# 11 Noise and vibration

## 11.1 Introduction

A noise and vibration assessment (NVA) of the project was conducted to assess the predicted noise and vibration impacts of both construction and operation of the project. The NVA also describes the initiatives built into the project design to avoid and minimise impacts, and identify the additional mitigation and management measures to be implemented to address residual impacts.

As described in Chapter 2, leading practice measures have been incorporated into the design of the project, including measures specifically related to avoiding, minimising and/or mitigating potential noise and vibration impacts including:

- latest generation rail locomotives and wagons will be used by Hume Coal, which have isolated engine and operator cab mountings to reduce vibration and noise transmission (refer to the Berrima Rail Project, Appendix D);
- low noise idlers on all conveyors;
- low frequency noise mitigation to the CPP, including variable voltage, variable frequency (VVVF) drives, concrete platforms for screens, increased steelwork and cladding system; and
- automated coal handling using stackers and reclaimers to minimise the reliance on mobile plant and equipment such as dozers.

The operational noise assessment identified that during adverse weather conditions and with all feasible and reasonable mitigation applied, of the 75 residential dwellings investigated within the area modelled, nine are predicted to experience residual noise levels between 3 to 5 dB above the project specific noise levels (PSNL) and are therefore entitled to voluntary mitigation upon request. Two assessment locations are predicted to experience residual noise levels greater than 5 dB above PSNLs and are therefore entitled to voluntary acquisition upon request. During construction, noise levels above relevant noise management levels (NML) are predicted to the north-west of the project area, mostly ranging from 1 dB to 3 dB above NMLs. The highly affected NML of 75 dB is not exceeded at any assessment location.

This chapter summarises the NVA, with the full technical report attached in Appendix I. The potential health impacts of the predicted noise emissions from the project were also investigated by Dr David McKenzie. The key findings of this assessment are also summarised in this chapter (refer to Section 11.4.10) and the full technical report is provided in Appendix J.

### 11.1.1 Assessment requirements and guidelines

The SEARs require an assessment of the likely noise and vibration impacts of the project. The specific requirements relating to noise and vibration are presented in Table 11.1.

### Table 11.1 Noise and vibration-related SEARs

| Requirement | Section addressed |
|---|---|
| An assessment of the likely operational noise impacts of the development (including construction noise) under the NSW Industrial Noise Policy, paying particular attention to the obligations in chapters 8 and 9 of the policy, and the Voluntary Land Acquisition and Mitigation Policy (DP&E). | Section 11.4.2 |
| If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the Interim Construction Noise Guideline. | Section 11.4.6i and 11.4.7 |
| An assessment of the likely road noise impacts of the development under the NSW Road Noise Policy. | Section 11.4.6 |

The RMS also raised matters relevant to the assessment of the noise and vibration impacts in their environmental assessment recommendations. These matters are listed in Table 11.2 and were taken into account in preparing the noise and vibration assessment, as indicated in the table.

### Table 11.2 RMS requirements relating to noise and vibration

| Requirement | Section addressed |
|---|---|
| The impacts of noise and vibration of the mine, including: | |
| – undermining or de-stabilisation of the Hume Highway through coal extraction operations or otherwise; and | Refer Chapter 14 (subsidence) |
| – vibration impacts on the Hume Highway through mine construction and operation. | Section 11.4.8 |

The NVA was prepared to address the SEARs listed in Table 11.1 and the requirements in Table 11.2 and was prepared following the appropriate guidelines, policies and industry requirements as follows:

- *NSW Industrial Noise Policy* (INP) (EPA 2000);
- *NSW draft Industrial Noise Guideline* (ING) (EPA 2015);
- *NSW Rail Infrastructure Noise Guideline* (RING) (EPA 2013);
- NSW *Road Noise Policy* (RNP) (DECCW 2011b);
- *The Interim Construction Noise Guideline* (ICNG) (EPA 2009);
- *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) (DPE);
- *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (Australian and New Zealand Environment Council 1990*); and*
- *Assessing Vibration: a technical guideline* (DEC 2006).

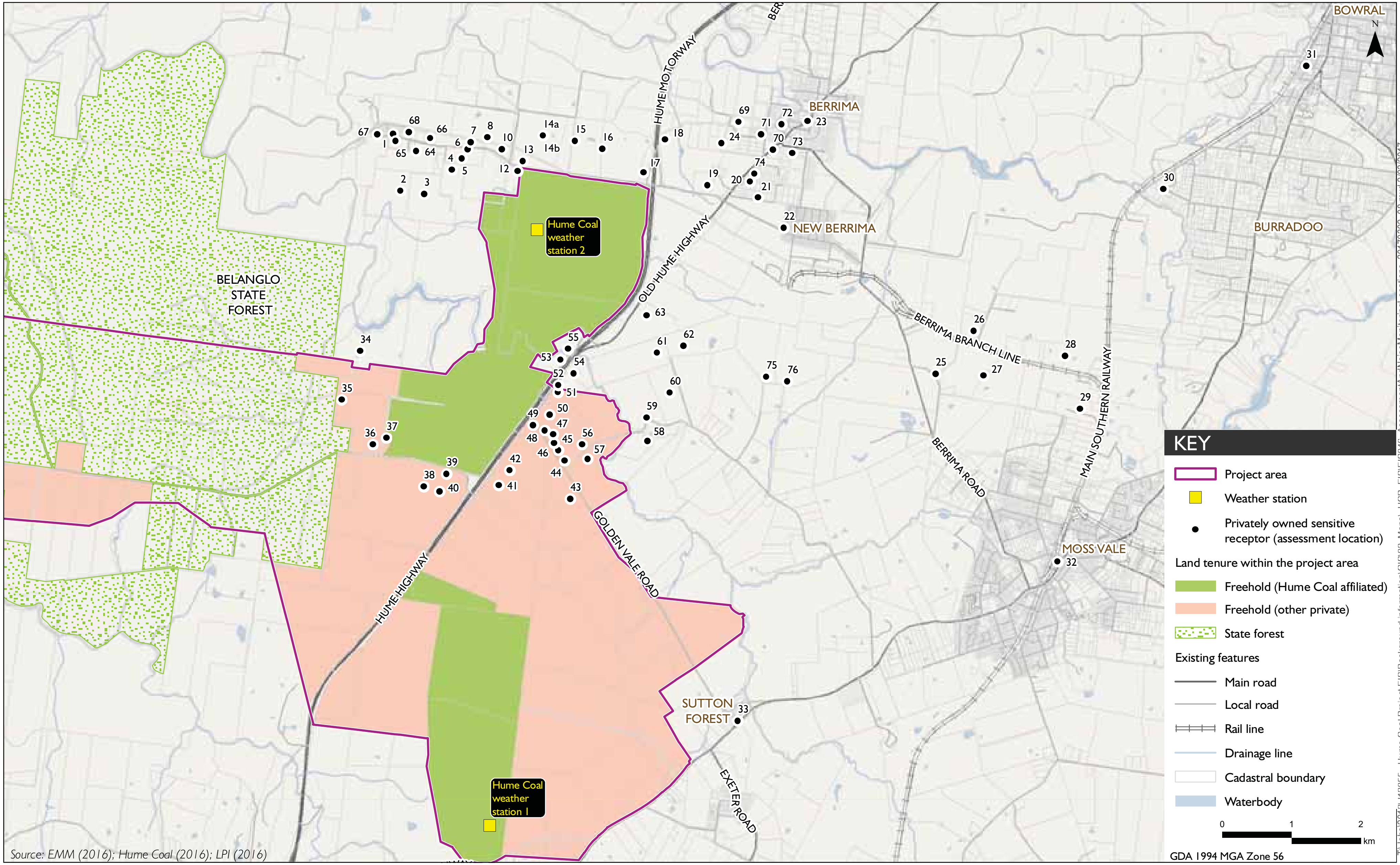
## 11.2 Existing environment

### 11.2.1 Properties surrounding the project

As described in detail in Chapter 5, the project is set in an area of mixed character including; grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns, and some extractive and other industries. Nearby industrial and manufacturing sites include the Berrima Cement Works and Berrima Feed mill on the outskirts of New Berrima. The Hume Highway and Golden Vale Road traverse the project area, whilst the Illawarra Highway borders the south-eastern project area boundary.

The NVA considered 74 potentially noise sensitive locations (ie residential properties) or 75 dwellings (location 14 was identified as having two dwellings on the property) surrounding the project area, and in particular around the proposed surface infrastructure site. They are referred to as assessment locations and are shown in Figure 11.1, with details listed in Appendix A of the NVA (refer to Appendix I).

The assessment locations were identified using land ownership registrations, aerial photography, and verification in the field where locations were publically accessible, and are considered representative of all residential locations and catchments in and surrounding the project area.




Source: EMM (2016); Hume Coal (2016); LPI (2016)

**Representative sensitive receptor locations**

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Figure 11.1

EMM HUMECOAL

### 11.2.2 Background noise monitoring

Background noise has been monitored quarterly since 2011 in and around the project area so as to establish representative ambient noise levels. The location of noise monitoring equipment was selected in consideration of extraneous noise sources atypical of the overall ambient noise environment, the proximity of sensitive receptors, security issues for the noise monitoring devices and gaining permission for access from the residents or landowners. The locations were revisited throughout the mine design process to ensure the representative baseline acoustic environment at all assessment locations surrounding the surface infrastructure site was established.

Unattended and attended noise monitoring was conducted. Noise loggers were installed for unattended monitoring in general accordance with the procedures described in Australian Standard AS 1055-1997 *Acoustics - Description and Measurement of Environmental Noise*, with monitoring undertaken by Pacific Environment Limited (PEL). Operator attended 15-minute measurements were also conducted at the unattended noise monitoring locations for each round of monitoring to qualify and quantify the existing noise sources contributing to the ambient noise environment. The relevant background noise monitoring locations (BG1 to BG12) are shown in Figure 11.2.

Natural noise sources, such as birds and insects and rustling vegetation, dominated background noise levels at all monitoring locations with the exception of the three locations adjacent to the Hume Highway (BG 8, 11 and 12), where highway traffic noise is dominant. Distant traffic noise from the Hume Highway is generally audible at the other monitoring locations at times, as is local traffic on local and arterial roads. General domestic and community noise is audible on occasion, depending on locations. The Berrima Cement Works is audible and dominant at times at BG5 and BG6, depending on wind direction and operations.

Weather data for the survey period was obtained from the Hume Coal meteorology monitoring station (Hume No. 1) shown in Figure 11.1. Hume Coal operates two meteorology stations; however the southern most of the two stations was used as this provided at least 12 months of data at the time the study was completed. The wind speed and the rainfall data from this station was used to exclude noise data during periods of rainfall and/or wind speed more than 5 m/s in accordance with INP methods.

A summary of existing background and ambient noise levels is provided in Table 11.3 for day, evening and night. Where more than one season of monitoring data is available the range in recorded noise levels has been provided, along with the adopted rating background level (RBL). The minimum RBL recorded over all quarterly monitoring periods since 2011 has been adopted as the final RBL for each location. Where the final RBL is less than 30 dB, the INP background noise level threshold of 30 dB has been adopted.

**Table 11.3 Summary of existing background and ambient noise levels, dB(A)**

| Monitoring location ID (Figure 11.2) | Period | Measured background noise level, RBL, dB[1] | Final background noise level, RBL, dB[2] | Measured existing $L_{Aeq}$ ambient noise level, dB[1,3] | Estimated existing $L_{Aeq}$ industrial noise contribution, dB |
|---|---|---|---|---|---|
| BG1 | Day | 26 - 34 | 30 | 43 - 57 | None observed |
| | Evening | 23 - 34 | 30 | 40 - 52 | None observed |
| | Night | 23 - 33 | 30 | 43 - 49 | None observed |
| BG2 | Day | 32 | 32 | 44 | None observed |
| | Evening | 36 | 32 | 44 | None observed |
| | Night | 33 | 32 | 41 | None observed |
| BG3 | Day | 35 - 39 | 35 | 46 - 68 | None observed |
| | Evening | 38 - 41 | 35 | 46 - 51 | None observed |
| | Night | 34 - 36 | 34 | 42 - 48 | None observed |

**Table 11.3 Summary of existing background and ambient noise levels, dB(A)**

| Monitoring location ID (Figure 11.2) | Period | Measured background noise level, RBL, dB[1] | Final background noise level, RBL, dB[2] | Measured existing $L_{Aeq}$ ambient noise level, dB[1,3] | Estimated existing $L_{Aeq}$ industrial noise contribution, dB |
|---|---|---|---|---|---|
| BG4 | Day | 29 - 45 | 30 | 46 - 51 | None observed |
| | Evening | 28 - 47 | 30 | 44 - 51 | None observed |
| | Night | 28 - 42 | 30 | 41 - 50 | None observed |
| BG5 | Day | 35 - 40 | 35 | 47 - 50 | 45[4] |
| | Evening | 34 - 41 | 34 | 45 - 60 | 45[4] |
| | Night | 31 - 44 | 31 | 40 - 48 | 45[4] |
| BG6 | Day | 46 | 46 | 56 | 39[4] |
| | Evening | 51 | 46 | 60 | 39[4] |
| | Night | 45 | 45 | 54 | 39[4] |
| BG7 | Day | 35 | 35 | 45 | 39[4] |
| | Evening | 39 - 40 | 35 | 49 - 50 | 39[4] |
| | Night | 38 | 35 | 46 | 39[4] |
| BG8 | Day | 45 - 48 | 45 | 53 - 56 | None observed |
| | Evening | 46 - 48 | 45 | 54 - 61 | None observed |
| | Night | 39 - 44 | 39 | 52 - 54 | None observed |
| BG9 | Day | 28 | 30 | 42 | None observed |
| | Evening | 32 | 30 | 40 | None observed |
| | Night | 29 | 30 | 42 | None observed |
| BG10 | Day | 32 - 42 | 32 | 44 - 62 | None observed |
| | Evening | 29 - 41 | 30 | 39 - 53 | None observed |
| | Night | 26 - 35 | 30 | 40 - 47 | None observed |
| BG11 | Day | 45 | 45 | 60 | None observed |
| | Evening | 48 | 45 | 60 | None observed |
| | Night | 38 | 38 | 58 | None observed |
| BG12 | Day | 41 - 50 | 41 | 55 - 61 | None observed |
| | Evening | 44 - 52 | 41 | 55 - 62 | None observed |
| | Night | 35 - 39 | 35 | 54 - 59 | None observed |

*Notes:* *1. A range in noise levels has been provided where more than one season of valid noise monitoring data as defined in the INP is available.*

*2. This is based on the noise level exceeded 90% of the time and representative of the underlying background noise level .The INP minimum background noise threshold of 30 dBA day, evening and night, has been adopted where applicable. In accordance with the INP Application Notes, the day RBL is adopted where the evening RBL is measured to be higher than day, evening RBL is adopted where the night RBL is measured to be higher than evening.*

*3. The energy averaged noise level over the measurement period which is representative of general ambient noise.*

*4. The existing energy averaged industrial noise level contribution from Berrima Cement Works as noted in attended noise surveys conducted by PEL.*

### 11.2.3 Noise catchment areas

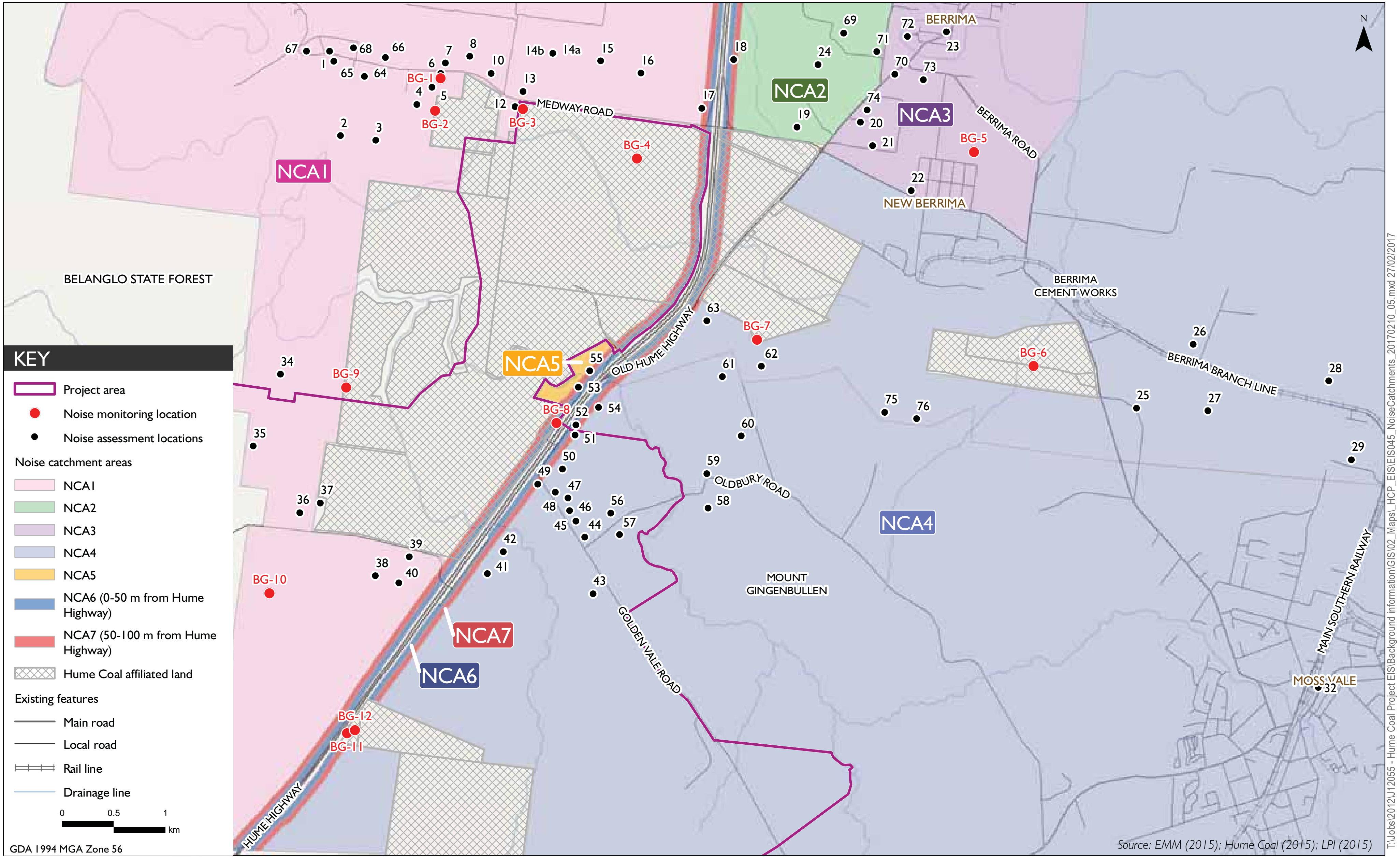
The area surrounding the Hume Coal Project is diverse in terms of existing background noise levels and the noise sources which make up the overall ambient acoustic environment. For example, the Hume Highway is a significant noise contributor at properties positioned nearby with its contribution reducing as distance increases. The presence of Berrima Cement Works also provides an existing level of industrial noise for properties in and around New Berrima and at some scattered rural properties to the south. Otherwise properties situated away from these two noise sources generally experience noise levels typical of a rural environment.

Seven noise catchment areas (NCAs) were defined to capture differences in the acoustic environment; each containing privately owned land and properties with similar acoustic environments, as illustrated in Figure 11.2. Specific industrial noise criteria for each NCA were set using background noise monitoring data most applicable to the area. Where multiple unattended noise monitoring locations are within one catchment, the one with the lowest RBLs was used for all properties. Table 11.4 lists the background noise levels for each catchment.

**Table 11.4 Noise catchment areas – adopted RBLs and estimated existing industrial noise levels**

| Noise catchment area (adopted noise logger results) | NCA description | Period | Adopted background noise level, RBL, dB[1] | Estimated existing $L_{Aeq}$ industrial noise contribution, dB |
|---|---|---|---|---|
| NCA1, NCA2, NCA5 (BG1 and BG4) | Generally rural in nature | Day | 30 | Nil |
| | | Evening | 30 | Nil |
| | | Night | 30 | Nil |
| NCA3 (BG5) | Town of New Berrima | Day | 35 | 45 |
| | | Evening | 34 | 45 |
| | | Night | 31 | 45 |
| NCA4 (INP minimum) | Generally rural in nature | Day | 30 | 39 |
| | | Evening | 30 | 39 |
| | | Night | 30 | 39 |
| NCA6 (BG11) | All privately owned land within a 50m offset from the Hume Highway | Day | 45 | Nil |
| | | Evening | 45 | Nil |
| | | Night | 38 | Nil |
| NCA7 (BG12) | All privately owned land between a 50m and 100m offset from the Hume Highway | Day | 41 | Nil |
| | | Evening | 41 | Nil |
| | | Night | 35 | Nil |

*Notes: 1. As required by the INP, the day RBL is adopted where evening is higher, evening RBL adopted where night is higher.*




## Noise catchment areas and noise monitoring locations

Hume Coal Project
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Figure 11.2

### 11.2.4 Meteorology

Site specific weather data was obtained from the Hume Coal Project's weather stations Hume No. 1 and Hume No. 2 as displayed in Figure 11.1. Hume No. 1 was installed in March 2012 and data from 2013, 2014 and 2015 calendar years where full annual datasets were available was used in the analysis of prevailing weather conditions. Hume No. 2 was installed in October 2015 shortly after the surface infrastructure location layout was confirmed. One year of weather data from Hume No. 2 (October 2015 to October 2016) was also used to support the assessment of noise enhancing prevailing weather conditions.

#### i Winds

During certain wind conditions, noise levels at sensitive receptors may increase or decrease compared with noise during calm conditions. This is due to refraction caused by the varying speed of sound with increasing height above the ground. The received noise level increases when the wind blows from the source to the assessment location, and conversely, decreases when the wind blows from the assessment location to the source. As per the INP, winds of up to 3 m/s must be considered in noise predictions when they occur for more than 30% of the time during day, evening or night. Winds were analysed to determine the percentage occurrence, as shown in Table 11.5, with the wind directions triggering the 30% INP threshold identified by shading.

**Table 11.5 Percentage occurrence of wind speeds between 0.5 to 3 m/s (vector at 22.5$^{o}$ intervals)**

| Direction | Day | | | | Evening | | | | Night | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wint | Aut | Spring | Sum | Wint | Aut | Spring | Sum | Wint | Aut | Spring | Sum |
| NNE | 17.1 | 21 | 12.6 | 13.2 | 21.5 | 26.7 | 22.6 | 21.7 | 18.2 | 21.8 | 19.2 | 29.1 |
| NE | 13.5 | 20 | 11.5 | 13.6 | 17.5 | 27.7 | 20.9 | 25.3 | 14.4 | 20.1 | 17.7 | **34.5** |
| ENE | 9 | 17.3 | 9.6 | 12.4 | 13 | 28.1 | 19.5 | 27 | 9.4 | 17 | 14.4 | **36.8** |
| E | 9.3 | 14.2 | 8.5 | 10.9 | 12.8 | 27.6 | 19 | 26.9 | 9.8 | 13.7 | 12.7 | **33.9** |
| ESE | 12.8 | 13 | 8.1 | 9.6 | 14.8 | 25.8 | 17.3 | 24.1 | 13.7 | 13 | 12.1 | 29.5 |
| SE | 13.2 | 12.7 | 7.8 | 8.5 | 16.5 | 22.1 | 16.1 | 20.3 | 15.9 | 14.6 | 14.7 | 26 |
| SSE | 11.8 | 12.6 | 7.7 | 7.3 | 16 | 21.4 | 15.8 | 15.9 | 17.3 | 17.6 | 17.4 | 24.9 |
| S | 15 | 14.6 | 8.7 | 6.5 | 20.2 | 21.9 | 15.3 | 13.8 | 22.8 | 24.3 | 20.7 | 22.6 |
| SSW | 18 | 16.5 | 9.6 | 5.4 | 25 | 23 | 14.9 | 9.8 | 28.7 | 28.4 | 23.7 | 16.3 |
| SW | 21 | 16.9 | 10.4 | 5.4 | 27.4 | 20.2 | 14.6 | 8.3 | **30.8** | 28.2 | 23.4 | 12.4 |
| WSW | 23.1 | 16.6 | 11.9 | 6.2 | 29.7 | 18.7 | 15.7 | 7.1 | **31.9** | 25.8 | 22.2 | 8.7 |
| W | 23.1 | 18.2 | 13.7 | 7.6 | 29.9 | 18.8 | 17.6 | 6.9 | **30.5** | 24.1 | 22.8 | 7.9 |
| WNW | 26.4 | 22.4 | 15.1 | 9.2 | **31.1** | 20 | 18.8 | 7.1 | **31.5** | 24.5 | 22.8 | 10.2 |
| NW | 26.5 | 24.3 | 15.2 | 10.6 | **30.2** | 23.9 | 20.2 | 9 | 29.7 | 26 | 22.5 | 16 |
| NNW | 23.6 | 23 | 14.4 | 11.3 | 27.5 | 24.3 | 21 | 12.9 | 26 | 23.8 | 21.1 | 21.7 |
| N | 20.4 | 21.9 | 13.4 | 12.4 | 24.8 | 25.4 | 22 | 17.4 | 21.6 | 22.9 | 20.5 | 25.2 |

*Notes: 1. Based on 2013 calendar year from the Hume Coal weather station indicated on Figure 11.1.*

#### ii Temperature inversions

Temperature inversions (ie where atmospheric temperature increases with altitude) typically occur over cooler times of the year during the night-time periods and can focus mine noise levels at surrounding assessment locations. In accordance with the INP, temperature inversions are to be assessed when they occur for 30% of the time (approximately two nights a week) or greater during the winter months.

Table 11.6 summarises atmospheric stability class occurrence (or a measure of temperature gradients). As evident in this table, 'F' stability class are a feature of the project area as they occur for more than 30% of the time during all seasons, and were therefore considered in the noise assessment.

**Table 11.6 Percentage occurrence of stability class**

| Stability class | Percentage occurrence (night period) | | | | |
|---|---|---|---|---|---|
| | Annual | Summer | Autumn | Winter | Spring |
| A | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| D | 36.0% | 44.5% | 32.3% | 27.4% | 40.0% |
| E | 16.6% | 17.8% | 15.1% | 17.3% | 16.4% |
| F | 40.6% | 30.8% | 45.5% | 47.7% | 38.0% |
| G | 6.8% | 6.9% | 7.1% | 7.6% | 5.6% |
| F+G | 47.4% | 37.7% | 52.6% | 55.4% | 43.6% |

*Notes: The results indicate that F class temperature inversions are a feature of the area as they occur for more than 30% of the time during the winter and therefore have been considered in the assessment.*

## 11.3 Noise criteria

### 11.3.1 Construction noise

The ICNG provides two methods to assess construction noise emissions; qualitative and quantitative. The quantitative method is suited to major construction projects that typically last more than three weeks, and as such was used in the assessment of potential noise impacts during the construction phase of the project.

Table 11.7 provides the NML for residential assessment locations.

**Table 11.7 Construction noise management levels for residential land uses**

| Time of day | Management level $L_{eq(15\text{-min})}$ | Application |
|---|---|---|
| Recommended standard hours:<br>• Monday to Friday 7.00 am to 6.00 pm;<br>• Saturday 8.00 am to 1.00 pm; and<br>• No construction work on Sundays or public holidays. | Noise-affected RBL + 10 dB | The noise-affected level represents the point above which there may be some community reaction to noise.<br>• Where the predicted or measured $L_{eq(15\text{-min})}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>• The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details. |
| | Highly noise affected 75 dB(A) | The highly noise-affected level represents the point above which there may be strong community reaction to noise.<br>• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:<br>i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences);<br>ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. |

### Table 11.7 Construction noise management levels for residential land uses

| Time of day | Management level $L_{eq(15\text{-}min)}$ | Application |
|---|---|---|
| Outside recommended standard hours | Noise-affected RBL + 5 dB | • A strong justification would typically be required for works outside the recommended standard hours.<br>• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>• Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise-affected level, the proponent should negotiate with the community.<br>• For guidance on negotiating agreements see Section 7.2.2 of the ICNG. |

*Source: ICNG (EPA, 2009).*

Table 11.8 lists the construction NML for recommended standard and out-of-hour periods as applicable to residences.

### Table 11.8 Construction noise management levels

| NCA | Period | Adopted RBL[1] | NML $L_{Aeq,15min}$, dB |
|---|---|---|---|
| NCA1, NCA2, NCA4, NCA5, | Day (standard ICNG hours) | 30 | 40 |
| | Evening (out of hours) | 30 | 35 |
| | Night (out of hours) | 30 | 35 |
| NCA3 | Day (standard ICNG hours) | 35 | 45 |
| | Evening (out of hours) | 34 | 39 |
| | Night (out of hours) | 31 | 36 |
| NCA6 | Day (standard ICNG hours) | 45 | 55 |
| | Evening (out of hours) | 45 | 50 |
| | Night (out of hours) | 38 | 43 |
| NCA7 | Day (standard ICNG hours) | 41 | 51 |
| | Evening (out of hours) | 41 | 46 |
| | Night (out of hours) | 35 | 40 |

*Notes: 1.Night-time RBLs adopted from Table 11.4.*

## 11.3.2 Operational noise

The objectives of noise assessment criteria for industry are to protect the community from excessive intrusive noise and to preserve amenity for specific land uses. To ensure these objectives are met, the INP provides two separate criteria: intrusiveness criteria and amenity criteria.

The intrusiveness criterion is equal to the RBL plus 5 dB(A), which means that the equivalent continuous noise level of the source should not be more than 5 dB(A) above the measured background level.

The amenity assessment is based on noise criteria specific to land use and associated activities that relate only to industrial-type noise and do not include road, rail or community noise.

Project specific noise level criteria are generally equal to the lower of the derived intrusiveness and amenity criteria. It is commonly acknowledged and accepted amongst regulators and industry that energy average noise levels are typically 3 dB louder over a 15 minute worst case assessment period when compared to an entire day (11 hour), evening (4 hour) and night (8 hour) assessment period. Therefore, where the amenity criterion is less than the intrusiveness criteria minus 3 dB, it typically must be shown that the project can satisfy both.

PSNL criteria for the operational phase of the project are provided in Table 11.9. It can be seen that the INP intrusive criterion (ie RBL plus 5 dB) becomes the PSNL for all NCAs for day, evening and night periods.

**Table 11.9 Project-specific noise levels, dB(A)**

| NCA | Amenity Area | Period | Adopted RBL[1] | Intrusive noise criteria[2], $L_{Aeq,15minute}$ | Amenity noise criteria[3], $L_{Aeq,period}$ | PSNL[6] |
|---|---|---|---|---|---|---|
| NCA1, NCA2, NCA4, NCA5 | Rural | Day | 30 | 35 | 50 | 35 $L_{Aeq,15min}$ |
| | | Evening | 30 | 35 | 45 | 35 $L_{Aeq,15min}$ |
| | | Night | 30 | 35 | 40 | 35 $L_{Aeq,15min}$ |
| NCA3 | Suburban | Day | 35 | 40 | 55 | 40 $L_{Aeq,15min}$ |
| | | Evening | 34 | 39 | 37[5] | 39 $L_{Aeq,15min}$ |
| | | Night | 31 | 36 | 35[5] | 36 $L_{Aeq,15min}$ |
| NCA6 | Rural | Day | 45 | 50 | 50 | 50 $L_{Aeq,15min}$ |
| | | Evening | 45 | 50 | 50[4] | 50 $L_{Aeq,15min}$ |
| | | Night | 38 | 43 | 48[4] | 43 $L_{Aeq,15min}$ |
| NCA7 | Rural | Day | 41 | 46 | 50 | 46 $L_{Aeq,15min}$ |
| | | Evening | 41 | 46 | 48[4] | 46 $L_{Aeq,15min}$ |
| | | Night | 35 | 40 | 47[4] | 40 $L_{Aeq,15min}$ |

*Notes:* 1. *RBL value taken from Table 11.4.*

*2. Equal to the RBL plus 5 dB.*

*3. Representative acceptable amenity noise criteria from Table 2.1 of the INP.*

*4. The amenity noise criteria have been corrected in accordance with the INP Application notes due to the high influence of existing road traffic noise levels, ie, measured $L_{Aeq,period(traffic)}$ minus 10 dB.*

*5. The amenity noise criteria have been corrected in accordance with Table 2.2 of the INP to account for the existing industrial noise contribution from Berrima Cement Works.*

*6. Typically the lowest of the intrusive and amenity noise criteria. Where the amenity noise criteria is less than the intrusive minus 3 dB, it must been demonstrated that the amenity noise criteria can also be satisfied.*

### 11.3.3 Voluntary land acquisition and mitigation policy

The NSW Government has developed and formally adopted the VLAMP. The VLAMP seeks to balance acquisition and mitigation obligations for mining operators with providing appropriate protections for landholders where impacts related to noise is significant. The consent authority is required to consider the VLAMP in determining applications for State significant mining, petroleum and extractive industry projects.

The VLAMP's voluntary mitigation and acquisition rights are assigned to privately owned dwellings based on the level of predicted noise above the PSNL, as explained in Table 11.10.

### Table 11.10 Characterisation of noise impacts and potential treatments

| Residual noise exceedances | Characterisation of impacts | Potential treatment |
|---|---|---|
| 0–2 dB(A) PSNL | Impacts are considered to be **negligible** | The exceedances would not be discernible by the average listener so would not warrant receiver-based treatments or controls. |
| 3–5 dB(A) above the PSNL in the INP but the development would contribute less than 1 dB to the total industrial noise level | Impacts are considered to be **marginal** | Provide mechanical ventilation/comfort condition systems so windows can be closed without compromising internal air quality/amenity. |
| 3–5 dB(A) above the PSNL in the INP and the development would contribute more than 1 dB to the total industrial noise level | Impacts are considered to be **moderate** | As for marginal impacts but also upgraded façade elements like windows, doors, roof insulation etc. to further increase the building façade's ability to reduce noise levels. |
| >5 dB(A) above the PSNL in the INP | Impacts are considered to be **significant** | Provide mitigation as for moderate impacts and see voluntary land acquisition provisions below. |

*Source: VLAMP 2014.*

The VLAMP also provides noise acquisition criteria for privately owned land parcels. The policy assigns acquisition rights if the noise generated by a development contributes to an exceedance of the recommended maximum noise levels in Table 2.1 of the INP on more than 25% of any privately owned land, where a dwelling could be built on the land under existing planning controls.

Table 11.11 shows the voluntary land mitigation and acquisition criteria for the project.

### Table 11.11 Privately owned land voluntary acquisition criteria

| NCA | Amenity area | Period | 25% privately owned land area trigger level, $L_{Aeq,\ period}$, dB |
|---|---|---|---|
| NCA1, NCA2, NCA4 to NCA7 | Rural | Day | 55 |
| | | Evening | 50 |
| | | Night | 45 |
| NCA3 | Suburban | Day | 60 |
| | | Evening | 50 |
| | | Night | 45 |

*Notes: 1. Based on the INP maximum amenity noise criteria.*

## 11.3.4 Low frequency noise

Section 4 of the INP provides guidelines for applying 'modifying factor' adjustments to account for low frequency noise emissions. Sources that could contain relatively higher components of low frequency noise energy may include pumps, screens, centrifuges and other plant typically used in material processing. Low frequency noise has been considered using the INP as well as its imminent successor, the EPA's draft Industrial Noise Guideline (ING 2016).

