction (hereafter GADDC, IAQM 2014). The GADDC provides a progressive approach to assessing the particulate matter impact risk associated with construction and demolition projects.

The key steps to the GADDC approach to assessing air quality risks of construction and demolition projects are as follows:

- **STEP 1** – screen requirement for a more detailed assessment based on proximity of surrounding receptors;
- **STEP 2** – assess the risk of dust impacts from demolition, earthworks, construction and truck movements and the sensitivity of surrounding receptors;
- **STEP 3** – determine the site-specific mitigation for each of the four potential activities in STEP 2;
- **STEP 4** – examine the residual effects and determine significance; and
- **STEP 5** – prepare dust assessment report.

The construction dust assessment for the project is presented in the following sections.

7.1 STEP 1 – Screen the need for a detailed assessment

Screening criteria for a detailed assessment are presented in Box 1 of Section 6 of the GADDC. The IAQM specify that if a human receptor is located within 350 m of the boundary of a site, or within 50 m of a route used by construction vehicles beyond 500 m from the site boundary, then a detailed construction dust assessment should be undertaken.

Of the receptor locations illustrated in **Figure 2-1**, the majority are located beyond 350 m from the proposed construction footprint. There are two receptors located within 350 m of the proposed construction area disturbance footprint – receptors 17 and 28. Consequently, the proposed construction activities trigger the criteria to undertake a more detailed construction dust assessment.

7.2 STEP 2 – Assess the risk of dust impacts

The GADDC identifies that the risk category for dust impacts from construction and demolition activities should be allocated based on the following factors:

- The scale and nature of works (STEP 2A); and
- The sensitivity of the area to dust impacts (STEP 2B).

These factors are then combined to determine the risk of impacts from the works (STEP 2C). The risk rating process is addressed in the following sections.

7.2.1 STEP 2A – Scale and nature of works

Section 7.2 of the GADDC requires that in allocating dust impact risk, the scale and nature of the following components are to be determined:

- Demolition;
- Earthworks;
- Construction; and
- Truck track out to public roads.

The GADDC prescribes a range of criteria that classify the magnitude of each activity as either Large, Medium or Small. The GADDC notes that not all criteria need to be satisfied to meet a certain classification. For this assessment, where more than one magnitude rating could be applied, the highest magnitude classification has been selected for conservatism. Based on the proposed activities at site, the following magnitude ratings, and the rationale behind the classification, are applied:

- Demolition – **SMALL** – no demolition activities are required;
- Earthworks – **LARGE** – total site area greater than 10,000 m^2 (approximately 30,000 m^2), potentially dusty soil type;
- Construction; – **SMALL** – construction primarily related to the Berrima Branch Line alignment, materials with low dust generation potential; and
- Truck track out – **SMALL** – truck movements are typically restricted to onsite, with the stockpiling of excavated material to occur in close proximity to point of extraction. Minimal track out to public roads would occur.

7.2.2 STEP 2B – Sensitivity of the surrounding environment

Section 7.3 of the GADDC details the approach to categorise the sensitivity of the surrounding environment reviewing the following factors:

- The specific sensitivities of receptors in the area;
- The proximity and number of those receptors;
- Local ambient PM_{10} concentrations and likelihood of impact to human health; and
- Site specific factors to reduce wind-blown dust.

Based on the classification definitions presented within Section 7.3 of the GADDC, the following sensitivity ratings have been applied:

- Sensitivity of people to dust soiling effects - HIGH;
- Sensitivity of people to health effects of PM_{10} – HIGH; and
- Sensitivity of surrounding flora and fauna communities – LOW.

The above receptor sensitivity classifications are then combined with the number of receptors, background PM_{10} concentration (with regard to human health) and distance from the source to classify the sensitivity of the surrounding environment. The specific influencing factors are as follows:

- There are only two receptors located within 350 m of the proposed construction area disturbance footprint – receptors 17 and 28. There are no receptors located within 100 m of the proposed construction area disturbance footprint. The surrounding environment is therefore within the ">350" category of the GADDC; and
- The annual mean PM_{10} concentration for the area is taken to be 14.3 $\mu g/m^3$. Therefore, a "low" risk rating for the existing sensitivity of the surrounding area to health impacts is allocated based on the GADDC.

After combining the above receptor sensitivity classifications with these influencing factors and comparing it with the relevant rating tables in the GADDC (Table 2, Table 3 and Table 4), the sensitivity classification of the surrounding environment is as follows:

- Sensitivity of area to dust soiling effects on people and property - **LOW**;
- Sensitivity of area to human health effects – **LOW**; and
- Sensitivity of area to ecological effects – **LOW**.

7.2.3 Define the Risk of Dust Impacts

To determine the risk of the impacts with no mitigation applied, Section 7.4 of the GADDC requires that the dust magnitude rating is combined with the sensitivity of the surrounding area (as per Section 7.2) for each of the four activity categories (demolition, earthworks, construction and truck track out). **Table 7-1** presents the risk rating for the proposed construction activities.

Table 7-1: Dust impact risk rating

Potential impact (sensitivity to impact)	Construction activity (impact risk magnitude)			
	Demolition (Small)	**Earthworks (Large)**	**Construction (Small)**	**Truck track out to public roads (Small)**
Dust Soiling (Low)	Negligible	Medium	Negligible	Negligible
Human Health (Low)	Negligible	Medium	Negligible	Negligible
Ecological (Low)	Negligible	Medium	Negligible	Negligible

7.3 STEP 3 - Mitigation measures

As detailed in **Section 7.2.3**, the proposed construction activities, without mitigation measures, represent a negligible to medium risk to dust impacts on the surrounding environment. In order to further minimise dust impact potential, it is considered that the following dust mitigation measures should be implemented during the construction phase:

- Maintain a log book during construction
- Record all dust and air quality complaints in the log book, identifying cause(s) and appropriate measures taken to reduce emissions;
- Record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the log book;
- Carry out regular site inspections, record inspection results, and make the log book available to the local authority when asked;
- Erect shade cloth barriers to site fences around potentially dusty activities where practicable;
- Impose a maximum-speed-limit of 20 km/h on all internal roads and work areas;
- Ensure proper maintenance and tuning of all equipment engines;
- Provide an adequate water supply on the construction site for effective dust/particulate matter suppression/mitigation; and
- Minimise drop heights from loading or handling equipment.

7.4 STEP 4 - Construction impacts

It can be seen from the results presented in **Table 7-1** that uncontrolled dust emissions from the proposed construction activities are negligible for demolition, construction and truck track out classifications and medium for earthworks.

The implementation of the measures listed in **Section 7.3** will further reduce the dust impact risk rating for earthworks.

8. OPERATIONAL EMISSIONS INVENTORY

8.1 Emissions from the project

Existing train movements on the Berrima Branch Line are associated with Boral's Berrima Cement Works (limestone, cement and clinker), Omya Southern Limestone (limestone) and Ingham's Berrima Feed Mill (grain). Future Berrima Branch Line train movements will also incorporate Hume Coal trains.

As described in **Section** 1 and illustrated in **Figure 1-3**, approval is sought for two slightly differing alignments of the new rail line where it will cross Berrima Road. From an air quality perspective, there is negligible difference in emissions and potential impacts at all of the surrounding receptors between the two alignment options.

Train movements along the Berrima Branch Line associated with the three existing users will be up to 120 movements per week. Hume Coal trains will add an additional 50 train movements per week.

Air pollutant emissions have been quantified for particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), oxides of nitrogen (NO_x) and the individual volatile organic compounds (VOCs) benzene, ethylbenzene, toluene and xylenes.

Model-predicted concentrations of NO_X have been converted to nitrogen dioxide (NO_2) using the conservative ozone limiting method.

8.2 Operational emissions assumptions

To enable the preparation of a realistic 'worst case' air quality impact assessment, emissions have been quantified based on the highest possible 24-hour emissions (for Total Suspended Particulates (TSP), PM_{10} and $PM_{2.5}$) and hourly emissions (for NO_x and VOCs) from rail movements using the assumptions listed below.

- In any 24-hour period, 26 train movements occur over a working weekday 24 hour period for Berrima Branch Line activity associated with existing users. Hume Coal will add up to an additional eight train movements per day.
- A peak hourly rail movement scenario was configured to assess peak 1-hour average concentrations of NO_2 and VOCs. Based on information provided by Hume Coal, the estimated run time for the rail section between Berrima Junction and Boral Cement is between 17 and 23 minutes. Consequently, the peak 1-hour traffic scenario assumed a total of three train movements per hour.
- Existing Berrima Branch Line train movements involve trains with one or two locomotives of 81 Class. For conservative purposes, all trains are assumed to have two locomotives.
- Hume Coal trains will have two locomotives of C44aci Class.
- Locomotive 81 Class has a gross power rating of 3,300 bhp, while C44aci Class has a gross power rating of 4,500 bhp.
- Based on information provided by Hume Coal, the average weighting of locomotive engine notch settings for the journey from Berrima Junction to Boral and Hume Coal is 2 and 3 respectively. Locomotive engines are assumed to be in notch 1 when idling. Based on Table 5-2 of US-EPA (1998), the power output for notch 1, 2 and 3 is 4.5%, 11.5% and 23.5% of gross power rating respectively. These values have been applied to the respective locomotive engines for existing users and Hume Coal train movements.
- Locomotive emissions were estimated based on US-EPA uncontrolled emission factors for the existing Berrima Branch Line, and US-EPA Tier 1+ emission factors for the Hume Coal trains (US-EPA, 2009);
- Based on information provided by Hume Coal, the weighted average travel speed for trains moving to the Berrima Cement Works and Hume Coal Project are 16 km/hr and 18 km/hr respectively. The moving distance of trains along the Berrima Branch Line is 4.5 km, while the moving distance between the Hume Coal rail loop and the Main Southern Rail Line is 9.5 km.

- Using the above speed and distances, the time for a single train movement between Berrima Junction and the Berrima Cement Works is 21 minutes for all existing trains, and 32 minutes between the Hume Coal rail loop and the Berrima Junction for Hume Coal trains.
- All existing trains are assumed to spend one hour idling per trip, while Hume Coal trains are assumed to spend three hours idling per trip.
- Of the existing Berrima Branch Line movements, only limestone wagons are assumed to be uncovered. Based on information provided by Hume Coal, limestone trains account for approximately 35% of existing movements on the Berrima Branch Line, with on average 30 wagons per train. Using the findings of Ferrier et al (2003) for uncovered 60 t coal wagons, fugitive TSP, PM_{10} and $PM_{2.5}$ emission factors were derived to estimate fugitive particulate matter emissions from uncovered wagons moving between the Boral Cement Works and the Main Southern Rail Line. While it is acknowledged that the emission factors are relevant to coal, in the absence of limestone-specific emission factors these values are considered appropriate for use in this assessment.
- All Hume Coal train wagons are assumed to be covered (both full and empty wagons).
- Fugitive PM_{10} and $PM_{2.5}$ emissions from the loading of product coal to wagons by Hume Coal are included in the future Berrima Branch Line scenario.
- The US-EPA emission factor for locomotive engines is for PM_{10}. 97% of PM_{10} is assumed to be made up of much smaller $PM_{2.5}$ particles (US-EPA, 2009).
- Emissions of the individual VOC species benzene, ethylbenzene, toluene and xylenes were estimated based on the hazardous air pollutant speciation profile presented by US-EPA (2011).

Calculated annual emissions from existing users and future rail movements, based on the above assumptions and emission factors, along the Berrima Branch Line are presented in Table 8.2.

Table 8-1: Annual emissions from the project

Pollutant	**Annual emissions (kg/annum)**	
	Existing users	**Future movements**
TSP	1,959.9	2,723.4
PM_{10}	1,672.0	2,435.6
$PM_{2.5}$	1,429.0	2,169.7
NO_x	56,233.6	81,813.5
Benzene	7.9	12.1
Ethylbenzene	4.2	6.4
Toluene	6.6	10.2
Xylene	10.0	15.3

9. AIR QUALITY MODELLING METHODOLOGY

9.1 Dispersion model selection and application

The atmospheric dispersion modelling completed within this assessment used the AMS/US-EPA regulatory model (AERMOD) (US-EPA, 2004). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it is considered to provide more realistic results with concentrations that are generally lower and more representative of actual concentrations compared to the ISC model. Compared to ISC, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions.

Predicted concentrations were calculated at three levels:

- An outer Cartesian receptor grid covering a 15km by 11km computational domain covering the project and surrounding area, with a grid resolution of 300m applied; and
- The 75 representative sensitive receptor locations listed in **Table 2-1**.

Atmospheric dispersion simulations were undertaken for two 12 month periods of meteorological modelling data. These datasets (Hume 1 and BoM Moss Vale AWS) are described in detail in **Section 4**.

9.2 Cumulative impact assessment

A cumulative impact assessment was undertaken by combining in time predicted incremental concentrations from the project and neighbouring emission sources for each hour of the modelling period at each sensitive receptor location. Ambient concentrations, as per **Section** 5, were then taken into consideration.

For hourly NO_2, a contemporaneous OLM analysis has been conducted using hourly predicted concentrations and hourly NO_2 and O_3 concentrations from the NSW OEH Bargo monitoring station (further discussion in **Section 9.3**);

Combining neighbouring emission source models predicted with local and regional ambient monitoring data, a degree of double counting of existing air quality will occur. By combining model-predicted project-only increment with the modelled neighbouring emissions source increment and ambient background, it is considered that cumulative impacts in the surrounding environment have been conservatively assessed.

9.3 Modelling of NO_x emissions

NO_x emissions associated with fuel combustion are primarily emitted as NO with some NO_2. The transformation in the atmosphere of NO to NO_2 was accounted for using the US-EPA's Ozone Limiting Method (OLM) which requires ambient ozone data, as per the Approved Methods for Modelling.

Reference has been made to the hourly-varying O_3 concentrations recorded at the NSW OEH Bargo station.

The equation used to calculate NO_2 concentrations from predicted NO_X concentrations is as follows:

$$[NO_2]_{TOTAL} = \{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\} + [NO_2]_{BKGD}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of NO_2 as µg/m^3.

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level NO_X concentrations as µg/m^3.

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – Hourly Varying OEH Bargo as µg/m^3.

46/48 = the molecular weight of NO_2 divided by the molecular weight of O_3.

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – Hourly Varying OEH Bargo as µg/m^3.

The US-EPA's OLM assumes that all of the available O_3 in the atmosphere will react with NO until either all of the O_3, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. Furthermore, the method assumes that the complete mixing of the emitted NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the emissions reach the ground level receiver of the maximum ground level NO_X concentration.

Finally, the use of NO_2 and O_3 air quality monitoring data from the NSW OEH Bargo air quality monitoring station, located in the southwest of the Sydney basin, is considered conservative for representing ambient concentrations at the project.

Consequently, concentrations of the NO_2 reported within this assessment should be viewed as highly conservative, providing an upper bound estimate of NO_2 concentrations.

10. DISPERSION MODELLING RESULTS

10.1 Project-only incremental concentrations

The results of the atmospheric dispersion modelling are presented in the following tables:

- **Table 10-1** lists a summary of the maximum predicted project-only incremental concentrations across all receptors for the existing scenario (ie emissions from train movements associated with the current users of the Berrima Branch Line) and the future Berrima Branch Line emission scenario (ie with the addition of Hume Coal trains). Additionally, as the criteria for benzene and ethylbenzene are applicable at or beyond the site boundary, the site boundary predictions for these two pollutants are listed in **Table 10-1**;
- **Table 10-2** presents the predicted project-only incremental concentrations at each receptor for the existing Berrima Branch Line emissions;
- **Table 10-3** presents the predicted project-only incremental concentrations at each receptor for the future Berrima Branch Line emissions (i.e. with the inclusion of Hume Coal trains); and
- **Table 10-4** presents the predicted incremental concentrations at each receptor for the future Berrima Branch Line emissions associated with Hume Coal trains only.

Table 10-1: Maximum predicted project-only incremental concentrations across all receptors – Existing versus future Berrima Branch Line emissions scenario

ID	Maximum Predicted Concentration (µg/m³)							99.9th Percentile 1-hour average Concentration (µg/m³)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
Existing	0.3	0.7	0.2	0.6	0.2	68.8	6.8	0.02	0.01	0.02	0.03
Future	0.3	0.9	0.3	0.7	0.2	109.8	10.5	0.05	0.02	0.04	0.06
Change	<0.1	0.2	0.1	0.1	<0.1	41.0	3.7	<0.01	<0.01	<0.01	<0.01
Site boundary maximum - Existing	-	-	-	-	-	-	-	0.03	0.01	-	-
Site boundary maximum - Future	-	-	-	-	-	-	-	0.03	0.02	-	-

Note: Criteria for benzene and ethylbenzene are applicable at or beyond the site boundary

Table 10-2: Predicted project-only incremental concentrations across all receptors - Existing Berrima Branch Line emissions

Receptor ID	Maximum Predicted Concentration (µg/m³)							99.9th Percentile 1-hour average Concentration (µg/m³)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
1	<0.1	<0.1	<0.1	<0.1	<0.1	9.7	0.2	<0.01	<0.01	<0.01	<0.01
2	<0.1	<0.1	<0.1	<0.1	<0.1	8.1	0.2	<0.01	<0.01	<0.01	<0.01
3	<0.1	<0.1	<0.1	<0.1	<0.1	8.2	0.2	<0.01	<0.01	<0.01	<0.01
4	<0.1	<0.1	<0.1	<0.1	<0.1	15.5	0.3	<0.01	<0.01	<0.01	<0.01
5	<0.1	<0.1	<0.1	<0.1	<0.1	12.5	0.3	<0.01	<0.01	<0.01	<0.01
6	<0.1	<0.1	<0.1	<0.1	<0.1	12.8	0.3	<0.01	<0.01	<0.01	<0.01
7	<0.1	<0.1	<0.1	<0.1	<0.1	13.4	0.3	<0.01	<0.01	<0.01	<0.01
8	<0.1	<0.1	<0.1	<0.1	<0.1	12.9	0.3	<0.01	<0.01	<0.01	<0.01

Table 10-2: Predicted project-only incremental concentrations across all receptors - Existing Berrima Branch Line emissions