## 11.3.5 Sleep disturbance

The project will operate during the night-time period (10 pm to 7 am) and as such assessment of sleep disturbance is required. Sleep disturbance screening criterion are provided in the INP application notes, which recommend the maximum noise level from a source should not exceed the existing RBL by more than 15 dB. This criterion applies at the nearest bedroom facade of a dwelling.

Also, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels below 50 to 55 dB(A) are unlikely to wake people from sleep; and
- one or two noise events a night, with maximum internal noise levels of 65 to 70 dB(A) (ie inside a dwelling), are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade of a residential building of standard construction including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 $dBL_{Amax}$ calculated at the facade of a residence are unlikely to cause sleep disturbance affects.

Table 11.12 provides the sleep disturbance screening criteria for the residential assessment locations.

**Table 11.12 Sleep disturbance criteria, residential assessment locations**

| NCA | Adopted RBL, dB(A)[1] | Sleep disturbance criteria dB(A), $L_{max}$ |
|---|---|---|
| NCA1, NCA2, NCA4, NCA5 | 30 | 45 |
| NCA3 | 31 | 46 |
| NCA6 | 38 | 53 |
| NCA7 | 35 | 50 |

*Notes: 1.Night-time RBLs adopted from Table 11.4.*

### 11.3.6 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

Clause 12AB of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) identifies non-discretionary development standards for mining. The clauses relevant to the project are listed below.

Clause 12AB(1):

> The object of this clause is to identify development standards on particular matters relating to mining that, if complied with, prevents the consent authority from requiring more onerous standards for those matters (but that does not prevent the consent authority granting consent even though any such standard is not complied with).

Clause 12AB(3) Cumulative noise level:

> The development does not result in cumulative amenity noise criteria greater than the acceptable noise levels, as determined in accordance with Table 2.1 of the Industrial Noise Policy, for residences that are private dwellings.

Other clauses of interest for this project are listed below.

Clause 12AB(5) Airblast overpressure:

> Airblast overpressure caused by the development does not exceed:
>
> (a) 120 dB (Lin Peak) at any time, and
>
> (b) 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.

Clause 12AB(6) Ground vibration:

Ground vibration caused by the development does not exceed:

(a) 10 mm/sec (peak particle velocity) at any time, and

(b) 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.

The above clauses are consistent with cumulative noise and blasting criteria adopted for the project.

### 11.3.7 Road traffic noise

Table 11.13 presents the road noise assessment criteria for residential land uses (ie sensitive receptors), reproduced from Table 3 of the RNP for road categories relevant to the project.

**Table 11.13 Road traffic noise assessment criteria for residential land uses**

| Road Category | Type of project/development | Assessment criteria – dB(A) | |
|---|---|---|---|
| | | Day (7:00 am to 10:00 pm) | Night (10:00 pm to 7:00 am) |
| Freeway/arterial/sub-arterial roads | Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments. | $L_{eq,15hr}$ 60 (external) | $L_{eq,9hr}$ 55 (external) |
| Local Roads | Existing residences affected by additional traffic on existing local roads generated by land use developments. | $L_{eq,1hr}$ 55 (external) | $L_{eq,1hr}$ 50 (external) |

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to +2 dB.

In addition to meeting the assessment criteria, any significant increase in total traffic noise at sensitive receptors must be considered. Sensitive receptors experiencing increases in total traffic noise levels above those presented in Table 11.14 should be considered for mitigation.

**Table 11.14 Relative increase criteria for residential land uses**

| Road Category | Type of project/development | Total traffic noise level increase - dB(A) | |
|---|---|---|---|
| | | Day (7:00 am to 10:00 pm) | Night (10:00 pm to 7:00 am) |
| Freeway/arterial/sub-arterial roads and transit ways | New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road. | Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external) | Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external) |

### 11.3.8 Operational and construction vibration

#### i Human comfort

*Environmental Noise Management – Assessing Vibration: a technical guideline* (DEC 2006) gives preferred and maximum vibration values for assessing human responses to vibration and recommends measurement and evaluation techniques. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types:

- continuous vibration – includes machinery, steady road traffic, and continuous construction activity (such as tunnel boring machinery);
- impulsive vibration – infrequent activities such as occasional dropping of heavy equipment, occasional loading and unloading, and blasting; and
- intermittent vibration – includes sources such as trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, and jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV), which requires the measurement of the overall weighted rms (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. The acceptable VDV for intermittent vibration are reproduced in Table 11.15.

**Table 11.15 Acceptable vibration dose values for intermittent vibration**

| Location | Daytime | | Night-time | |
|---|---|---|---|---|
| | Preferred value, $m/s^{1.75}$ | Maximum value, $m/s^{1.75}$ | Preferred value, $m/s^{1.75}$ | Maximum value, $m/s^{1.75}$ |
| Critical areas | 0.10 | 0.20 | 0.10 | 0.20 |
| Residences | 0.20 | 0.40 | 0.13 | 0.26 |
| Offices, schools, educational institutions and places of worship | 0.40 | 0.80 | 0.40 | 0.80 |
| Workshops | 0.80 | 1.60 | 0.80 | 1.60 |

*Notes: 1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

*2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.*

The adverse comment or disturbance to building occupants is unlikely at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

Impulsive vibration can be caused by blasting. The applicable criteria for construction blasting are discussed further in Section 11.3.9, and otherwise are not applicable to the operations or construction phase of the project.

Although continuous vibration is not likely to be a project risk given the depth of mining, potential continuous vibration from underground mine construction is discussed generally in Section 11.4.8.

### ii Structural vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of threshold and/or cosmetic surface cracks, and are set well below the levels that could cause damage to the main structure. For the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 "*Explosives* - Storage *and Use - Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2*" be used as they are applicable to Australian conditions.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are listed in Table 11.16.

**Table 11.16 Transient vibration guide values – minimal risk of cosmetic damage**

| Line[1] | Type of building | Peak component particle velocity in frequency range of predominant pulse | |
|---|---|---|---|
| | | 4 Hz to 15 Hz | 15 Hz and above |
| 1 | Reinforced or framed structures Industrial and heavy commercial buildings | 50 mm/s at 4 Hz and above | |
| 2 | Unreinforced or light framed structures Residential or light commercial type buildings | 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz | 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above |

The guide values in Table 11.16 mainly relate to transient vibration that does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%.

Some construction or tunnelling activities are considered to have the potential to cause dynamic loading in some structures and therefore transient values in Table 11.16 have been reduced by 50% for assessment purposes, with a vibration screening criteria set at 7.5 mm/s. In addition, in the absence of specific structural vibration criteria for other infrastructure surrounding the project, this criterion has also been conservatively applied to assess potential structural vibration impacts on the Hume Highway as requested by RMS.

## 11.3.9 Construction blasting

The blast limits that apply to the project are provided in Table 11.17.

#### Table 11.17 Airblast overpressure and ground vibration limits

| Blasting | Criteria | Allowable exceedance |
|---|---|---|
| Airblast overpressure | 115 dB($L_{peak}$) | 5% of the total number of blasts over 12 months |
| | 120 dB($L_{peak}$) | 0% |
| Ground vibration | 5 mm/s (peak particle velocity – PPV) | 5% of the total number of blasts over 12 months |
| | 10 mm/s (PPV) | 0% |

## 11.4 Impact assessment

### 11.4.1 Modelling methodology

Noise modelling was based on three-dimensional digitised ground contours of the surrounding land and surface infrastructure for the project's construction and operations phases. The construction and operational noise models represent snapshots, with equipment placed at various locations and heights, representing realistic scenarios.

Noise predictions used the Brüel and Kjær Predictor Version 11 software, which calculates total noise levels at sensitive receptors from the concurrent operation of multiple noise sources. The model considers factors such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the mine and surrounding area, and the weather.

### 11.4.2 Operational noise

Acoustically significant fixed and mobile equipment items considered in the noise model are shown for day, evening and night operations in Table 11.18. As evident in this table, the operational noise sources modelled for the project include the train load out and activities within the rail loop such as locomotives idling and slow moving through the loop. The movement of trains once they leave the rail loop is assessed separately in the Berrima Rail Project EIS (EMM 2017a, refer Appendix D).

#### Table 11.18 Indicative operations equipment quantities and sound power levels

| Item and location | Mitigated sound power level (Lw), dB $L_{Aeq(15\text{-}min)}$ | Quantity | | | Adopted noise mitigation/management |
|---|---|---|---|---|---|
| | | Day | Evening | Night | |
| **Mining infrastructure area** | | | | | |
| Ventilation fan | 93 (total) | 2 | 2 | 2 | External casing acoustic treatment. Discharge attenuation. NW orientation. |
| Compressors | 77 | 5 | 5 | 5 | Enclosed |
| Sewage treatment (pumps) | 84 | 1 | 1 | 1 | Enclosed |
| Fuel pump | 89 | 1 | 1 | 1 | |
| Workshop activity | 103 | 1 | 1 | 1 | Limited external activities in the evening and night period |
| Vehicle washdown / service area (pump/gerni) | 90 | 1 | 1 | 1 | |
| Load-haul-dump truck | 85 | 1 | 1 | 1 | |
| Personnel transport | 85 | 4 | 4 | 4 | |
| Tele handler | 95 | 1 | 0 | 0 | |

### Table 11.18 Indicative operations equipment quantities and sound power levels

| Item and location | Mitigated sound power level (Lw), dB $L_{Aeq(15\text{-}min)}$ | Quantity | | | Adopted noise mitigation/management |
|---|---|---|---|---|---|
| | | Day | Evening | Night | |
| **Coal handling and preparation plant area** | | | | | |
| D9 dozer | 115 | 1 | 0 | 0 | Noise attenuated |
| Loader | 105 | 1 | 0 | 0 | 3.5m bund around rejects load hopper |
| Overland conveyor | 65/m (east side)<br>75/m (west side) | | 1780m | | Machined steel idlers and enclosed (roof and east side) |
| ROM stockpile (radial stacker/reclaimer) | 104 | 1 | 1 | 1 | Drives enclosed |
| Crushing station | 106 | 1 | 1 | 1 | Sheet metal enclosure |
| Tertiary screens | 105 | 1 | 1 | 1 | Sheet metal enclosure |
| CPP | 94 | 1 | 1 | 1 | Fully enclosed in metal clad building, VVVFdrives, concrete platforms for screens, increased steel work to stiffen structure |
| Product stacker | 104 | 2 | 2 | 2 | Drives enclosed |
| Product reclaimer | 104 | 1 | 1 | 1 | Drives enclosed |
| Rejects stacker | 104 | 1 | 1 | 1 | Drives enclosed |
| Reject plant (paste plant) | 102 | 1 | 1 | 1 | Fully enclosed in metal clad building |
| Product stockpile conveyors | 75/m | | 770 m | | Machined steel idlers |
| Enclosed conveyors | 65/m | | 890 m | | Machined steel idlers and full enclosure |
| All other conveyors | 75/m | | 1000 m | | Machined steel idlers |
| Conveyor drive small (<500 kW) | 90 | 9 | 9 | 9 | Sheet metal enclosure |
| Conveyor drive large (>500 kW) | 100 | 7 | 7 | 7 | Sheet metal enclosure |
| Water treatment plant | 85 | 1 | 1 | 1 | Sheet metal enclosure |
| **Train load out** | | | | | |
| Bin, feeder and train load out | 103 | 1 | 1 | 1 | Enclosed |
| Train load out conveyor | 65/m | | 650 m | | Machined steel idlers and full enclosure |
| Locomotives (idle to slow moving < 10km/h) | 101 | 4 | 4 | 4 | Latest generation locomotives |

The predicted noise levels at each assessment location for each meteorological condition with all feasible and reasonable mitigation applied are provided in Table 11.19. The green, orange and blue shading indicates assessment locations where noise predictions fall into negligible (1 to 2 dB above PSNL), moderate (3 to 5 dB above PSNL) or significant (greater than 5 dB above PSNL) noise impact characterisations (respectively) as described in the VLAMP. Other predicted noise levels satisfy PSNLs.

## Table 11.19 Predicted operations noise levels

| Assessment location (NCA) | Predicted noise level, $L_{Aeq,15min}$, dB | | | PSNL (D/E/N), $L_{Aeq,15min}$ dB | Voluntary mitigation noise level trigger (D/E/N), $L_{Aeq,15min}$ dB | Voluntary acquisition noise level trigger (D/E/N), $L_{Aeq,15min}$ dB |
|---|---|---|---|---|---|---|
| | Day | Night | | | | |
| | Calm | Calm | Adverse[1] | | | |
| 1 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 2 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 3 (NCA1) | <35 | <35 | 35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 4 (NCA1) | 37 | 35 | 38 | 35/35/35 | 37/37/37 | >40/40/40 |
| 5 (NCA1) | 37 | 35 | 38 | 35/35/35 | 37/37/37 | >40/40/40 |
| 6 (NCA1) | 37 | 35 | 38 | 35/35/35 | 37/37/37 | >40/40/40 |
| 7 (NCA1) | 37 | <35 | 37 | 35/35/35 | 37/37/37 | >40/40/40 |
| 8 (NCA1) | 38 | 35 | 38 | 35/35/35 | 37/37/37 | >40/40/40 |
| 10 (NCA1) | 40 | 37 | 40 | 35/35/35 | 37/37/37 | >40/40/40 |
| 12 (NCA1) | 44 | 41 | 43 | 35/35/35 | 37/37/37 | >40/40/40 |
| 13 (NCA1) | 43 | 39 | 42 | 35/35/35 | 37/37/37 | >40/40/40 |
| 14A, 14B (NCA1) | 37 | 36 | 38 | 35/35/35 | 37/37/37 | >40/40/40 |
| 15 (NCA1) | 40 | 36 | 39 | 35/35/35 | 37/37/37 | >40/40/40 |
| 16 (NCA1) | 40 | 37 | 40 | 35/35/35 | 37/37/37 | >40/40/40 |
| 17 (NCA7) | <46 | <39 | 40 | 46/46/40 | 48/48/42 | >51/51/45 |
| 18 (NCA7) | <46 | <39 | <39 | 46/46/40 | 48/48/42 | >51/51/45 |
| 19 (NCA2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 20 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 21 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 22 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 23 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 24 (NCA2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 25 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 26 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 27 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 28 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 29 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 30 (n/a2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 31 (n/a2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 32 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 33 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 34 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 35 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 36 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 37 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 38 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 39 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 40 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 41 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 42 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 43 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 44 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |

## Table 11.19 Predicted operations noise levels

| Assessment location (NCA) | Predicted noise level, $L_{Aeq,15min}$, dB | | | PSNL (D/E/N), $L_{Aeq,15min}$ dB | Voluntary mitigation noise level trigger (D/E/N), $L_{Aeq,15min}$ dB | Voluntary acquisition noise level trigger (D/E/N), $L_{Aeq,15min}$ dB |
|---|---|---|---|---|---|---|
| | Day | Night | | | | |
| | Calm | Calm | Adverse[1] | | | |
| 45 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 46 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 47 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 48 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 49 (NCA7) | <46 | <39 | <40 | 46/46/40 | 48/48/42 | >51/51/45 |
| 50 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 51 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 52 (NCA7) | <46 | <39 | <40 | 46/46/40 | 48/48/42 | >51/51/45 |
| 53 (NCA7) | <46 | <39 | <40 | 46/46/40 | 48/48/42 | >51/51/45 |
| 54 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 55 (NCA7) | <46 | <39 | <40 | 46/46/40 | 48/48/42 | >51/51/45 |
| 56 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 57 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 58 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 59 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 60 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 61 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 62 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 63 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 64 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 65 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 66 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 67 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 68 (NCA1) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 69 (NCA2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 70 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 71 (NCA2) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 72 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 73 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 74 (NCA3) | <40 | <36 | <36 | 40/39/36 | 42/41/38 | >45/44/41 |
| 75 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |
| 76 (NCA4) | <35 | <35 | <35 | 35/35/35 | 37/37/37 | >40/40/40 |

*Notes: 1. Maximum predicted noise level from all assessed prevailing meteorological conditions.*

During adverse weather conditions for all assessment periods, for the mining life, with all feasible and reasonable mitigation applied, the VLAMP assessment indicates:

- one assessment location within the area modelled is predicted to experience negligible residual noise levels between 1 to 2 dB above PSNLs;
- eight assessment locations (nine dwellings) within the area modelled are predicted to experience residual noise levels between 3 to 5 dB above PSNLs and are therefore entitled to voluntary mitigation upon request; and
- two assessment locations within the area modelled are predicted to experience residual noise levels greater than 5 dB above PSNLs and are therefore entitled to voluntary acquisition upon request.

Alternatively, Hume Coal may enter into amenity agreements with the landholders who are entitled to voluntary mitigation or acquisition.

A summary of the assessment locations predicted to experience residual noise impacts across all periods and meteorological conditions, with all feasible and reasonable mitigation applied, are presented in Table 11.20 below. These are illustrated further in Figure 11.3.

### Table 11.20 Residual Noise Impacts at Assessment Locations

| Negligible (1 to 2 dB above PSNL) | Moderate (3 to 5 dB above PSNL)[1] | Significant (>5 dB above PSNL)[2] |
|---|---|---|
| ID | ID | ID |
| 7 | 4 | 12 |
| | 5 | 13 |
| | 6 | |
| | 8 | |
| | 10 | |
| | 14A, 14B | |
| | 15 | |
| | 16 | |
| Total quantity - 1 | Total quantity – 8 (9 dwellings) | Total quantity - 2 |

*Notes:* *1. Assessment locations entitled to voluntary noise mitigation in the form of mechanical ventilation / comfort condition systems and upgraded facade elements to reduce internal noise levels.*

*2. Assessment locations entitled to voluntary acquisition.*

### 11.4.3 Privately owned land assessment

Noise modelling has shown that there are no privately owned land parcels exceeding the 25% area voluntary land acquisition criteria as defined in the VLAMP.

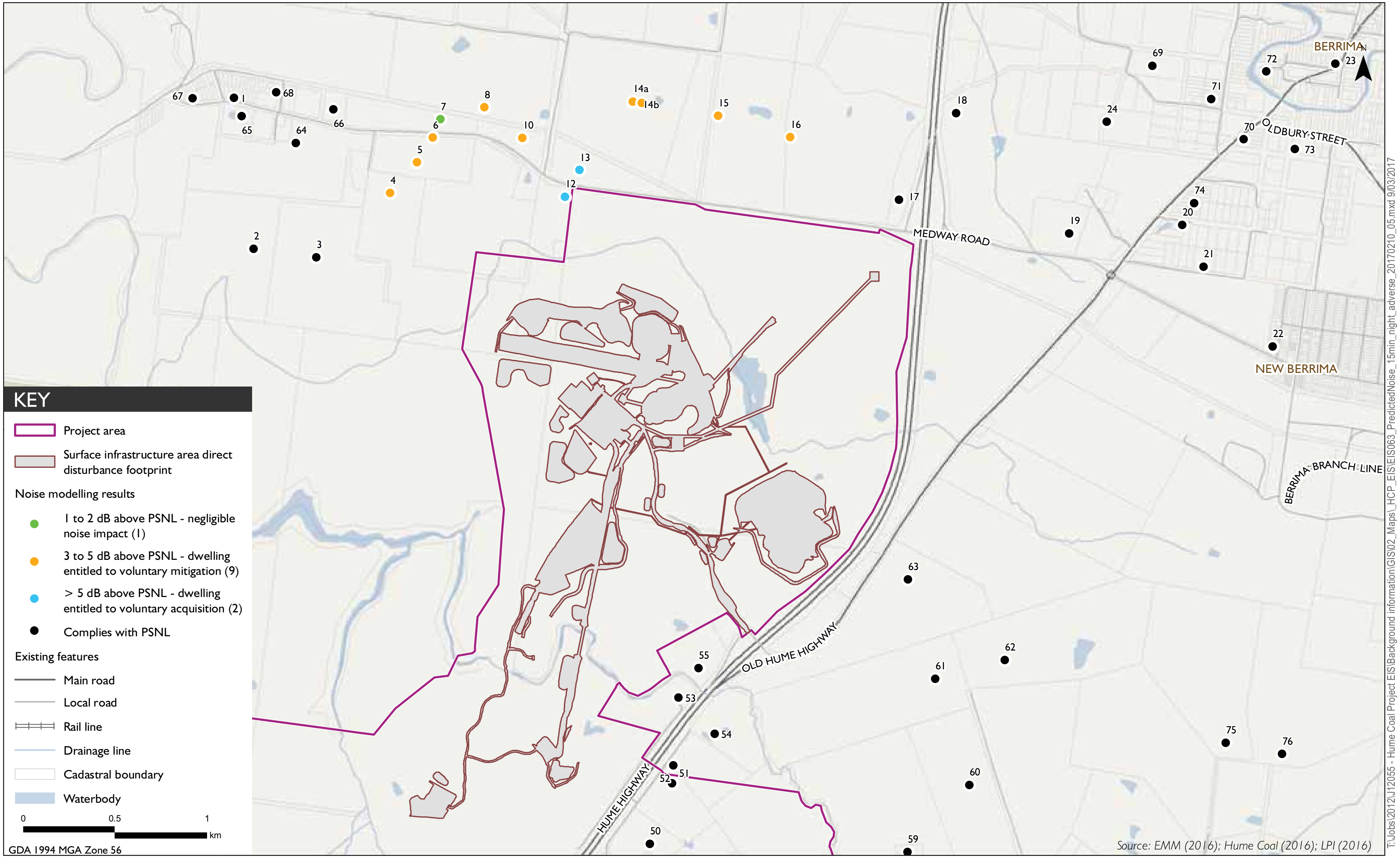
### 11.4.4 Sleep disturbance

Typical noise sources from the project that could disturb sleep include stacker/reclaimer start-up alarm, haul dump truck start-up and a locomotive pass-by. Noise modelling demonstrated that maximum ($L_{Amax}$) external noise levels associated with the project will be below the INP sleep disturbance screening criteria at most residential assessment locations for all assessable weather conditions, with the exception of three residential locations as follows:

- 15 - where a minor exceedance of 1 dB is predicted during adverse weather conditions;
- 16 - where a 3 dB exceedance is predicted during calm conditions and a 6 dB exceedance is predicted during adverse weather conditions; and
- 17 - where a 2 dB exceedance is predicted during calm conditions and a 3 dB exceedance is predicted during adverse weather conditions.

The predicted exceedances relate to a train pass-by arrival event on the rail loop. The predicted external maximum noise levels during calm and adverse weather conditions would equate to an internal noise level of 36 dB for location 15, 38 to 41 dB for location 16, and 42 to 43 dB for location 17. Although the INP screening criteria is exceeded, the calculated internal noise levels are well below those likely to cause sleep disturbance (refer to Section 11.3.5). A maximum of two trains are likely to be loaded in any night period, so the predicted maximum noise level event would only occur up to two times during the night when passing closest to assessment locations (ie inbound only). On this basis sleep disturbance noise impacts are considered unlikely.

In addition, assessment locations 15 and 16 are entitled to voluntary mitigation upon request due to $L_{Aeq,15min}$ operational noise levels, as described in Section 11.4.2.




**Summary of worst case operational noise impacts**

Hume Coal Project

Environmental Impact Statement

Figure 11.3

### 11.4.5 Cumulative noise

The application of the INP and the derivation of amenity criteria for all assessment locations take into account existing industrial noise levels and therefore the potential for cumulative noise impacts from all industrial noise sources. Therefore, where PSNLs are satisfied, it can reasonably be inferred that cumulative impacts are highly unlikely as a result of the Hume Coal Project.

There is no existing industrial noise contribution at assessment locations directly impacted by the Hume Coal Project. Therefore the potential for increased impacts due to cumulative noise levels is considered highly unlikely.

The Berrima Rail Project will include a rail maintenance facility located to the east of the Hume Highway. Noise levels from this facility have been assessed with noise from the Hume Coal Project. The assessment found that total noise levels due to the operation of both facilities when combined would not lead to increased noise impacts. That is, properties currently entitled to voluntary mitigation or acquisition would remain as those identified in this report.

### 11.4.6 Road traffic noise

Road traffic movements associated with operation and construction of the project have been referenced from the *Hume Coal Project Traffic and Transport Assessment* (EMM 2017b).

#### i Construction

All roads that will be used to access the Hume Coal Project where adjacent assessment locations exist will experience zero to negligible (1 to 2 dB) noise level increases for both early and peak construction periods. In summary, road traffic noise levels are predicted to satisfy RNP assessment requirements.

#### ii Operation

All roads that will be used to access the Hume Coal Project where adjacent assessment locations exist will experience zero to negligible (1 to 2 dB) noise level increases during operations. In summary, road traffic noise levels are predicted to satisfy RNP assessment requirements.

### 11.4.7 Construction noise

The construction noise assessment assessed the following project components:

- early works phase;
- portals and portals access;
- overland conveyor;
- ventilation shaft; and
- CPP construction.

Appendix C in the NVA (refer to Appendix I) details the construction scenarios and equipment considered in the construction noise assessment, with associated sound power levels, hours of operation and indicative scheduling.

Predicted construction noise levels for the early works, portals and access, overland conveyor, ventilation shaft and CPP are provided in Appendix D of the NVA (refer to Appendix I). Potential cumulative construction noise scenarios with all works occurring simultaneously were also considered. Although such a scenario is considered it is highly unlikely, it represents the absolute worst case construction noise level scenario. Further, construction noise level predictions assume all plant and equipment are to operate continuously throughout any 15 minute period and are therefore considered conservative. Notwithstanding, Hume Coal would manage construction noise levels where NMLs are exceeded. This may include limiting construction duration, using localised noise barriers around high noise generating construction activities, or similar. Details on noise management and mitigation will be provided in a construction noise management plan (refer Section 11.5.2).

Most construction activities will occur during standard hours, however due to safety, geotechnical or the specialist nature of some works it is not possible to avoid some out of hours activities. The results of the construction noise modelling are discussed below.

#### i Early works

Total construction noise levels are predicted to satisfy NMLs at 56 of the 74 assessment locations during the early works stage. Noise levels above relevant NMLs are predicted to the north-west of the project area, with the largest being 16 dB above the NML. Most predicted noise levels in other locations range from 1 dB to 3 dB above NMLs. The highly affected NML of 75 dB is not exceeded at any assessment location.

Construction noise levels for individual scenarios in the early works stage are predicted to be at their greatest during the construction of the CPP access road and temporary accommodation village. This is mainly due to the proximity of the CPP access road to surrounding assessment locations to the north-west.

#### ii Portals and portals access

##### a. Standard hours

Predicted total construction noise levels for the portals and portals access stage satisfy NMLs for 56 of the 74 assessment locations. The highly affected NML of 75 dB is not exceeded at any assessment location. The Hume Coal Project noise levels predicted at assessment locations to the south and south-east of the portals generally range between 3 dB and 8 dB above NMLs, with the largest being up to 15 dB above the relevant NML. Predicted noise levels of this magnitude will only occur when construction activity is at the surface. Surface construction will be limited for this phase as it will mostly occur underground.

Predicted construction noise levels for individual scenarios in the portals and portals access stage are similar to each other, with noise levels up to 12 dB above NMLs, but generally no more than 10 dB above NMLs. Noise levels above NMLs are expected to the south and south-east of the portal access and NMLs for assessment locations to the north are predicted to be satisfied.

##### b. Out of hours

Construction noise levels from proposed out of hours activity are predicted to satisfy the evening and night NML at all assessment locations. Maximum noise levels (ie $L_{max}$) from construction activity are unlikely to be more than 10 dB above the predicted energy-average construction noise level (ie $L_{eq}$) and therefore the minimum sleep disturbance screening criteria of 45 dB $L_{max}$ external, is also likely to be satisfied.

### iii Overland conveyor

#### a. Standard hours

Total construction noise levels for the overland conveyor stage are predicted to satisfy NMLs at 62 of the 74 assessment locations. The highly affected NML of 75 dB is not exceeded at any assessment location. Noise levels above NMLs are predicted to the south of the surface infrastructure area and are generally 1 dB to 2 dB above the relevant NML, with the largest being 12 dB above the relevant NML.

Construction noise levels for individual scenarios are predicted to satisfy NMLs for almost all assessment locations. Predictions generally range from 1 dB to 5 dB above NMLs, with the largest being 9 dB above the relevant NML. These are limited to the south of the surface infrastructure area.

### iv Ventilation shaft

#### a. Standard hours

Total construction noise levels for the ventilation shaft stage are predicted to satisfy NMLs at 59 of the 74 assessment locations. The highly affected NML of 75 dB is not exceeded at any assessment location. Noise levels above NMLs are expected to the south-east and south-west of the surface infrastructure area and generally range between 2 dB and 4 dB, with the largest being up to 10 dB above the relevant NML.

Construction noise levels for individual scenarios are predicted to be the highest during the construction of the shaft site access track and shaft pad dam (MWD07), with noise levels above NMLs generally ranging from 1 dB to 5 dB for assessment locations to the south east and south west. The highest predicted noise levels are up to 8 dB above the NML. NMLs are satisfied for all assessment locations during the shaft pad and dam, shaft drilling and ventilation fan construction scenarios.

#### b. Out of hours

Construction noise levels from proposed out of hours activity are predicted to be up to 3 dB above the evening and night NML. These are generated by ventilation shaft construction and the use of a blind bore rig. Actual noise levels from this activity will be verified during the construction stage and noise mitigation in the form of localised noise barriers or similar will be adopted if noise levels above the NMLs are identified. A localised noise barrier could provide 5 to 10 dB of noise reduction and therefore with such mitigation in place this activity will satisfy the NML at all assessment locations.

Maximum noise levels (ie $L_{max}$) from general out of hours construction activities are unlikely to be more than 10 dB above the predicted energy-average construction noise level (ie $L_{eq}$). Therefore the minimum sleep disturbance screening criteria of 45 dB, $L_{max}$ is also likely to be satisfied.

### v CPP

#### a. Standard hours

Total construction noise levels for the CPP stage are predicted to satisfy NMLs at 14 of the 74 assessment locations. The highly affected NML of 75 dB is satisfied at any assessment location. However, there are ten construction scenarios proposed in the CPP stage, as opposed to generally two or three scenarios in the other stages. This has elevated predicted total construction noise levels and represents an extreme total worst case scenario, which is highly unlikely to occur. For individual scenarios elevated noise levels are much more localised (ie they only occur for assessment locations in certain areas). The expected noise levels for individual construction scenarios are generally between 3 dB and 8 dB above NMLs, with the highest exceedances predicted to occur during the construction of mine water dam 1 (MWD01).

#### b. Out of hours

Construction noise levels from proposed out of hours activity are predicted to satisfy the evening and night NML at all assessment locations. Maximum noise levels (ie $L_{max}$) from construction activity are unlikely to be more than 10 dB above the predicted energy-average construction noise level (ie $L_{eq}$) and therefore the minimum sleep disturbance screening criteria of 45 dB, $L_{max}$ is also likely to be satisfied.

### vi Surface infrastructure area

#### a. Standard hours

Total construction noise levels for the surface infrastructure area stage are predicted to satisfy NMLs at 50 of the 74 assessment locations. The highly affected NML of 75 dB is not exceeded at any assessment location. Noise levels above NMLs are predicted to the north and south of the surface infrastructure area and are no more than 6 dB above the relevant NML for individual construction scenarios. The largest predicted noise level for total construction noise is up to 8 dB above the relevant NML and occurs to the north-east of the project area.

#### b. Out of hours

The vent shaft will be the noisiest out of hours construction activity and has been described in Section 11.4.7ivb.

## 11.4.8 Vibration

### i Operations

RMS require the consideration of potential structural vibration impact on the Hume Highway as underground mining passes below.

Typical ground vibration levels from various construction activities that are likely to produce similar levels of vibration to underground mining activities are presented in a technical paper, *The prediction and mitigation of vibration impacts of tunnelling* (Hiller D, Arup 2011). The technical paper *Tunnelling induced ground-borne noise modelling* (Speakman C & Lyons S, Parsons Brinckerhoff 2009) also provides typical peak particle velocity (PPV) vibration levels from a tunnel boring machine in an undefined ground type, which also represents vibration levels that could be generated from constructing an underground mine.

Underground mining will occur at depths of about 110 m under the Hume Highway. Based on published data cited in the noise assessment (refer to Section 5.8 in Appendix I), PPV vibration levels are significantly less than 0.1 mm/s for a tunnel boring machine operation at a distance of 100 m. This provides a reasonably close approximation of the type of vibration levels that could be expected from the type of mining equipment that will be used by the project.

Therefore, based on the structural vibration screening criteria of 7.5 mm/s, it is highly unlikely that vibration levels associated with underground mining will cause structural damage to the Hume Highway. Further, the areas where underground mining will occur under the Highway is limited to intermittent crossings to provide first working access headings, occuring at only six locations.

### ii Construction

Safe working distances for typical items of vibration intensive plant are listed in Table 11.21. These distances apply to cosmetic damage of typical buildings under typical geotechnical conditions, are indicative, and will vary depending on the particular item of plant and local geotechnical conditions.

#### Table 11.21 Recommended safe working distances for vibration intensive plant

| Plant item | Rating/description | Safe working distance | |
|---|---|---|---|
| | | Cosmetic damage (BS 7385) | Human response (BS 6472) |
| Vibratory roller | <50kN (typically 1–2 tonnes) | 5 m | 15 to 20 m |
| | <100kN (typically 2–4 tonnes) | 6 m | 20 m |
| | <200kN (typically 4–6 tonnes) | 12 m | 40 m |
| | <300kN (typically 7–13 tonnes) | 15 m | 100 m |
| | >300kN (typically 13–18 tonnes) | 20 m | 100 m |
| | >300kN (>18 tonnes) | 25 m | 100 m |
| Small hydraulic hammer | (300 kg – 5 to 12t excavator) | 2 m | 7 m |
| Medium hydraulic hammer | (900 kg – 12 to 18t excavator) | 7 m | 23 m |
| Large hydraulic hammer | (1600 kg – 18 to 34t excavator) | 22 m | 73 m |
| Vibratory pile driver | Sheet piles | 2 m to 20 m | 20 m |
| Pile boring | ≤800 mm | 2 m (nominal) | N/A |
| Jackhammer | Hand held | 1 m (nominal) | Avoid contact with structure |

*Source: From Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.*

In relation to human comfort (response), the safe working distances presented in Table 11.21 relate to continuous vibration and apply to residential receivers. Most construction activities have intermittent vibration emissions, which is why higher vibration levels occurring over shorter periods are allowed, as discussed in British Standard BS 6472-1.

Based on the safe working distances for typical plant items in Table 11.21 and the location of surrounding privately owned residential properties, it is unlikely human response vibration criteria will be exceeded. For example, the nearest privately owned assessment location to construction activity is approximately 300 m away (location 55), which is greater than the maximum safe working distance of 100 m for an 18 tonne or greater vibratory roller. Because human response criteria are more stringent than cosmetic damage criteria, it is also highly likely that cosmetic damage criteria would be satisfied at privately owned residential properties.

Despite this, Hume Coal will monitor and manage construction noise and vibration, which will include preparing a construction noise and vibration management plan discussed further in Section 11.5.

### 11.4.9 Construction blasting

A quantitative assessment of blast overpressure and vibration levels was prepared using the method given in the *AS2187-2-2006: Explosives – Storage and Use Part 2: Use of Explosives* and the *Imperial Chemical Industries (ICI) Explosives Blasting Guide* (ICI Technical Services 1995), as applicable to blasting in hard rock. This formula has been shown to be conservative in calculating overpressure and vibration.