Receptor ID	Maximum Predicted Concentration (µg/m³)							99.9th Percentile 1-hour average Concentration (µg/m³)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
10	<0.1	<0.1	<0.1	<0.1	<0.1	14.5	0.3	<0.01	<0.01	<0.01	<0.01
12	<0.1	<0.1	<0.1	<0.1	<0.1	14.3	0.4	<0.01	<0.01	<0.01	<0.01
13	<0.1	<0.1	<0.1	<0.1	<0.1	16.0	0.4	<0.01	<0.01	<0.01	<0.01
14a	<0.1	<0.1	<0.1	<0.1	<0.1	17.9	0.4	<0.01	<0.01	<0.01	<0.01
14b	<0.1	<0.1	<0.1	<0.1	<0.1	17.9	0.4	<0.01	<0.01	<0.01	<0.01
15	<0.1	<0.1	<0.1	<0.1	<0.1	23.0	0.4	<0.01	<0.01	<0.01	<0.01
16	<0.1	<0.1	<0.1	<0.1	<0.1	21.5	0.5	<0.01	<0.01	<0.01	<0.01
17	<0.1	<0.1	<0.1	<0.1	<0.1	26.0	0.6	<0.01	<0.01	<0.01	<0.01
18	<0.1	<0.1	<0.1	<0.1	<0.1	21.5	0.6	<0.01	<0.01	<0.01	<0.01
19	<0.1	0.1	<0.1	0.1	<0.1	39.5	0.9	<0.01	<0.01	<0.01	<0.01
20	<0.1	0.2	<0.1	0.2	<0.1	57.2	1.2	<0.01	<0.01	<0.01	<0.01
21	<0.1	0.2	<0.1	0.1	<0.1	55.2	1.3	<0.01	<0.01	<0.01	<0.01
22	<0.1	0.3	<0.1	0.2	<0.1	67.5	1.8	<0.01	<0.01	<0.01	<0.01
23	<0.1	0.2	<0.1	0.2	<0.1	26.3	1.1	<0.01	<0.01	<0.01	<0.01
24	<0.1	0.1	<0.1	<0.1	<0.1	55.8	0.7	<0.01	<0.01	<0.01	<0.01
25	0.1	0.3	<0.1	0.3	<0.1	50.3	3.1	<0.01	<0.01	<0.01	<0.01
26	0.1	0.3	0.1	0.3	<0.1	58.3	5.0	<0.01	<0.01	<0.01	<0.01
27	<0.1	0.3	<0.1	0.2	<0.1	68.8	2.0	<0.01	<0.01	<0.01	<0.01
28	0.3	0.7	0.2	0.6	0.2	66.4	6.8	0.01	<0.01	<0.01	0.01
29	0.1	0.2	<0.1	0.2	<0.1	33.1	3.1	<0.01	<0.01	<0.01	<0.01
30	<0.1	<0.1	<0.1	<0.1	<0.1	13.0	0.8	<0.01	<0.01	<0.01	<0.01
31	<0.1	<0.1	<0.1	<0.1	<0.1	7.6	0.3	<0.01	<0.01	<0.01	<0.01
32	<0.1	<0.1	<0.1	<0.1	<0.1	18.6	0.7	<0.01	<0.01	<0.01	<0.01
33	<0.1	<0.1	<0.1	<0.1	<0.1	5.3	0.3	<0.01	<0.01	<0.01	<0.01
34	<0.1	<0.1	<0.1	<0.1	<0.1	8.9	0.2	<0.01	<0.01	<0.01	<0.01
35	<0.1	<0.1	<0.1	<0.1	<0.1	5.9	0.2	<0.01	<0.01	<0.01	<0.01
36	<0.1	<0.1	<0.1	<0.1	<0.1	4.3	0.2	<0.01	<0.01	<0.01	<0.01
37	<0.1	<0.1	<0.1	<0.1	<0.1	4.3	0.2	<0.01	<0.01	<0.01	<0.01
38	<0.1	<0.1	<0.1	<0.1	<0.1	11.0	0.2	<0.01	<0.01	<0.01	<0.01
39	<0.1	<0.1	<0.1	<0.1	<0.1	8.0	0.2	<0.01	<0.01	<0.01	<0.01
40	<0.1	<0.1	<0.1	<0.1	<0.1	7.6	0.2	<0.01	<0.01	<0.01	<0.01
41	<0.1	<0.1	<0.1	<0.1	<0.1	8.3	0.3	<0.01	<0.01	<0.01	<0.01
42	<0.1	<0.1	<0.1	<0.1	<0.1	8.5	0.3	<0.01	<0.01	<0.01	<0.01
43	<0.1	<0.1	<0.1	<0.1	<0.1	6.4	0.4	<0.01	<0.01	<0.01	<0.01
44	<0.1	<0.1	<0.1	<0.1	<0.1	9.2	0.4	<0.01	<0.01	<0.01	<0.01
45	<0.1	<0.1	<0.1	<0.1	<0.1	10.0	0.4	<0.01	<0.01	<0.01	<0.01
46	<0.1	<0.1	<0.1	<0.1	<0.1	10.3	0.4	<0.01	<0.01	<0.01	<0.01
47	<0.1	<0.1	<0.1	<0.1	<0.1	10.6	0.4	<0.01	<0.01	<0.01	<0.01
48	<0.1	<0.1	<0.1	<0.1	<0.1	10.6	0.4	<0.01	<0.01	<0.01	<0.01
49	<0.1	<0.1	<0.1	<0.1	<0.1	10.7	0.4	<0.01	<0.01	<0.01	<0.01
50	<0.1	<0.1	<0.1	<0.1	<0.1	10.4	0.4	<0.01	<0.01	<0.01	<0.01
51	<0.1	<0.1	<0.1	<0.1	<0.1	9.8	0.4	<0.01	<0.01	<0.01	<0.01
52	<0.1	<0.1	<0.1	<0.1	<0.1	9.1	0.4	<0.01	<0.01	<0.01	<0.01
53	<0.1	<0.1	<0.1	<0.1	<0.1	10.6	0.4	<0.01	<0.01	<0.01	<0.01
54	<0.1	<0.1	<0.1	<0.1	<0.1	8.8	0.4	<0.01	<0.01	<0.01	<0.01
55	<0.1	<0.1	<0.1	<0.1	<0.1	11.9	0.4	<0.01	<0.01	<0.01	<0.01
56	<0.1	<0.1	<0.1	<0.1	<0.1	9.8	0.4	<0.01	<0.01	<0.01	<0.01
57	<0.1	<0.1	<0.1	<0.1	<0.1	8.6	0.4	<0.01	<0.01	<0.01	<0.01
58	<0.1	<0.1	<0.1	<0.1	<0.1	10.3	0.5	<0.01	<0.01	<0.01	<0.01
59	<0.1	<0.1	<0.1	<0.1	<0.1	12.6	0.6	<0.01	<0.01	<0.01	<0.01
60	<0.1	0.1	<0.1	<0.1	<0.1	22.1	0.7	<0.01	<0.01	<0.01	<0.01
61	<0.1	0.1	<0.1	0.1	<0.1	28.0	0.7	<0.01	<0.01	<0.01	<0.01
62	<0.1	0.1	<0.1	0.1	<0.1	28.3	0.8	<0.01	<0.01	<0.01	<0.01
63	<0.1	0.1	<0.1	<0.1	<0.1	34.4	0.7	<0.01	<0.01	<0.01	<0.01
64	<0.1	<0.1	<0.1	<0.1	<0.1	14.8	0.2	<0.01	<0.01	<0.01	<0.01
65	<0.1	<0.1	<0.1	<0.1	<0.1	11.2	0.2	<0.01	<0.01	<0.01	<0.01
66	<0.1	<0.1	<0.1	<0.1	<0.1	12.4	0.3	<0.01	<0.01	<0.01	<0.01
67	<0.1	<0.1	<0.1	<0.1	<0.1	10.5	0.2	<0.01	<0.01	<0.01	<0.01
68	<0.1	<0.1	<0.1	<0.1	<0.1	10.5	0.2	<0.01	<0.01	<0.01	<0.01
69	<0.1	0.2	<0.1	0.1	<0.1	57.0	0.8	<0.01	<0.01	<0.01	<0.01
70	<0.1	0.2	<0.1	0.2	<0.1	57.2	1.1	<0.01	<0.01	<0.01	<0.01
71	<0.1	0.2	<0.1	0.2	<0.1	57.0	1.0	<0.01	<0.01	<0.01	<0.01

Table 10-2: Predicted project-only incremental concentrations across all receptors - Existing Berrima Branch Line emissions

Receptor ID	Maximum Predicted Concentration ($\mu g/m^3$)							99.9th Percentile 1-hour average Concentration ($\mu g/m^3$)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
72	<0.1	0.2	<0.1	0.1	<0.1	35.6	1.0	<0.01	<0.01	<0.01	<0.01
73	<0.1	0.2	<0.1	0.2	<0.1	58.2	1.3	<0.01	<0.01	<0.01	<0.01
74	<0.1	0.2	<0.1	0.2	<0.1	57.7	1.2	<0.01	<0.01	<0.01	<0.01
75	<0.1	0.2	<0.1	0.1	<0.1	27.6	1.2	<0.01	<0.01	<0.01	<0.01
76	<0.1	0.1	<0.1	0.1	<0.1	23.3	1.2	<0.01	<0.01	<0.01	<0.01

Table 10-3: Predicted project-only incremental concentrations across all receptors - Future Berrima Branch Line emissions (inclusive of Hume Coal trains)

Receptor ID	Maximum Predicted Concentration ($\mu g/m^3$)							99.9th Percentile 1-hour average Concentration ($\mu g/m^3$)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
1	<0.1	<0.1	<0.1	<0.1	<0.1	20.6	0.6	<0.01	<0.01	<0.01	<0.01
2	<0.1	<0.1	<0.1	<0.1	<0.1	16.7	0.6	<0.01	<0.01	<0.01	<0.01
3	<0.1	<0.1	<0.1	<0.1	<0.1	20.1	0.7	<0.01	<0.01	<0.01	<0.01
4	<0.1	<0.1	<0.1	<0.1	<0.1	32.2	0.9	<0.01	<0.01	<0.01	<0.01
5	<0.1	<0.1	<0.1	<0.1	<0.1	25.7	0.9	<0.01	<0.01	<0.01	<0.01
6	<0.1	<0.1	<0.1	<0.1	<0.1	27.3	0.9	<0.01	<0.01	<0.01	<0.01
7	<0.1	<0.1	<0.1	<0.1	<0.1	29.3	0.9	<0.01	<0.01	<0.01	<0.01
8	<0.1	<0.1	<0.1	<0.1	<0.1	31.8	1.0	<0.01	<0.01	<0.01	<0.01
10	<0.1	0.1	<0.1	<0.1	<0.1	33.3	1.2	<0.01	<0.01	<0.01	<0.01
12	<0.1	0.1	<0.1	0.1	<0.1	32.7	1.4	<0.01	<0.01	<0.01	<0.01
13	<0.1	0.1	<0.1	0.1	<0.1	35.9	1.5	<0.01	<0.01	<0.01	<0.01
14a	<0.1	0.1	<0.1	0.1	<0.1	37.3	1.4	<0.01	<0.01	<0.01	<0.01
14b	<0.1	0.1	<0.1	0.1	<0.1	37.3	1.4	<0.01	<0.01	<0.01	<0.01
15	<0.1	0.1	<0.1	0.1	<0.1	60.0	1.8	<0.01	<0.01	<0.01	0.01
16	<0.1	0.2	<0.1	0.2	<0.1	59.6	3.0	0.01	<0.01	<0.01	0.01
17	0.1	0.4	0.1	0.3	<0.1	64.5	5.7	0.02	0.01	0.02	0.03
18	<0.1	0.2	<0.1	0.1	<0.1	39.7	2.5	<0.01	<0.01	<0.01	0.01
19	<0.1	0.2	<0.1	0.2	<0.1	53.4	3.4	0.01	<0.01	<0.01	0.01
20	<0.1	0.2	<0.1	0.2	<0.1	75.1	2.9	<0.01	<0.01	<0.01	0.01
21	<0.1	0.2	<0.1	0.2	<0.1	64.3	2.8	<0.01	<0.01	<0.01	<0.01
22	<0.1	0.3	<0.1	0.3	<0.1	88.0	3.4	<0.01	<0.01	<0.01	0.01
23	<0.1	0.2	<0.1	0.2	<0.1	33.3	2.0	<0.01	<0.01	<0.01	<0.01
24	<0.1	0.1	<0.1	0.1	<0.1	75.5	1.6	<0.01	<0.01	<0.01	<0.01
25	0.1	0.4	0.1	0.3	<0.1	64.5	4.9	0.01	<0.01	<0.01	0.01
26	0.2	0.4	0.1	0.4	0.1	93.1	7.6	0.01	<0.01	<0.01	0.01
27	<0.1	0.3	<0.1	0.3	<0.1	89.9	3.1	<0.01	<0.01	<0.01	<0.01
28	0.3	0.9	0.3	0.7	0.2	109.8	10.5	0.02	<0.01	0.01	0.02
29	0.1	0.3	0.1	0.2	<0.1	47.9	4.7	<0.01	<0.01	<0.01	<0.01
30	<0.1	<0.1	<0.1	<0.1	<0.1	19.3	1.2	<0.01	<0.01	<0.01	<0.01
31	<0.1	<0.1	<0.1	<0.1	<0.1	11.0	0.5	<0.01	<0.01	<0.01	<0.01
32	<0.1	<0.1	<0.1	<0.1	<0.1	23.1	1.1	<0.01	<0.01	<0.01	<0.01
33	<0.1	<0.1	<0.1	<0.1	<0.1	7.2	0.6	<0.01	<0.01	<0.01	<0.01
34	<0.1	<0.1	<0.1	<0.1	<0.1	15.0	0.5	<0.01	<0.01	<0.01	<0.01
35	<0.1	<0.1	<0.1	<0.1	<0.1	12.5	0.5	<0.01	<0.01	<0.01	<0.01
36	<0.1	<0.1	<0.1	<0.1	<0.1	7.8	0.5	<0.01	<0.01	<0.01	<0.01
37	<0.1	<0.1	<0.1	<0.1	<0.1	7.9	0.5	<0.01	<0.01	<0.01	<0.01
38	<0.1	<0.1	<0.1	<0.1	<0.1	18.3	0.5	<0.01	<0.01	<0.01	<0.01