The relevant formulae are as follows:

$$PVS = K (R/Q^{0.5})^{-1.6}$$

$$dB = 164.2 - 24(\log_{10} R - 0.33 \log_{10} Q)$$

Where,

PVS = peak vector sum ground vibration level (mm/s)

dB = peak airblast level (dB Linear)

| | | |
|---|---|---|
| K | = | factor applied according to blasting type |
| R | = | distance between charge and residence (m) |
| Q | = | charge mass per delay (kg) or maximum instantaneous charge (MIC) |

A K factor of 1140 (for average rock) was used to calculate levels associated with drift portal and ventilation shaft construction.

Minor blast activity will be required for personnel material portal, drift portal and ventilation shaft construction. One of the key parameters used to control blast overpressure and vibration is the maximum instantaneous change (MIC), quantified in kilograms (kg).

The nearest privately owned assessment location is approximately 600 m from any potential construction blast activity at the personnel and materials portal. Based on the blast prediction formula above, a blast MIC of 180 kg along with other appropriate blast design practices will satisfy ANZECC blasting limits at this nearest assessment location. This is well in excess of the maximum potential MIC that would be employed in any drift shotfiring that may be undertaken during drift construction. Nonetheless, construction blasts will be designed to satisfy ANZECC airblast and ground vibration criteria at all surrounding privately owned assessment locations.

### 11.4.10 Health impacts

Road, rail and aircraft noise are the main environmental noise pollutants that have been investigated and reported in the medical literature. Numerous studies have shown that extraneous noise pollution in residential and other settings (eg schools) seems to have minimal health effects at levels below 55 dBA (McKenzie 2016).

As reported in Section 11.4.2, during adverse weather conditions and with all feasible mitigations applied, it is predicted that eight assessment locations (nine dwellings) within the area modelled will experience residual noise levels from the mine of between 3 to 5 dB above PSNLs, and two assessment locations are predicted to experience residual noise levels greater than 5 dB above PSNLs.

However, whilst exceedances of noise criteria are predicted, the maximum noise level predicted at any assessment location (43 $L_{Aeq,15min}$ dB) is orders of magnitude less than those that have been shown to cause health effects or learning problems throughout medical literature. Further, the 10 locations predicted to experience noise levels above the noise criteria will be entitled to either acquisition or mitigation measures upon request. In addition, real time noise monitoring will be undertaken during construction and operation of the mine allowing a quick response should levels be found to exceed PSNLs. Measures that will be available to complainants through the independent review process will include modifying plant and procedures, erecting noise barriers and fitting insulation and air conditioning to homes. In addition, if PSNLs are likely to be exceeded due to adverse temperature, humidity and wind conditions, work will cease or be modified.

In relation to the potential effects on sleep to due noise emissions, the bulk of the evidence from medical research suggests that sleep quantity and measures of sleep quality, including daytime performance, are unaffected at indoor noise levels less than 40–55 dBA (Passier-Vermeer & Passchier 2000).

No health related impacts are therefore predicted to occur as a result of noise levels from operation of the mine.

## 11.5 Management and mitigation

### 11.5.1 Operational noise – feasible and reasonable measures

The project design, in conjunction with the noise assessment, considered feasible and reasonable mitigation measures in accordance with the guidance provided in the INP so as to minimise noise and vibration impacts on sensitive receivers. The design process was therefore an iterative one, with the project layout and design altered as various scenarios were modelled. Further discussion on alternatives considered is provided in Chapter 6. These leading noise mitigation and management measures that were included and modelled in the project design to manage operational noise are as follows:

- overall site design to reduce the height of acoustically significant plant and equipment wherever practicable;
- highly considered placement of the surface infrastructure in coordination with other environmental constraints and flood levels so as to maximise distance to surrounding residential properties;
- automated coal handling using stackers and reclaimers to minimise the reliance on mobile plant and equipment (eg dozers);
- machined steel idlers on all conveyors;
- enclosures on conveyor drives, crushing plant, tertiary screens, paste plant and CPP;
- low frequency noise mitigation to the CPP, including VVVF drives, concrete platforms for screens, increased steelwork to stiffen the structure and bespoke cladding system;
- ventilation fan attenuation;
- limiting dozer operation to the day time only;
- limited workshop activities during the evening and night periods;
- procurement of latest generation AC locomotives and wagons with electronically controlled pneumatic brakes; and
- constructing a rail noise barrier to the north of the rail loop to attenuate loading and rail loop activity.

In addition to the above, it is noted that the noise model assumed worst case plant and equipment locations and therefore represents the worst case noise 'envelope' from the project area over the mine life.

A noise management plan (NMP) will be developed for the project, which will:

- identify noise-affected properties consistent with the environmental assessment and any subsequent assessments;
- outline mitigation measures to achieve the noise limits established;
- outline measures to reduce the impact of intermittent, low frequency and tonal noise (including truck reversing alarms using broadband quackers and ambient noise level adjusting alarms or in-cabin alarms);
- specify measures to document any higher level of impacts or patterns of temperature inversions, and detail actions to quantify and ameliorate enhanced impacts if they occur;

- specify protocols for routine, regular attended and unattended noise monitoring of the project, including provision for regular low frequency noise monitoring;
- outline the procedure to notify property owners and occupiers that could be affected by noise from the mine;
- establish a protocol to handle noise complaints that includes recording, reporting and acting on complaints; and
- specify procedures for undertaking independent noise investigations.

### 11.5.2 Construction noise

The methods to manage construction noise will be detailed in a CEMP that will address noise and vibration management and mitigation options (where required). The plan will be completed before construction and will describe how construction noise levels will be managed where predicted noise levels above the NMLs have been identified.

The CEMP's main objective will be to manage construction activities to meet ICNG NMLs and applicable vibration criteria across the project as far as practicable. This will be achieved by measuring construction noise levels at early stages to validate the predicted construction noise levels, and subsequently re-evaluating the predicted construction noise levels at assessment locations. Where required, noise management and mitigation measures will then be reviewed to reduce levels below the NMLs.

A localised noise barrier could provide 5 to 10 dB of noise reduction during construction of the ventilation shaft and therefore with such mitigation in place this activity will satisfy the out of hours NML at all assessment locations.

Affected landholders will be consulted before and during construction where exceedance of NMLs are predicted, and will be notified of proposed mitigation measures that will be used to manage construction noise levels to below ICNG NMLs.

### 11.5.3 Vibration

A construction vibration management plan will be prepared that will as a minimum:

- identify nearby residences and sensitive land uses;
- describe approved hours of work and what work will be undertaken;
- describe what work practices will be applied to minimise vibration;
- describe the complaints handling process; and
- describe the monitoring that is required.

If the safe working distances in Section 11.4.7 are encroached, vibration monitoring will be carried out at nearby structures. If required, the monitoring system will be fitted with an auditory and visual alarm that triggers when vibration levels reach the nominated cosmetic damage criteria. This would indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection, etc).

Supplementary vibration monitoring will be carried out in response to any complaints, exceedance or to refine construction techniques to minimise vibration emissions (if required). Monitoring will be attended to provide immediate feedback to the operators.

## 11.6 Conclusions

The operational noise assessment has identified that during adverse weather conditions and with all the feasible mitigations applied:

- eight assessment locations (nine dwellings) within the area modelled are predicted to experience residual noise levels between 3 to 5 dB above PSNLs and are therefore entitled to voluntary mitigation upon request; and
- two assessment locations within the area modelled are predicted to experience residual noise levels greater than 5 dB above PSNLs and are therefore entitled to voluntary acquisition upon request.

Alternatively, Hume Coal may enter into amenity agreements with these landholders.

No privately owned land parcels are predicted to exceed the 25% area voluntary land acquisition criteria as defined in the VLAMP.

The sleep disturbance assessment concluded that the predicted internal noise levels at the assessment locations will be well below those likely to cause awakenings.

Construction noise levels from the project during standard ICNG construction hours will exceed the noise affected NML (or noise management level) at several assessment locations across the various construction stages. The 'highly affected' noise limit of 75 dB will not be exceeded at any time. This outcome is not uncommon for construction projects, and it is important to note that the NML is not a criterion (as are operational noise limits). It is simply a trigger for when construction noise management is to be considered and implemented. Hume Coal will manage construction noise levels where NMLs are exceeded. The key management measure that will be adopted is generally limiting construction activities to standard hours only. The construction noise management methods will be detailed in the project CEMP.

Construction noise levels from proposed out of hours activity are predicted to satisfy the evening and night NML at all assessment locations, with mitigation in place.

Maximum noise levels (ie $L_{max}$) from general construction activity during out of hour periods are likely to satisfy criteria. The proponent will monitor construction noise levels during out of hour periods during the initial construction stages and will implement noise management and mitigation measures.

Based on the safe working distances for typical construction plant items and the location of surrounding privately owned residential properties, human response vibration criteria are unlikely to be exceeded. Because human response criteria are more stringent than cosmetic damage criteria, it is also highly likely that cosmetic damage criteria will be satisfied at privately owned residential properties. Despite this, Hume Coal will manage construction vibration, which will include preparing a construction vibration management plan.

Underground mine construction will occur at depths of approximately 110 m under the Hume Highway. Based on the structural vibration screening criteria of 7.5 mm/s and the identified vibration levels from similar construction activities (typically 0.1 mm/s at such distances), it is highly unlikely vibration levels will cause structural vibration impacts to the Hume Highway.

Blasting may be required for the personnel and material portal, drift portal and ventilation shaft construction. The nearest privately owned assessment location to these activities is approximately 600 m away. Based on empirical blast prediction formula, a blast MIC of less than 180 kg along with other appropriate blast design practices will likely satisfy ANZECC blasting limits at this nearest assessment location. Nevertheless, blasting activities during construction will be designed to satisfy ANZECC airblast and ground vibration criteria at all surrounding privately owned assessment locations.

Road traffic noise has been assessed for all public roads potentially used for the operation and construction phases of the project. All roads that will be used to access the mine site where adjacent assessment locations exist will experience zero to negligible (1-2 dB) noise level increases, which satisfies RNP (EPA 2013) requirements.

# 12 Air quality

## 12.1 Introduction

An air quality impact assessment of the project was undertaken to assess predicted ground-level concentrations and deposition levels of potential air pollutants at neighbouring and regional sensitive receptors. The assessment also describes the measures built into the project design to avoid and minimise air quality related impacts, and identifies additional mitigation and management measures to address residual impacts.

As described in Chapter 2, leading practice measures have been incorporated into the design of the project, including measures specifically related to avoiding, minimising and/or mitigating potential air quality impacts, including:

- covering all Hume Coal train wagons, when both empty and loaded, travelling to and from the mine;
- underground emplacement of rejects, eliminating the need for a permanent surface reject stockpile, thereby avoiding the potential dust related impacts associated with surface tailings ponds;
- procurement of the latest generation rail locomotives and wagons;
- covered conveyors;
- enclosed CPP and train load-out; and
- orientation of stockpiles.

The results of the dispersion modelling show that emissions of particulate matter, gaseous pollutants, odour concentrations and dust deposition rates as a result of the project will be well below applicable air quality impact assessment criteria, and minor relative to existing ambient conditions.

This chapter summarises the air quality impact assessment, with the full technical report attached in Appendix K. The potential health impacts of the predicted emissions from the project were also investigated by Dr David McKenzie. The key findings of this assessment are also summarised in this chapter and the full technical report is provided in Appendix J.

### 12.1.1 Assessment requirements

The SEARs require an assessment of the likely air quality impacts of the project. The specific requirement relating to air quality is shown in Table 12.1. The RMS also raised matters relating to air quality in their assessment recommendations, which are also listed in Table 12.1.

**Table 12.1 Air quality-related SEARs and assessment recommendations**

| Requirement | Section addressed |
|---|---|
| **DP&E** | |
| 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 and the EPA's additional requirements. | This chapter |
| **RMS** | |
| The impact of dust pollution on the travelling public. | Section 12.4.1 describes the predicted project-related particulate matter concentrations and deposition rates, which are all well below the applicable impact assessment criteria. Therefore the travelling public and road signs/markings will not be affected by dust pollution from the project. The project does not involve truck transportation of coal, which is typically the source of these impacts. |
| The impact of dust pollution or the depositing of fines on the functioning of reflective signs, pavement markers and pavement line marking. | |

The air quality assessment was completed in accordance with the following relevant guidelines:

- *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016) (the Approved Methods); and
- *Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline* (EPA 2011).

## 12.2 Existing environment

### 12.2.1 Nearest receptors

The surrounding environment and nearest potentially sensitive receptors to the project are described in detail in Chapter 5 (site and surrounds) and in Chapter 11 (noise, refer to Section 11.2.1). The air quality assessment considered the same receptors as per the noise assessment and illustrated in Figure 11.1; which are 74 assessment locations or 75 dwellings (location 14 was identified as having two dwellings on the property).

### 12.2.2 Meteorology

Meteorological conditions affect the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Dust generation events are particularly dependent on wind regimes, rainfall, evaporation, atmospheric stability and depth of mixing in the lower atmosphere.

In order to characterise the dispersion meteorology of the project area and surrounds, long-term climate records, time resolved meteorological monitoring data and meteorological modelling for the region were drawn upon.

Hume Coal commissioned a meteorological station in March 2012 at the southern end of the project area (referred to as Hume No. 1) to collect site specific meteorological data, approximately 8.1 km south of where the surface infrastructure area is now proposed. In addition to this Hume Coal meteorological station, monitoring data was also obtained from the following weather stations:

- BoM automatic weather station (AWS) at Moss Vale (station number 068239), approximately 11.5 km east-south-east of the surface infrastructure area;
- BoM long-term climate station at Moss Vale (Hoskins Street, station number 068045), approximately 8.3 km south-east of the surface infrastructure area; and

- Boral-owned meteorological station at the Berrima Cement Works, approximately 4.5 km east-south-east of the surface infrastructure area.

Siting of the Hume No. 1 onsite weather station was undertaken prior to the location of the surface infrastructure area being decided upon. Once the location was confirmed in the north of the project area, a second weather station (Hume No. 2) was commissioned in this area to determine the representativeness of the data recorded by Hume No. 1 for the surface infrastructure area. This second station was installed in October 2015.

Concurrent data recorded between October 2015 and July 2016 from the BoM Moss Vale AWS, Hume No. 1, Hume No. 2 and Boral's Berrima Cement Works weather stations was collated, with period wind roses generated (refer to Figure 12.1). The wind roses presented in Figure 12.1 show that:

- The general wind direction profile recorded at all four monitoring stations is similar, with dominant air flow from the north-east, south-east and west evident;

- The Hume No. 1 station typically records higher wind speeds than the concurrent wind speed recorded at the Hume No. 2 station due to differing geography between the locations; and

- The BoM Moss Vale AWS records higher wind speeds than all other analysed sites, which is due to its exposed siting in an area with minimal surrounding trees and structures.

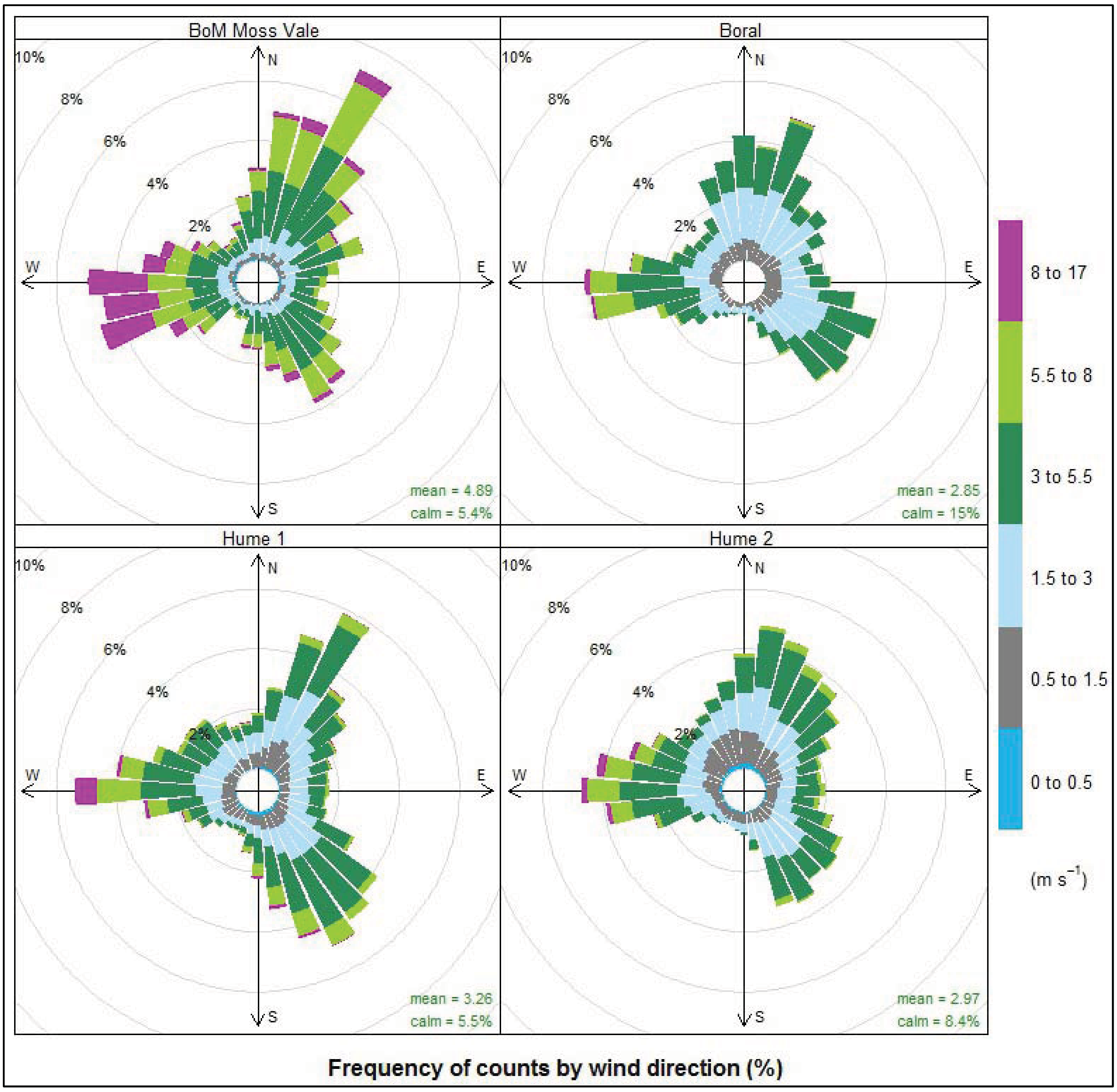



**Figure 12.1** **Wind roses – comparison of concurrent wind data (October 2015 to July 2016) (Ramboll Environ 2017)**

The wind roses in Figure 12.1 show that the general wind direction profile to be similar at all four weather stations, and confirmed the data collected by Hume Coal No. 1 is representative of conditions likely to be experienced in the surface infrastructure area.

Data collected during 2013 was used in the air quality assessment as it represented a complete calendar year which was recorded by the Hume Coal No. 1 monitoring station at the commencement of the air quality assessment. Data capture for 2014 was below the 90% completeness requirement of the Approved Methods due to instrumentation issues between June and September 2014, while 2015 was not yet a complete calendar year at the time of commencement of dispersion modelling and data analysis for the assessment. Analysis of long-term climate records was undertaken to confirm the appropriateness of using 2013 data. 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 were generated from recorded wind speed and direction data at the BoM Moss Vale AWS for the five year period between 2010 and 2014 inclusive. These figures are presented within Appendix 1 of the air quality assessment report (refer to Appendix K) and show that minimal variation in winds occurred from year to year across this period at Moss Vale.

The inter-annual consistency in recorded wind speed and direction at the BoM Moss Vale AWS confirmed the representativeness of data recorded during the 2013 calendar year, and was therefore used in the air quality assessment.

Wind rose diagrams showing wind speed and direction data recorded at the Hume No. 1, BoM Moss Vale AWS and Boral's Berrima Cement Works monitoring stations during 2013 is presented in Figure 12.2.

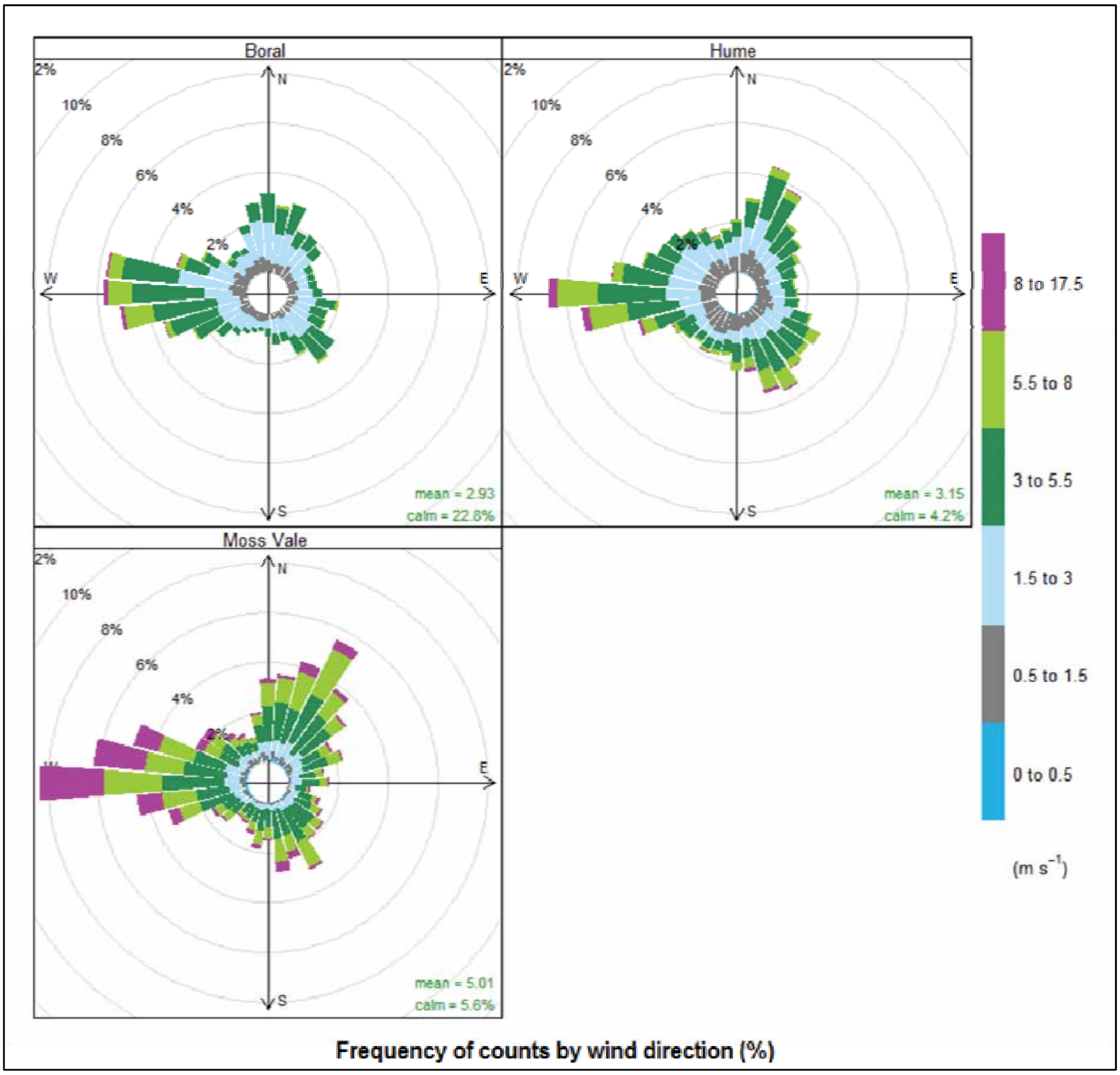



**Figure 12.2 Annual wind roses (2013) – Hume No. 1, BoM Moss Vale AWS and Boral's Berrima Cement Works weather stations**

Figure 12.2 shows that the dominant wind direction is westerly, and that the wind direction experienced across the local area is relatively uniform. However, there is spatial variance with regard to wind speed, in particular high wind speeds. Depending on the input meteorological dataset applied, this variance in wind speed will result in a variation in both particulate matter emission calculations and the predicted ground level concentrations in the surrounding environment. To understand the implications of different wind speed data, emission calculations and atmospheric dispersion modelling have been undertaken using two meteorological monitoring datasets (ie two complete years of modelling):

- the 2013 Hume No. 1 monitoring dataset; and
- the 2013 BoM Moss Vale AWS monitoring dataset.

Further reasons for the use of two climate data sets as provided in the air quality assessment are as follows:

- data recorded at the BoM Moss Vale AWS is reflective of elevated wind conditions due to a very exposed station siting. The BoM Moss Vale station therefore provides a conservative monitoring dataset for the calculation of wind-dependant emissions from the project (eg stockpile wind erosion, material handling activities);
- the comparison of data recorded at the more recently installed Hume No. 2 meteorological monitoring station (in the surface infrastructure area) with concurrent measurements at the Hume No. 1 station (in the southern extent of the project area) demonstrates that the Hume No. 1 station is representative of conditions in the northern section of the project area. The Hume No.1 2013 meteorological dataset was therefore adopted as a more realistic representation of meteorological conditions in the project area, relative to the BoM Moss Vale dataset; and
- 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.

To supplement these data sets, the CSIRO prognostic meteorological model, The Air Pollution Model (TAPM), was used to generate parameters not routinely measured; specifically the vertical temperature profile, and to substitute any data gaps in the monitoring datasets. Details on the TAPM model are contained in Appendix K.

A summary of the key meteorological parameters of the project area obtained from the BoM Moss Vale AWS and Hume No. 1 station is provided in Chapter 5.

### 12.2.3 Baseline air quality environment

#### i Existing sources of air emissions

In order to characterise baseline air quality, a review of existing sources of air pollutants in the local environment was undertaken. The National Pollutant Inventory (NPI) database lists the following sources of air pollution emissions within 10 km of the project area:

- Berrima Cement Works, New Berrima – clinker and cement manufacture;
- Ingham 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 POEO Act public register lists the following activities within the surrounding 10 km from the project area:

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

Other sources of potential atmospheric emissions in the vicinity of the project area are:

- dust entrainment due to vehicle movements along unsealed and sealed public roads;
- farming;
- forestry;
- quarrying;
- light industry;
- petrol and diesel emissions from vehicle movements along public roads;
- wind generated dust from exposed areas within the surrounding region;
- episodic emissions from local vegetation burning (eg grass and bushfires); and
- seasonal emissions from household wood burning fires, pollen and volatiles from vegetation.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires.

### ii Monitoring data

Monitoring data from a number of stations was collated to establish the baseline air quality environment in the vicinity of the project area, as listed below:

- Hume-owned tapered element oscillating microbalance (TEOM) 1 - continuous concentrations of particulate matter ($PM_{10}$ and $PM_{2.5}$) is recorded, approximately 8 km south of the surface infrastructure area;
- Boral Berrima Cement Works high volume air sampler – one-in-six day 24-hour average concentrations of total suspended particulate matter (TSP) and $PM_{10}$ is measured, approximately 4.5 km east of the surface infrastructure area;
- NSW OEH air quality monitoring stations (TEOM) - located at Bargo and Camden, approximately 33 km and 62 km to the north-east of the surface infrastructure area respectively. Continuous concentrations of particulate matter ($PM_{10}$ and $PM_{2.5}$) and gaseous air pollutants are recorded; and

- ACT Government air quality monitoring station at Monash - located approximately 150 km south-west of the surface infrastructure area, and records continuous concentrations of particulate matter and gaseous pollutants. While spatially distant from the project area, the inclusion of this data assisted with understanding particulate matter concentrations beyond the influence of the Greater Sydney Metropolitan area and identifies any regional elevated events.

The locations of meteorological and air quality monitoring stations in and surrounding the project area are shown in Figure 5.1 (refer to Chapter 5). A summary of the existing air quality environment based on data collected by these stations is summarised below.

### iii Total suspended particles

Publically available TSP monitoring in the project area, TSP data recorded since 2010 at the Boral Berrima Cement Works was used in the air quality assessment. Annual average TSP concentrations are presented in Figure 12.3. Average TSP concentrations are lower than the applicable NSW EPA assessment criterion of 90 µg/m³ for all years.

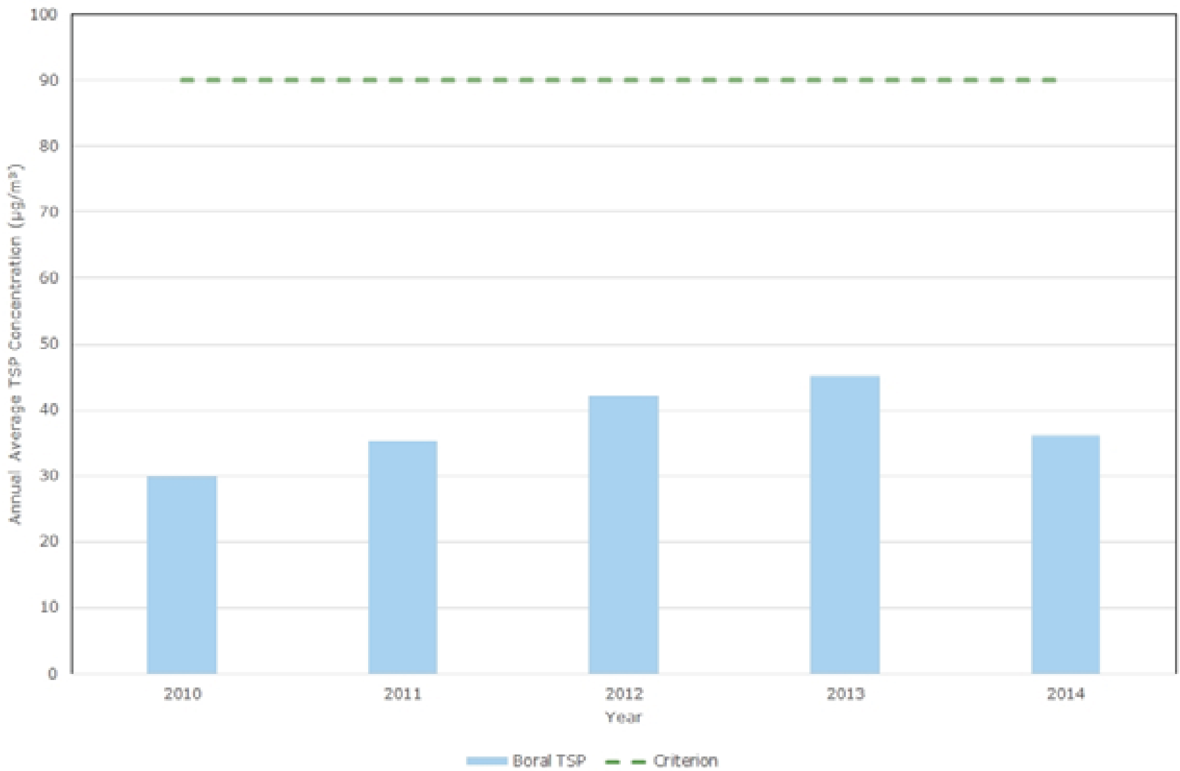



**Figure 12.3 Annual average TSP concentrations**

### iv $PM_{10}$

Concentrations of $PM_{10}$ are recorded at the Hume TEOM 1, Boral Berrima Cement Works, OEH Camden and Bargo stations and the ACT Government Monash station. Data collected from these stations from 2010-2014 is presented in Figure 12.4, which shows that 24-hour average $PM_{10}$ concentrations fluctuated over the period described above, and there were a small number of exceedances of the 24-hour average NSW EPA assessment criterion (50 µg/m³) occurring at each monitoring location. Most of these exceedances occurred in late October/early November 2013, when extensive bushfires occurred across NSW.

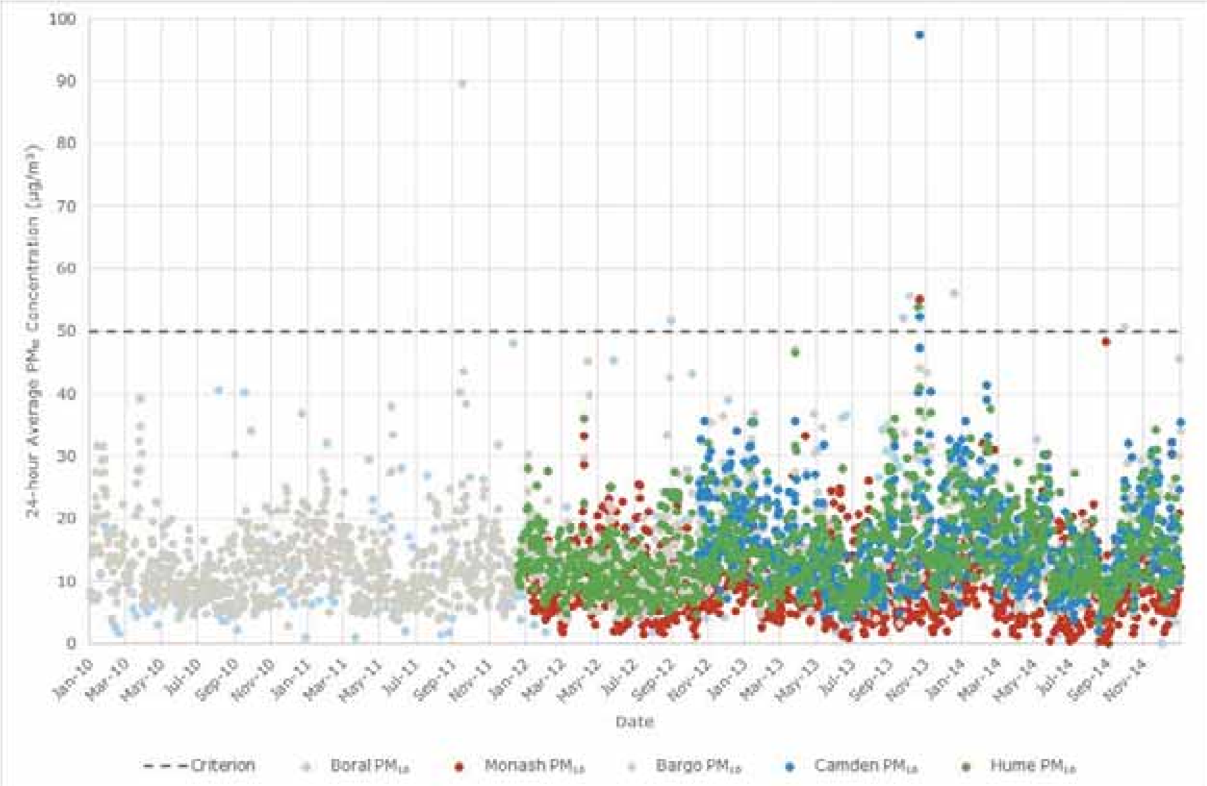



**Figure 12.4 Time series plot of daily varying 24-hour average $PM_{10}$ concentrations – January 2010 to December 2014 (Ramboll Environ 2017)**

Annual average $PM_{10}$ concentrations for the same period are presented in Figure 12.5, and are below the NSW EPA assessment criterion of 30 µg/m³ at all locations. At the Hume TEOM 1 station, the average annual $PM_{10}$ concentration across the dataset is 14.3 µg/m³.

Notably, there is good agreement between the local stations (Hume TEOM 1 and Boral Berrima) with stations located further afield (Bargo, Camden and Monash), indicating that the Hume TEOM 1 $PM_{10}$ dataset is appropriate for the representation of ambient concentrations in the local area.

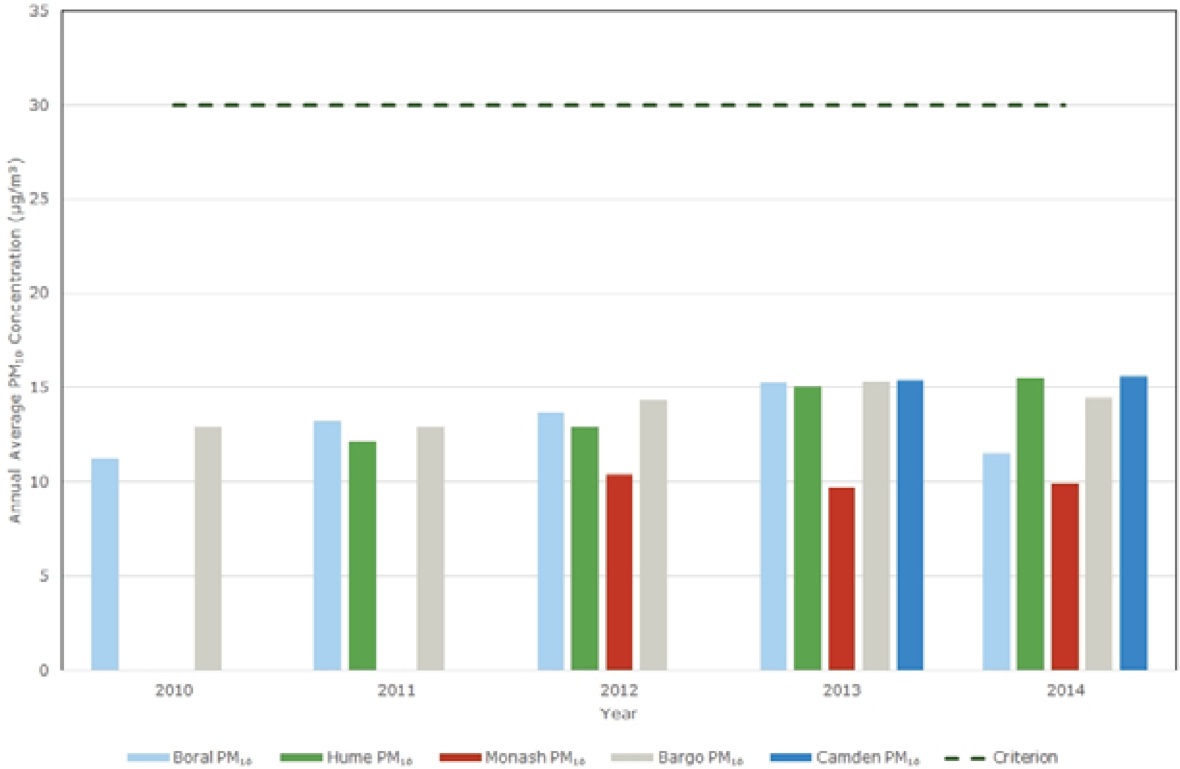



**Figure 12.5 Annual average $PM_{10}$ concentrations – local and regional monitoring locations - 2010 to 2014 (Ramboll Environ 2017)**

### v $PM_{2.5}$

Concentrations of $PM_{2.5}$ are monitored at the Hume TEOM 1, OEH Camden and ACT Government Monash stations. The average ratio of recorded $PM_{2.5}$ to corresponding $PM_{10}$ concentrations at the Hume TEOM 1 station is approximately 0.8. This is significantly higher than the average ratio of $PM_{2.5}$ to $PM_{10}$ concentrations across all NSW OEH monitoring stations, which ranges from 0.3 to 0.5. A second TEOM (TEOM 2) was therefore installed by Hume Coal in the vicinity of the surface infrastructure area in July 2015. Analysis of data from TEOM 2 showed agreement for both $PM_{10}$ (across all stations), and $PM_{2.5}$ (for regional stations only), indicating that the original Hume TEOM 1 $PM_{2.5}$ station concentrations were erroneously high. Further investigation and maintenance work on Hume TEOM 1 subsequently confirmed that the equipment was reading incorrectly high levels of $PM_{2.5}$. Therefore, the $PM_{2.5}$ to $PM_{10}$ ratio of the nearest OEH monitoring station (Camden) was adopted to derive a background $PM_{2.5}$ dataset for the project area. The referencing of the $PM_{2.5}/PM_{10}$ ratio from the Camden dataset is consistent with Section 4.2 of the Approved Methods to conservatively derive existing $PM_{2.5}$ concentrations in the project area.

The average $PM_{2.5}/PM_{10}$ ratio recorded at Camden between October 2012 (when monitoring commenced there) and January 2014 was 0.41, which was therefore used to derive $PM_{2.5}$ values for the Hume TEOM 1 station, based on the $PM_{10}$ results recorded at that station. 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 12.6.

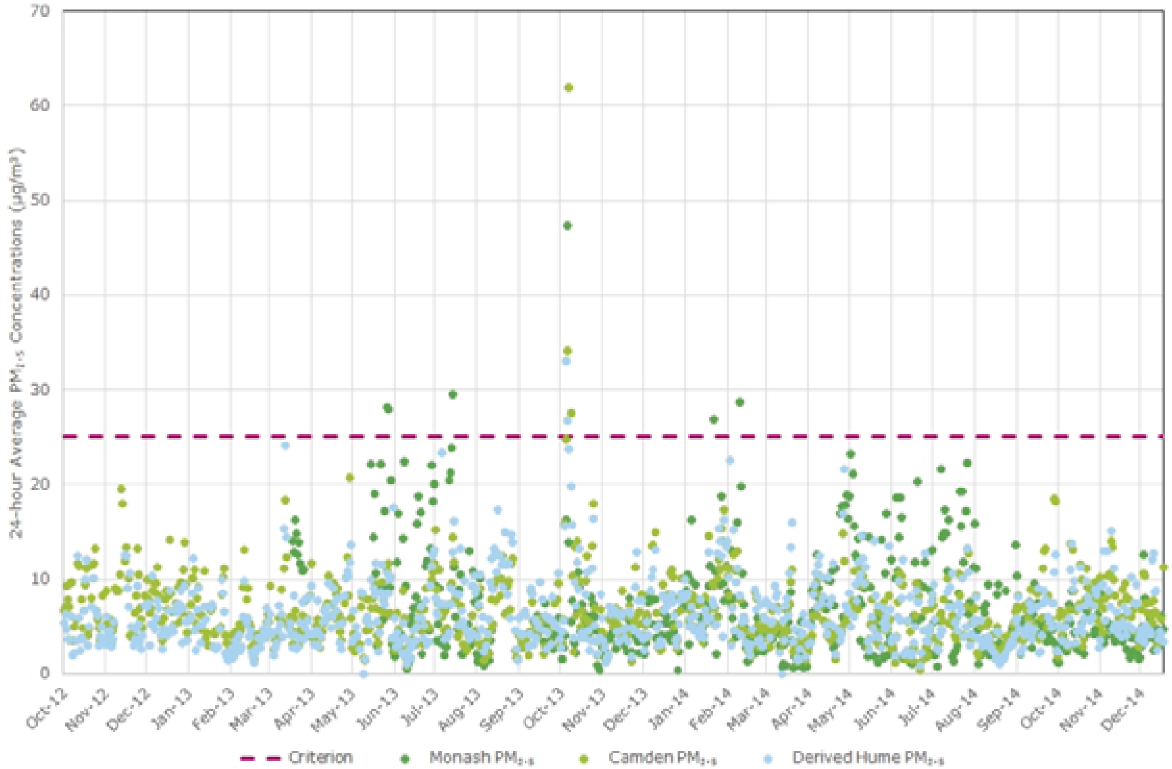



**Figure 12.6 Time series plot of daily varying 24-hour average $PM_{2.5}$ concentrations – October 2012 to December 2014 (Ramboll Environ 2017)**

Like the $PM_{10}$ monitoring data, $PM_{2.5}$ levels fluctuate throughout the period analysed. Some exceedances of the 24-hour average NEPM advisory reporting goal (25 µg/m³) occur; once again mostly occurring during the NSW October/November 2013 bushfires. Ramboll Environ also analysed the frequency distribution of derived and recorded $PM_{2.5}$ concentrations between December 2012 and December 2014, finding the majority of $PM_{2.5}$ concentrations at all locations were below 10µg/m³.

The annual average $PM_{2.5}$ concentration across the derived Hume $PM_{2.5}$ dataset (October 2012 – January 2014) is 6.3 µg/m³. This is below the NEPM advisory reporting goal of 8 µg/m³.

### vi Dust deposition

A network of dust deposition gauges was progressively installed by Hume Coal from 2012 in and around the project area. The average annual dust deposition across all sites between 2012 and 2015 was 0.8 g/m²/month. This is below the applicable NSW EPA criterion of 4 g/m²/month (refer to Figure 12.7).

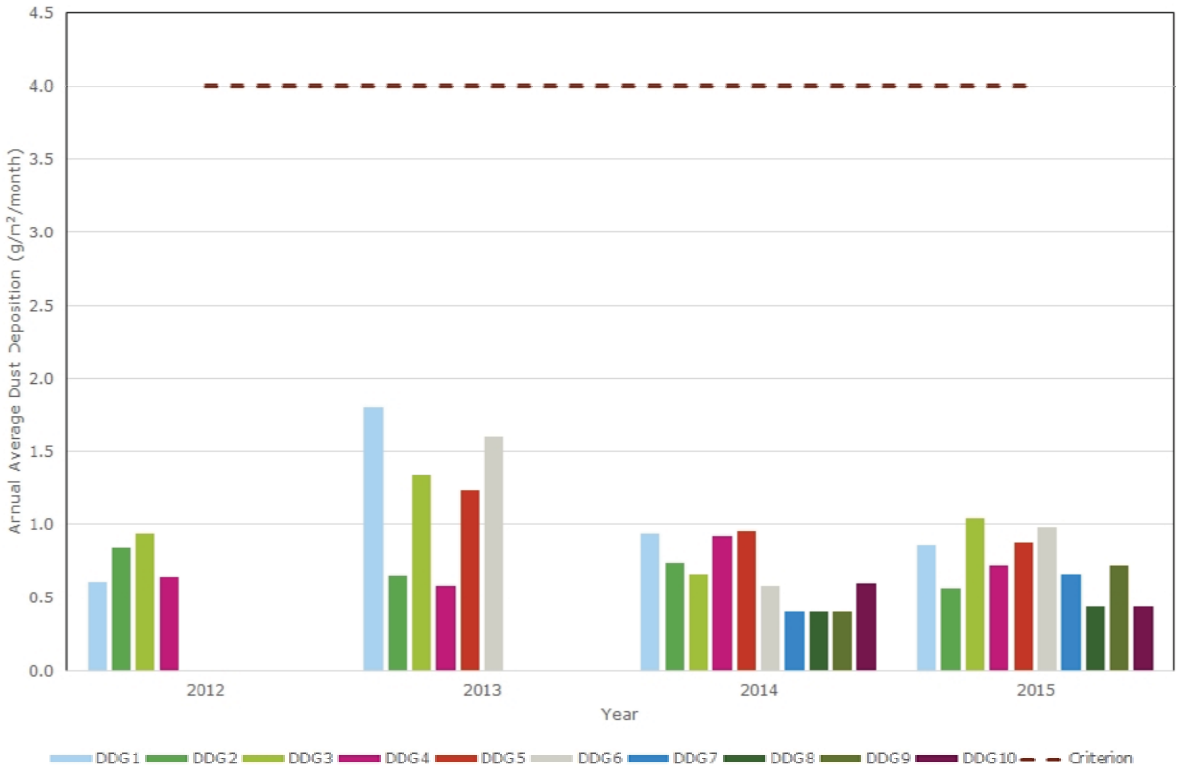



**Figure 12.7 Annual average dust deposition levels - Project area - 2012 to 2015**

### vii Gaseous air pollutants

The air quality assessment predicted levels of nitrogen dioxide ($NO_2$) and the individual volatile organic compound (VOC) species benzene, ethylbenzene, toluene and xylenes. Of these pollutants, only $NO_2$ has a cumulative impact assessment criterion, with individual VOC species assessed as increment only. No monitoring of ambient gaseous pollutants is conducted in the immediate vicinity of the project area. The closest available data is from the NSW OEH Bargo station. A summary of maximum and average concentrations recorded since 2010 is presented in Table 12.2.

**Table 12.2 Summary of gaseous air pollutant concentrations (NSW OEH Bargo monitoring station)**

| Year | $NO_2$ (µg/m$^3$) | | $O_3$ (µg/m$^3$) | |
|---|---|---|---|---|
| | **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** | **-** |

### viii Summary of baseline air quality parameters

A summary of the ambient baseline air quality data used in the air quality assessment for cumulative impacts is presented in Table 12.3.

**Table 12.3 Ambient baseline air quality data summary**

| Parameter | Data used in cumulative impact assessment |
|---|---|
| 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 Berrima, 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$^3$ |
| Annual dust deposition | 0.8 g/m$^2$/month |
| $NO_2$ | Hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous ozone limiting method (OLM) analysis with modelling period predictions (as per the Approved Methods). |
| $O_3$ | Hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous OLM analysis with modelling period predictions (as per the Approved Methods). |

## 12.3 Air quality methodology and assessment criteria

### 12.3.1 Methodology

The air quality assessment included assessment of particulate matter emissions, particularly TSP, $PM_{10}$ and $PM_{2.5}$. Dust deposition and gaseous air pollutants, as well as greenhouse gas emissions were also assessed. The results of the greenhouse gas assessment are presented in Chapter 13.

Atmospheric dispersion modelling was conducted using 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.

The air quality impacts associated with the project were predicted for both the construction and operation phases. Construction impacts were assessed based on the year in which the peak amount of material will be handled. Operational scenarios were based on peak ROM coal extracted (3.5 Mtpa). Assumptions and emission sources associated with each phase are presented below.

### i Construction phase

For the purposes of the air quality assesment, the construction phase of the project can be broadly divided into three stages:

- early works;
- construction of surface infrastructure; and
- underground drifts and associated infrastructure.

Peak air pollution emissions potential from the construction phase of the project will be associated with surface infrastructure construction and the establishment of the drift portals. The peak year of construction activities will involve the movement and handling of around 635,000 $m^3$ of material. Emissions from truck movements along unpaved roads will be the most dominant sources of coarser particulate matter fractions, while diesel combustion in construction vehicles will be the more dominant source of finer fractions ($PM_{10}$ and $PM_{2.5}$). Construction activities were assumed to occur concurrently in the areas of the drift portal, primary water dam and the remainder of the surface infrastructure area, as well as the construction of the rail loop associated with the Berrima Rail Project. This is conservative as construction of the surface infrastructure will be phased rather than simultaneous.

Particulate matter emissions will be largely controlled during the construction phase of the project by the application of water. The particulate matter control measures incorporated into the modelling of air quality impacts in the construction phase are presented in Table 12.4.

### Table 12.4 Particulate matter control measures – construction scenario

| Emission source | Control measure | Emission reduction factor (%) |
|---|---|---|
| Dozer operations | Water added to travel routes | 50 |
| Grader operations | Water added to travel routes | 50 |
| Material haulage | Watering of unsealed roads | 75 |
| Wind erosion | Watering of exposed areas | 50 |

### ii Operational phase

By the time peak ROM coal extraction is reached, it is unlikely that the surface storage of rejects material will still be occurring, as by this time there will be sufficient room underground to store rejects within the void. Therefore, when the mine is at full ROM coal production rejects will be pumped to the underground void. However, to ensure a conservative assessment of air quality impacts, the assessment assumed that emissions relating to the surface storage of reject material (bulldozer, front end loader (FEL) handling and transportation, conveyor transfer and wind erosion) will coincide with peak coal extraction.

Emissions of particulate matter from the ventilation shaft were quantified by referencing monitoring data from a number of operational underground coal mines located in the Illawarra, Western and Central Coast coal mining areas.

Emissions from stockpile wind erosion and the ventilation shafts will be the most dominant sources of particulate matter, as expected given the underground nature of the project, since typical dominant sources associated with open cut operations are eliminated for underground projects. Hume Coal is investigating several control methods for effective dust mitigation from the product stockpiles, including automated water sprays and veneering, which would be undertaken using biodegradable starch-based or polymer-based veneering solutions, of which there are a wide range currently available on the market. The veneer acts by forming a crust on the surface of the stockpile and preventing wind lift-off of fine particles.

The emission scenarios are as follows:

- Operations with product stockpiles controlled by watering only – a nominal 50% emission reduction factor was applied to product stockpile emissions to account for control by water sprays (Katestone, 2011). This factor is considered lower bound, as supported by Katestone (2011).

- For storage pile wind erosion, the estimated control efficiency for water sprays is reported at 50% to 80%. Modern automated sprays may be capable of better performance than this.

- Operations with product stockpiles controlled by watering and veneering – a nominal 95% emission reduction factor was applied to product stockpile emissions to account for the application of a surface veneer (Katestone, 2011). For this scenario it was assumed that at any given time, 20% of the total product coal stockpile area is actively disturbed by stacker/reclaimer activity and controlled by water sprays only (50% reduction), with the remaining 80% area stabilised by a veneer (95% reduction).

Laboratory analysis of the dust extinction moisture (DEM) content of project coking coal samples was undertaken for two project samples. DEM content is the level of material moisture content above which dust emissions can be controlled. The results of the DEM content analysis showed that the Hume Coal coking coal samples possessed a DEM content between 4% and 5%. The typical moisture level in product coal will be around 10%. The application of water to coal stockpiles and transfer points to maintain moisture content above the DEM content will assist with the management of fugitive particulate matter emissions from the project. The particulate matter control measures assumed in the modelling of air quality during the operation of the project are presented in Table 12.5.

**Table 12.5 Particulate matter control measures – operational scenario**

| Emissions Source | Control Measure(s) | Emission Reduction Factor (%)[1] |
|---|---|---|
| ROM coal conveyor transfer points, sizing and screening stations, CPP internal processes | Water sprays / wet process | 50 |
| | Full enclosure | 70 |
| | Combined emission reduction | 85 |
| Product coal and rejects and paste plant conveyor transfer points | Full enclosure | 70 |
| FEL handling rejects | Watering | 50 |
| Dozer on temporary storage area | High moisture in travel routes / watering | 50 |
| FEL travel from storage area to hopper | Route watering | 75 |
| Conveyor belt wind erosion - enclosed sections | Enclosure | 70 |
| ROM stockpile | Water sprays | 50 |
| Product stockpiles | Water sprays | 50 |
| Product stockpiles | Surface veneering | 95 |
| Reject temporary storage | Water sprays | 50 |
| Wind erosion of coal dust from rail wagons | Full enclosure | 100 |

Note: 1. All control reduction factors adopted from *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011). Where multiple controls are in place (eg sizing station), the multiplicative control factor has been applied as per NPI (2012).

### 12.3.2 Air quality criteria

In NSW, proposed developments must demonstrate compliance with the impact assessment criteria specified in the Approved Methods (EPA 2016). The impact assessment criteria are designed to ensure maintenance of ambient air quality levels that protect human health and well-being. Relevant ambient air quality criteria applicable to the project are described below.

### i Airborne particulate matter

Table 12.6 lists the criteria used for the assessment of impacts from particulate matter including TSP, $PM_{10}$ and $PM_{2.5}$. The impact assessment criteria for TSP and $PM_{10}$ are prescribed in the Approved Methods. The 2016 update to the Approved Methods, which was 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). 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 12.6 for information only.

The NSW EPA's 24-hour $PM_{10}$ assessment criterion of 50 µg/m³ is numerically identical to the current National Environment Protection Measures (NEPM) air quality standard, except that the NEPM standard allows up to five exceedances per year to provide for infrequent bushfires or dust storms. The EPA $PM_{10}$ 24-hour criterion does not allow any exceedances.

**Table 12.6 Impact assessment criteria for particulate matter**

| Pollutant | Concentration (µg/m³) | Averaging Period | Reference |
|---|---|---|---|
| TSP | 90 | Annual | NSW EPA(1) |
| $PM_{10}$ | 50 | 24 hours | NSW EPA(1) |
| | 25 | Annual | NSW EPA(1) |
| $PM_{2.5}$ | 25 | 24 hours | NSW EPA(1) |
| | 8 | Annual | NSW EPA(1) |
| | 20 | 24 hours | AAQ NEPM long term goal for 2025 |
| | 7 | Annual | AAQ NEPM long term goal for 2025 |

*Notes: 1.NSW EPA, 2016 Approved Methods for Modelling.*

### ii Dust deposition criteria

Nuisance dust deposition is regulated through the stipulation of the maximum permissible dust deposition rates. The NSW EPA impact assessment goals for dust deposition are summarised in Table 12.7. The table illustrates the allowable increment in dust deposition above ambient (background) dust deposition rates to avoid nuisance.

**Table 12.7 Impact assessment criteria for dust deposition**

| Pollutant | Maximum increase in deposited dust level | Maximum total deposited dust level | Agency |
|---|---|---|---|
| Deposited dust | 2 g/m²/month | 4 g/m²/month | EPA |

*Source: Approved Methods (EPA 2016).*

### iii Gaseous air pollutants

Emissions of gaseous air pollutants are the result of fuel combustion by mobile plant and equipment and diesel locomotives associated with the project. The relevant combustion-related gaseous air pollutants considered in the air quality assessment were $NO_2$ and VOCs including benzene, ethylbenzene, toluene and total xylenes. The NSW EPA air quality criteria for these pollutants are summarised in Table 12.8.

The air quality impact assessment criterion for $NO_2$ is applicable at the nearest existing or likely future off-site privately owned residences. In making assessments against these criteria, the total concentration (increment from the project plus background concentration) must be reported as the 100th percentile in concentration units consistent with the impact assessment criteria. These are then compared with the relevant impact assessment criteria (EPA 2016).

The criteria specified for benzene and ethylbenzene are applicable at and beyond the boundary of the facility. For a Level 2 assessment, as was undertaken in the air quality assessment, 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 privately owned residences. 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 12.8 Impact assessment criteria for combustion pollutants

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

*Notes:* *1. Approved Methods (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.*

### iv Odour criteria

The odour performance criteria are expressed in terms of odour units. The detectability of an odour is defined as a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU). An odour criterion of less than 1 OU would theoretically result in no odour impact being experienced.

Odour criteria are based on the population of the potentially affected community; the higher the population the lower the criteria. The odour performance criteria for different population densities as outlined in the Approved Methods (EPA 2005) are presented in Table 12.9.

### Table 12.9 OEH Odour performance criteria

| Population of Affected Community | Odour Performance Criteria - OU(1) |
|---|---|
| Urban area (> 2000) | 2.0 |
| 500 – 2000 | 3.0 |
| 125 – 500 | 4.0 |
| 30 – 125 | 5.0 |
| 10-30 | 6.0 |
| Single residence (< 2) | 7.0 |

A conservative odour criterion of 2 OU was adopted for the project.

## 12.4 Air quality impact assessment

The detailed emission calculations and equations for the two scenarios (construction and operation) are presented in Appendix 4 of the air quality impact assessment report (Ramboll Environ 2017, refer to Appendix K), and a summary of the results presented in the sub-sections below.

### 12.4.1 Particulate matter

Peak air pollution emissions from the construction phase of the project will be associated with surface infrastructure construction and the establishment of the drift portals. Key sources of particulate matter emissions from the operation of the project will be as follows:

- conveying and transfer of coal and rejects;
- stacker/reclaimer at the ROM and product coal stockpiles;
- ROM coal sizing and screening stations;
- operation of the CPP;
- loading of product coal to rail wagons for dispatch to market;
- transfer and loading of coal rejects to temporary storage area;
- bulldozer operations on rejects temporary storage area;
- handling of rejects by front end loader and transfer to the paste plant hopper;
- wind erosion of stockpiles, temporary storage area and conveyor belts; and
- ventilation shaft emissions from underground operations, including diesel combustion.

#### i Project-only emissions

The maximum predicted project-only incremental particulate matter concentrations and dust deposition rates across all selected sensitive receptor locations for the peak construction and peak operations scenarios are presented in Table 12.10.

**Table 12.10 Maximum particulate matter and deposition rates – Project only emissions**

| Scenario | Maximum Predicted Concentration (µg/m³) – all receptors | | | | | Dust Deposition (g/m²/month) |
|---|---|---|---|---|---|---|
| | Annual TSP | 24-hour $PM_{10}$ | Annual $PM_{10}$ | 24-hour $PM_{2.5}$ | Annual $PM_{2.5}$ | |
| **Criterion** | **90** | **50** | **25** | **25** | **8** | **2** |
| Construction | 2.0 | 4.6 | 0.9 | 1.9 | 0.3 | 0.2 |
| Operation[1] | 1.1 | 4.7 | 0.3 | 1.6 | 0.2 | 0.1 |
| Operation[2] | 1.1 | 2.1 | 0.3 | 1.6 | 0.2 | 0.1 |

*Notes* *1. Product stockpile watering only.*

*2. Product stockpile veneering and watering.*

The results presented in Table 12.10 show the following:

- all project-only incremental concentrations and deposition rates are well below the applicable impact assessment criteria;
- predicted TSP and $PM_{10}$ concentrations are generally higher during the construction phase due to the high amount of surface-based activities (material excavation and handling, unpaved road haulage of materials) compared to the operational phase of the project;
- predicted $PM_{2.5}$ concentrations are comparable between the construction and operational scenarios. Highest $PM_{2.5}$ concentrations in the area are associated with emissions from the ventilation outlets, with $PM_{2.5}$ impacts associated with diesel combustion;
- the application of veneering (assumed control efficiency of 95% in accordance with literature) in combination with water spraying at the product stockpiles is effective at reducing worst case 24-hour average $PM_{10}$ concentrations (occurring on days with high wind conditions) relative to the implementation of water spraying alone. There is little change between the watering only and veneering and watering product stockpile scenarios for annual average $PM_{10}$ concentrations at receptors; and
- for both operational emission scenario options (watering only or watering and veneering at the product stockpiles), the predicted emissions are well below applicable impact assessment criteria at all surrounding receptors.

The criteria for TSP, $PM_{10}$ and $PM_{2.5}$ noted in Table 12.10 are applicable to cumulative concentrations. Cumulative impacts are addressed in Sections 12.4.1 iii and 12.4.1 iv below.

### ii Project and neighbouring industrial operations

The combined maximum predicted project-related and neighbouring industrial emission source incremental particulate matter concentrations and dust deposition rates, across all selected sensitive receptor locations, for the peak construction and peak operations scenarios are presented in Table 12.11.

**Table 12.11 Maximum particulate matter and deposition rates – Project only plus neighbouring industrial sources**

| Scenario | Maximum Predicted Concentration (µg/m³) – all receptors | | | | | Dust Deposition (g/m²/month) |
|---|---|---|---|---|---|---|
| | Annual TSP | 24-hour $PM_{10}$ | Annual $PM_{10}$ | 24-hour $PM_{2.5}$ | Annual $PM_{2.5}$ | |
| **Criterion** | **90** | **50** | **25** | **25** | **8** | **2** |
| Construction | 4.9 | 13.5 | 3.1 | 4.0 | 0.6 | 0.2 |
| Operation[1] | 5.0 | 13.5 | 3.2 | 4.0 | 0.6 | 0.3 |
| Operation[2] | 5.0 | 13.5 | 3.2 | 4.0 | 0.6 | 0.2 |

*Notes 1 Product stockpile watering only.*
*2 Product stockpile veneering and watering.*

All concentrations and deposition rates are predicted to be well below the applicable impact assessment criteria. It is noted however that the criteria for TSP, $PM_{10}$ and $PM_{2.5}$ are applicable to cumulative concentrations, as discussed in the following sub-sections.

### iii Cumulative 24-hr average concentrations

The cumulative 24-hr average particulate concentrations were assessed based on predicted project-related emissions, neighbouring industrial emission sources, and ambient air quality levels.

Cumulative impacts for 24-hour $PM_{10}$ and $PM_{2.5}$ were evaluated using a statistical approach which calculated the likelihood of the project causing exceedances of the 24-hour average assessment criterion of 50 µg/m$^3$ and 25 µg/m$^3$ for $PM_{10}$ and $PM_{2.5}$ respectively. To provide an analysis of the likelihood of compliance with the NSW EPA assessment criterion for 24-hour average $PM_{10}$ (50 µg/m$^3$) and $PM_{2.5}$ (25 µg/m$^3$), every predicted 24-hour average concentration over the 12-month analysis period (365 individual concentrations) was paired with every recorded 24-hour average concentration from the data sources described in Section 12.2.3. Due to the large number of assessment locations, the top ten highest receptor locations for 24-hour $PM_{10}$ and $PM_{2.5}$ were selected for detailed cumulative analysis.

The frequency analysis of the ambient air quality background dataset, comprising data from local and regional monitoring sources indicates that the region has a 0.2% likelihood (or 0.7 days per year) of experiencing a 24-hour average $PM_{10}$ concentration greater than 50 µg/m$^3$ and a 0.5% likelihood (or 1.9 days per year) of experiencing a 24-hour average $PM_{2.5}$ concentration greater than 25 µg/m$^3$. Infrequent exceedances of the applicable particulate matter criterion are generally associated with large-scale natural events, such as bush fires and dust storms.

When particulate emissions from the project are also taken into account, the frequency of potential cumulative 24-hour average $PM_{10}$ concentrations greater than 50 µg/m$^3$ across all ten receptors is between 0.2% and 0.3%, representing a negligible change. Similarly, the frequency of potential cumulative 24-hour average $PM_{2.5}$ concentrations greater than 25 µg/m$^3$ is between 0.5% and 0.6%, which again is a negligible change. The frequency analysis therefore demonstrates that the likelihood of an additional exceedance day occurring as a result of emissions from the project is negligible for both 24-hour average $PM_{10}$ and $PM_{2.5}$.

#### iv Cumulative annual average concentrations

The predicted annual average concentrations as a result of project-related emissions and neighbouring industrial operations, combined with ambient background levels, are presented in Table 12.12. The results show that all cumulative annual average concentrations and deposition levels are predicted to be below the applicable impact assessment criteria for all modelling scenarios across all sensitive receptor locations.

**Table 12.12 Predicted annual cumulative particulate concentrations and deposition rates**

| Scenario | Maximum Predicted Concentration (µg/m$^3$) – all receptors | | | Dust Deposition (g/m$^2$/month) |
|---|---|---|---|---|
| | Annual TSP | Annual $PM_{10}$ | Annual $PM_{2.5}$ | |
| **Criterion** | **90** | **25** | **8** | **2** |
| Construction | 42.5 | 17.4 | 6.8 | 1.0 |
| Operation[1] | 42.6 | 17.5 | 6.9 | 1.1 |
| Operation[2] | 42.6 | 17.5 | 6.9 | 1.0 |

*Notes: 1 Product stockpile watering only.*

*2 Product stockpile veneering and watering.*

On an annual average basis, the predicted $PM_{10}$ and $PM_{2.5}$ emissions from the project are low relative to the combination of existing neighbouring emission sources and ambient baseline levels at all selected receptor locations. It is also noted that for the operational emission scenarios, the inclusion of veneering as a dust mitigation measure at the product stockpiles does not significantly reduce annual average concentrations. The benefit of this additional control measure is observed in reducing peak short-term (24-hour average) concentrations under elevated wind speed conditions.

### 12.4.2 Gaseous pollutants

The maximum predicted concentrations of $NO_2$ and VOCs are presented in Table 12.13, including project only and cumulative concentrations. The predicted concentrations are below applicable air quality impact assessment criteria, noting that the methodology for deriving $NO_2$ concentrations from predicted $NO_x$ concentrations is highly conservative, as discussed in detail in the air quality impact assessment (refer to Appendix K).

**Table 12.13 Maximum predicted incremental and cumulative NO2 and VOC concentrations**

| Criterion | Max Predicted Concentration (µg/m³) – all receptors | | 99.9th Percentile 1-hour concentration (µg/m³) – all receptors | | | |
|---|---|---|---|---|---|---|
| | 1-hour $NO_2$ | Annual $NO_2$ | Benzene | Ethylbenzene | Toluene | Xylenes |
| | 246 | 62 | 29 | 8,000 | 360 | 190 |
| Project Only | 16.7 | 0.3 | 0.1 | 0.1 | 0.2 | 0.3 |
| Project + Neighbouring Emissions Sources + Ambient Background | 201.7 | 23.0 | - | - | - | - |

*Notes: 1. Criterion for benzene, ethylbenzene, toluene and xylenes is applicable to incremental concentrations.*

### 12.4.3 Odour concentrations

Potential odour emissions from the ventilation shaft outlet were modelled, drawing on odour monitoring results obtained from other underground coal mining operations in NSW.

The predicted 99th percentile 1-second (nose response) odour concentrations across all surrounding receptors is below the conservative odour assessment criterion of 2 OU.

## 12.5 Health impact assessment

### 12.5.1 Background

Inhalation of suspended particulate matter is a natural phenomenon that has occurred throughout evolution, and the normal lung is well adapted to remove most forms of foreign matter using a range of defence mechanisms. The potential for inhaled particulates to cause harm depends on a number of factors including:

- the chemical and physical nature of the particles;
- the concentration of the particles in the air;
- the percentage of particulate matter which is less than 10 µm in diameter, and therefore small enough to be inhaled into the lung, and large enough to be deposited into the lung rather than to be exhaled (also known as $PM_{10}$); and
- the individual susceptibility of the person inhaling the dust.

The composition of the $PM_{10}$ fraction of airborne dust varies markedly from place to place, and with the temperature, humidity, weather and the time of year. The bulk of $PM_{10}$ in urban areas is in the smaller $PM_{2.5}$ fraction, whereas in rural areas the majority of the particles are larger than 2.5 µg. However, the air quality in Australian cities is better than in most other cities of similar size, particularly in relation to the levels of $PM_{2.5}$.

Evidence suggests that the health effects of airborne particles are predominantly due to the $PM_{2.5}$ fraction, which includes the bulk of the products of combustion.

A study in the Hunter Valley (the Upper Hunter Fine Particle Characterisation Study) that assessed $PM_{2.5}$ levels was conducted at two sites, Singleton and Muswellbrook, which are two major towns in close proximity to coal mines and power stations. The study was commissioned by the NSW EPA and undertaken by the CSIRO and ANSTO. It found secondary sulphates (~20%, from sources such as power stations) and wood smoke (~30%, primarily from residential wood heaters) to be the largest contributing factors to $PM_{2.5}$ levels in Muswellbrook and Singleton respectively. Soil, whichincludes fugitive coal dust, accounted for 10-14% across the Upper Hunter (Hibberd et al 2013).

### 12.5.2 Relevant project-related emissions

As described above in Section 12.4.1, particulate matter emissions, gaseous pollutants, odour emissions and dust deposition rates as a result of the mine are all predicted to be well below applicable air quality impact assessment criteria and minor relative to existing ambient conditions.

Operation of the mine is predicted to generate a small increase in $PM_{10}$ and an even smaller increase in $PM_{2.5}$ in the vicinity of the project area. The maximum concentrations predicted to occur in the surrounding area in a 24-hour period of $PM_{10}$ and $PM_{2.5}$ are 4.7 µg/m³ (compared to a criterion of 50 µg/m³) and 0.2 µg/m³ (compared to a criterion of 8 µg/m³), respectively.

The main source of $PM_{2.5}$ from the project will be exhaust fumes from diesel equipment and machinery, which disperse rapidly in the atmosphere. Studies of school children and residents living near major roads in Europe suggest that a localised increase in exhaust emissions can be detected for about 200 m (Van Vliet et al., 1997). Any increase in particulate matter levels from the operation of the mine will not result in exceedances of the criteria specified in the Approved Methods (EPA 2016). Further, the predicted levels of $PM_{2.5}$ are lower than those currently experienced in Australian cities and very low by world standards. Nevertheless, any increase in PM levels may result in a small increase in the statistical risk of health effects. A health risk assessment was therefore conducted to quantify these potential impacts.