Table 10-3: Predicted project-only incremental concentrations across all receptors - Future Berrima Branch Line emissions (inclusive of Hume Coal trains)

Receptor ID	Maximum Predicted Concentration ($\mu g/m^3$)							99.9th Percentile 1-hour average Concentration ($\mu g/m^3$)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
39	<0.1	<0.1	<0.1	<0.1	<0.1	14.9	0.6	<0.01	<0.01	<0.01	<0.01
40	<0.1	<0.1	<0.1	<0.1	<0.1	13.8	0.5	<0.01	<0.01	<0.01	<0.01
41	<0.1	<0.1	<0.1	<0.1	<0.1	13.4	0.7	<0.01	<0.01	<0.01	<0.01
42	<0.1	<0.1	<0.1	<0.1	<0.1	14.9	0.7	<0.01	<0.01	<0.01	<0.01
43	<0.1	<0.1	<0.1	<0.1	<0.1	9.7	0.8	<0.01	<0.01	<0.01	<0.01
44	<0.1	<0.1	<0.1	<0.1	<0.1	14.5	0.9	<0.01	<0.01	<0.01	<0.01
45	<0.1	<0.1	<0.1	<0.1	<0.1	17.7	0.9	<0.01	<0.01	<0.01	<0.01
46	<0.1	<0.1	<0.1	<0.1	<0.1	19.3	0.9	<0.01	<0.01	<0.01	<0.01
47	<0.1	<0.1	<0.1	<0.1	<0.1	20.4	0.9	<0.01	<0.01	<0.01	<0.01
48	<0.1	<0.1	<0.1	<0.1	<0.1	20.2	0.9	<0.01	<0.01	<0.01	<0.01
49	<0.1	<0.1	<0.1	<0.1	<0.1	19.7	0.9	<0.01	<0.01	<0.01	<0.01
50	<0.1	<0.1	<0.1	<0.1	<0.1	19.0	0.9	<0.01	<0.01	<0.01	<0.01
51	<0.1	<0.1	<0.1	<0.1	<0.1	17.0	1.0	<0.01	<0.01	<0.01	<0.01
52	<0.1	<0.1	<0.1	<0.1	<0.1	16.0	1.0	<0.01	<0.01	<0.01	<0.01
53	<0.1	<0.1	<0.1	<0.1	<0.1	17.9	1.1	<0.01	<0.01	<0.01	<0.01
54	<0.1	<0.1	<0.1	<0.1	<0.1	15.6	1.1	<0.01	<0.01	<0.01	<0.01
55	<0.1	<0.1	<0.1	<0.1	<0.1	21.1	1.2	<0.01	<0.01	<0.01	<0.01
56	<0.1	<0.1	<0.1	<0.1	<0.1	16.8	0.9	<0.01	<0.01	<0.01	<0.01
57	<0.1	<0.1	<0.1	<0.1	<0.1	12.8	0.9	<0.01	<0.01	<0.01	<0.01
58	<0.1	<0.1	<0.1	<0.1	<0.1	15.1	1.2	<0.01	<0.01	<0.01	<0.01
59	<0.1	<0.1	<0.1	<0.1	<0.1	21.7	1.3	<0.01	<0.01	<0.01	<0.01
60	<0.1	0.2	<0.1	0.1	<0.1	41.1	1.6	<0.01	<0.01	<0.01	<0.01
61	<0.1	0.2	<0.1	0.2	<0.1	43.8	1.9	<0.01	<0.01	<0.01	<0.01
62	<0.1	0.2	<0.1	0.2	<0.1	47.1	2.5	<0.01	<0.01	<0.01	<0.01
63	<0.1	0.2	<0.1	0.2	<0.1	70.5	2.2	<0.01	<0.01	<0.01	<0.01
64	<0.1	<0.1	<0.1	<0.1	<0.1	28.8	0.7	<0.01	<0.01	<0.01	<0.01
65	<0.1	<0.1	<0.1	<0.1	<0.1	22.8	0.6	<0.01	<0.01	<0.01	<0.01
66	<0.1	<0.1	<0.1	<0.1	<0.1	26.0	0.7	<0.01	<0.01	<0.01	<0.01
67	<0.1	<0.1	<0.1	<0.1	<0.1	21.5	0.6	<0.01	<0.01	<0.01	<0.01
68	<0.1	<0.1	<0.1	<0.1	<0.1	23.0	0.7	<0.01	<0.01	<0.01	<0.01
69	<0.1	0.2	<0.1	0.2	<0.1	69.1	1.8	<0.01	<0.01	<0.01	<0.01
70	<0.1	0.3	<0.1	0.2	<0.1	74.2	2.3	<0.01	<0.01	<0.01	<0.01
71	<0.1	0.2	<0.1	0.2	<0.1	73.2	2.1	<0.01	<0.01	<0.01	<0.01
72	<0.1	0.2	<0.1	0.2	<0.1	46.4	1.9	<0.01	<0.01	<0.01	<0.01
73	<0.1	0.3	<0.1	0.3	<0.1	77.4	2.4	<0.01	<0.01	<0.01	<0.01
74	<0.1	0.3	<0.1	0.2	<0.1	80.3	2.8	<0.01	<0.01	<0.01	0.01
75	<0.1	0.2	<0.1	0.2	<0.1	40.3	2.7	0.01	<0.01	<0.01	0.01
76	<0.1	0.2	<0.1	0.2	<0.1	33.3	2.5	<0.01	<0.01	<0.01	0.01

Table 10-4: Predicted incremental concentrations across all receptors- Future Berrima Branch Line emissions (Hume Coal trains only)

Receptor ID	Maximum Predicted Concentration ($\mu g/m^3$)							99.9th Percentile 1-hour average Concentration ($\mu g/m^3$)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
1	<0.1	<0.1	<0.1	<0.1	<0.1	10.9	0.4	<0.01	<0.01	<0.01	<0.01
2	<0.1	<0.1	<0.1	<0.1	<0.1	8.6	0.4	<0.01	<0.01	<0.01	<0.01

Table 10-4: Predicted incremental concentrations across all receptors- Future Berrima Branch Line emissions (Hume Coal trains only)

Receptor ID	Maximum Predicted Concentration (µg/m³)							99.9th Percentile 1-hour average Concentration (µg/m³)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
3	<0.1	<0.1	<0.1	<0.1	<0.1	11.9	0.5	<0.01	<0.01	<0.01	<0.01
4	<0.1	<0.1	<0.1	<0.1	<0.1	16.7	0.6	<0.01	<0.01	<0.01	<0.01
5	<0.1	<0.1	<0.1	<0.1	<0.1	13.2	0.6	<0.01	<0.01	<0.01	<0.01
6	<0.1	<0.1	<0.1	<0.1	<0.1	14.5	0.6	<0.01	<0.01	<0.01	<0.01
7	<0.1	<0.1	<0.1	<0.1	<0.1	15.8	0.6	<0.01	<0.01	<0.01	<0.01
8	<0.1	<0.1	<0.1	<0.1	<0.1	18.9	0.7	<0.01	<0.01	<0.01	<0.01
10	<0.1	<0.1	<0.1	<0.1	<0.1	18.9	0.9	<0.01	<0.01	<0.01	<0.01
12	<0.1	<0.1	<0.1	<0.1	<0.1	18.4	1.1	<0.01	<0.01	<0.01	<0.01
13	<0.1	<0.1	<0.1	<0.1	<0.1	19.9	1.1	<0.01	<0.01	<0.01	<0.01
14a	<0.1	<0.1	<0.1	<0.1	<0.1	19.5	1.0	<0.01	<0.01	<0.01	<0.01
14b	<0.1	<0.1	<0.1	<0.1	<0.1	19.5	1.0	<0.01	<0.01	<0.01	<0.01
15	<0.1	0.1	<0.1	0.1	<0.1	37.0	1.4	<0.01	<0.01	<0.01	0.01
16	<0.1	0.2	<0.1	0.2	<0.1	38.1	2.5	0.01	<0.01	<0.01	0.01
17	<0.1	0.3	<0.1	0.3	<0.1	38.5	5.1	0.02	0.01	0.02	0.03
18	<0.1	0.1	<0.1	0.1	<0.1	18.2	1.9	<0.01	<0.01	<0.01	0.01
19	<0.1	0.1	<0.1	0.1	<0.1	13.9	2.5	0.01	<0.01	<0.01	0.01
20	<0.1	<0.1	<0.1	<0.1	<0.1	17.9	1.7	<0.01	<0.01	<0.01	<0.01
21	<0.1	<0.1	<0.1	<0.1	<0.1	9.1	1.5	<0.01	<0.01	<0.01	<0.01
22	<0.1	<0.1	<0.1	<0.1	<0.1	20.5	1.6	<0.01	<0.01	<0.01	<0.01
23	<0.1	<0.1	<0.1	<0.1	<0.1	7.1	0.9	<0.01	<0.01	<0.01	<0.01
24	<0.1	<0.1	<0.1	<0.1	<0.1	19.8	0.9	<0.01	<0.01	<0.01	<0.01
25	<0.1	<0.1	<0.1	<0.1	<0.1	14.2	1.8	<0.01	<0.01	<0.01	<0.01
26	<0.1	<0.1	<0.1	<0.1	<0.1	34.8	2.6	<0.01	<0.01	<0.01	<0.01
27	<0.1	<0.1	<0.1	<0.1	<0.1	21.1	1.1	<0.01	<0.01	<0.01	<0.01
28	<0.1	0.2	<0.1	0.2	<0.1	43.4	3.7	<0.01	<0.01	<0.01	0.01
29	<0.1	<0.1	<0.1	<0.1	<0.1	14.8	1.6	<0.01	<0.01	<0.01	<0.01
30	<0.1	<0.1	<0.1	<0.1	<0.1	6.3	0.5	<0.01	<0.01	<0.01	<0.01
31	<0.1	<0.1	<0.1	<0.1	<0.1	3.4	0.2	<0.01	<0.01	<0.01	<0.01
32	<0.1	<0.1	<0.1	<0.1	<0.1	4.5	0.4	<0.01	<0.01	<0.01	<0.01
33	<0.1	<0.1	<0.1	<0.1	<0.1	2.0	0.2	<0.01	<0.01	<0.01	<0.01
34	<0.1	<0.1	<0.1	<0.1	<0.1	6.1	0.3	<0.01	<0.01	<0.01	<0.01
35	<0.1	<0.1	<0.1	<0.1	<0.1	6.6	0.3	<0.01	<0.01	<0.01	<0.01
36	<0.1	<0.1	<0.1	<0.1	<0.1	3.5	0.3	<0.01	<0.01	<0.01	<0.01
37	<0.1	<0.1	<0.1	<0.1	<0.1	3.6	0.3	<0.01	<0.01	<0.01	<0.01
38	<0.1	<0.1	<0.1	<0.1	<0.1	7.3	0.3	<0.01	<0.01	<0.01	<0.01
39	<0.1	<0.1	<0.1	<0.1	<0.1	6.9	0.3	<0.01	<0.01	<0.01	<0.01
40	<0.1	<0.1	<0.1	<0.1	<0.1	6.2	0.3	<0.01	<0.01	<0.01	<0.01
41	<0.1	<0.1	<0.1	<0.1	<0.1	5.1	0.4	<0.01	<0.01	<0.01	<0.01
42	<0.1	<0.1	<0.1	<0.1	<0.1	6.4	0.4	<0.01	<0.01	<0.01	<0.01
43	<0.1	<0.1	<0.1	<0.1	<0.1	3.3	0.4	<0.01	<0.01	<0.01	<0.01
44	<0.1	<0.1	<0.1	<0.1	<0.1	5.3	0.5	<0.01	<0.01	<0.01	<0.01
45	<0.1	<0.1	<0.1	<0.1	<0.1	7.6	0.5	<0.01	<0.01	<0.01	<0.01
46	<0.1	<0.1	<0.1	<0.1	<0.1	8.9	0.5	<0.01	<0.01	<0.01	<0.01
47	<0.1	<0.1	<0.1	<0.1	<0.1	9.7	0.5	<0.01	<0.01	<0.01	<0.01
48	<0.1	<0.1	<0.1	<0.1	<0.1	9.6	0.5	<0.01	<0.01	<0.01	<0.01
49	<0.1	<0.1	<0.1	<0.1	<0.1	9.1	0.5	<0.01	<0.01	<0.01	<0.01
50	<0.1	<0.1	<0.1	<0.1	<0.1	8.5	0.5	<0.01	<0.01	<0.01	<0.01
51	<0.1	<0.1	<0.1	<0.1	<0.1	7.2	0.6	<0.01	<0.01	<0.01	<0.01
52	<0.1	<0.1	<0.1	<0.1	<0.1	6.8	0.6	<0.01	<0.01	<0.01	<0.01
53	<0.1	<0.1	<0.1	<0.1	<0.1	7.3	0.7	<0.01	<0.01	<0.01	<0.01
54	<0.1	<0.1	<0.1	<0.1	<0.1	6.9	0.7	<0.01	<0.01	<0.01	<0.01
55	<0.1	<0.1	<0.1	<0.1	<0.1	9.2	0.8	<0.01	<0.01	<0.01	<0.01
56	<0.1	<0.1	<0.1	<0.1	<0.1	7.0	0.5	<0.01	<0.01	<0.01	<0.01
57	<0.1	<0.1	<0.1	<0.1	<0.1	4.2	0.5	<0.01	<0.01	<0.01	<0.01
58	<0.1	<0.1	<0.1	<0.1	<0.1	4.8	0.7	<0.01	<0.01	<0.01	<0.01
59	<0.1	<0.1	<0.1	<0.1	<0.1	9.0	0.8	<0.01	<0.01	<0.01	<0.01
60	<0.1	<0.1	<0.1	<0.1	<0.1	19.0	0.9	<0.01	<0.01	<0.01	<0.01
61	<0.1	<0.1	<0.1	<0.1	<0.1	15.8	1.2	<0.01	<0.01	<0.01	<0.01
62	<0.1	<0.1	<0.1	<0.1	<0.1	18.8	1.6	<0.01	<0.01	<0.01	<0.01
63	<0.1	<0.1	<0.1	<0.1	<0.1	36.1	1.5	<0.01	<0.01	<0.01	<0.01
64	<0.1	<0.1	<0.1	<0.1	<0.1	14.1	0.4	<0.01	<0.01	<0.01	<0.01
65	<0.1	<0.1	<0.1	<0.1	<0.1	11.6	0.4	<0.01	<0.01	<0.01	<0.01

Table 10-4: Predicted incremental concentrations across all receptors- Future Berrima Branch Line emissions (Hume Coal trains only)

Receptor ID	Maximum Predicted Concentration (µg/m³)							99.9th Percentile 1-hour average Concentration (µg/m³)			
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**90**	**50**	**25**	**25**	**8**	**246**	**62**	**29**	**8,000**	**360**	**190**
66	<0.1	<0.1	<0.1	<0.1	<0.1	13.5	0.5	<0.01	<0.01	<0.01	<0.01
67	<0.1	<0.1	<0.1	<0.1	<0.1	11.0	0.4	<0.01	<0.01	<0.01	<0.01
68	<0.1	<0.1	<0.1	<0.1	<0.1	12.4	0.4	<0.01	<0.01	<0.01	<0.01
69	<0.1	<0.1	<0.1	<0.1	<0.1	12.1	1.0	<0.01	<0.01	<0.01	<0.01
70	<0.1	<0.1	<0.1	<0.1	<0.1	16.9	1.1	<0.01	<0.01	<0.01	<0.01
71	<0.1	<0.1	<0.1	<0.1	<0.1	16.2	1.1	<0.01	<0.01	<0.01	<0.01
72	<0.1	<0.1	<0.1	<0.1	<0.1	10.8	0.9	<0.01	<0.01	<0.01	<0.01
73	<0.1	<0.1	<0.1	<0.1	<0.1	19.1	1.1	<0.01	<0.01	<0.01	<0.01
74	<0.1	<0.1	<0.1	<0.1	<0.1	22.6	1.5	<0.01	<0.01	<0.01	<0.01
75	<0.1	<0.1	<0.1	<0.1	<0.1	12.7	1.5	<0.01	<0.01	<0.01	0.01
76	<0.1	<0.1	<0.1	<0.1	<0.1	10.0	1.3	<0.01	<0.01	<0.01	0.01

10.2 Analysis of results

As can be seen from the results presented in **Table 10-1** through to **Table 10-4**, the predicted concentrations from train movements associated with the existing Berrima Branch Line users are very low and well below applicable air quality criteria at all surrounding receptors.

The introduction of additional train movements by Hume Coal and the associated increase in annual air pollutant emissions will increase ground level concentrations relative to existing activities. However, the increased emissions will not result in an exceedance of any applicable air quality criteria at any receptor location.

10.3 Operational cumulative impacts

In order to assess cumulative impacts, the predicted impacts from the Berrima Rail Project, the Hume Coal Project, neighbouring emission sources and existing ambient background levels were paired in time at each of the selected assessment locations. The results showed that:

- predicted cumulative concentrations would not exceed applicable cumulative impact assessment criteria at any surrounding sensitive receptors, beyond those already occurring in the existing environment (i.e. days influenced by bushfires, dust storms, etc.); and
- emissions from the Berrima Branch Line (existing and future Hume Coal Project related movements) are very minor contributors to the predicted cumulative concentrations at all receptors, as shown in **Figure 10-1**.

The significance of annual average $PM_{2.5}$ impacts from existing and future rail movements relative to existing ambient background and impacts from neighbouring emissions sources and the proposed Hume Coal Project is illustrated in **Figure 10-1**.

It can be seen from **Figure 10-1** that the contribution of $PM_{2.5}$ emissions from existing and future rail movements along the Berrima Branch Line to total cumulative annual average $PM_{2.5}$ concentrations is very small at all selected assessment locations across the surrounding local area.

Given the above, cumulative impacts in exceedance of applicable air quality impact assessment criteria associated with the Berrima Rail Project are unlikely to occur.

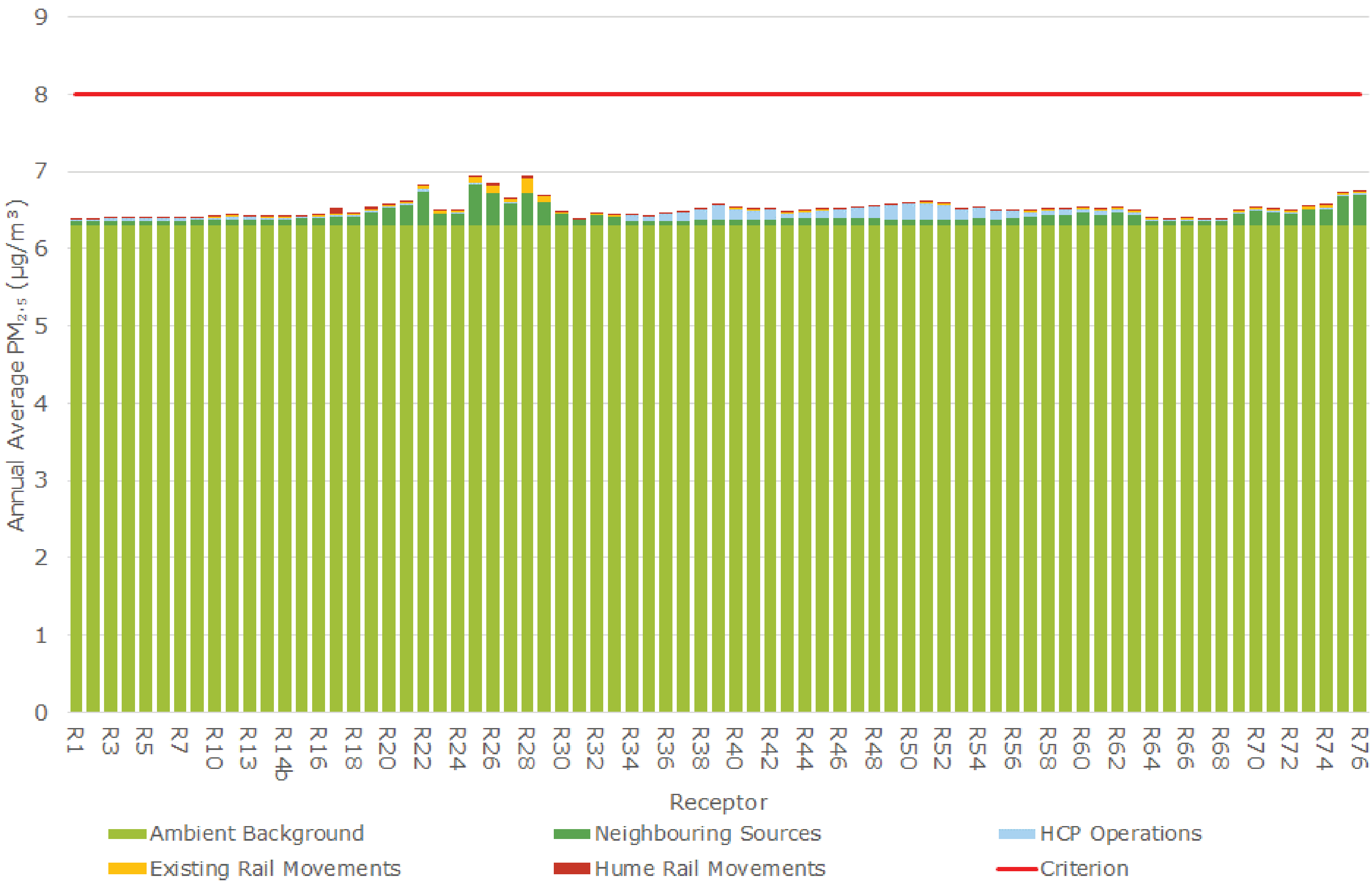


Figure 10-1: Source contribution to predicted cumulative annual average $PM_{2.5}$ concentrations

11. GREENHOUSE GAS ASSESSMENT

The estimation of greenhouse gas (GHG) emissions for the project is based on the Australian Government Department of the Environment (DoE) National Greenhouse Accounts Factors (NGAF) workbook (DoE, 2016). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the National Greenhouse and Energy Reporting Act 2007 (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2016). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

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

11.1 Emission estimates

The following emission factors have been adopted in estimating GHG emissions from the project:

- Diesel consumption; locomotive engines (Scope 1) – Post-2004 Diesel oil factors from Table 4 of the NGAF Workbook (2016)
- Diesel consumption; locomotives engines (Scope 3) – Diesel oil factor from Table 40 of the NGAF Workbook (2016);

Diesel consumption associated with the transport of product coal from the Hume Coal Project to port have been estimated based on the amount of product coal to be transported, a site to port travel distance of 80km and a diesel fuel consumption rate sourced from the NSW EPA[2]. Annual diesel consumption by locomotive engines will fluctuate annually based on the production rate of the Hume Coal Project, however peak annual diesel consumption rate by locomotives is estimated to be approximately 1,357 kL.