### 12.5.3 Health risk assessment

#### i Methodology

A health risk assessment is an analysis that uses information about potentially hazardous pollutants to estimate a theoretical level of risk for people who might be exposed to defined levels of these pollutants.

Assumptions used in a health risk assessment relate to the population profile and health of the potentially exposed, existing air quality, incremental exposures related to the project and known and possible health effects of the exposures. There is insufficient data on health effects of living near a coal mine to derive the exposure concentration – response functions to the various components of pollution. These functions are therefore drawn from large overseas epidemiological studies of populations usually in cities and exposed to urban pollution dominated by products of combustion. On this basis, health risk assessments for a project such as an underground coal mine in a rural setting assume that the health effects of urban pollution at higher concentrations can be extrapolated to a rural setting with a coal mine and other industries. This assumption is likely to overestimate the risk from a mine and is therefore conservative.

A health risk assessment also needs to set specific effects (or 'end-points') to report against. For the health risk assessment of the project, a number of end-points were used in relation to $PM_{2.5}$, as per the method of Jalaludin and Cowie (2012). These were:

- annual mortality all causes, 30+ years (CRF 6% per 10 µg/m³ increase);
- daily mortality all causes, all ages (CRF 0.9% per 3.78 µg/m³ increase); and
- hospital admissions for respiratory disease, 15-64 years (1.1% per 3.78 µg/m³ increase).

The end-points used for the $PM_{10}$ risk assessment were:

- annual mortality all causes, 30+ years (CRF 3.86% per 10 µg/m³ increase);
- daily mortality cardiovascular, all ages (CRF 1.3% per 10 µg/m³ increase); and
- hospital admissions for respiratory disease, 15-64 years (1.22% per 10 µg/m³ increase).

The baseline health statistics used in the risk assessment were based on average rural values for NSW (incidence per annum per 100,000 population), as listed below:

- mortality all causes 30+ years 353
- cardiovascular mortality 136
- respiratory admissions 15-64 years 299

#### ii Results

The predicted number of cases per 100,000 population attributable to the exposure to emissions of $PM_{2.5}$ from cumulative sources, including existing industrial sources, ambient levels from sources such as the Hume Highway, and the Hume Coal project, has been calculated as follows:

> Exposure Response Function (0.00582) x cumulative annual average $PM_{2.5}$ (0.3 µg/m³) x population exposed x death rate 353/100,000 = 0.02

Therefore, the annual number of cases from exposure to $PM_{2.5}$ assuming an exposed population in the sensitive receptor zone of 1,300 is 0.02 cases per 100, 000 population. This represents an increase in annual mortality of approximately 0.005%.

Similar calculations for daily mortality from all causes and for all ages for increases in the 24 hour average $PM_{2.5}$ levels yields 0.0001 attributable cases per 100,000 population, and for hospital respiratory admissions 15-64 years predicts approximately 0.005 attributable cases per 100,000 population.

Calculations for $PM_{10}$ provide similar very small numbers for the attributable cases.

In relation to VOCs and $NO_2$, exposures to these gaseous emissions will be so small that any health effects are likely to be undetectable. The likely concentrations would be below those believed to have no effect in asthmatics, the most sensitive to $NO_2$.

#### iii Summary

The increased risk in the population (based on annual mortality rates, all causes) due to the worst case annual average increased long-term exposure to $PM_{2.5}$ and $PM_{10}$ as a result of the project, will be significantly less than 1 in 100,000. This level of increase is considered to be "sufficiently small and to be of no cause for concern" (NEPM AAQM).

Exposures to daily increases of $PM_{2.5}$ and $PM_{10}$ pose an insignificant risk as the predicted number of attributable cases of daily mortality and cardiovascular disease are substantially less than 1 and orders of magnitude lower than that due to long-term exposure.

## 12.6 Management and monitoring

### 12.6.1 Best practice dust mitigation

The OEH guideline *Coal Mine Particulate Matter Control Best Practice Site-specific determination* (OEH 2011) outlines the process to follow when conducting a site-specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities.

In accordance with this guideline, the top four controlled emission sources should be identified, with the proposed control measures compared with best practice dust management techniques as identified within *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone 2011).

The top four potential sources of TSP, $PM_{10}$ and $PM_{2.5}$ emissions from the project have been identified as:

- wind erosion from coal stockpiles;
- ventilation shaft emissions from underground operations, incorporating both fugitive emissions from coal extraction and transportation and diesel fuel combustion;
- conveyor belt and transfer stations, from both wind erosion and coal transfer emissions; and
- stacking and reclaiming of coal.

A comparison of the dust controls proposed for the project against best practice control measures according to Katestone (2011) is presented in Table 12.14, showing that the proposed control measures are comparable to current best practice measures wherever practicable. Even though not a top four source, coal sizing has been included in the table as it is a potential, if minor, source, and is easily controlled.

### Table 12.14 Best practice dust control measures review

| Emissions source category | Best practice control measures (Katestone 2011) | Proposed for implementation at Project | Comments |
|---|---|---|---|
| Wind erosion - coal stockpiles | Stockpile watering on continuous cycle with modification of cycle depending on prevailing weather conditions to allow greater or lesser watering intensity | Yes | Water sprays will be fitted to the ROM and product stockpiles and the temporary reject storage area to maintain surface moisture levels. Water spray intensity will be adjusted in real-time based on meteorological observations (wind speed and temperature). |
| | Shaping and orientation to minimise emissions of particulate matter | Yes | Product stockpiles to be aligned with dominant westerly air flow to reduce erodible surface area during peak wind events. |
| Conveyors and transfers | Application of watering at transfer points | Yes | Watering will be implemented at the overland conveyor to ROM stockpile stacker transfer. Watering will also be applied to the ROM and product stockpiles and tertiary sizing station, ensuring carry over moisture through the conveying and transfer process. |
| | Enclosure of transfer points | Yes | Conveyor transfer stations will be fitted with full enclosure. |
| | Wind shielding of conveyor belts – roof and/or side wall | Yes | With the exception of the product stockpile stacking and reclaim conveyors, conveyors will be fitted with either a side wall wind break or side wall and roof. The extent of all conveyor shielding will be designed with functional considerations accommodated. |
| | Belt cleaning and spillage minimisation | Yes | While not quantified in the emission calculations, this control measure would be incorporated into general site maintenance practices. |
| Stacking and reclaiming of coal | Avoidance – bypass stockpiles | No | Measure not practicable to the project. Stockpiling of ROM and product coal will be an essential element of the project. |
| | Stacking coal – variable height luffing stacker to allow drop height to be minimised and stacking to occur without dozer push | Yes | Stacker design will be such that bulldozer operations at the stockpiles are avoided. |

### Table 12.14 Best practice dust control measures review

| Emissions source category | Best practice control measures (Katestone 2011) | Proposed for implementation at Project | Comments |
|---|---|---|---|
| | Stacking coal– use of chutes or wind shields to shroud falling coal from static trippers | Yes | Wind guards will be fitted to stockpile stackers. |
| | Stacking coal – water application through boom tip sprays | Yes | Water will be added to coal prior to stockpile loading and direct to stockpile surface to maintain surface moisture content. |
| | Reclaiming coal – use of bucket-wheel, portal or bridge reclaimer | Yes | Reclaimer design will be such that bulldozer operations at the stockpiles are avoided. |
| | Reclaiming coal – coal moisture management through water application | Yes | Water will be added to coal stockpile surface to maintain surface moisture content. |
| | Reclaiming coal – reclaim tunnel with minimal mechanical disturbance | Yes | Central reclaim tunnel designed for ROM pile. |
| | Reclaiming coal – minimise residence time in stockpiles | Yes | Coal from stockpiles will be reclaimed and replenished on a continuous basis. |
| Coal sizing | Not considered in Katestone, 2011 | - | Emissions from coal sizing will be controlled by enclosure and water sprays at the tertiary sizing station and walled and roof enclosure at the screening station. |
| Ventilation Shaft emissions | Not considered in Katestone, 2011 | - | Emissions from underground ventilation discharge will be managed through a combination of underground operation dust mitigation practices (water sprays at coal extraction and handling points and along underground haulage routes) and maintenance of underground mining fleet to maintain manufacturer engine emissions specifications. |

## 12.6.2 Further mitigation measures

### a. Diesel combustion emissions

The following management practices will be implemented to minimise emissions from the combustion of diesel:

- new rolling stock and locomotives will be used minimise emissions from diesel combustion;
- all equipment will be routinely serviced to ensure manufacturers' emission specifications are maintained;
- idling of diesel equipment will be minimised wherever practicable;
- use of electric powered underground mining equipment where practicable, such as continuous miners, shuttle cars, flexible conveyors etc; and
- use of diesel exhaust scrubbers and diesel particulate filters on all underground diesel equipment.

### b. Management and Monitoring of Spontaneous Combustion

The spontaneous combustion potential of the coal has been assessed using a number of coal samples from the seam including roof and floor samples, and using the SponComSIM test conducted by CB3 Mine Services Pty Ltd (CB3 2014). These tests have demonstrated that the coal is typical of the Wongawilli Seam and South Coast coals and has a low potential for spontaneous combustion.

Notwithstanding, Hume Coal will manage the potential risk of spontaneous combustion for the project through the implementation of the following measures, as appropriate:

- undertake a spontaneous combustion risk assessment for coal and rejects and develop and implement a Spontaneous Combustion Management Plan if deemed necessary;
- undertake continuous real-time monitoring of ventilation air for the presence of the products of combustion;
- seal mined-out panels progressively as the mine is worked; and
- stockpile management in accordance with good practice.

### 12.6.3 Air quality monitoring

An extensive network of air quality and meteorological monitoring equipment is already in place at the project area (refer to Figure 5.1), and includes real-time measurements of meteorological conditions and particulate matter concentrations ($PM_{10}$ and $PM_{2.5}$). Dust deposition levels are also monitored. This equipment will form the basis for air quality monitoring to be conducted during the life of the project. Daily and annual average $PM_{10}$ and $PM_{2.5}$ concentrations and monthly average dust deposition results will be recorded and reported in annual environmental management reports.

An air quality monitoring plan will be developed for the project, documenting monitoring locations, monitoring methods and reporting responsibilities.

During operations, monitoring will be undertaken by Hume No. 2 and TEOM 2, both of which are adjacent to the majority of the surface infrastructure.

Monitoring of the ventilation shaft emissions will also be undertaken by a suitably qualified stack testing company once the mine is at full operation to verify the assumptions within this modelling assessment.

## 12.7 Conclusions

The results of the dispersion modelling conducted for the construction and operational phases of the project indicate the following:

- project-only related particulate matter, gaseous pollutant and odour concentrations, and dust deposition rates, are predicted to be well below applicable air quality impact assessment criteria and minor relative to existing ambient conditions;
- the construction phase of the project will generate higher impacts in the immediate surrounding environment relative to the operational project due to a greater proportion of surface based material handling, and truck transportation;
- when project incremental concentrations are combined with concentrations from neighbouring emission sources, the combined concentrations are well below applicable impact assessment criteria; and

- analysis of cumulative impacts, accounting for the combination of project and neighbouring emission sources with ambient background levels, shows that the potential for an exceedance of applicable NSW EPA impact assessment criteria to occur as a result of the project is very low, beyond those that would occur in the absence of the project (i.e. days influenced by bushfires, dust storms, etc.).

A review of best practice dust control measures found the measures incorporated into the project design are in accordance with or above accepted industry best practice dust control standards. Modelling conducted shows that the proposed mitigation measures will effectively control emissions to minimise impacts on the surrounding environment, and to levels that are within the applicable criteria. The integration of a surface crusting veneer product to the product coal stockpiles in addition to water sprays will achieve a higher emission and impact reduction than watering alone; however, it is noted that impacts from either control configuration are low relative to impact assessment criteria.

In relation to possible health impacts from particulate emissions, the increased risk in the population (based on annual mortality rates, all causes) due to the worst case annual average increased long-term exposure to $PM_{2.5}$ and $PM_{10}$ from the mine, will be considerably less than 1 in 100,000. This level of increase is considered to be “sufficiently small and to be of no cause for concern” (NEPM AAQM).

# 13 Greenhouse gas

## 13.1 Introduction

The SEARs require an assessment of the likely greenhouse gas (GHG) emissions from the project. The specific requirements relating to GHG emissions are in Table 13.1.

**Table 13.1 Greenhouse gas related SEARs**

| Requirement | Section addressed |
|---|---|
| An assessment of the likely greenhouse gas impacts of the development, having regard to the EPA's requirements. | Section 13.4 and Appendix K |

A detailed assessment which addresses the requirement listed in Table 13.1 is provided in Appendix K and summarised in this chapter. As described in the following sub-sections, greenhouse gas (GHG) emissions from the project are predicted to be minimal, only making minor contributions to the total GHG emissions from NSW and Australia.

The GHG assessment was undertaken in accordance with the following regulations, methods and guidance documents:

- Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGERS Act);
- *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (DoE 2014a);
- *National Greenhouse Accounts Factors (NGAF) workbook* (DoE 2015);
- Australian National Greenhouse Gas Inventory – Kyoto Protocol Accounting Framework; and
- *Standard Secretary's Environmental Assessment Requirements (SEARs) for State Significant Mining Developments*, as recommended by the EPA in their assessment recommendations.

## 13.2 Emission sources and GHG inventory

### 13.2.1 Scope 1, 2 and 3 emissions

The GHG emissions attributed to the project were estimated in accordance with the methods outlined in the NGAF workbook (DoE 2015). The methods 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 2014a). The NGAF workbook defines three scopes (Scopes 1, 2 and 3) for different emission categories based on whether the emissions generated are from 'direct' (scope 1) or 'indirect' (scope 2 and 3) sources. Direct 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 2015).

Scope 1, 2 and 3 emissions are further defined as follows:

- Scope 1: Direct GHG Emissions – those emissions that occur from sources that are owned or controlled by the applicant. The project-related scope 1 emissions included in the GHG assessment for the project are emissions associated with:
  - Fuel consumption (diesel) by onsite plant and equipment;

- Fuel combustion (diesel) for transport of coal in company owned locomotives; and
- Fugitive emissions of gas from mine ventilation.

- Scope 2: Energy Product Use Indirect GHG Emissions – are those emissions from the generation of purchased energy products, such as electricity. The project-related scope 2 emissions included in the GHG assessment are therefore emissions associated with the on-site consumption of purchased electricity.
- Scope 3: Other Indirect GHG Emissions – are those emissions that are a consequence of the activities of the applicant, but which arise from sources not owned or controlled by them, such as extraction and production of purchased materials, transportation of purchased fuel and the use of sold products and services. The project-related scope 3 emissions included in the GHG assessment are emissions associated with:
    - upstream emissions from the extraction, production and transport of diesel and petrol fuel;
    - upstream emissions from electricity lost in delivery in the transmission and distribution network; and
    - downstream emissions generated from the end use of product coal.

There are a number of GHG emissions that are considered minor relative to the emission sources listed above, and have therefore not been incorporated into this GHG assessment. These include:

- consumption of fuels other than diesel and petrol (eg LPG) (scope 1);
- fugitive leaks from high voltage switch gear and refrigeration (scope 1);
- wastewater handling (scope 1);
- land use change and land clearing (scope 1);
- disposal of solid waste at landfill (scope 3); and
- travel of employees to and from the mine (scope 3).

In the case of land use change, it is considered that the GHG emissions generated by the changes to the land use in the establishment of the project will be offset by the rehabilitation of the site at the completion of the project. It is also noted that scope 3 is an optional reporting category 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, which are included in the scope 3 emissions reported in this chapter.

Spontaneous combustion can also be a source of GHG emissions in a mining context. The spontaneous combustion potential of the coal to be mined by the project was assessed using samples from the seam, roof and floor, including using the SponComSIM test conducted by CB3 Mine Services Pty Ltd. These tests demonstrated that the coal is typical of the Wongawilli Seam and South Coast coals and has a low potential for spontaneous combustion. To date, there have not been any recorded incidents of spontaneous combustion in South Coast mines.

### 13.2.2 Emission inventory

Activity data used in the estimates of GHG emissions for the project is summarised in Table 13.2.

**Table 13.2 Annual ROM coal production schedule and activity data**

| Year | ROM production (Mt) | Product coal (Mt) | Diesel consumption (kL) – onsite mobile equipment | Diesel consumptio n (kL) – onsite stationary equipment | Diesel consumption (kL) –Hume owned locomotives | Petrol consumptio n (kL) | Electricity (kWh) |
|---|---|---|---|---|---|---|---|
| Construction Y1 | N/A | N/A | 4,205 | - | - | 128 | 3,756,225 |
| Construction Y2 | 0.033 | 0.030 | 4,536 | 2 | 15 | 132 | 30,710,745 |
| Operations Y1 | 1.03 | 0.85 | 662 | 5 | 430 | 7 | 53,909,040 |
| Operations Y2 | 2.42 | 1.99 | 993 | 5 | 1,008 | 11 | 80,863,560 |
| Operations Y3 | 3.08 | 2.62 | 1,324 | 6 | 1,327 | 14 | 107,818,080 |
| Operations Y4 | 2.17 | 1.79 | 1,324 | 7 | 906 | 14 | 107,818,080 |
| Operations Y5 | 3.10 | 2.51 | 1,324 | 8 | 1,271 | 14 | 107,818,080 |
| Operations Y6 | 3.10 | 2.44 | 1,324 | 9 | 1,236 | 14 | 107,818,080 |
| Operations Y7 | 3.18 | 2.40 | 1,324 | 10 | 1,215 | 14 | 107,818,080 |
| Operations Y8 | 3.22 | 2.49 | 1,324 | 10 | 1,261 | 14 | 107,818,080 |
| Operations Y9 | 3.28 | 2.68 | 1,324 | 10 | 1,357 | 14 | 107,818,080 |
| Operations Y10 | 2.32 | 1.92 | 1,324 | 10 | 972 | 14 | 107,818,080 |
| Operations Y11 | 3.02 | 2.48 | 1,324 | 10 | 1,256 | 14 | 107,818,080 |
| Operations Y12 | 3.14 | 2.56 | 1,324 | 10 | 1,296 | 14 | 107,818,080 |
| Operations Y13 | 3.40 | 2.60 | 1,324 | 10 | 1,317 | 14 | 107,818,080 |
| Operations Y14 | 3.11 | 2.04 | 1,324 | 10 | 1,033 | 14 | 107,818,080 |
| Operations Y15 | 2.56 | 1.72 | 1,324 | 10 | 871 | 14 | 107,818,080 |
| Operations Y16 | 3.20 | 2.63 | 1,324 | 10 | 1,332 | 14 | 107,818,080 |
| Operations Y17 | 2.73 | 2.28 | 1,324 | 10 | 1,155 | 14 | 107,818,080 |
| Operations Y18 | 2.19 | 1.80 | 1,059 | 10 | 912 | 12 | 86,254,464 |
| Operations Y19 | 0.20 | 0.16 | 265 | 10 | 81 | 3 | 21,563,616 |
| Rehabilitation Y1 | - | - | 4,205 | - | - | 128 | 3,756,225 |
| Rehabilitation Y2 | - | - | 4,205 | - | - | 128 | 3,756,225 |

## 13.3 Impact assessment

Table 13.3 shows the estimated annual GHG emissions for each source based on the activity data in Table 13.2, and Table 13.4 presents the annual total and annual average project scope 1, 2 and 3 emissions.

## Table 13.3 Estimated GHG emissions (tonnes $CO_{2-e}$)

| Year | ROM (Mt) | Scope 1 | | | | | Scope 2 | Scope 3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diesel (on-site mobile equipment) | Diesel (on-site stationary equipment) | Diesel (Hume owned locomotives) | Petrol | Mine ventilation gas | Electricity | Diesel (transport) | Electricity | Petrol | End use of Coking Coal | End use of thermal coal |
| Construction Y1 | - | 11,281 | - | - | 306 | - | 3,155 | 584 | 451 | 16 | - | - |
| Construction Y2 | 0.033 | 12,169 | 5 | 41 | 315 | 23 | 25,797 | 633 | 3,685 | 16 | 3,456 | 972 |
| Operations Y1 | 1.0 | 1,776 | 14 | 1,155 | 17 | 703 | 45,284 | 152 | 6,469 | 1 | 97,920 | 27,540 |
| Operations Y2 | 2.4 | 2,663 | 14 | 2,703 | 26 | 1,656 | 67,925 | 279 | 9,704 | 1 | 229,248 | 64,476 |
| Operations Y3 | 3.1 | 3,551 | 16 | 3,559 | 33 | 2,108 | 90,567 | 369 | 12,938 | 2 | 301,824 | 84,888 |
| Operations Y4 | 2.2 | 3,551 | 19 | 2,432 | 33 | 1,482 | 90,567 | 311 | 12,938 | 2 | 206,208 | 57,996 |
| Operations Y5 | 3.1 | 3,551 | 22 | 3,410 | 33 | 2,125 | 90,567 | 362 | 12,938 | 2 | 289,152 | 81,324 |
| Operations Y6 | 3.1 | 3,551 | 24 | 3,315 | 33 | 2,119 | 90,567 | 357 | 12,938 | 2 | 281,088 | 79,056 |
| Operations Y7 | 3.2 | 3,551 | 27 | 3,260 | 33 | 2,175 | 90,567 | 354 | 12,938 | 2 | 276,480 | 77,760 |
| Operations Y8 | 3.2 | 3,551 | 27 | 3,383 | 33 | 2,206 | 90,567 | 361 | 12,938 | 2 | 286,848 | 80,676 |
| Operations Y9 | 3.3 | 3,551 | 27 | 3,641 | 33 | 2,244 | 90,567 | 374 | 12,938 | 2 | 308,736 | 86,832 |
| Operations Y10 | 2.3 | 3,551 | 27 | 2,608 | 33 | 1,589 | 90,567 | 320 | 12,938 | 2 | 221,184 | 62,208 |
| Operations Y11 | 3.0 | 3,551 | 27 | 3,369 | 33 | 2,066 | 90,567 | 360 | 12,938 | 2 | 285,696 | 80,352 |
| Operations Y12 | 3.1 | 3,551 | 27 | 3,478 | 33 | 2,151 | 90,567 | 365 | 12,938 | 2 | 294,912 | 82,944 |
| Operations Y13 | 3.4 | 3,551 | 27 | 3,532 | 33 | 2,324 | 90,567 | 368 | 12,938 | 2 | 299,520 | 84,240 |
| Operations Y14 | 3.1 | 3,551 | 27 | 2,771 | 33 | 2,129 | 90,567 | 329 | 12,938 | 2 | 235,008 | 66,096 |
| Operations Y15 | 2.6 | 3,551 | 27 | 2,337 | 33 | 1,752 | 90,567 | 306 | 12,938 | 2 | 198,144 | 55,728 |
| Operations Y16 | 3.2 | 3,551 | 27 | 3,573 | 33 | 2,190 | 90,567 | 370 | 12,938 | 2 | 302,976 | 85,212 |
| Operations Y17 | 2.7 | 3,551 | 27 | 3,097 | 33 | 1,871 | 90,567 | 346 | 12,938 | 2 | 262,656 | 73,872 |
| Operations Y18 | 2.2 | 2,841 | 27 | 2,445 | 29 | 1,501 | 72,454 | 275 | 10,351 | 1 | 207,360 | 58,320 |
| Operations Y 19 | 0.2 | 710 | 27 | 217 | 7 | 137 | 18,113 | 49 | 2,588 | 0 | 18,409 | 5,178 |
| Rehabilitation Y1 | - | 11,281 | - | - | 306 | - | 3,155 | 584 | 451 | 16 | - | - |
| Rehabilitation Y2 | - | 11,281 | - | - | 306 | - | 3,155 | 584 | 451 | 16 | - | - |
| **Project total** | | **107,267** | **465** | **54,326** | **1,807** | **34,551** | **1,597,543** | **8,392** | **228,220** | **97** | **4,606,825** | **1,295,670** |
| **Annual average** | | **4,664** | **23** | **2,716** | **79** | **1,728** | **69,458** | **365** | **9,923** | **4** | **230,341** | **64,784** |

**Table 13.4 Scope 1, 2 and 3 emission sources (tonnes $CO_{2-e}$)**

| Year | Scope 1 | Scope 2 | Scope 3 |
|---|---|---|---|
| Construction Y1 | 11,586 | 3,155 | 1,051 |
| Construction Y2 | 12,553 | 25,797 | 8,762 |
| Operations Y1 | 3,664 | 45,284 | 132,082 |
| Operations Y2 | 7,062 | 67,925 | 303,708 |
| Operations Y3 | 9,268 | 90,567 | 400,021 |
| Operations Y4 | 7,517 | 90,567 | 277,455 |
| Operations Y5 | 9,141 | 90,567 | 383,778 |
| Operations Y6 | 9,043 | 90,567 | 373,441 |
| Operations Y7 | 9,047 | 90,567 | 367,534 |
| Operations Y8 | 9,200 | 90,567 | 380,824 |
| Operations Y9 | 9,496 | 90,567 | 408,882 |
| Operations Y10 | 7,809 | 90,567 | 296,652 |
| Operations Y11 | 9,046 | 90,567 | 379,348 |
| Operations Y12 | 9,241 | 90,567 | 391,161 |
| Operations Y13 | 9,468 | 90,567 | 397,068 |
| Operations Y14 | 8,512 | 90,567 | 314,373 |
| Operations Y15 | 7,700 | 90,567 | 267,118 |
| Operations Y16 | 9,375 | 90,567 | 401,498 |
| Operations Y17 | 8,581 | 90,567 | 349,814 |
| Operations Y18 | 6,843 | 72,454 | 276,307 |
| Operations Y19 | 1,098 | 18,113 | 26,224 |
| Rehabilitation Y1 | 11,586 | 3,155 | 1,051 |
| Rehabilitation Y2 | 11,586 | 3,155 | 1,051 |
| **Project total** | **198,422** | **1,597,543** | **6,139,203** |
| **Annual average** | **8,627** | **69,458** | **266,922** |

The total scope 1 and scope 2 emissions over the life of the project is 1,795,965 t $CO_{2-e}$.

Annual average scope 1, 2 emissions and 3 emissions (excluding the end use of coal), have been compared to GHG emissions for NSW (130,115.7 kt $CO_2$-e) and Australia (523,309.8 kt $CO_2$-e) for the latest reporting period (National Greenhouse Gas Inventory for 2014). The project emissions represent approximately 0.068% of the annual GHG emissions for NSW and 0.017% of GHG emissions for Australia.

## 13.4 Management and mitigation

Mitigation measures that will be implemented by Hume Coal to reduce direct (scope 1) GHG emissions from the project are:

- best available emissions technology locomotives, underground mining fleet and surface plant and equipment will be acquired;
- equipment will be routinely serviced to maximise efficiency and ensure manufacturer's emission specifications are maintained;
- lower emission fuels will be used where practical; and
- idling of diesel equipment will be minimised where possible during all phases of the mine life.

Mitigation measures that will be implemented by Hume Coal to reduce indirect (scope 2 and scope 3) GHG emissions from the project are:

- materials will be sourced locally where feasible to minimise emissions generated from upstream activities;
- energy efficient lighting technologies and hot water and air conditioning systems will be used wherever practical; and
- awareness and training programs on energy efficiency measures for site personnel will be conducted.

## 13.5 Conclusion

GHG emissions from the project are predicted to be minimal and make only minor contributions to the total GHG emissions for NSW and Australia. A total of 1,795,965 t $CO_{2-e}$ (scope 1 and 2) GHG emissions will be emitted over the life of the project. The annual average scope 1, 2 and 3 emissions (excluding the end use of coal) from the project represent approximately 0.068% and 0.017% of total GHG emissions for NSW and Australia, respectively, based on the latest National Greenhouse Gas Inventory for 2014.

# 14 Subsidence

## 14.1 Introduction

The term 'subsidence' is used to describe the formation of a depression at the surface of land above mine workings as a result of underground mining. The direct impacts of subsidence are project specific, and relate to the mining method implemented below the surface as well as other factors such as mining geometry, depth and geotechnical factors.

As described in Chapter 2, the first workings mining method adopted for the project was specifically chosen so that subsidence related impacts will be negligible as a result of mining. In this regard, the principal design features of the mining layout are as follows:

- To prevent overburden fracturing, the layout is similar to that of highwall mining, whereby a series of long drives are installed using a remote mining method, with long, slender pillars in-between drives and interspersed wider barrier pillars to enhance geotechnical stability and reduce geotechnical risk.

- A suitably high Factor of Safety (FoS) has been used as a design criteria, so that the coal pillar system left behind after mining is designed to be stable over a long-term.

A subsidence assessment of the project was prepared by Mine Advice to assess the predicted subsidence associated with the project and address the SEARs, which require an assessment of the project's potential impacts due to subsidence. Specific assessment requirements relating to subsidence and the relevant sections where these requirements are addressed in the EIS are shown in Table 14.1.

**Table 14.1 Subsidence related SEARs**

| Requirement | Section addressed |
|---|---|
| An assessment of the likely conventional and non-conventional subsidence effects and impacts of the development, and the potential consequences of these effects and impacts on the natural and built environment, paying particular attention to those features that are considered to have significant economic, social, cultural or environmental value, and having regard to DRE's and OEH's requirements. | Section 14.4 |
| An assessment of the likely impact of the development on landforms (topography), including:<br>- the potential subsidence impacts on cliffs, rock formations and steep slopes; and<br>- the long-term geotechnical stability of any new landforms. | Section 14.4.2<br>No new significant landforms are proposed as the mine will be underground, and no permanent surface reject emplacements will be created. |

Three government agencies, DRE, RMS and Fisheries NSW also raised matters relevant to the subsidence assessment in their input to the SEARs. The matters raised are listed in Tables 14.2, 14.3 and 14.4 respectively, and have been taken into account in preparing this assessment, as indicated in the tables.

### Table 14.2 DRE assessment recommendations

| Recommendation | Section addressed |
|---|---|
| To justify the proposed underground mining projects, the proponent must demonstrate the feasibility of: | |
| - the proposed mining operation (eg mining methods, layout and sequences); and | Chapter 2 |
| - the proposed strategies to manage subsidence risks to surface or sub-surface features that are considered to have significant economic, social, cultural or environmental value. | Section14.5 |
| The justification must be supported by the information provided by the proponent, including, but not limited to: | |
| - a description of the proposed mining operation; | Chapter 2 |
| - identification and general characteristics of surface and subsurface features that may be affected by subsidence caused by the proposed mining; | Chapter 5 and 14.2 |
| - general and relevant site conditions including depths of cover, geological, hydrogeological, hydrological, geotechnical, topographic and climate conditions, as well as any conditions that may cause elevated or abnormal subsidence; | Section 14.2 |
| - identification and general characteristics of any previously excavated or abandoned workings that may interact with the proposed or existing mine workings; | Section 14.2 |
| - results of preliminary prediction of the nature, magnitude, distribution, timing and duration of subsidence; | Section 14.3 |
| - results of a risk assessment in relation to subsidence of surface or sub-surface features that are considered to have significant economic, social, cultural or environmental value, taking into consideration the points above; and | Predicted subsidence has been calculated based on first principles, and the predicted impacts of these subsidence levels are presented in Section 14.4. |
| - results of feasibility studies in relation to the proposed mining operation and proposed strategies to manage subsidence risks to surface or sub-surface features that are considered to have significant economic, social, cultural or environmental value. | Chapter 2 and Appendix A of the subsidence assessment (Mine Advice 2016a), refer to Appendix L. Subsidence risks on surface and sub-surface features are discussed in Section 14.4. |

### Table 14.3 RMS assessment recommendations

| Recommendation | Section addressed |
|---|---|
| The impacts of noise and vibration of the mine, including: | |
| - undermining or de-stabilisation of the Hume Highway through coal extraction operations or otherwise; and | Section 14.4.1ii, and Chapter 11 (noise and vibration) |
| - vibration impacts on the Hume Highway through mine construction and operation. | Chapter 11 (11.4.8) |

### Table 14.4 Fisheries NSW assessment recommendations

| Recommendation | Section addressed |
|---|---|
| Analysis of impacts of subsidence upon water flow within and downstream of all waterways within the proposal area. | Section 14.4.2iii |

The subsidence assessment prepared by Mine Advice (2016a) is presented in full in Appendix L and a summary is provided in this chapter. The subsidence assessment was independently peer reviewed by Professor Bruce Hebblewhite (B.E.(Min.) PhD). This review found that the proposed mine layout represents a sound design based on geotechnical mine design documents, with negligible adverse impacts on surface features, and that the design and outcomes of the subsidence predictions in Mine Advice (2016a) are in compliance with the SEARs.

## 14.2 Existing environment

### 14.2.1 Geological environment and rock unit material properties

The geology of the project area and surrounds is described in detail in Chapter 5. Further information on the existing geological and geotechnical environment, as is relevant to the subsidence assessment, is provided below.

Laboratory testing was undertaken on drill core samples from the project area to determine various material properties of the stratigraphic units that occur in the area. A summary of these material properties is presented in Table 14.5. The values presented are an average of the results from the series of tests undertaken in the laboratory, with the exception of unconfined compressive strength (UCS) and Poisson's ration of the Wianamatta Group, which is drawn from published third party sources.

**Table 14.5 Summary of major stratigraphic properties in the project area**

| Stratigraphic unit | UCS (Mpa) | Young's Modulus (GPa) | Poisson's Ratio |
|---|---|---|---|
| Wianamatta Group | 30.0[1] | n/a | 0.25[2] |
| Hawkesbury Sandstone | 43.0 | 16.5 | 0.22 |
| Illawarra Coal Measures (above the Wongawilli coal seam) | 69.0 | 15.6 | 0.25 |
| Wongawilli coal seam | 8.5 | 2.4 | 0.25 |
| Kembla Sandstone | 68.0 | 18.3 | 0.22 |

*Notes: 1. from Won 1985.*
*2. from McNally 1996.*

The target coal seam (the Wongawilli Seam) generally dips toward the east and is approximately 130 m higher in elevation in the west of the underground mining area compared to that in the east. The average seam dip to the east across the mining area is in the order of 1 in 50, with some panels in the west possibly experiencing slightly higher average grades of 1 in 35. These seam dips are very low and therefore are not expected to have an adverse impact on mineability or, more importantly, pillar system design for long-term stability.

There are no recorded underground mine workings in the project area. Adits located in Longacre Creek have what are believed to be minor hand workings outside the proposed underground footprint. Their nature and extent will be confirmed prior to mining commencing in this area. Figure 5.8 in Chapter 5 shows the indicative locations of historical mine workings in the area.

### 14.2.2 In situ stress environment

Vertical stress is one of the major considerations used in calculations of coal pillar stability. The magnitude of in situ horizontal stresses is relevant to discussions of far field horizontal movements which can be an issue for caving methods of mining such as longwall mines.

In situ vertical stresses across the project area are expected to range from 2 MPa at 80 m cover depth to just over 4 MPa at 170 m cover depth, with the majority of the mine expected to be between 2 and 3 MPa of vertical stress.

In situ horizontal stress is best described by the tectonic stress factor (TSF). Project area-specific TSF values were determined from a borehole drilled in the area (HU0040) for both major and minor horizontal stresses, which were $TSF_H = 0.44$ and $TSF_h = 0.31$, respectively. Notably, these $TSF_H$ values are substantially lower than the general range for the NSW Southern Coalfield and other coalfields in NSW, which is likely to be a direct function of the Wongawilli coal seam outcropping to the west and south in deeply incised gorges; a source of tectonic strain relief over geological time. The measurements recorded suggest that the orientation of the major component of horizontal stress in the project area is approximately north-south (010°-190°).