By applying this peak diesel consumption rate during the operation of the Hume Coal Project and appropriate GHG emission estimation factors (DoE 2015), maximum annual GHG emissions from the movement of locomotive engines in units of tonnes of carbon dioxide equivalent (CO_2-e), are as follows:

- Scope 1 emissions (diesel combustion) - 3,641 t CO_2-e/year; and
- Scope 3 emissions (diesel combustion) - 633 t CO_2-e/year.

Maximum annual Scope 1 and 3 emissions represent approximately 0.0033% of total GHG emissions for NSW and 0.0008% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

[2] NSW EPA (2012). Technical Report No. 6. Air Emissions Inventory for the Greater Metropolitan Region in New South Wales. 2008 Calendar Year. Off Road Mobile Emissions: Results

12. CONCLUSIONS

A qualitative analysis of the risk to the local environment from proposed construction activities has been undertaken for the activity categories of demolition, earthworks, construction and truck track out to public roads. Uncontrolled earthworks were identified as presenting a medium risk for dust impacts at the closest receptors only. Through the implementation of dust mitigation and construction procedure management practices, the potential impact of the earthworks proposed can be minimised. The risk of potential impacts from all other assessed construction activities was determined to be negligible.

The results of the atmospheric dispersion modelling identified that the air emissions from the upgrading and increased use of the Berrima Branch Line will increase relative to train movements associated with the existing users along the line. However, the predicted project only air quality impacts at all receptors are well below the applicable air quality criteria for both existing and future Berrima Branch Line activities.

A study of the cumulative impacts associated with the combination of emissions from the project, the Hume Coal Project, neighbouring emission sources and existing ambient background concentrations was undertaken. The results of the cumulative air quality impact assessment also demonstrated that no exceedance of air quality criteria will occur at any receptor locations including with all emissions from the Berrima Rail Project.

A greenhouse gas quantification assessment was undertaken for the project. The maximum annual Scope 1 and Scope 3 emissions associated with the combustion of diesel fuel by Hume Coal locomotives represent approximately 0.0033% of total GHG emissions for NSW and 0.0008% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

13. GLOSSARY OF KEY ACRONYMS AND SYMBOLS

Approved Methods for Modelling	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AWS	Automatic Weather Station
BoM	Australian Bureau of Meteorology
CO_2	Carbon dioxide
CO_2-e	CO_2 equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency
DoE	Commonwealth Department of the Environment (now the Department of the Environment and Energy)
EMM	EMM Consulting
EPL	Environment Protection Licence
GHG	Greenhouse Gas
LGA	Local government area
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NGAF	National Greenhouse Accounts Factors
NPI	National Pollutant Inventory
NSW EPA	New South Wales Environment Protection Authority
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
OEH	Office of Environment and Heritage
Ramboll Environ	Ramboll Environ Australia Pty Ltd
SEARs	Secretary's Environmental Assessment Requirements
TAPM	The Air Pollution Model
tpa	Tonnes per annum
TSP	Total Suspended Particulate
US-EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VKT	Vehicle Kilometres Travelled

14. REFERENCES

ACT EPA (2015) Air quality monitoring data from the ACT EPA air quality monitoring network.

ABS (2015). Survey of Motor Vehicle Use, Australia, 12 months ended 31 October 2014. Released 15/10/2015. http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

Boral (2015) Air quality and meteorological monitoring data from the Berrima Cement Works

BoM (2015) Meteorological monitoring data from the BoM Moss Vale AWS

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

DoE (2014). Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia. National Greenhouse and energy Reporting (Measurement) Determination. July 2014. Published by the Australian Government, Department of the Environment.

DoE (2016). National Greenhouse Accounts Factors – Australian National Greenhouse Accounts. August 2016. Published by the Australian Government, Department of the Environment.

Environ (2015) Air Quality Impact Assessment – Widemere Recycling Facility

Hurley, P. (2008) "TAPM V4. Part 1: Technical Description, CSIRO Marine and Atmospheric Research Paper".

Hurley, P., M. Edwards. (2009) "Evaluation of TAPM V4 for Several Meteorological and Air Pollution Datasets." Air Quality and Climate Change 43(3): 19.

NEPC (1998). National Environmental Protection Measure for Ambient Air Quality. National Environmental Protection Council.

NEPC (2003). National Environmental Protection Measure (Ambient Air Quality) Measure, as amended, made under the National Environment Protection Act 1994. National Environmental Protection Council, 7 July 2003.

NEPC (2015). Variation to the National Environment Protection (Ambient Air Quality) Measure. National Environment Protection Act 1994. National Environmental Protection Council, 15 December 2015.

NPI (2007) Emission estimation technique manual for Intensive livestock - beef cattle Version 3.1 May 2007

NPI (2008) Emission estimation technique manual for combustion engines

NPI (2012) Emission estimation technique manual for mining

NSW EPA (2012), Air Emission Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year. Off-Road Mobile Emissions: Results.

NSW EPA (2016), Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

NSW OEH (2015) Air quality monitoring data from the NSW OEH air quality monitoring network

Sweeten, J M, Parnell Jr. C B, Shaw B W, Auvermann B W (1998) PARTICLE SIZE DISTRIBUTION OF CATTLE FEEDLOT DUST EMISSION American Society of Agricultural Engineers 0001-2351 / 98 / 4105-1477.

US-EPA (1998a). AP42 Emission Factor Database, Chapter 11.9 Western Surface Coal Mining, United States Environmental Protection Agency, 1998.

US-EPA (1998b) Locomotive Emission Standards Regulatory Support Document

US EPA (2004a). User's Guide for the AMS/EPA Regulatory Model - AERMOD.

US-EPA (2004b). AP42 Emission Factor Database, Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing, United States Environmental Protection Agency, 2004.

US-EPA (2006a). AP42 Emission Factor Database, Chapter 13.2.2 Unpaved Roads, United States Environmental Protection Agency, November 2006.

US-EPA (2006b). AP42 Emission Factor Database, Chapter 13.2.4 Aggregate Handling and Storage Piles, United States Environmental Protection Agency, 2006.

US EPA (2005). Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. Federal Register Part III Environmental Protection Agency 40 CFR Part 51.

US-EPA (2009) Emission Factors for Locomotives

US-EPA (2011) Documentation for Locomotive Component of the National Emissions Inventory Methodology.

WBCSD (2004). The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition. World Business Council for Sustainable Development & World Resources Institute. March 2004

APPENDIX 1
SEASONAL AND DIURNAL WIND ROSES

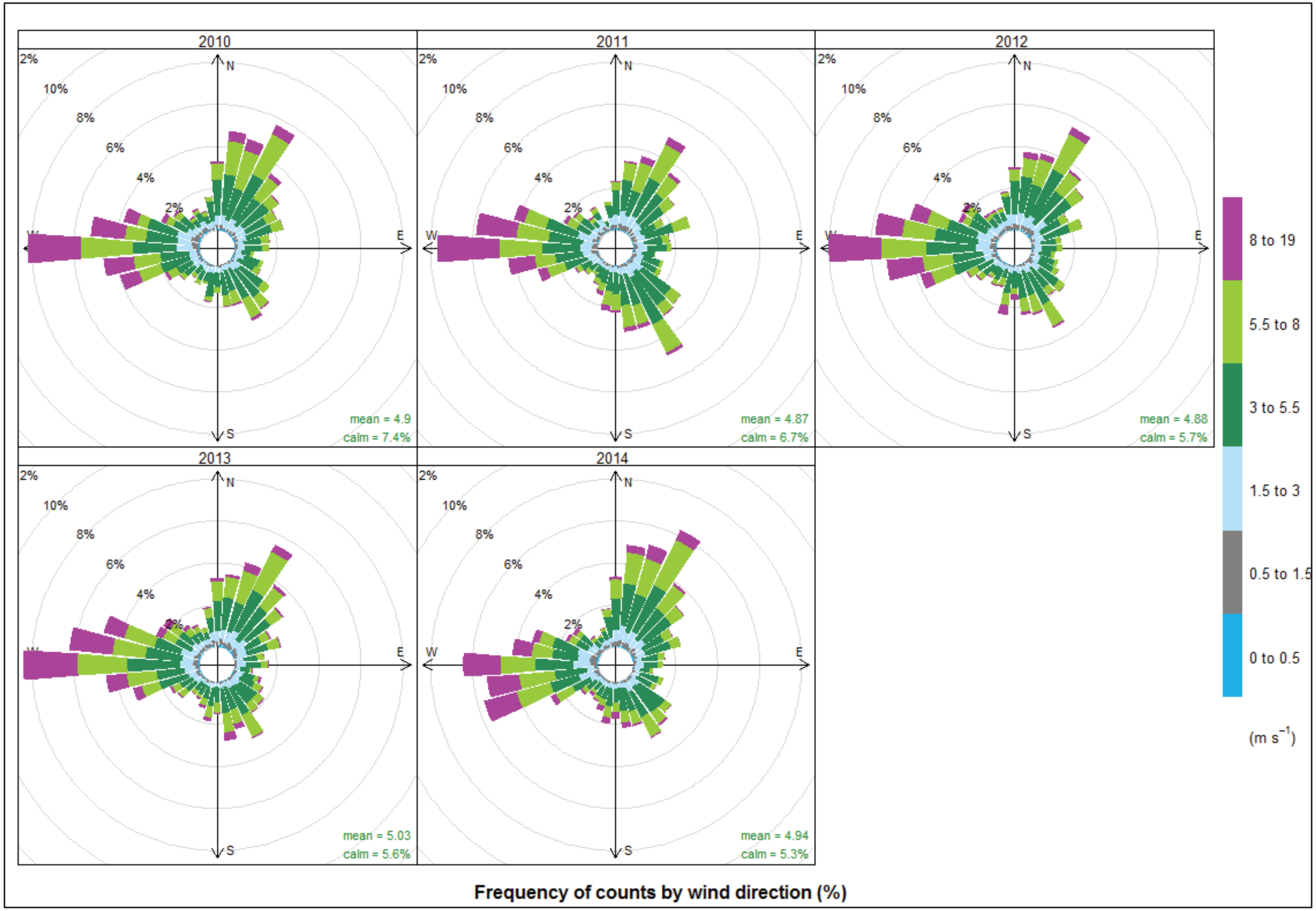


Figure A1-1: Annual wind roses – BoM Moss Vale – 2010 to 2014

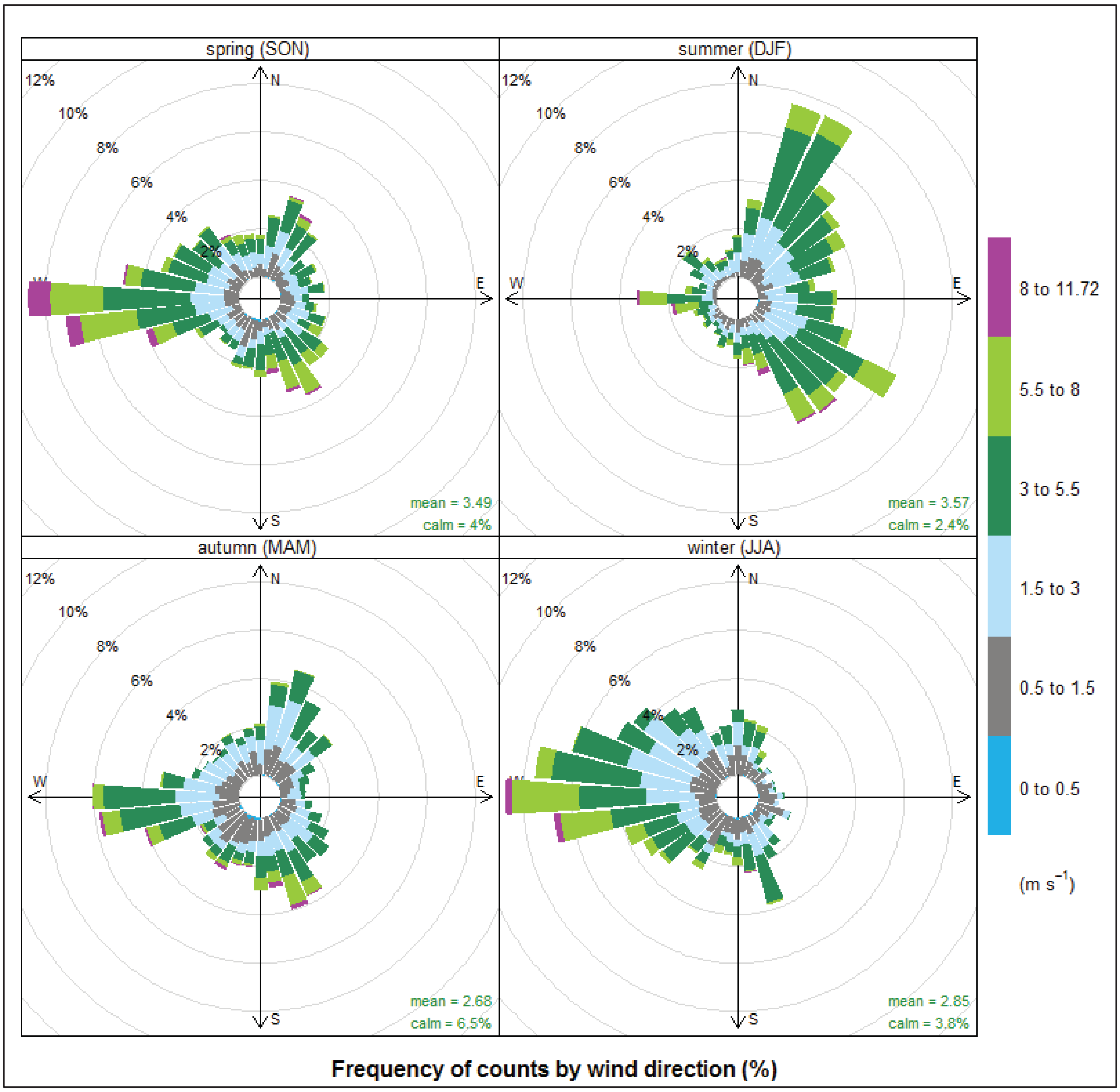


Figure A1-2: Seasonal wind roses – Hume 1 - 2013

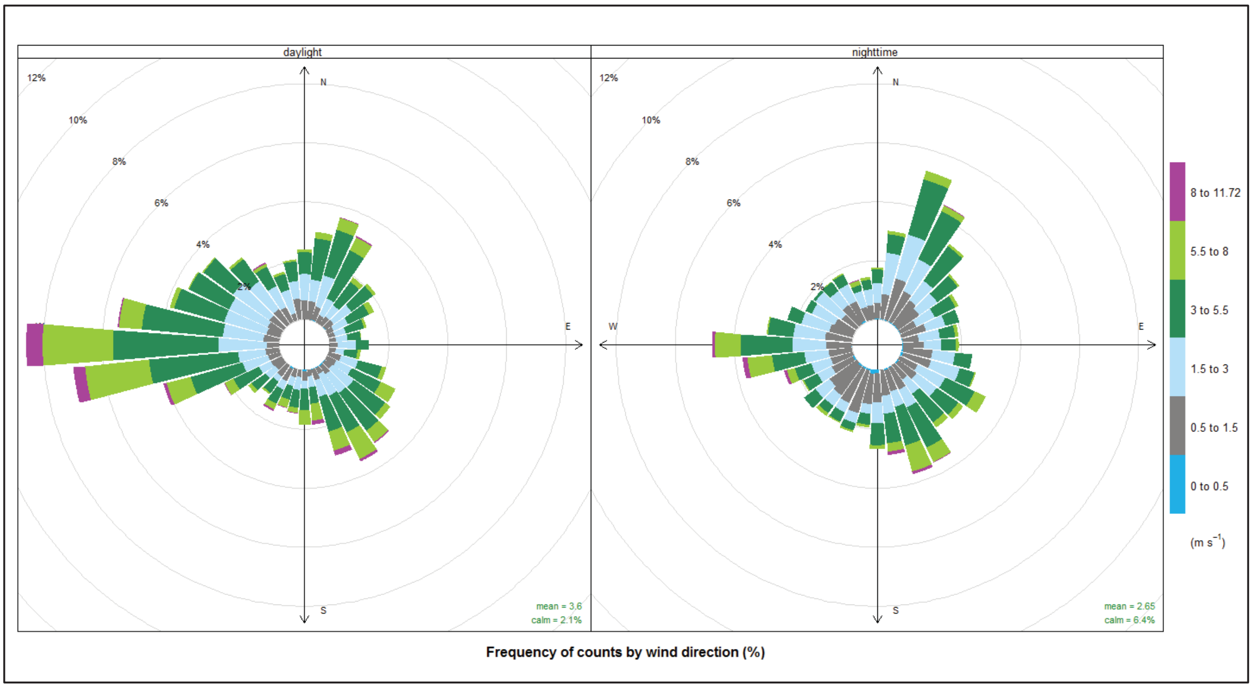


Figure A1-3: Diurnal wind roses – Hume 1 - 2013

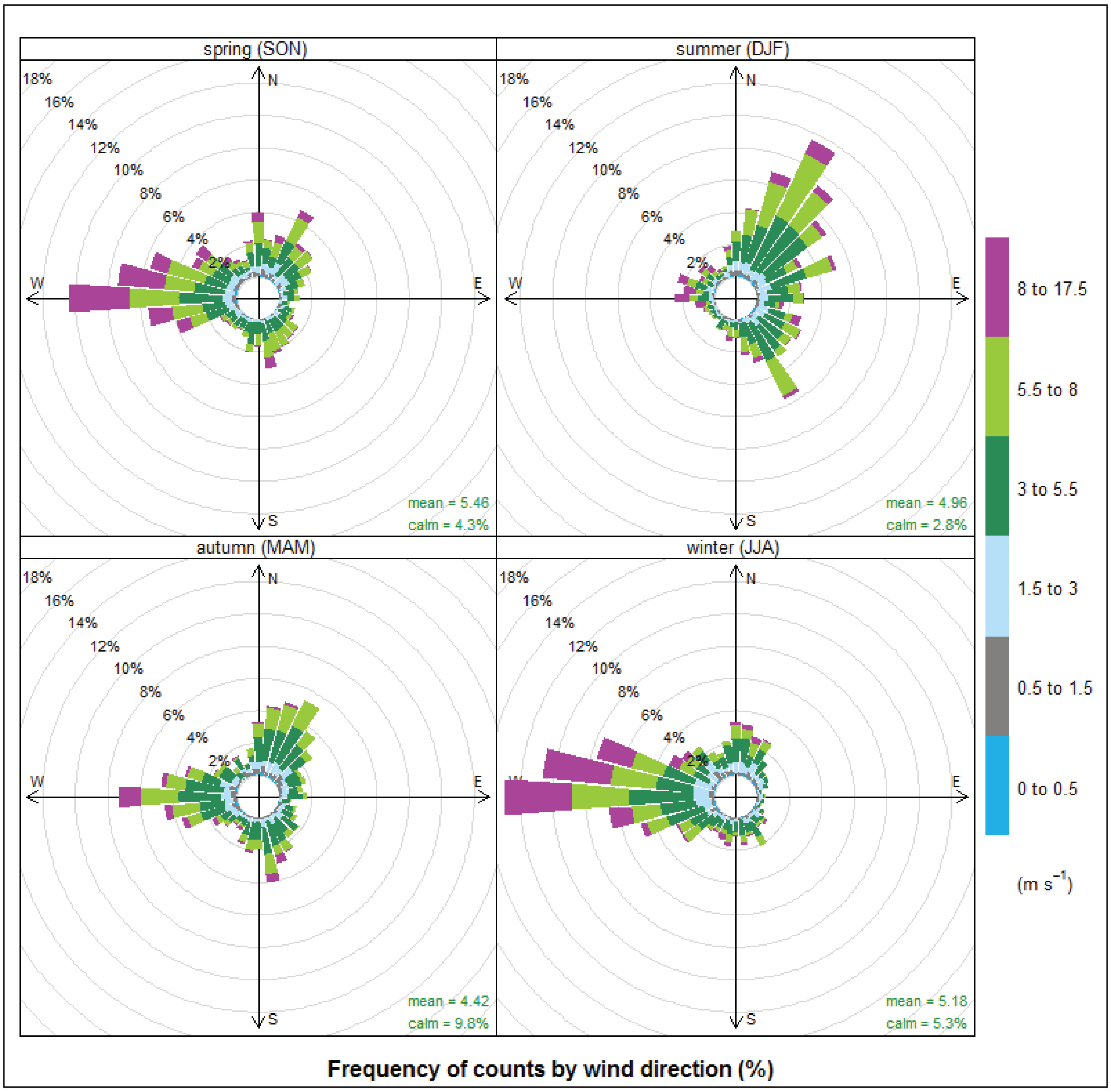


Figure A1-4: Seasonal wind roses – BoM Moss Vale - 2013

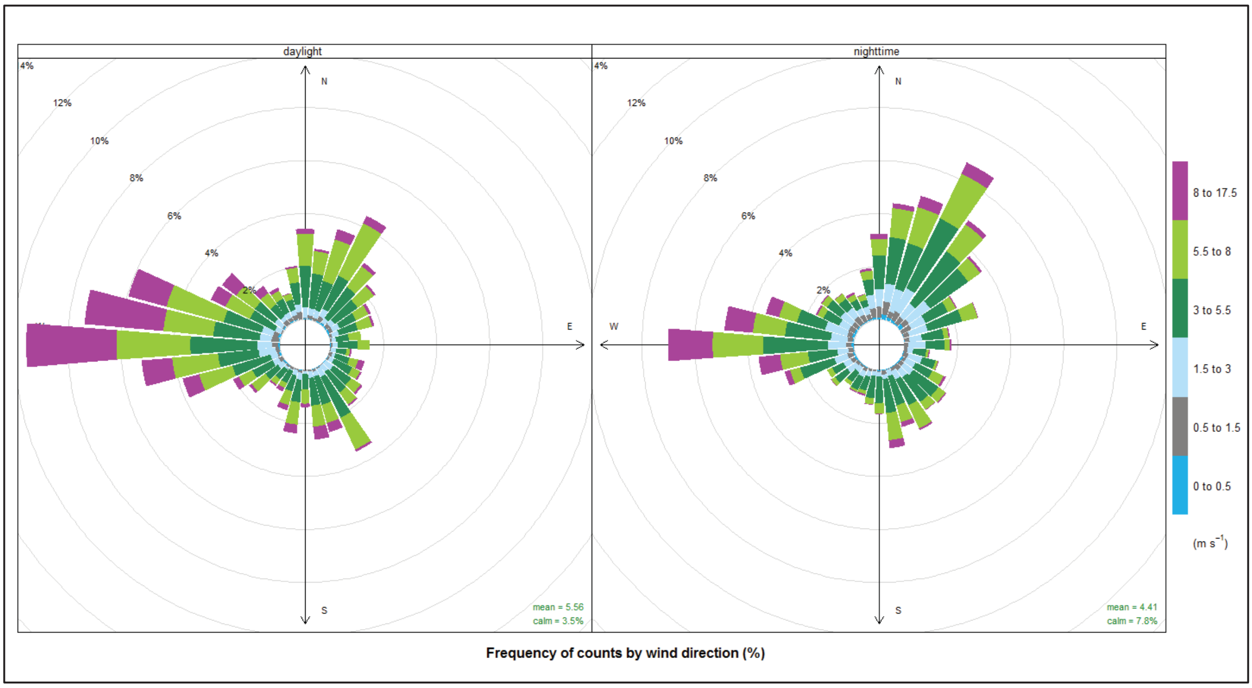


Figure A1-5: Diurnal wind roses – BoM Moss Vale - 2013

APPENDIX 2
NEIGHBOURING EMISSION SOURCE EMISSION CALCULATIONS AND IMPACTS

Emission Calculations

Air pollution emissions from neighbouring industrial operations have been quantified through a combination of publicly available air quality impact assessment reports, NPI annual reporting totals, EPL maximum authorised production rates and emission estimation manuals. The following sections provide a discussion of emission calculations by source.

Hume Coal Project

Emissions calculations from the Hume Coal Project are documented in detail in the air quality impact assessment prepared by Ramboll Environ (2017).

Boral Berrima Cement Works

The primary resource for emission estimation from the Boral Berrima Cement Works facility was the air quality impact assessment *Boral Cement Berrima Works Use of Solid Waste Derived Fuels in Kiln 6 –Air Quality Impact Assessment* (Air Quality Professionals, 2015).

Emission rates presented in Section 4.8 of the Boral Berrima Cement air quality assessment were adopted in this assessment. Fugitive wind-dependant emissions (e.g. wind erosion) were varied by wind speed, with higher emissions from such sources coinciding with higher wind speeds. Emission source parameters presented in Section 5 of the Boral Berrima Cement air quality assessment were adopted in the modelling conducted for this assessment.

New Berrima Shale Quarry

The primary resource for emission estimation from the approved New Berrima Shale Quarry was the air quality impact assessment *Modified New Berrima Clay/Shale Quarry Appendix 5 Air Quality Impact Assessment* (SLR, 2015).

Annual emission rates presented in Section 2.1 of the New Berrima Shale Quarry air quality assessment were adopted in this assessment. Fugitive wind-dependant emissions (e.g. wind erosion) were varied by wind speed, with higher emissions from such sources coinciding with higher wind speeds. In the absence of source location details, emission sources were configured across the proposed site extraction and site access road areas.

Dux Manufacturing, Moss Vale

The primary resource for emission estimation from the Dux Manufacturing facility at Moss Vale was the NPI annual reporting totals of PM_{10}, $PM_{2.5}$, and NO_x for 2013/2014, as archived on the NPI website database. Emissions were released on a continuous basis in the absence of facility-specific operating details.

To estimate TSP, annual emissions of PM_{10} were up scaled by a factor of two.

Volume emission sources were configured across the Dux Manufacturing site in the absence of site emission parameters.

Ingham's Berrima Feed Mill

The primary resource for emission estimation from Ingham's Berrima Feed Mill facility was the NPI annual reporting totals of PM_{10}, $PM_{2.5}$, and NO_x for 2013/2014, as archived on the NPI website database. Emissions were released on a continuous basis in the absence of facility-specific operating details.

To estimate TSP, annual emissions of PM_{10} were up scaled by a factor of two.

Volume emission sources were configured across Ingham's Berrima Feed Mill site in the absence of site emission parameters.

Omya Southern Limestone, Moss Vale

There was no publicly available air quality impact assessment or NPI reporting totals for the Omya Southern Limestone facility. The EPL for the facility identifies that operation is approved to process up to 500,000tpa of limestone material.