### 14.2.3 Major geological structures and hydrogeological features

Major geological discontinuities have the potential to adversely impact coal pillar stability. Faulting has been inferred in the project area by Mine Advice (2016a) in one dominant direction from a combination of drill hole interpretation and identified faulting in the adjacent Berrima Colliery workings. The dominant faulting alignment is north-northwest to south-southeast. A secondary faulting direction has also been detected as east-southeast to west-northwest. Whilst igneous features including dykes and plugs have also been detected within the underground mining area, the intersection of major geological structures can be easily identified during mining. Together with the flexibility of a first workings mining method, this means that geological hazards within the coal seam can be effectively managed during mining.

Hawkesbury Sandstone is a productive water source within the project area, though its thickness in this area is highly variable. The Wongawilli Seam is an additional aquifer, which is linked to the overlying Hawkesbury Sandstone. Subsequently, mining the Wongawilli Seam will unavoidably result in some degree of depressurisation. However, the adopted first workings mining method will limit drawdown effects by preventing overburden fracturing and/or the opening of existing fractures within the overburden.

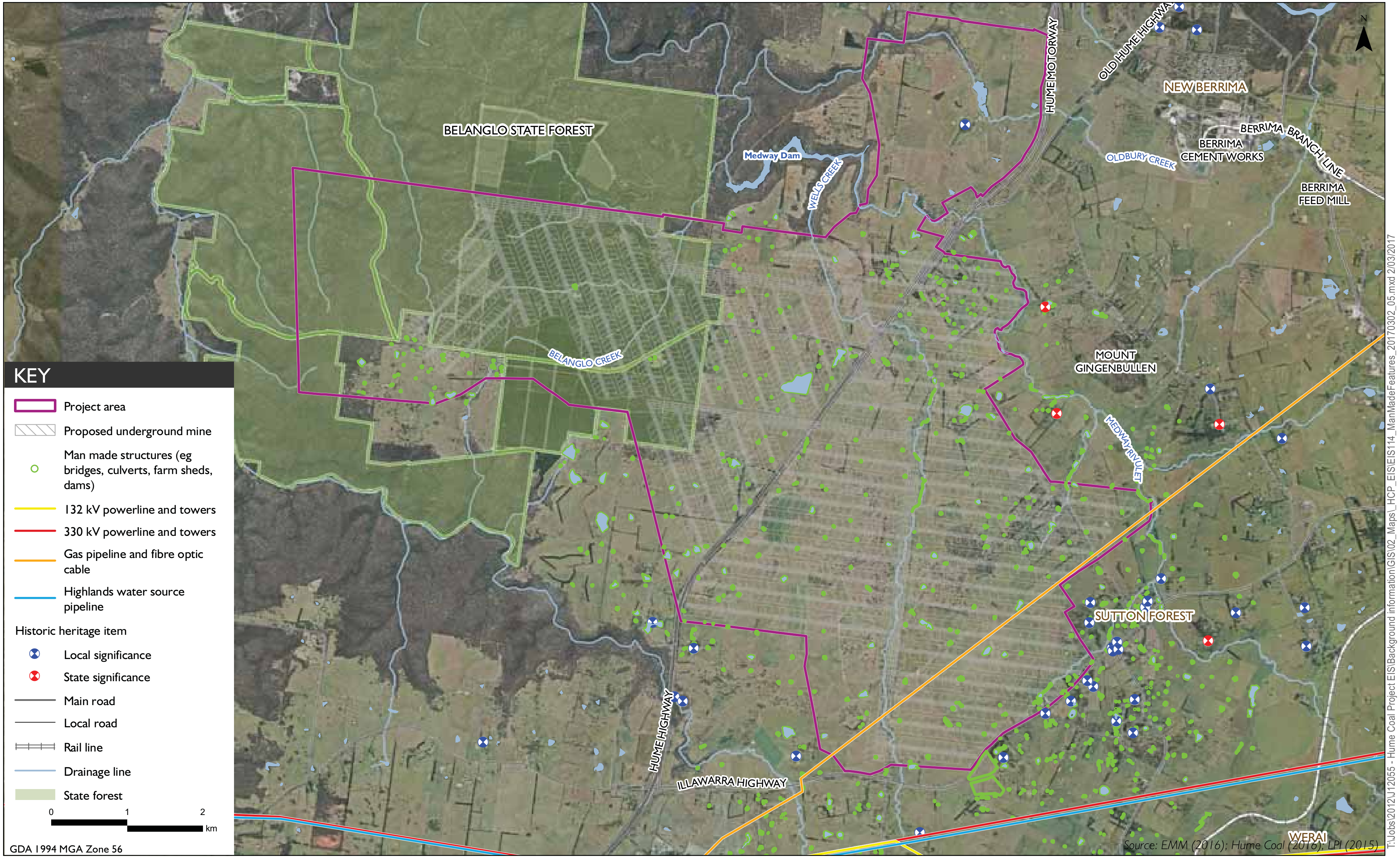
Further discussion on the hydrogeological environment in the project area and predicted depressurisation as a result of mining is provided in Chapter 7 (water resources).

### 14.2.4 Natural and built surface features

Identification of natural and built surface features in the project area is necessary to assess potential subsidence related impacts on these features.

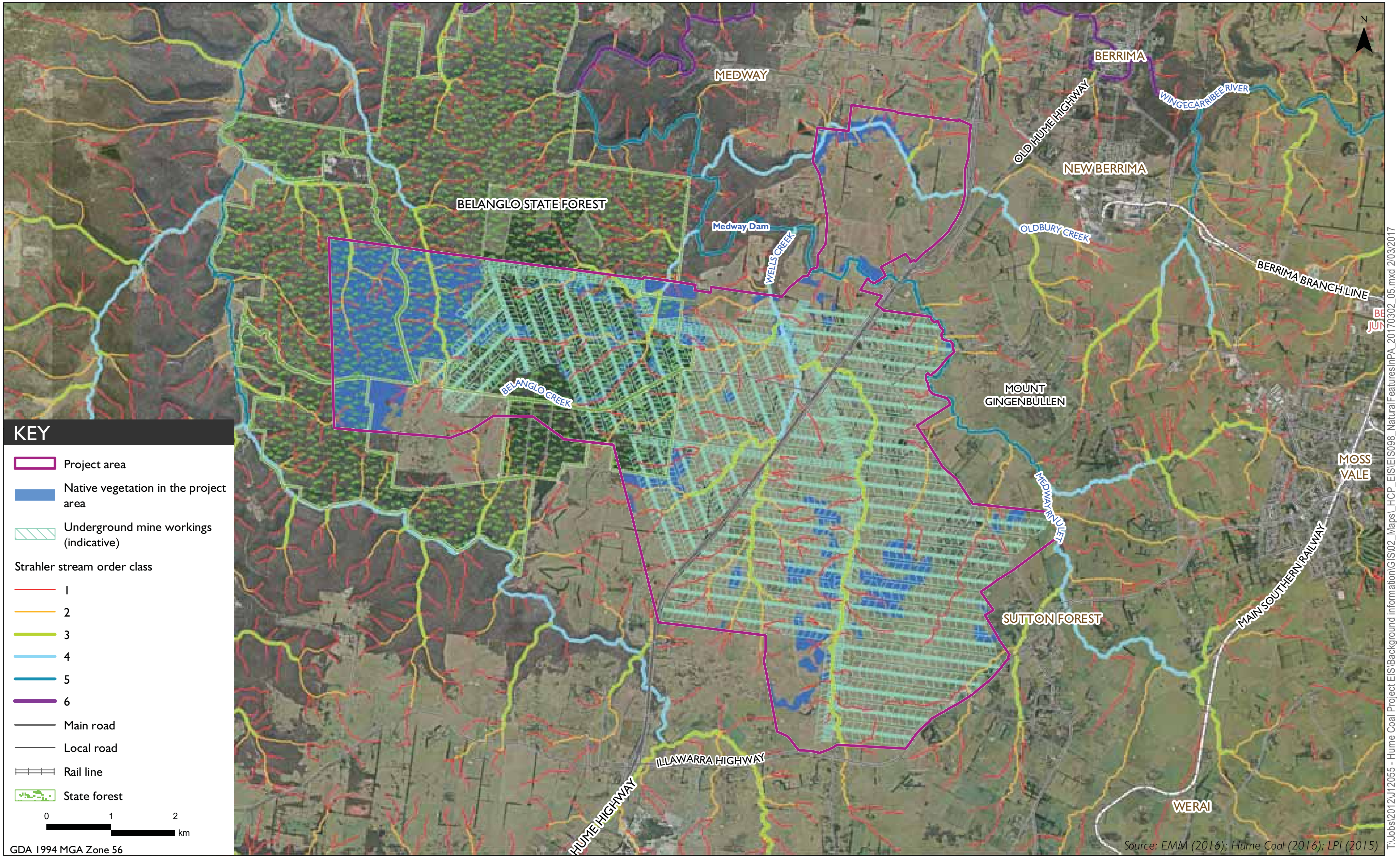
As described in detail in Chapter 5, the project area is within a semi-rural setting characterised by varying land uses including grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns, some industrial developments and the Hume Highway. Land above the underground mining area mainly comprises cleared land that is used for livestock grazing, small-scale farm businesses and the Belanglo State Forest.

Built and man-made features identified in the project area are shown in Figure 14.1. Key natural features relevant to the discussion on subsidence impacts in Section 14.4 are shown in Figure 14.2. The natural surface features within the project area, including cliffs and steep slopes, surface water resources, soils, native vegetation and plant communities, are also discussed in detail in the relevant sections of Chapters 5, 7, 8 and 10, respectively.




**Existing built and man-made features in the project area**

Hume Coal Project
Environmental Impact Statement
Figure 14.1




**Existing natural features in the project area**

Hume Coal Project

Environmental Impact Statement

Figure 14.2

## 14.3 Subsidence predictions

### 14.3.1 Mine design parameters

As mentioned above in Section 14.1, a first workings mining method has been adopted for the project as it offers the maximum level of protection to both the overlying Hawkesbury Sandstone and surface features. As no secondary extraction will be undertaken, no caving of the roof strata due to the formation of wide unsupported voids will occur.

The first workings mine design resembles an underground mining version of highwall mining, which is a surface mining method that uses long but generally narrow unsupported plunges formed via a remotely controlled continuous miner with a conveying system back to the surface. In an underground setting, the challenge is to form up a number of closely spaced long plunges that generate suitably high rates of production whilst maintaining adequate levels of underground mine safety.

The adopted mine design uses five fundamental coal pillar types:

1. mains heading pillars;
2. web pillars between drives/plunges;
3. intra-panel barriers between a series of narrow drives and web pillars;
4. inter-panel barriers which are either solid barriers between adjacent mining panels or the pillars used to form the three heading 'gateroad' panels; and
5. solid barriers between mining panels and the main headings.

The five types of pillars are illustrated in Figure 2.6 (refer to Chapter 2). The web pillars and intra-panel barriers represent the key elements of the mining system as they are required to be as narrow as possible to allow efficient mining, yet also retain suitable stability as they act as the primary foundation for longer-term overburden stability.

The use of sub-critical geometries between intra-panel barriers is another key element of the mine design to achieve long-term stability, so as to prevent the low width to height web pillars ever being subject to full tributary area loading under a soft overburden loading system. The use of sub-critical panel geometries effectively negates the ability of the overburden to ever force the web pillars between plunges to a state of full collapse independent of the intra-panel barriers.

In addition, drives will be limited to a maximum length of 120 m so that overall panel stability is directly influenced by all coal pillar types excluding the mains pillars.

Panel geometries, as proposed for the maximum working section height of 3.5 m and plunge length of 120 m, are provided in Table 14.6.

**Table 14.6 Pillar and panel geometries for the maximum working height of 3.5 m**

| Depth of cover | Web pillar width (m) | Intra panel barrier width pillar (m) | Web panel width (excluding barriers) (m) |
|---|---|---|---|
| 170 | 6.0 | 22.8 | 54.0 |
| 150 | 5.1 | 20.7 | 58.6 |
| 130 | 4.4 | 18.0 | 54.4 |
| 110 | 3.8 | 16.4 | 58.6 |
| 90 | 3.5 | 14.0 | 56.5 |

As evident in Table 14.6, the web pillar panels between intra-panel barriers are all less than 60 m wide, thereby ensuring a sub-critical panel geometry. The other important design element from a global stability perspective is that the web pillars and intra-panel barrier pillars all increase in width as depth of cover increases, so as to maintain overall pillar system stability at the same level regardless of cover depth.

A summary of the minimum pillar and panel geometries used to predict worst case subsidence levels is presented in Table 14.7. These areas represent the deepest areas of the mine where each coal pillar type will be used. This is where the highest level of vertical stress re-distribution will inevitably occur, which is the primary driver for surface settlement due to mining.

**Table 14.7 Mining geometry used to assess subsidence predictions**

| Panel type | Depth of cover (D) (m) | Solid pillar length (l) (m) | Solid pillar width (w) (m) | Pillar height (m) | Panel width (m) |
|---|---|---|---|---|---|
| Mains | 80-130 | 74.5 | 29.5 | 3.5 | 145.5 |
| Gate roads | 150-170 | 44.15 | 16.0 | 3.5 | 48.5 |
| Web panels | 150-170 | 117.25 | 6.0 | 3.5 | 54.0 |
| Intra-web panels | 150-170 | 117.25 | 22.8 | 3.5 | Single pillar only |
| Barrier pillars | 80-170 | >200 | 50.0 | 3.5 | Single pillar only |

The basis of subsidence predictions undertaken by Mine Advice (2016a) is that the mine layout design and the coal pillars to be left in place will achieve long-term stability. Further information justifying the mine plan and mine layout, and in particular investigating pillar stability, is provided in a separate report produced by Mine Advice (*Mine Design Justification Report* (Mine Advice 2016b)), which is included in Appendix A of the subsidence assessment report (refer to Appendix L).

### 14.3.2 Strata compression effects

Surface lowering due to the vertical compression of the various coal pillars (ie main headings pillars, gate road pillars, web pillars, intra-panel and solid barrier pillars) occurs when the overburden load is redistributed due to coal extraction. As coal is extracted, the overburden load absorbed by this coal is transferred to the coal pillars, resulting in increased vertical stress and the potential for adjoining roof and floor strata to be compressed.

Surface settlement estimates based on elastic strata compression estimates by Mine Advice (2016a) for the different coal pillars in the overall pillar system are summarised in Table 14.8. The values presented are based on worst case vertical loading conditions according to maximum cover depth. As shown in the results in Table 14.8, the surface settlement due to strata compression for each of the pillar types under this scenario will be negligible.

**Table 14.8 Surface settlement estimates due to strata compression by coal pillar type**

| Panel type | Associated surface settlement (mm) |
|---|---|
| Mains pillars | 6.6 |
| Gate road pillars | 10.5 |
| Web pillars | 10.0 |
| Intra-web barrier pillars | 5.4 |
| Barrier pillars | 6.7 |

### 14.3.3 Groundwater depressurisation effects

The potential for significant surface settlements due to groundwater depressurisation effects is considered by Mine Advice (2016a) to be negligible, as the required strata conditions and groundwater pressures are not present to cause significant change in the overall state of the overburden and hence surface settlement. Notwithstanding, Mine Advice (2016a) completed an assessment of the worst case surface settlement associated with complete depressurisation of the Hawkesbury Sandstone and Wongawilli Seam working section and roof strata at the maximum pressure head that could be present prior to mining. It is noted though that this was done for the purpose of conservatism, and this level of effect on the groundwater system is well beyond the results of the groundwater assessment.

The worst case settlement conditions can be expected at a cover depth of approximately 170 m where the Hawkesbury Sandstone is approximately 120 m thick and contains a maximum possible head of water of 120 m or 1.2 MPa. Using these inputs, the estimated worst case settlement due to the full depressurisation of the Hawkesbury Sandstone is 4.4 mm.

In terms of the coal seam itself, assuming an average intact Young's Modulus of 2.4 GPa, the predicted settlement across a 7 m section of coal (3.5 m working section and 3.5 m of either roof or floor coal) for the maximum head loss of 1.2 MPa is 3.5 mm.

Combining the surface settlement of both coal and Hawkesbury Sandstone due to the complete removal of the maximum possible water head of 1.2 Mpa, results in a total shrinkage of 7.9 mm across the underground mining area.

### 14.3.4 Maximum surface settlement

The predicted maximum surface settlement as a result of the project, being a combination of settlement due to strata compression (Section 14.3.2) and groundwater depressurisation (Section 14.3.3), per pillar type is presented in Table 14.9.

**Table 14.9 Maximum surface settlement due to the project**

| Panel type | Associated surface settlement (mm) |
|---|---|
| Mains pillars | 14.5 |
| Gate road pillars | 18.4 |
| Web pillars | 17.9 |
| Intra-web barrier pillars | 13.3 |
| Barrier pillars | 14.6 |

As shown in Table 14.9, the range of predicted settlement at the surface associated with each of the different pillar types within the mine plan is very low (13.3 mm to 18.4 mm). This, in conjunction with the influence of the Hawkesbury Sandstone, leads to the conclusion that surface subsidence will manifest as a broad lowering across the mining area, rather than in discrete troughs as would be the case for a longwall mine (ie secondary extraction).

Based on the results above, for the purpose of assessing a worst case subsidence impact assessment Mine Advice (2016a) set the predicted value of surface settlement due to mining at 20 mm.

### 14.3.5 Maximum tilt, curvature and horizontal strain

Maximum values for the various differential subsidence parameters of tilt, curvature and horizontal strain can be estimated empirically using the estimate of maximum subsidence and the proposed panel geometry. Maximum tilt is the maximum rate of change of vertical subsidence with distance, while maximum curvature is the maximum rate of change of tilt with distance. Maximum horizontal strain is the change in length (either extension or compression) divided by the relevant length.

Due to the very low values of differential vertical subsidence predicted for the project as described above in Section 14.3.4, there is very little, if any, potential for disruptive tilts, curvatures and strains to develop as a result of mining. However, so as to assess a credible worst case scenario, Mine Advice (2016a) assessed the predicted upper values of tilts, curvatures and strains associated with a maximum surface settlement of 20 mm across a width of 60 m (this being the maximum span between intra-panel barriers).

The resulting worst case values for tilt, curvatures and horizontal strains are as follows:

- maximum tilt = 0.26 mm/m
- maximum convex curvature = 0.07 $km^{-1}$
- maximum concave curvature = 0.063 $km^{-1}$
- maximum tensile strain = 0.36 mm/m
- maximum compressive strain = 0.33 mm/m

These results are considered to be extremely conservative since the likelihood of obtaining 20 mm differential surface settlement over a 60 m width is extremely remote. The difference in settlement between the surface above the web pillars (17.9 mm) and the intra-web barrier pillars (13.3 mm) is only a 4.6 mm differential, not 20 mm. Secondly, at lower depths of cover, this differential will be reduced even further. In addition, the assumed degree of depressurisation on the groundwater system is purposefully conservative and well beyond the findings of the groundwater assessment.

The impacts related to these low predicted values for tilt, curvature and horizontal strain are discussed in Section 14.4.

### 14.3.6 Angle of draw and far-field horizontal movements

On the basis that the maximum predicted vertical surface settlement due to mining in the project area has been set at 20 mm, by definition the associated angle of draw is 0°. An angle of draw of 0° does not necessarily mean that there will be no vertical subsidence outside of the actual mining area; simply that it will be less than 20 mm in magnitude.

The subsidence assessment also found that the general reduction in horizontal stress within the Hawkesbury Sandstone due to mining will be less than 5 kPa. When this is compared with the pre-mining values of between 7.26 MPa and 5.1 MPa, this represents a maximum reduction in horizontal stress of only 0.1%. Therefore, the potential for significant far-field movements outside of the angle of draw is negligible and requires no further consideration.

## 14.4 Subsidence impact assessment

### 14.4.1 Overview

Vertical subsidence impacts, in particular non-conventional local curvature and strain concentrations, are all directly linked to both the level of surface lowering and the shape of the resultant subsidence trough. The magnitude and variation in vertical subsidence levels due to mining within the project area will be a combined function of both strata compression and groundwater depressurisation effects.

The primary conclusion in relation to vertical subsidence, as described in Section 14.3, is that surface lowering is likely to develop relatively uniformly across the underground mining area, albeit at the very low level of less than 20 mm. The drivers for significant surface subsidence due to groundwater depressurisation are not generally present such that any associated movements from this cause are likely to be very small.

The very low credible-worst case predictions for maximum tilt, curvature and horizontal strain associated with the project, the prevention of potential secondary curvature effects, and the compressive horizontal stresses within the near-seam overburden being almost fully maintained via the proposed mine design, are all significant mitigating factors in relation to surface damage potential. 20 mm is the generally accepted limit below which subsidence will have a negligible or imperceptible impact on surface features. 20 mm is also the historically accepted survey limit related to subsidence measurements due to variations in surface levels caused by non-mining related influences such as the swelling and shrinkage of near-surface reactive soils (Mine Advice 2016a). Notwithstanding, a discussion of predicted subsidence related impacts on surface features is provided below, including on sub-vertical discontinuities in the Hawkesbury Sandstone as is relevant to the groundwater assessment (refer to Chapter 7).

### 14.4.2 Impacts on built and man-made surface features

#### i Buildings

Built features across the project area include scattered rural residences and farm improvements such as outbuildings, dams, access tracks, fences, yards and gardens. The region is not a declared Mine Subsidence District, which means that no restrictions have been placed on building design to accommodate any future mine subsidence related movements.

Where mining induced ground tilt is expected to be less than 5 mm/m, it is unlikely that remedial work will be required on any buildings or built features. The maximum predicted tilt for the project is significantly lower at 0.26 mm/m. Further, given that no discernible differential vertical subsidence is predicted, there is negligible potential for damage to one and two-storey buildings.

#### ii Roads

There are a number of roads in and near the project area that vary from major interstate highways (the Hume Highway and Illawarra Highway) to local council managed roads (eg the Old Hume Highway, Mereworth Road, Oldbury Road, Belanglo Road and Golden Vale Road) as well as smaller farm roads. Roads are able to tolerate different levels of subsidence based on their construction and specific serviceability requirements.

The Illawarra Highway is outside of the mining area, and as discussed in Section 14.3.6, the angle of draw associated with the mine is 0°.The mine plan for the project has specifically taken into account the presence of the Hume Highway transecting the project area, with the extent of mine workings under the highway limited to intermittent crossings to provide first working access headings, with negligible subsidence.

Further, there is local evidence of roads and highways being successfully undermined with no significant impact and at significantly higher vertical surface settlement, tilt and horizontal strain values than those predicted for this project. For example, Mine Advice (2016a) cites longwall extraction at Appin Colliery under the Hume Highway, where a maximum surface lowering of 530 mm and maximum horizontal strains of 3.5 mm/m recorded over a 20 m bay length were observed in the highway corridor. With the implementation of a remedial and monitoring program, the highway pavement remained serviceable at all times.

#### iii Bridges

A number of bridges and culverts are present in the project area, including the Hume Highway bridge over Wells Creek, the Hume Highway box culvert over an un-named tributary of Wells Creek, Golden Vale Road culvert, Belanglo Road culvert and other minor road culverts. Given that subsidence levels due to mining have been found to be negligible (ie less than 20 mm of surface lowering), no impacts on bridges or culverts in the project area are predicted. Similarly, in relation to far-field horizontal movements, the predicted general reduction of less than 0.1% in horizontal stress from pre-mining values as a result of mining means that far-field horizontal movements will not affect bridges or culverts in the area.

### iv Transmission towers

A network of local and regional electrical services infrastructure occurs across the project area. The most significant are high voltage transmission lines located in the southern portion of A349. Both are located well outside of the underground mining area.

Problematic subsidence impacts relative to transmission lines, which include power pole instability and cable issues, commence at tilt levels in the order of 20 mm/m. The maximum predicted tilt associated with the project is almost two orders of magnitude below this level.

### v Gas pipelines

The Moomba to Sydney natural gas pipeline passes through the southern portion of the project area, and within the underground mining footprint. Gas pipelines have previously been successfully undermined with no loss of utility where maximum vertical subsidence values fall in the range of 760 mm to 1000 mm. Therefore, with subsidence associated with the project being a maximum of 20 mm, no impacts on gas pipelines will occur.

### vi Water pipelines, telecommunication cables and optical fibre cables

Both local and regional water supply infrastructure is located within the project area, including the Highlands water source pipeline, which supplies drinking water from the Wingecarribee Reservoir to Goulburn via a pipeline. Whilst this pipeline is in the southern section of the project area, it is outside of the underground mining area. There are also numerous minor local services infrastructure in the project area.

There are numerous examples as cited in Mine Advice (2016a) of underground longwall mines mining successfully under water pipelines in the Southern Coalfields, with significantly higher maximum values of vertical subsidence, tilt and horizontal strain compared with that predicted for the Hume Coal Project. The project will not produce levels of subsidence that has the potential to damage, or impede the utility of any of this infrastructure.

### vii Wire-fences

An extensive network of fencing occurs in the project area, associated with the predominant agricultural land use across the area. These structures are generally flexible in construction and can usually tolerate tilts up to 10 mm/m and strains to 5 mm/m without significant impacts occurring. As discussed in Section 14.3.5, the predicted values for the project are more than an order of magnitude less than these values.

### viii Vineyards

A small number of small local vineyards occur in the project area; namely Cherry Tree Hill Wines and Eling Forest, both adjacent to the Hume Highway.

Numerous examples of mining beneath vineyards are available in Australia, most of which are related to longwall mining which results in far greater levels of vertical subsidence and potential changes in the hydrogeological environment than will occur as a result of this project. With negligible subsidence predicted as result of the project, no subsidence related impacts on local vineyards are anticipated.

### ix Heritage

The first workings mining method and mine layout have been designed to minimise surface disturbance and subsequent damage potential to surface features including Aboriginal and non-Aboriginal heritage sites. Damage to heritage sites within the project area will be dependent upon their pre-mining condition; however, given the negligible subsidence predicted, no impacts to identified Aboriginal and non-Aboriginal sites are anticipated. Further, no angle of draw is predicted for the mine, as well as no far-field horizontal movements, and as such no subsidence related impacts on heritage features are predicted to occur.

Further discussion on potential impacts to Aboriginal and non-Aboriginal heritage sites is provided in Chapters 21 and 22 respectively.

### 14.4.3 Impacts on natural surface features

#### i Cliffs

The land above the underground mining footprint within the project area is predominantly cleared land used for agricultural purposes, generally comprising a gently undulating landscape. There are few, if any, significant cliffs within the project area. Some rock outcrops and minor cliffs that are less than 10 m high are present in the north-western portion of the project area in the Belanglo State Forest.

The very low credible-worst-case predictions for maximum tilt, curvature and horizontal strain are significant mitigating factors in relation to damage potential for cliffs. The mining method and mine layout has sought to minimise the level of disturbance to imperceptible levels.

#### ii Flora, fauna and groundwater dependent ecosystems

Impacts on vegetation and fauna habitat as a result of subsidence can occur due to shearing of plant roots and localised ponding. The resultant impacts are directly proportional to the magnitude of subsidence that occurs. With negligible subsidence predicted as result of the project, no subsidence related impacts on the flora and fauna in the project area and surrounds will occur.

Of particular relevance to potential impacts on flora and fauna is that surface subsidence will occur as a broad lowering across the mining area, rather than in discrete troughs as would be the case for a mine utilising secondary extraction (such as a longwall mine). Ponding of surface water as a result of subsidence is therefore not anticipated to occur across the surface of the underground mining area.

Some groundwater depressurisation will occur as a result of mining, which has the potential to impact on GDEs. Terrestrial vegetation, Long Swamp and Stingray Swamp were identified as potential GDEs in the biodiversity assessment (refer to Chapter 10). Areas of terrestrial vegetation along Belanglo Creek and Wells Creek were identified as having a higher risk of drawdown impact from underground mining. However, these areas have an opportunistic dependence on groundwater, and will be able to respond to changes in the water table outside of periods of prolonged drought. Monitoring and mitigation strategies have been proposed to manage these ecosystems in the event of prolonged drought (refer to Chapter 10).

In relation to potential impacts on Stingray Swamp; the dominant water source for this swamp has been identified as rainfall and surface runoff, and therefore this swamp will not be affected by drawdown-related impacts.

Although the water table is predicted to be shallow at Long Swamp, it is outside the maximum drawdown footprint (at Year 17 of mining). Long Swamp also accesses water from rainfall and runoff, which will not be affected by the project.

#### iii Water resources

As described in Chapter 5, a number of drainage lines traverse the project area, all of which ultimately discharge to the Wingecarribee River north of the project area. Watercourses that are third-order or above in accordance with the Strahler stream classification system within the project area are Medway Rivulet, Wells Creek, Belanglo Creek, and Longacre Creek.

Given the negligible to imperceptible subsidence impacts predicted for this project, none of the typical potential subsidence impacts on surface water resources in the project area are predicted to occur, such as ponding, realignment of drainage lines and stream bed cracking.

In relation to groundwater resources, a first workings system of mining has been adopted for the project to prevent overburden fracturing and/or collapsing, as well as assisting the rapid re-establishment of water pressure within the mine workings. By adopting this methodology, the hydrogeological impact during the period of mining will be minimised and groundwater regimes will be able to be returned to their pre-mining state as soon as possible after the cessation of mining.

A detailed discussion on groundwater impacts as a result of the project are provided in Chapter 7.

### 14.4.4 Long-term subsidence impacts

With no subsidence related impacts predicted as a result of the project, the only long-term subsidence risk relates to the integrity and stability of the remnant coal pillar system that is left behind after mining is complete. The specific details of this are contained in Appendix A of the subsidence impact assessment (Mine Advice 2016a, refer to Appendix L), noting that the mine design principles and stability criteria utilised are consistent with the need to engineer long-term stability based on a suitably low Probability of Failure combined with coal pillars within the system with suitable width to height ratios of greater than four. In addition to the mine layout and the coal pillars being left in place, long-term stability will also be assisted by the emplacement of rejects back into the mine workings and the post-mining flooding of the mine workings and associated re-establishment of full hydrostatic water pressures, although the design has been assessed without any assumed stability benefit related to these factors.

## 14.5 Management and mitigation

As documented in this chapter, subsidence impacts on surface features during mining will be negligible to imperceptible as a result of the project. The requirement for subsidence impact mitigation will therefore be dependent upon the long-term stability of the coal pillars, which are an integral component of the first workings mining method. Subsequently, from a subsidence management perspective, the actual geometry of the coal pillars will need to accurately reflect the proposed layout and associated design principles. To ensure that this occurs, continual monitoring and survey verification of the coal pillars will be undertaken throughout the mine life.

As described in Chapter 2, individual mining panels will be separated by wide solid barrier pillars and will be sealed as soon as possible after mining. This will allow the completed workings to flood, thereby re-developing hydrostatic pressures within the coal seam, which has been identified as a necessary pre-cursor for the overlying near-surface strata also re-charging.

General surface monitoring for verification purposes will also be undertaken. To minimise the impact of natural variations due to climatic effects on verification monitoring, survey points will be founded on solid bedrock and highly accurate survey methods will be adopted.

As discussed in Sections 14.4.1, 14.4.2 and 14.4.3, predicted subsidence related impacts of the project on surface features will be negligible in all cases. However, natural surface features that are judged to have low levels of pre-mining stability and large built-features that could be sensitive to low ground movements may require specific monitoring. Given the negligible nature of anticipated subsidence impacts, introduction of a Subsidence Management Plan and systematic monitoring of compliance to that plan will be sufficient.

## 14.6 Conclusion

The adopted first workings mining method and associated mine layout for the project will reduce the levels of surface and sub-surface subsidence due to mining to the lowest practical impact level, whilst still allowing productive and economic recovery of the coal resource. The predicted maximum values of associated subsidence parameters are sufficiently low such that subsidence related impacts on surface features will be imperceptible. Further, with maximum surface settlement across the project area less than 20 mm, the potential for significant three-dimensional horizontal shear effects to develop as a direct result of mining subsidence is also negligible.

The first workings mining method will offer a significant level of protection to both existing surface features and aquifers, by preventing overburden caving and fracturing of the overlying Hawkesbury Sandstone. As the coal seam is hydraulically connected to the Hawkesbury Sandstone, some level of drawdown due to depressurisation of the target coal seam will occur, as discussed further in Chapter 7 (water resources). However, once again, surface settlements will be negligible due to groundwater depressurisation effects.

The mine design principles and stability criteria utilised in developing the mine plan are consistent with the need for long-term stability based on a suitably low Probability of Failure, combined with coal pillars within the system with appropriate width to height ratios. In addition to the mine layout and the coal pillars being left in place, long-term stability will be assisted by the emplacement of rejects back into the mined-out voids, and the post-mining flooding of the mined workings and associated re-establishment of full hydrostatic water pressures.

Survey verification of mine workings, monitoring and surface feature-specific subsidence management and monitoring will be implemented as part of ongoing subsidence management strategies.

# 15 Traffic and transport

## 15.1 Introduction

This chapter addresses all of the traffic and transport issues relating to the project, in accordance with the relevant SEARs. The traffic and transport related SEARs are presented in Table 15.1.

### Table 15.1 Traffic and transport related SEARs

| Requirement | Section addressed |
|---|---|
| An assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the local and State road network and the rail network, having regard to Transport for NSW's and RMS's requirements. | This chapter |

To inform the preparation of the SEARs, DP&E invited other government agencies to recommend matters to be addressed in the EIS. Two agencies, Transport for NSW and RMS, raised matters relevant to traffic and transport. The matters raised by the two agencies are listed in Tables 15.2 and 15.3, and were taken into account in preparing the transport assessment, as indicated in the tables. The full technical report is in Appendix M, and is summarised in this chapter.

### Table 15.2 Transport for NSW's assessment requirements

| Recommendation | EIS section addressed |
|---|---|
| A traffic impact study prepared in accordance with the methodology set out in Section 2 of the RTA's Guide to Traffic Generating Development and include: | |
| • Accurate daily and peak traffic forecasts generated by the project during construction and operation, including details of transport routes, types of vehicles like to be used and expected ramp up periods. Forecasts are to include anticipated service vehicle movements, including vehicle types and arrival and departure times; | Section 15.3.1 (construction), Section 15.3.2 (operation) |
| • Details of the proposed staging of the project covering construction and operational stages; | Chapter 2 |
| • Details of the proposed access to the site from the road network during construction and operation of the project, including hours of operation, days of construction and operation for each stage of the project, intersection location, design and sight distances; | Chapter 2 |
| • Detailed assessment of the impact of the proposed project on the capacity, efficiency and safety of the road networks during construction and operation. The assessment should consider the cumulative impacts of the project on current road users and should also include the contribution of mining inputs, having regard to the transportation of dangerous goods (explosives, fuel and chemicals) to be utilised during the construction and operational phases of the project. A risk assessment should be undertaken to identify management measures that will be implemented to ensure that dangerous goods are safely transported; | Section 15.3.1 (construction), Section 15.3.2 (operation)<br><br>Chapter 18(Hazards and risk) |
| • Any oversize and over-mass vehicles and loads expected for the construction, operation or decommissioning of the project should be identified, including the shortest and least trafficked route having been given priority for the movement of construction materials and machinery to minimise the risk and impact to other motorists; | Section 15.5.4 |
| • A description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road network for the construction and over the life of the project; and | Section 15.5 |
| • Detailed plans of the proposed layout of the internal access roads and on-site parking in accordance with the relevant Australian standards. | Chapter 2 |

### Table 15.3 RMS assessment requirements

| Recommendation | | Section addressed |
|---|---|---|
| • | A traffic impact study prepared in accordance with the RTA Guide to Traffic Generating Development. | Sections 15.1 – 15.3 |
| • | The effects on traffic volumes and roadway configurations associated with entry to and exit from the mine and rail line during construction and operation from vehicles associated with the mine. RMS will not accept any direct access to the Hume Highway. If significant road works are proposed to accommodate any changes to the traffic regime, then the EIS will need to be expanded to address these proposals. | Section 15.3.1(iii),<br>Section 15.3.2 (iii) |
| • | The movement of overweight and oversize vehicles on the Hume Highway associated with the mine. | Section 15.5.4 |
| • | The impact of dust pollution or the depositing of fines on the functioning of reflective signs, pavement markers and pavement line marking. | Appendix K (air quality assessment) |

Traffic impacts on the road network, including at intersections, were determined with reference to the levels of service and intersection design standards for rural roads, as defined in the *Guide to Traffic Generating Developments* (RTA 2002) and the *Guide to Road Design* (Austroads 2010).

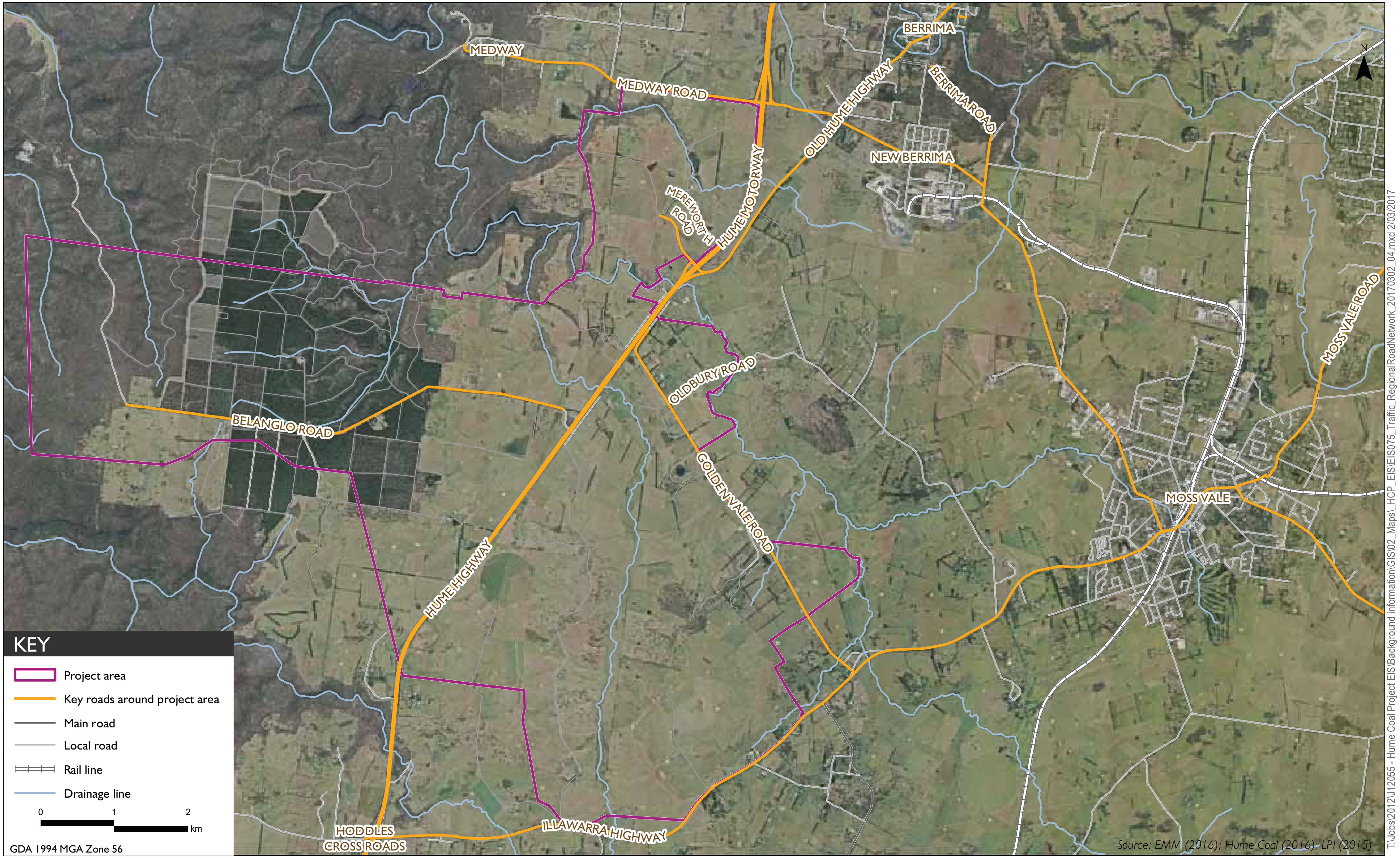
## 15.2 Existing environment

### 15.2.1 Overview of the existing road network

The major roads most likely to be used by project-related traffic are:

- the Hume Highway (SH 2);
- the Illawarra Highway (SH 25), which passes through Moss Vale and Sutton Forest continuing to access the Illawarra and South Coast via Robertson and other routes towards Kangaroo Valley, Kiama and Nowra;
- the Old Hume Highway, which passes through Berrima and Mittagong and intersects with the Hume Highway about 5 km south of Berrima, 3 km west of Mittagong and 6 km north of Mittagong; and
- the Berrima Road–Taylor Avenue–Medway Road route, which connects the Illawarra Highway at Moss Vale to the Old Hume Highway and the Hume Highway about 2 km south of Berrima.

The regional road network is shown in Figure 15.1, and described further below.




Regional road network

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Figure 15.1

### i Hume Highway

The Hume Highway provides a continuous 873 km high standard connection between Sydney and Melbourne. It is suitable for use by most vehicle types up to and including the largest B-double trucks, but excluding other larger road train-type vehicles. In the Berrima locality the highway has a continuous four-lane dual carriageway cross-section; its typical lane width is 3.5 m with a sealed shoulder of 3 m. Around 17.5% of traffic on the highway is heavy vehicles.

The highway was built to motorway standard (with no surface access intersections) to the north of the Old Hume Highway (Mereworth Road) interchange, where the dual carriageway road was originally built as the Hume Highway bypass of Berrima. Additional slow vehicle lanes are provided on some steeper sections of the highway between Berrima and Mittagong, providing six lanes of traffic capacity at these locations. The road surface along all sections of the highway is maintained to a high standard to provide for safe and comfortable travel conditions for nearly all types of vehicles.

### ii Illawarra Highway

The Illawarra Highway provides the main arterial road connection between the Illawarra and Southern Highlands. It has generally been designed and constructed as a high standard, two-lane rural highway with generous traffic lane and sealed shoulder widths for most of its length, but has only limited overtaking opportunities in the Moss Vale and Sutton Forest areas. The road is suitable for most types of larger trucks but only permits B-double vehicles to travel as far as Robertson.

Trucks larger than semi-trailers are not allowed to use the Macquarie Pass section east of Robertson, which connects to Wollongong and the coastal Illawarra region. Within urban areas, where the road passes through the townships of Sutton Forest, Moss Vale and Robertson, it uses a range of urban type road cross-sections and lower speed limits generally apply, including 40 km/hr school zone limits. The road surface is generally maintained in good condition with few visible surface defects. There is one railway level crossing just west of Robertson.

Through Moss Vale, the Illawarra Highway is known as Argyle Street, and has urban intersections with major local roads, including Berrima Road, which is known as Waite Street in Moss Vale.

### iii Old Hume Highway

The Old Hume Highway, north of Mereworth Road, provides local access and distribution through the Berrima area as well as a non-motorway connection between Berrima and Mittagong, which carries predominantly local traffic. To the south of Mereworth Road, the Old Hume Highway ceases to exist but some sections have effectively been incorporated into the four-lane dual carriageway alignment of the Hume Highway. Other isolated sections remain as service roads providing local access to properties, such as near the Golden Vale Road intersection. There is a former railway level crossing on the Old Hume Highway, south of Medway Road, where the former private railway branch line operated between the Berrima Cement Works and Medway Village. The line has been closed for many years.

### iv Mereworth Road

Mereworth Road, west of the Hume Highway is the main local road that mine-related traffic will use for future access. The existing daily traffic volumes using the road are generally low as it is mainly used to access two rural properties (including Mereworth).

### v Taylor Avenue, Berrima Road and Medway Road

These roads provide an east-west major road connection between the Hume Highway, the Old Hume Highway and Moss Vale. The route provides vehicular access to a number of major industrial sites which are located between Moss Vale and Berrima and residential areas in New Berrima and in the south and west of Moss Vale.

The speed limit is generally 80 km/hr but is reduced to 50 km/hr in residential areas. There is one railway level crossing east of the Berrima Cement Works, which is used by a relatively small number of trains each day travelling to and from the cement works.

#### vi Other local roads

Medway Road (west of the Hume Highway), Golden Vale Road, Oldbury Road and Belanglo Road are other local roads that mine-related traffic could use for some future access. The existing daily traffic volumes using these roads are generally low, as the farming properties in the area are relatively large and the rural residential population is low. Future usage of these roads by project-related traffic is expected to be minimal.

### 15.2.2 Level of service

The daily and peak hourly traffic volume standards for major rural roads are set by the *Guide to Traffic Generating Developments* (RTA 2002), defining six levels of service (LoS) for rural roads based on these volume standards.

The six LoS (A, B, C, D, E and F) for rural roads are described in Table 15.4.

**Table 15.4 Definitions of level of service for rural roads (RTA 2002)**

| Level of Service | Description |
|---|---|
| A | • Free-flow condition in which individual drivers are virtually unaffected by the presence of others in the traffic stream.<br>• Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high.<br>• General level of comfort and convenience provided to traffic is excellent. |
| B | • Stable flow in which drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.<br>• General level of comfort and convenience for traffic is a little less than that of LoS A. |
| C | • Stable flow zone, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream.<br>• The general level of comfort and convenience for traffic declines noticeably at this level. |
| D | • This level is close to the limit of stable flow, approaching unstable flow.<br>• All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream.<br>• The general level of comfort and convenience is poor and small increases in traffic flow will generally cause operational problems. |
| E | • This level occurs when traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream.<br>• Flow is unstable and minor disturbances within the traffic stream will cause a traffic-jam. |
| F | • This level is termed forced flow where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result. |

The LoS that the roads in the locality of the project area are operating at are described in Table 15.5.

**Table 15.5 Current level of service of roads around the project area**

| Road | Level of service | Comment |
|---|---|---|
| Hume Highway | A | The surveyed peak hourly directional volumes on the highway near the project area are up to 750 vehicles per hour. This volume is within the range for LoS A. Traffic is free flowing and drivers have a high degree of freedom to travel at their desired speed, subject to the speed limit. |
| Local roads near the project area[1] | A/B | These roads are either two-lane local roads or rural highways, with peak hourly two-way traffic volumes less than 360 vehicles per hour. This volume corresponds to the two highest LoS (A or B) and unconstrained traffic flow for these routes. |
| Berrima Road | C | The combined peak hourly two-way traffic volumes for Berrima Road are up to 440 vehicles per hour at certain locations, corresponding to a LoS C, where the traffic flow is 'stable' but most drivers are restricted in their freedom to select their desired travel speed. |
| Argyle St in Moss Vale | D-E | Surveyed peak hourly directional traffic volumes are up to 905 vehicles per hour, corresponding to the transition stage between LoS D to E, where the traffic flow is highly constrained, all drivers are generally restricted in their ability to travel at their desired speed and the traffic flow is subject to frequent interruptions. |

*Note: 1. Golden Vale Road, Mereworth Road, Old Hume Highway, Medway Road, and Taylor Avenue.*

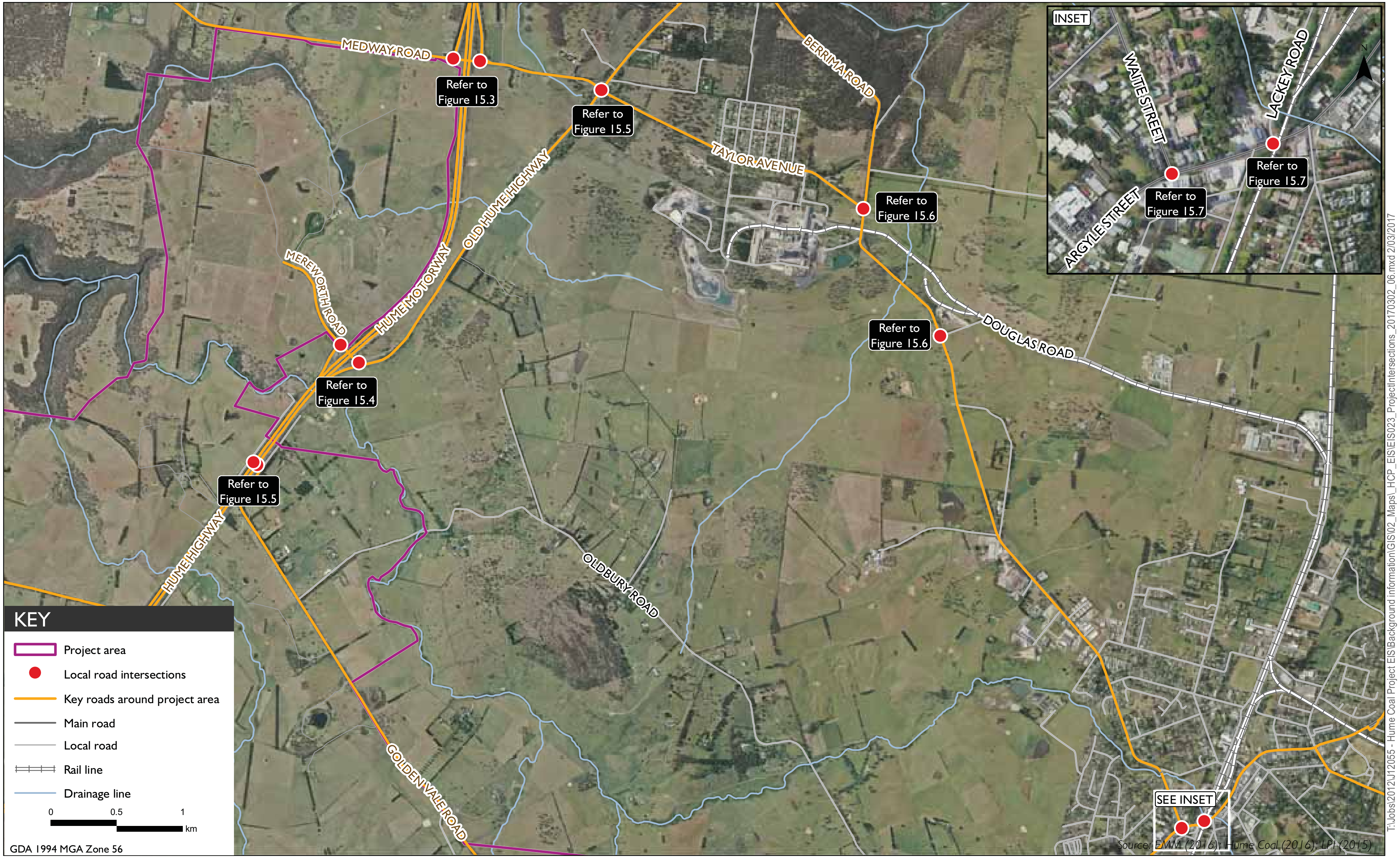
### 15.2.3 Intersections

The major road intersections near the project area that will be used the most by project-related traffic are the two grade separated interchanges on the Hume Highway at Medway Road and the Old Hume Highway (Mereworth Road).

Other nearby intersections that may be affected by project-related traffic are:

- Hume Highway/Golden Vale Road;
- Old Hume Highway/Medway Road roundabout;
- Berrima Road/Taylor Avenue (in New Berrima);
- Berrima Road/Douglas Road (south of New Berrima, near the Berrima Feed Mill);
- Argyle Street/Waite Street (in Moss Vale); and
- Argyle Street/Lackey Road (in Moss Vale).

The locations of these intersections relevant to the project are shown in Figure 15.2, and their current configurations are illustrated in Figures 15.3 to 15.7.




**Intersections relevant to the project**

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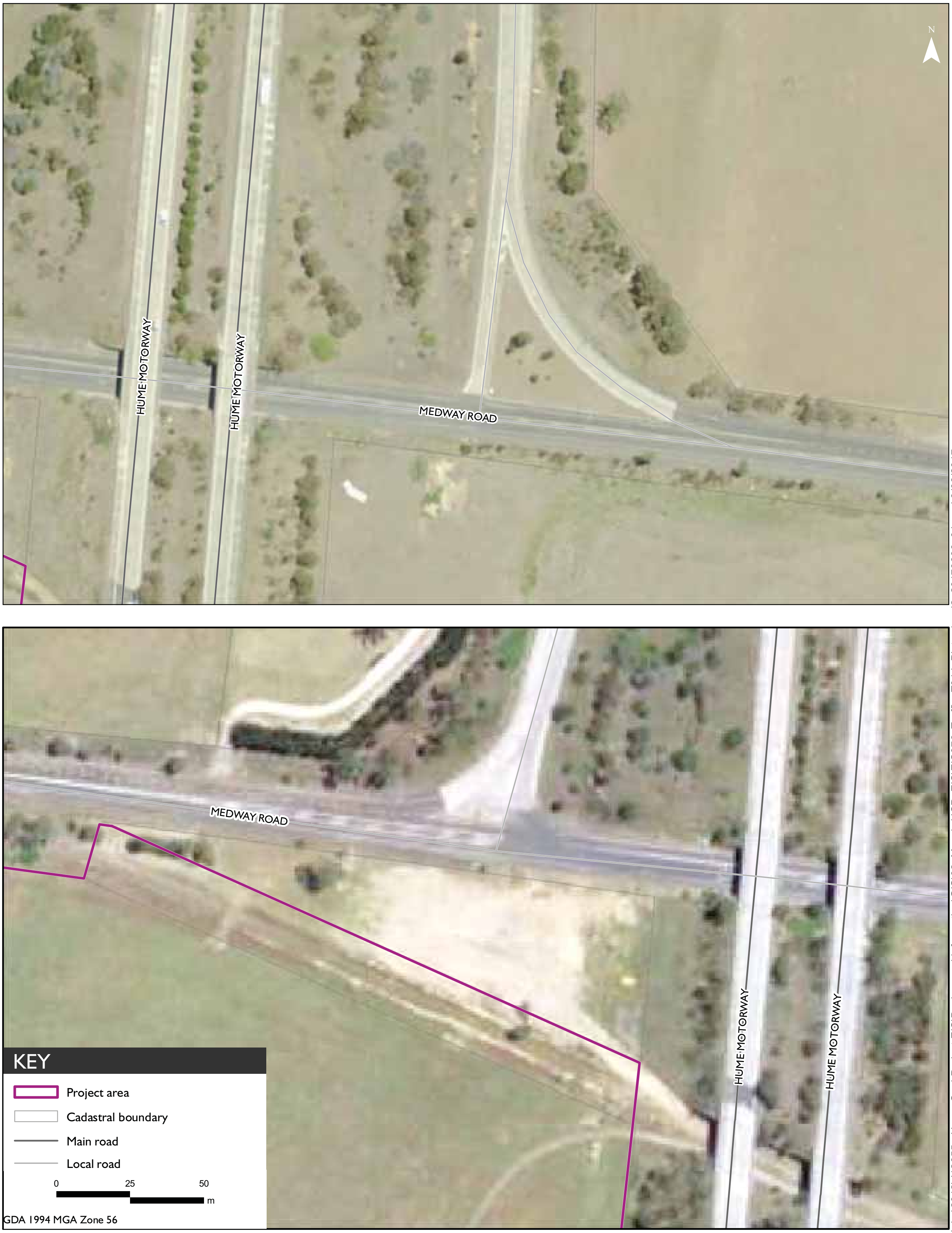
Figure 15.2

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**Hume Highway and Medway Road ramp intersection east side (top) and west side (bottom)**

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Figure 15.3



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**Hume Highway and Mereworth Road ramp intersection east side (top) and west side (bottom)**

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Figure 15.4



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**Hume Highway and Golden Vale Road access intersection (top) and Old Hume Highway and Medway Road roundabout intersection (bottom)**

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Figure 15.5





**Berrima Road and Taylor Avenue Y intersection (top) and Berrima Road and Douglas Road T intersection (bottom)**

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Figure 15.6



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**Argyle Street and Waite Street intersection in Moss Vale (top) and Argyle Street and Lackey Road intersection in Moss Vale (bottom)**

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Figure 15.7

The SIDRA intersection analysis program can be used to assess intersection traffic delay and other operating performance, such as the maximum traffic queue length for any left or right turn deceleration/storage movement. The current operating conditions at intersections likely to be used by project-related traffic were assessed using SIDRA 5.1 intersection capacity analysis, and are described below.

#### i Hume Highway intersections

The analysis found that all intersections within or close to the project area are operating at very low degrees of saturation, at less than 20% maximum traffic capacity, and have a corresponding high LoS (either A or B). In particular, the two major road intersections near the project area that will be used the most by project-related traffic (Hume Highway/Medway Road and Hume Highway/Mereworth Road) are both operating at less than 10% capacity during peak hours, with a maximum intersection traffic queue of typically 2 m or less. The Hume Highway/Medway Road intersections (northbound and southbound) were found to be operating at a LoS A under all traffic scenarios considered and at 6-9% capacity during peak hours. The Hume Highway/Mereworth Road intersections are also generally operating at LoS A, except the east side intersection during the morning peak, which operates at LoS B. Peak hour saturation is generally very low at 2-7% capacity.

The Hume Highway/Golden Vale Road (northbound and southbound) local access intersection, whilst carrying significant through traffic volumes, is generally operating at a high level of service (LoS B) and at 15-19% maximum capacity during peak hours.

The large roundabout at the Old Hume Highway, Medway Road and Taylor Avenue intersection is also operating at a LoS B, and at around 10% its maximum capacity during peak hours.

#### ii Berrima Road and Moss Vale intersections

The intersections along Berrima Road at Taylor Avenue (near the Berrima Cement Works) and Douglas Road (near the Berrima Feed Mill) are both operating at high levels of service during peak hours, operating at LoS A and around 20% capacity, and LoS B and 10-13% capacity, respectively.

The intersections along the Berrima Road and Argyle Street routes towards and through Moss Vale become progressively more congested towards the centre of Moss Vale. The two intersections assessed in Moss Vale (Argyle Street/Waite Street and Argyle Street/Lackey Road) are now operating with significantly congested traffic conditions during both the morning and afternoon peak hours.

The Argyle Street/Waite Street intersection in Moss Vale is operating at LoS C or D during peak hours and between 45% and 48% of its maximum capacity, with typical traffic queues of 19-27 m long.

The Argyle Street/Lackey Road intersection is further congested during peak hours, operating at a LoS F, at up to 54% of its maximum capacity and traffic queues between 39-55 m long.

### 15.2.4 Road safety

The most recent available five-year accident history (for 2009 to 2013 inclusive) for the Wingecarribee LGA is illustrated in Figure 15.8.

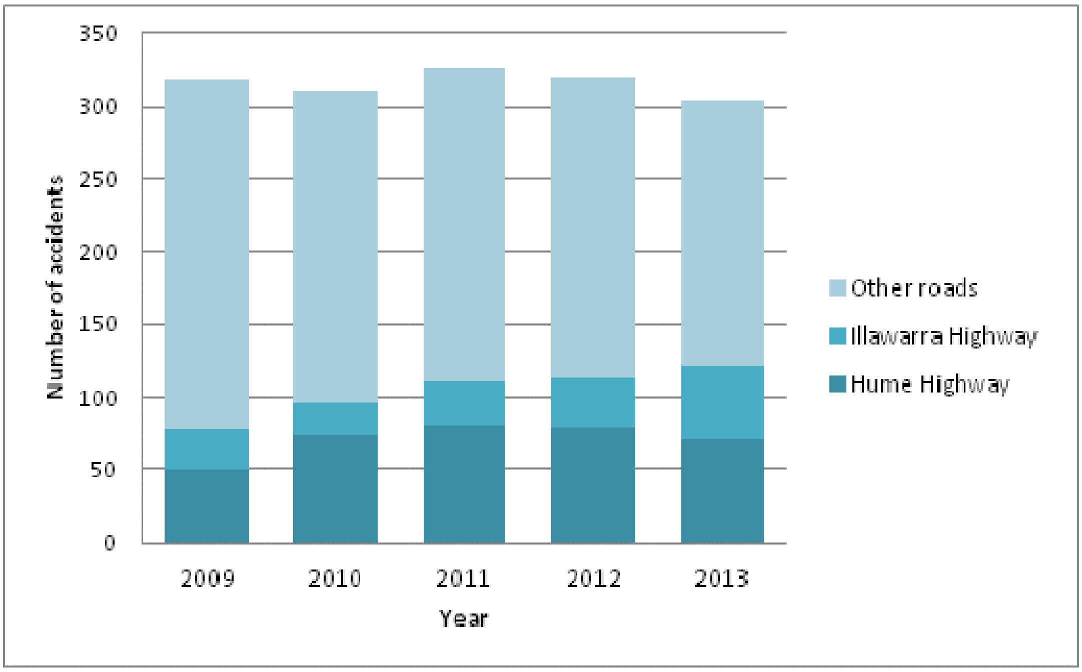



**Figure 15.8 Recent five-year accident history for all roads in the Wingecarribee LGA**

As shown by Figure 15.8, the total number of accidents in the LGA each year over the five year period has generally not increased. However, the number and proportion of accidents that have occurred on the two state highways has steadily increased, from around 25% of all accidents in 2009 to almost 40% of all accidents in 2013.Conversely, the proportion and the total number of accidents that have occurred on other roads in the LGA have both decreased significantly, with the number of accidents reducing by 23% over the five year period.

The proportion of fatal accidents on the two state highways is between 1.7% and 1.8%, while it is 1.1% for the other roads, giving an overall average LGA fatal accident proportion of 1.3%. This proportion is higher than the NSW state average, which was 0.8% in 2013, but is lower than in most rural areas of NSW where proportions of around 2% fatal accidents are normal.

### 15.2.5 Public transport

School buses are the predominant form of public transport in and around the project area. Most school buses in the area travel to and from Mittagong, Moss Vale, Bowral and Berrima. Other villages in the local area are also serviced by these school buses.

Commuter and CountryLink train services operate from Sydney to and from the railway stations at Mittagong, Bowral, Burradoo, Moss Vale and Exeter. These services include the Sydney to Melbourne CountryLink and Sydney to Goulburn and Canberra NSW Trainlink.

Public bus services also operate within and between most of these townships but they do not extend into the main project surface access areas on the western side of the Hume Highway.

## 15.3 Impact assessment

To account for background growth in traffic volumes and when construction is anticipated to start, the traffic impact assessment was undertaken against a base year of 2020, when traffic volumes will have increased by about 10% on the Hume Highway, and 5% on other routes, compared to the surveyed (2015) traffic volumes.

### 15.3.1 Traffic related impacts during construction

#### i Construction stage traffic generation

The anticipated maximum daily light and heavy vehicle traffic movements on weekdays that will be generated by the project construction workforce and traffic delivery movements are summarised in Table 15.6.Figures 15.9 and 15.10 also illustrate the distribution of daily generated traffic during the early and peak construction phases, respectively.

**Table 15.6 Light and heavy vehicle movements to and from the project area during construction**

| | Light vehicles (two way movements) | Heavy vehicles (two way movements) |
|---|---|---|
| Early stage construction (before accommodation village is operating) | 111 (222) | 39 (78) |
| Peak construction period (90% of construction workforce resident in accommodation village) | 84 (168) | 64 (132) |

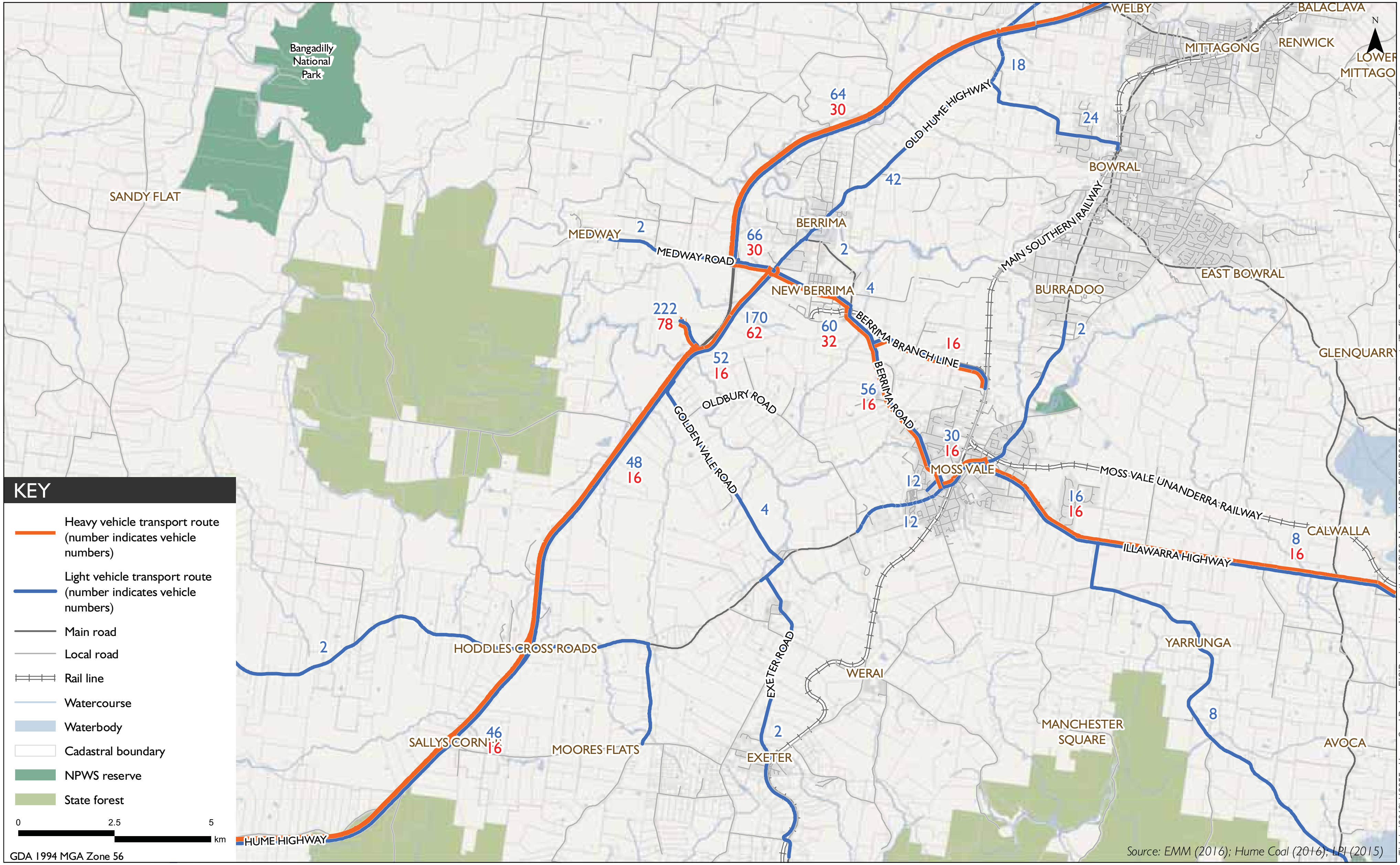
Car movements for arriving and departing residents of the accommodation village will normally be on a Sunday and will not contribute to the weekday traffic movements presented above.

During the peak stage of construction about 86% of light vehicle movements to and from the project area will be locally based from within the Wingecarribee LGA. There will be a lower proportion of locally based light vehicle movements during the early stages of construction, before the accommodation village is operating, with about 50% of the early stage construction workforce coming from outside the Wingecarribee LGA due to the specific skills required at this stage.

Heavy vehicle movements will be generated by deliveries of construction materials, construction equipment and waste removal. Between 20-40% of heavy vehicles during the construction stage will be contained within the Wingecarribee LGA. About 80% of the daily heavy vehicle delivery movements will normally occur during the morning and early afternoon (between 8 am–2 pm) on weekdays and the remaining 20% will generally occur at other times of the day, including some evening and night-time deliveries, such as for oversize vehicle movements that may not be allowed to travel during daylight hours. The distribution of heavy vehicle traffic on weekdays is presented in Table 15.7.

**Table 15.7 Project construction stage daily heavy vehicle traffic**

| Type of heavy vehicle movement | Daily number of deliveries | Approximate time period |
|---|---|---|
| **Early Stage Construction (without accommodation village)** | | |
| Deliveries of materials | 24 | 6 am– 6 pm |
| Deliveries of equipment and machinery | 12 | 5 am–3 pm |
| Waste removal | 3 | 5 am–2 pm |
| **Total heavy vehicles** | **39** | |
| **Peak Stage Construction (with accommodation village)** | | |
| Deliveries of materials | 40 | 6 am–6 pm |
| Deliveries of equipment and machinery | 18 | 5 am–3 pm |
| Waste removal | 6 | 5 am–2 pm |
| **Total heavy vehicles** | **64** | |

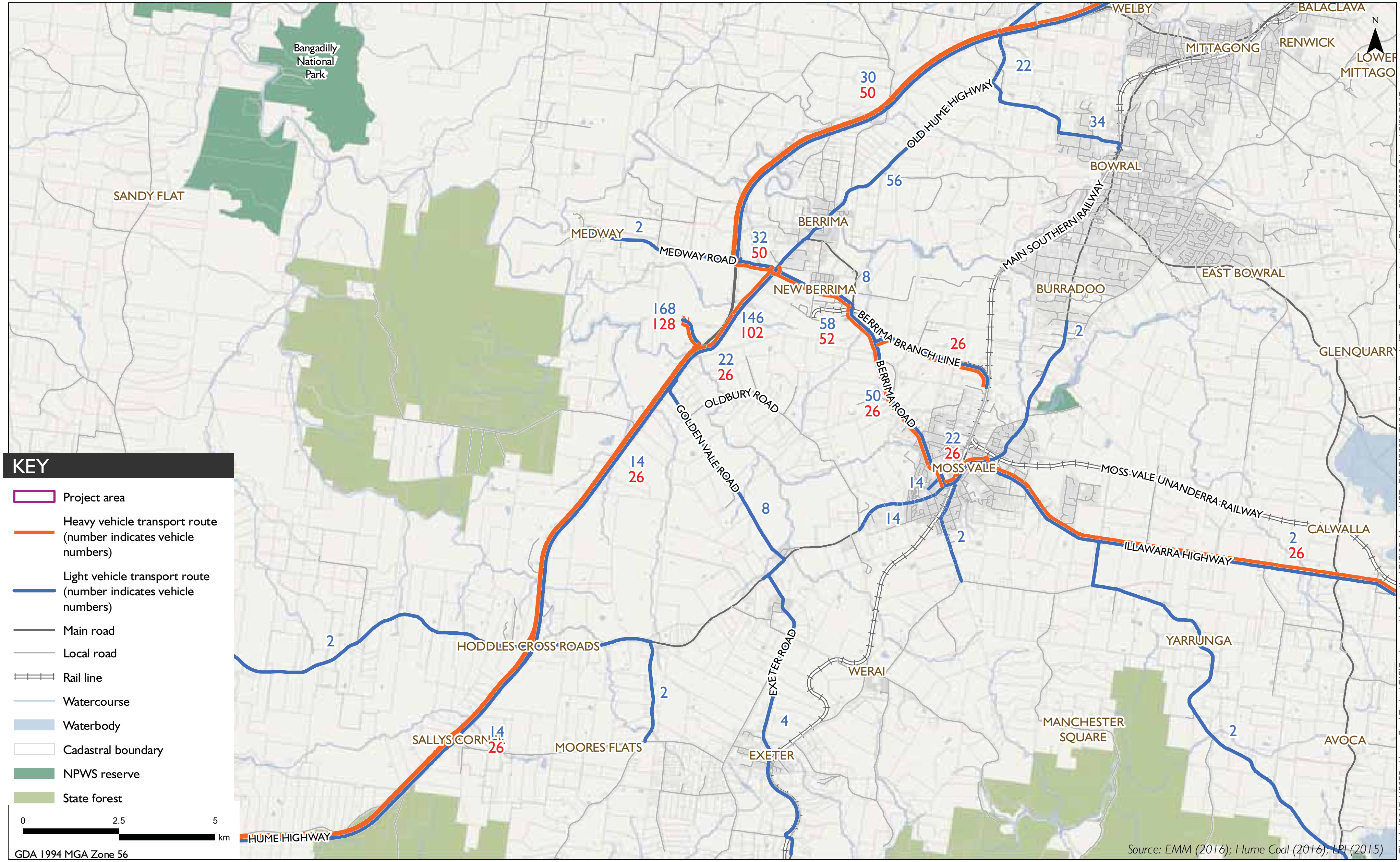



**Daily traffic movements - early project construction**

Hume Coal Project

Environmental Impact Statement

Figure 15.9




# Daily traffic movements - peak project construction

Hume Coal Project

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Figure 15.10

The destination for all workforce, construction materials and equipment delivery traffic during both the construction and operations stages will be the main project infrastructure area at the western end of Mereworth Road.