Using US-EPA AP-42 equations and emission factors and a peak processing throughput of 500,000tpa, annual emissions of TSP, PM_{10} and $PM_{2.5}$ were estimated for the Omya Southern Limestone facility. Emission calculations are presented in **Table A2.1**.

<u>Southern Regional Livestock Exchange</u>

There was no publicly available air quality impact assessment or NPI reporting totals for the Southern Regional Livestock Exchange at Moss Vale. The EPL for the facility identifies that operation is approved to accommodate 25,000 head of cattle.

The NPI *Emission Estimation Manual for Intensive livestock - beef cattle* (NPI, 2007) provides a PM_{10} emission estimation factor of 11.7t PM_{10}/1,000 standard cattle unit (SCU). A scaling factor of 0.15 was applied to the PM_{10} emission factor to derive a $PM_{2.5}$ emission factor (1.8t/1,000 SCU). Sweeton et al (1998) identify that 66% of TSP is in the form of PM_{10}, which was used to derive a TSP emission factor (17.7t/1,000 SCU).

Control factors of 50% for water application and 70% for wind breaks due to the facility shed structure, were applied. Using the NPI emission factor/derived emission factors and 25,000 cattle per year, the following annual emissions were calculated

- 66,477.3kg TSP;
- 43,875.0kg PM_{10}; and
- 6,581.3kg $PM_{2.5}$.

Volume emission sources were configured across the Southern Regional Livestock Exchange site in the absence of site emissions parameters.

<u>Wingecarribee Resource Recovery Centre, Moss Vale</u>

There was no publicly available air quality impact assessment or NPI reporting totals for the Wingecarribee Resource Recovery Centre at Moss Vale. The EPL for the facility identifies that operation is approved to compost up to 50,000 t of organics received, however this threshold is not appropriate to calculate annual emissions from all practices onsite.

In order to estimate potential annual emissions from this facility, a recent air quality impact assessment for an existing recycling facility in western Sydney undertaken by Ramboll Environ (*Widemere Recycling Facility - Air Quality Impact Assessment* - Environ 2015) has been referenced.

Based on the approximate land area of the Wingecarribee Resource Recovery Centre (6.2ha) and the Widemere facility (10ha), the annual particulate matter emissions for the Widemere facility have been scaled by 0.62. Annual emissions for the Wingecarribee Resource Recovery Centre are therefore derived as:

- 21,708.1kg TSP;
- 5,175.3kg PM_{10}; and
- 668.0kg $PM_{2.5}$.

Volume emission sources were configured across the Wingecarribee Resource Recovery Centre site.

Table A2-1 Emission Calculations and Assumptions – Omya Southern Limestone

Emissions Source	Number of Sources	Factor Source	Emission Factor			Unit	Emission Control	Reduction Factor	Annual Emission (kg/annum)		
			TSP	PM_{10}	$PM_{2.5}$				TSP	PM_{10}	$PM_{2.5}$
Unloading trains	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Stockpile Loading	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Watering	0.5	375.0	137.5	38.9
Crushing	4	AP-42 11.19.2 - Tertiary Crushing	0.0027	0.0012	0.000222	kg/t	Enclosed	0.7	405.0	180.0	33.3
Screening	4	AP-42 11.19.2 - Screening	0.0125	0.0043	0.000291	kg/t	Enclosed	0.7	1,875.0	645.0	43.6
Conveying transfer	6	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Truck Loading	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Material Handling Yard	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Watering	0.5	375.0	137.5	38.9
Unpaved Roads	1	AP-42 13.2.2 - Unpaved Roads equation	3.3808	0.9318	0.0932	kg/VKT	Watering	0.75	7,043.4	1,941.3	194.1
Paved Roads	1	AP-42 13.2.1 - Paved Roads equation	0.0613	0.0118	0.0028	kg/VKT			510.7	98.0	23.7
Wind Erosion	1	AP-42 11.9 - Wind erosion from exposed surfaces	850	425	63.75	kg/ha/year	Watering	0.5	382.5	191.3	28.7
								Total	**11,641.6**	**3,578.1**	**471.1**

Other assumptions: Paved and Unpaved road length – 500m return journey; Load in truck – 30t; Average truck weight – 45t – Unpaved road silt content – 7.1% (US-EPA default for sand and gravel processing); Paved road silt loading – 0.6g/m^2 (US-EPA default).