### ii Impacts on the road network

The predicted impact of the daily construction traffic movements anticipated to be generated by the project, and distributed onto the surrounding road network, is shown in Table 15.8 and Figure 15.10 for the early and peak construction stages.

**Table 15.8 Summary of predicted year 2020 traffic increases for early stage construction**

| Road | Predicted 2020 daily traffic volume | Early construction | | Peak construction | |
|---|---|---|---|---|---|
| | | 2020 daily project traffic | Traffic increase (%) | 2020 daily project traffic | Traffic increase (%) |
| Hume Highway at Penrose | 24,900 | 62 | 0.2 | 36 | 0.1 |
| Hume Highway south of Golden Vale Road | 20,100 | 64 | 0.3 | 40 | 0.2 |
| Hume Highway south of Mereworth Road | 20,600 | 68 | 0.3 | 48 | 0.2 |
| Hume Highway north of Medway Road | 22,200 | 94 | 0.4 | 80 | 0.4 |
| Hume Highway at Mittagong Bypass | 23,000 | 76 | 0.3 | 60 | 0.3 |
| Old Hume Highway south of Medway Road | 1,150 | 232 | 20.2 | 248 | 21.6 |
| Old Hume Highway north of Medway Road | 1,700 | 44 | 2.6 | 56 | 3.3 |
| Medway Road west of Old Hume Highway | 2,200 | 96 | 4.2 | 82 | 3.7 |
| Medway Road west of Hume Highway | 420 | 2 | 0.4 | 2 | 0.5 |
| Golden Vale Road east of Hume Highway | 840 | 4 | 0.5 | 8 | 1.0 |
| Mereworth Road west of Hume Highway | 22 | 300 | 1,364* | 296 | 1,345* |
| Taylor Avenue east of Old Hume Highway | 2,750 | 92 | 3.3 | 110 | 4.0 |
| Taylor Avenue west of Berrima Road | 2,650 | 88 | 3.3 | 102 | 3.8 |
| Berrima Road south of Taylor Avenue | 4,200 | 88 | 2.1 | 102 | 2.4 |
| Berrima Road north of Douglas Road | 4,500 | 88 | 2.0 | 102 | 2.3 |
| Berrima Road south of Douglas Road | 3,900 | 72 | 1.8 | 76 | 1.9 |
| Douglas Road east of Berrima Road | 740 | 16 | 2.1 | 26 | 3.5 |
| Waite Street north of Argyle Street | 7,350 | 60 | 0.8 | 62 | 0.8 |
| Illawarra Highway at Sutton Forest | 4,100 | 4 | 0.1 | 4 | 0.1 |
| Argyle Street west of Waite Street | 10,400 | 14 | 0.1 | 16 | 0.2 |
| Argyle Street east of Waite Street | 15,800 | 46 | 0.3 | 46 | 0.3 |
| Argyle Street east of Lackey Road | 19,300 | 46 | 0.2 | 46 | 0.2 |
| Illawarra Highway east of Robertson | 3,800 | 24 | 0.6 | 28 | 0.7 |

*Note:* ** Only two rural properties have access via Mereworth Road currently so the proportional project traffic increase is very high for this route.*

As it is evident from Table 15.8, with the exception of Mereworth Road which will be reconstructed as the main operational access road, the highest proportional increases in project-related construction traffic (about 20–22%) will occur on the section of the Old Hume Highway route, between the project access (Mereworth Road) and Medway Road (Old Hume Highway south of Medway Road).

This section of the Old Hume Highway was built to a relatively high standard due to its former use as the main Hume Highway. Therefore, the existing road carriageway will be able to comfortably accommodate the future daily traffic increase related to project construction (230–250 extra daily vehicle movements) during both the early and peak construction stages, with minimal change to the existing traffic flow conditions and level of service.

This section of the Old Hume Highway also has a relatively high proportion of existing heavy vehicle traffic, due to truck movements from the Berrima Cement Works and other local industries. As such, the additional daily heavy vehicle traffic related to the project during the construction stage will be relatively minor compared to the existing heavy vehicle traffic usage.

As can also be seen in Table 15.8, the increase in traffic movements on the other routes around the project area as a result of project-related construction traffic will be 4% or less, which will not generally be noticeable on any specific route.

On the main street sections of the Illawarra Highway (Argyle Street) through the Moss Vale town centre, the existing traffic volumes are already sufficiently heavy such that daily traffic increases from the project construction will be minimal at around 0.2–0.3%. Notwithstanding, the high existing daily traffic usage for the Argyle Route is a concern to the Wingecarribee Shire Council, which has been developing a preliminary traffic bypass proposal with RMS. This would have an additional railway line crossing at the northern edge of Moss Vale.

#### iii Impacts on intersections

The peak period for the construction workforce traffic arrivals during the early stage of construction will be generally 6.00–7.00 am on weekday mornings, which is well before the morning peak traffic period of 8.00 am and 9.00 am for the surrounding roads. During the peak stage of the project construction, the morning peak will coincide more closely with the surrounding roads; however, the construction peak hourly volumes will be lower by then as the accommodation village will be in use.

On weekday afternoons, the volumes of the project construction traffic that will coincide with the current afternoon peak traffic period for the surrounding roads, which is generally between 4.00 pm and 5.00 pm, will be more variable, although generally significantly lower than the morning construction traffic peak volumes.

The impacts of the above traffic change on the intersection operations during both stages of construction are expected to be minimal. The LoS at relevant intersections will remain at either A or B for all traffic scenarios considered.

At the Mereworth Road and Hume Highway off-ramp (north bound) interchange intersection where project-related traffic volume increases will be the highest, the current intersection priority will be reconfigured to realign the future traffic priority to Mereworth Road. This reconfiguration is in recognition of the increased future traffic volumes that will be using this route. The changed traffic priority will have minimal future impact on the Hume Highway off-ramp traffic, as it already has to slow to a virtual stop to make either a sharp right or a sharp left turn at the intersection.

#### iv Impacts on traffic safety

The additional daily traffic movements during the construction phase will not have any adverse road safety impacts on the local road network, particularly during the peak stage when nearly all of the workforce will reside in the onsite construction accommodation village.

### 15.3.2 Traffic related impacts during operation

#### i Operational stage traffic generation

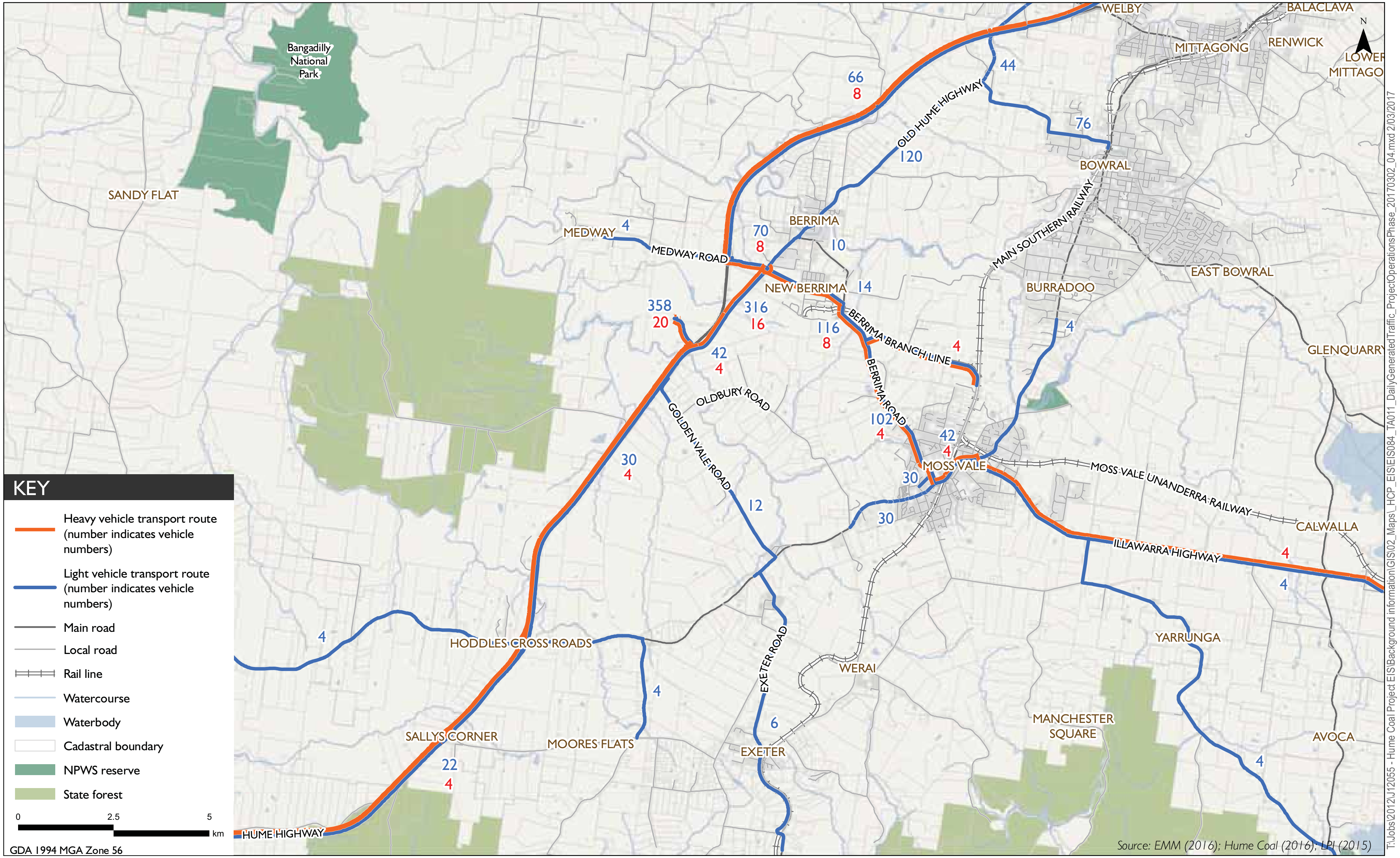
The maximum daily light vehicle traffic movements anticipated to be generated on weekdays by an operational workforce of approximately 300 people is 179 external vehicle visits (358 daily vehicle movements). This accounts for varying anticipated car pooling rates across the workforce, including 20% for the main shift workforce. Also, 64 people will work on weekend shifts, and therefore will not travel to/or from work on normal weekdays.

The daily vehicle movements to and from the project area on weekdays over a 24 hour period are presented in Table 15.9, and illustrated in Figure 15.11.

## Table 15.9 Hourly traffic generation summary for project operations

| Hourly interval commencing | Light vehicles arriving | Heavy vehicles arriving | Light vehicles departing | Heavy vehicles departing | Total hourly traffic movements |
|---|---|---|---|---|---|
| 0 am | | | 42 | | 42 |
| 1 am | | | | | |
| 2 am | | 1 | | | 1 |
| 3 am | | | | | |
| 4 am | | | | 1 | 1 |
| 5 am | 7 | | | | 7 |
| 6 am | 62 | 1 | | | 63 |
| 7 am | 7 | | 7 | 1 | 15 |
| **8 am** | **2** | **2** | **42** | | **46** |
| 9 am | 2 | | 1 | 1 | 4 |
| 10 am | 2 | 1 | 1 | 1 | 5 |
| 11 am | | | 2 | 1 | 3 |
| 12 midday | 2 | 1 | 1 | | 4 |
| 1 pm | 1 | | 1 | 1 | 3 |
| 2 pm | 44 | 2 | | | 46 |
| 3 pm | | | 3 | 1 | 4 |
| **4 pm** | **1** | **1** | **53** | **1** | **56** |
| 5 pm | | | 10 | 1 | 11 |
| 6 pm | 7 | | 9 | | 16 |
| 7 pm | | | 7 | | 7 |
| 8 pm | | 1 | | | 1 |
| 9 pm | | | | | 0 |
| 10 pm | 42 | | | 1 | 43 |
| 11 pm | | | | | 0 |
| **Total** | **179** | **10** | **179** | **10** | **378** |

The predicted increase in daily traffic movements on the local road network as a result of traffic generated by the project, based on the estimated year 2020 road network volumes, are presented in Table 15.10.




Daily traffic movements - project operation

Hume Coal Project

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Figure 15.11

### Table 15.10 Summary of predicted year 2020 traffic increases for project operations

| Road | 2020 daily traffic volume | 2020 daily project traffic | Proportional project traffic increase (%) |
|---|---|---|---|
| Hume Highway at Penrose | 24,900 | 26 | 0.1 |
| Hume Highway south of Golden Vale Road | 20,100 | 34 | 0.2 |
| Hume Highway south of Mereworth Road | 20,600 | 46 | 0.2 |
| Hume Highway north of Medway Road | 22,200 | 74 | 0.3 |
| Hume Highway at Mittagong Bypass | 23,000 | 30 | 0.1 |
| Old Hume Highway south of Medway Road | 1,150 | 332 | **28.9** |
| Old Hume Highway north of Medway Road | 1,700 | 130 | **7.6** |
| Medway Road west of Old Hume Highway | 2,200 | 78 | 3.5 |
| Medway Road west of Hume Highway | 420 | 4 | 1.0 |
| Golden Vale Road east of Hume Highway | 840 | 12 | 1.4 |
| Mereworth Road west of Hume Highway | 22 | 378 | 1,718* |
| Taylor Avenue east of Old Hume Highway | 2,750 | 124 | 4.5 |
| Taylor Avenue west of Berrima Road | 2,650 | 110 | 4.2 |
| Berrima Road south of Taylor Avenue | 4,200 | 110 | 2.6 |
| Berrima Road north of Douglas Road | 4,500 | 110 | 2.4 |
| Berrima Road south of Douglas Road | 3,900 | 106 | 2.7 |
| Douglas Road east of Berrima Road | 740 | 4 | 0.5 |
| Waite Street north of Argyle Street | 7,350 | 76 | 1.0 |
| Illawarra Highway at Sutton Forest | 4,100 | 6 | 0.1 |
| Argyle Street west of Waite Street | 10,400 | 30 | 0.3 |
| Argyle Street east of Waite Street | 15,800 | 46 | 0.3 |
| Argyle Street east of Lackey Road | 19,300 | 46 | 0.2 |
| Illawarra Highway east of Robertson | 3,800 | 8 | 0.2 |

*Notes: * Only two rural properties have access via Mereworth Road currently so the proportional project traffic increase is very high for this route.*

#### ii Impacts on the road network

As shown by the predicted hourly vehicle movements presented in Table 15.9, the majority of vehicle movements on a normal weekday will not generally coincide with peak hourly traffic periods for the roads surrounding the project area and through Moss Vale. Rather, movements will be distributed over a wide range of daytime travel periods, including early morning, mid-afternoon and evening shift change times.

The morning peak period for the operations workforce shift traffic, which comprises mainly workforce arrivals, will be between 6.00 am and 7.00 am on weekday mornings, which is well before the morning peak traffic period for the surrounding roads of 8.00 am and 9.00 am. However, there will be some traffic from night-shift departures from the mine during this morning peak period.

During the main afternoon peak period for the operations workforce shift traffic, traffic departures will mainly be from 4.00–5.00 pm on weekdays. This will generally coincide with the afternoon peak traffic periods at most intersections on the surrounding road network, which are generally between 3.30 pm and 4.30 pm.

As it can be seen in Table 15.10, with the exception of Mereworth Road, the highest proportion of increases in project operations related traffic (28.9% and 7.6%) will occur on the section of the Old Hume Highway route to the north and south of the Medway Road and Taylor Avenue (roundabout) intersection.

As discussed in Section 15.3.1 (ii), this part of the Old Hume Highway was built to a relatively high design standard due to its former use as the main Hume Highway. As such, the existing Old Hume Highway carriageway will comfortably accommodate the future project operations-related daily traffic increase (130–330 extra daily vehicle movements) with minimal change to the existing traffic flow conditions and level of service.

The proportional daily traffic increases generated by the project on other traffic routes (refer to Table 15.10) will be generally 4% or less, which will not normally be noticeable.

On the main Illawarra Highway route (Argyle Street) through the centre of Moss Vale, the existing traffic volumes are already generally heavy at up to 18,400 daily vehicle movements in 2015, and predicted to increase to approximately 19,300 daily vehicle movements by 2020. Similarly to during project construction the proportional project operations daily traffic increases of 0.2% to 0.3% on this route will therefore produce only minimal traffic impacts to existing traffic flow conditions and the town centre traffic amenity along Argyle Street.

As noted in Section 15.3.1 (ii), Mereworth Road will be rebuilt as the main future project access road, and will therefore be constructed to handle the increased operational traffic volumes.

### iii Impacts on intersections

The operation of intersections to be used by project-related traffic was assessed using the SIDRA 5.1 intersection analysis program. The level of service at which these intersections will function when the project is operating is summarised in Table 15.11.

**Table 15.11 Intersection level of service during project operations**

| Intersection | Level of service | Maximum queue length |
|---|---|---|
| Hume Highway/Medway Road interchange | A | 0-3 m |
| Hume Highway/Mereworth Road interchange | A/B | 0-2 m |
| Hume Highway/Golden Vale Road interchange | B | 2-4 m |
| Old Hume Highway/Medway Road roundabout | B | 4 m |
| Berrima Road/Taylor Avenue | A | 6-8 m |
| Berrima Road/Douglas Road | B | 3-4 m |
| Argyle St/Waite St (in Moss Vale) | C/D/E | 19-30 m |
| Argyle St/Lackey Road | F | 39-59 m |

*Notes: 1.The SIDRA intersection analysis program automatically adds 5% to all surveyed traffic volumes as a contingency measure.*

As it can be seen in Table 15.11, the majority of intersections to be used by project-related traffic will continue to operate at a high level of service (A or B). At the Medway interchange, the maximum intersection delays will not increase with the added project operational traffic, with the maximum intersection degree of saturation increasing marginally to 0.103. The degree of saturation is a measure of how much demand an intersection is experiencing compared to its total capacity, with a value of 1 meaning demand and capacity are equal and no further traffic is able to pass through the junction. The traffic priority at Mereworth interchange will be reconfigured, which will have minimal impact on the Hume Highway off-ramp traffic.

At the Hume Highway/Golden Vale Road intersection, the maximum intersection delay during the morning period will increase very marginally to 20.4 seconds, although the maximum degree of saturation will not change from the 2020 baseline traffic conditions. The maximum intersection delay and degree of saturation during the afternoon period will not change.

Similarly, the maximum intersection traffic delay and degree of saturation will increase marginally during the morning period at the Old Hume Highway/Medway Road roundabout to 17.5 seconds and 0.107 respectively. This will be a relatively minor impact for the morning peak hour project operations traffic. The maximum intersection delay and degree of saturation during the afternoon period will not change.

At the Berrima Road/Taylor Road intersection, the maximum intersection delay with the added project traffic in the morning period will not increase, although the maximum degree of saturation will increase to 0.235 with the project operations traffic. During the afternoon the maximum intersection delay will also not increase, although the maximum degree of saturation will increase to 0.239.

Also, the intersection delay in the morning will increase marginally to 17.5 seconds and the degree of saturation will increase to 0.107 with the project operations traffic. The afternoon maximum intersection delay will also increase marginally to 15.7 seconds and the degree of saturation will increase to 0.146 with the project operations traffic.

As evident in Table 15.11, the two intersections in Moss Vale will operate at low levels of service, as they do now. At the Argyle/Waite Street intersection, the added project-related traffic will not increase the morning peak hour intersection traffic delays, and only marginally increase the intersection degree of saturation to 0.503. In the afternoon, the peak hour level of service at this intersection will remain the same.

At the Argyle Street/Lackey Road intersection, the intersection traffic delay in the morning period will increase very marginally to 83.8 seconds and the degree of saturation to 0.503 with the added project-related traffic. Similarly, in the afternoon peak period the intersection traffic delay will increase very marginally to 131.8 seconds and the degree of saturation to 0.582.

Whilst the intersections of Waite Street and Lackey Road with Argyle Street will be congested, the assessment shows that the project will not result in any significant worsening of existing conditions at these intersections.

#### iv Impacts on traffic safety

As described in Section 15.2.4, the road safety record for most of the roads in the LGA is generally good and improving, particularly for the local road network managed by Wingecarribee Shire Council, which excludes the two major state highways (Hume Highway and Illawarra Highway).

The additional daily traffic movements due to the operation of the project will not have any adverse road safety impacts on the local road network. Most of the workforce will be locally based, with between 65% and 85% of people resident within the Wingecarribee LGA, largely in Moss Vale, Mittagong and Bowral.

The maximum commute time to the mine of 45-minutes which will be enforced by Hume Coal will assist in reducing the risk of fatigue related traffic incidents.

## 15.4 Impacts on the rail network

### 15.4.1 Project-related rail movements

Up to 3 Mtpa of coal produced by the project will be transported by rail to market. This coal will be transported via the new rail loop to be constructed as part of the Berrima rail project, which as described in Chapter 1 is the subject of a separate SSD application (refer to Appendix D). The coal will then travel via the Berrima Branch Line and onto the Main Southern Rail Line.

The transportation of 3 Mtpa will require about 25 loaded coal trains each week (50 coal train movements). In general, this will require four daily coal train movements in each direction on most days of the year.

### 15.4.2 Impacts on the Berrima Branch Line

The Berrima Branch Line is about 4.5 km long. The line has a practical capacity of around 40 train movements each day, 20 in each direction, including all freight train and light loco (locomotive only) movements.

The usage of the Berrima Branch Line associated with the existing users of the line is 120 train movements per week, and up to 26 train movements over a 24 hour period. Based on the current typical train operating times for the Berrima Cement Works trains using the Berrima Branch Line, which is 21 minutes, the maximum daily capacity of the Berrima Branch Line is 68 trains. The practical capacity is then calculated by taking 65% of the maximum capacity, which equates to 44 trains. Therefore 26 trains per day represents 59% of the practical operating capacity of the line, or 38% of the maximum line capacity.

To transport up to 3 Mtpa of product coal from the proposed Hume Coal mine to Port Kembla, about 25 loaded coal trains each week (50 coal train movements) will be required. This represents on average 3.57 loaded and 3.57 empty coal train movements daily. In general, this will require four daily coal train paths in each direction on most days of the year.

Table 15.12 shows the combined effects of the future train movements by all operators (including Hume Coal) on the line's capacity.

**Table 15.12 Existing and future usage of Berrima Branch Line**

| Line operations | Daily train movements | % maximum line capacity | % practical operating capacity |
|---|---|---|---|
| Daily maximum operations (existing users) | 26 | 38% | 59% |
| Future maximum daily operations (existing users and Hume Coal) | 34 | 50% | 77% |

The additional Hume Coal trains will increase the line's operations to 50% of the maximum line capacity(77% of the practical operating capacity) on the busiest days. This usage level would be within the Australian Rail Track Corporation (ARTC) recommended limits for freight line operations.

### 15.4.3 Impacts on the Main Southern Rail Line

Project coal trains will require gaps of about ten minutes between the existing timetabled northbound and southbound passenger and freight train paths on the Main Southern Rail Line at Moss Vale, so as to cross between the junctions with the Berrima Branch Line on the western side and the Unanderra Line on the eastern side.

Coal train movements from Hume Coal will only occur over a short (1.6 km) section of the Main Southern Rail Line and will be aided by an additional siding to be constructed as part of the Berrima Rail Project (see Appendix D) that will be provided at Berrima Junction in the northbound direction. The additional project coal train movements that will be 'crossing' over the main line tracks will occur during 'slack' periods in the existing timetable and so will have a minimal effect on the overall line capacity for longer distance passenger or freight train movements.

Further discussion and detailed analysis of the impacts of the project on the rail network is provided in Chapter 10 of the Berrima Rail Project EIS (Appendix D).

## 15.5 Management and monitoring

### 15.5.1 Construction traffic

With the exception of Mereworth Road, no external road widening or upgrades will be required to accommodate the traffic movements during the construction phase of the project.

Widening and reconstruction of Mereworth Road west of the Hume Highway, which is effectively a private road, will be required for it to serve as the project's main access route during both construction and operation. The cross-section of Mereworth Road will be widened and upgraded to an appropriate standard for the anticipated peak hour and daily traffic volumes the project will generate, including heavy vehicle movements, with marked road centre and edge lines and gravel road shoulders. Further detail on the works to be undertaken on Mereworth Road is provided in Chapter 2.

Project-related traffic impacts during the construction phase will effectively be avoided through the housing of the majority of the construction workforce in the onsite accommodation village. The village will accommodate up to 90% of the project construction workforce during the major part of the project construction period. This will minimise externally generated light and heavy vehicle movements such that there will be no significant project construction stage traffic impacts within local area roads surrounding the project, or on major locality traffic routes.

Where temporary construction stage access is required for any project worksite that is not within the Mereworth Road locality, an additional locality project construction stage traffic management plan and traffic control plan will be prepared to confirm the local access safety and traffic management requirements for the work, in accordance with RMS traffic control at worksite requirements.

### 15.5.2 Operational traffic

The main site access for light and heavy vehicles during operation will continue to be Mereworth Road, as per the construction phase. No further upgrades to Mereworth Road will be required over and above that undertaken during the construction phase.

Upon completion of construction the accommodation village will be decommissioned, and the project will operate with a locally based workforce, whereby approximately 85% of the workforce will be residents of the Wingecarribee LGA.

As described in Section 15.3.2(iv), a maximum commute time to the mine of 45-minutes will be enforced by Hume Coal, reducing the risk of fatigue related traffic incidents.

### 15.5.3 Intersection improvement

One intersection will require upgrading to safely accommodate the project-related traffic during construction and operation; the intersection of the Hume Highway north bound off-ramp with Mereworth Road.

Mereworth Road currently has very low traffic volumes west of the Hume Highway and the primary traffic movement is from the Hume Highway off ramp, turning right onto Mereworth Road. This suits the current intersection priority which has Give Way signs on the two Mereworth Road approaches. However, the additional Hume Coal project traffic volumes mean that a design change to this intersection will be required. Potential design changes considered were:

- Retaining the existing T intersection design but changing the intersection priority to the eastern and western approaches via Mereworth Road, which is the normal intersection priority for a T-intersection, and would be generally more familiar to most road users in the future.

- Constructing a new roundabout at the intersection with an outside diameter of 32 m. This is the effective minimum future circulating area which would be required for a B Double truck to undertake all possible traffic movements at the intersection.

SIDRA analysis of these two options was conducted. In relation to traffic delays, the analysis found that changing the priority to east-west at the T-intersection would reduce the average traffic delays by approximately 40% in comparison to the existing intersection priority, while the roundabout option would increase the average traffic delays by approximately 10%. The east-west priority intersection would provide a Level of Service A under the am and pm peak hour traffic scenarios considered, while the roundabout would provide a Level of Service B under the same six traffic scenarios. In addition only minimal changes to the existing intersection roadway (line marking primarily) will be required to change the existing intersection priority.

Retention of the existing T-intersection with a change in intersection priority was therefore shown to be best solution. The changed traffic priority will have minimal future impact on the Hume Highway off-ramp traffic, as it already has to slow to a virtual stop to make either a sharp right or a sharp left turn at the intersection. The reconfiguration of the Mereworth Road/Hume Highway interchange has been discussed with representatives of RMS and Wingecarribee Shire Council, as outlined in Chapter 5.

Hume Coal will fund the necessary works associated with the required intersection upgrade. Whilst ongoing maintenance will be the responsibility of Council, Hume Coal will enter into a VPA or similar, which could be used by WSC to fund local community services and facilities such as road maintenance.

### 15.5.4 Oversize vehicle movements and hazardous materials

Suppliers of equipment for the project will be chosen following a detailed engineering design and procurement process, which will occur after the development application is determined so that investment decisions can be made with certainty. Given this, the exact dimensions and quantities of construction materials, machinery and equipment, or where these items will be sourced from has not been confirmed. However, it is anticipated that oversize vehicles transporting items to the project area could be up to 8 m wide and 30 m long.

The permitted routes and time restrictions for oversize vehicles, which may include either night-time or daytime deliveries, will be determined in consultation with RMS and documented in the CEMP and OEMP before construction commences. RMS will decide on the oversize vehicle routes and travel times for the project on a case by case basis in accordance with its policy for oversize vehicle movements within urban areas and key transport routes, such as Picton Road, which connects from the Hume Highway near Wilton to the Wollongong urban area near Mount Keira.

Appendix P of the EIS considered if transportation of hazardous goods would qualify the project as a hazardous development under State Environmental Planning Policy 33 (Hazardous and Offensive Development) (SEPP 33). This involved comparison of the quantities and frequency of transportation of dangerous goods to the thresholds in Table 2 of *Applying SEPP 33* (DoP 2011). This comparison determined that transportation of hazardous goods to and from the project will not qualify it as a potentially hazardous development under SEPP 33.

## 15.6 Conclusions

No significant adverse traffic impacts have been identified as a result of traffic movements to be generated by the project during both the construction and operation phases on the local and regional road network based on:

- the road network traffic capacity;
- current intersection traffic operations; or
- the prevailing levels of traffic safety on the road network.

During construction, around 90% of the project workforce will reside in the onsite purpose built accommodation village, eliminating the risk of significant impacts on the local road network during the construction phase. During operation, 85% of the workforce will reside in the Wingecarribee LGA, with a maximum commute time of 45-minutes to be imposed to reduce the risk of fatigue related accidents.

All vehicles will access the mine site via Mereworth Road during construction and operation, which will be upgraded to accommodate the project-related traffic volumes. The intersection at the Mereworth Road/Hume Highway northbound off-ramp will be reconfigured to realign the future traffic priority to Mereworth Road, due to the increased traffic volumes travelling along Mereworth Road to the mine site. No other road or intersection upgrades will be required.

With the exception of the intersections along Argyle Street in Moss Vale, all assessed intersections to be used by project-related traffic will remain operating at a high level of service A or B. Although the traffic assessment found that the future peak hourly intersection traffic conditions at the two Argyle Street intersections will be congested (in particular at the Lackey Road intersection), as they are now, there will be no significant worsening of intersection traffic operations at these intersections in Moss Vale with the addition of project-related traffic.

# 16 Visual amenity

## 16.1 Introduction

The SEARs require an assessment of the likely visual impacts of the project. In the project planning phase the project design evolved to address potential visual impacts, through the specific siting of the surface infrastructure area such that it will be shielded from view from publicly accessible and privately owned areas as much as possible by existing topography and vegetation. Hume Coal has also already planted tree screens in identified locations around the surface infrastructure area to allow sufficient time for these screens to mature before construction commences.

Being an underground mine the potential for visual impact is limited to the surface infrastructure area. No significant new landforms, such as permanent surface waste emplacements, form part of the project.

The specific SEAR relating to visual amenity is presented in Table 16.1.

**Table 16.1 SEARs related to visual amenity**

| Requirement | Section addressed |
|---|---|
| An assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to the creation of any new landforms and minimising the lighting impacts of the development. | This chapter<br>Section 16.4 addresses potential impacts and Section 16.5 summarises mitigation measures |

The RMS also recommended matters relevant to visual amenity to be addressed in the EIS. The specific matter raised is presented in Table 16.2, and was taken into account in preparing the assessment.

**Table 16.2 RMS assessment recommendations**

| Recommendation | Section addressed |
|---|---|
| The visual amenity impact of the mine works with regard to driver behaviour. | Section 16.4.2 – viewpoints 1 and 5 address visual impacts on motorists travelling on the Hume Highway |

A visual impact assessment (VIA) was prepared to address the SEARs listed in Tables 16.1 and 16.2. In the absence of Federal, State Government or Local Government planning policies, guidelines or standards applicable to conducting a VIA of a coal-mining development, the assessment was undertaken in accordance with wider industry standards, in particular the United Kingdom (UK) guidelines: *Guidelines for Landscape and Visual Impact Assessment* (GLVIA) Third Edition (2013) prepared by the Landscape Institute and Institute of Environmental Management and Assessment.

The VIA was also prepared with regard to Australian Standard (AS4282) *Control of Obtrusive Effects of Outdoor Lighting* and the UK's *Guidance notes for the Reduction of Obtrusive Light* (The Institution of Lighting Engineers 2005).

The full technical report is attached as Appendix N, and a summary of the assessment is provided in the sub-sections below.

## 16.2 Existing environment

The majority of the project area (principally land above the underground mining area) comprises cleared land that is, and will continue to be, used for livestock grazing and small-scale farm businesses. Belanglo State Forest covers the north-western portion of the project area and contains introduced pine forest plantations, areas of native vegetation and several creeks that flow through sandstone gorges. Native vegetation within the project area is largely restricted to parts of Belanglo State Forest and riparian corridors along some watercourses. Photograph 16.1 illustrates the typical rural setting that exists across the majority of the project area.

The region surrounding the project area also primarily consists of grazing properties, small-scale farm businesses and scattered rural residences, particularly to the north, east and south. West and north-west of the project area lies Belanglo State Forest, and other natural forested areas extend to the west. A number of towns and villages are to the east of the project area, including New Berrima, Berrima, Moss Vale, Sutton Forest and Exeter. The nearest towns to the surface infrastructure area are Medway (2.5 km), New Berrima (3.5 km), Berrima (4.2 km) and Moss Vale (8.5 km). The larger towns of Bowral and Mittagong are around 11 km and 15 km from the surface infrastructure area respectively.

Industrial and manufacturing facilities in the vicinity of the project area include the Berrima Cement Works and Berrima Feed Mill on the fringe of New Berrima, around 3.6 km and 4.8 km from the surface infrastructure area, respectively. Underground coal mining in the area is a long established activity that dates back to the mid 1800s. Berrima Colliery's mining lease (CCL 748) adjoins the project area's northern boundary. Berrima Colliery ceased production in 2013 after almost one hundred years of operation.

The road network in and around the project area consists of a range of roadways from State Highways through to minor unsealed rural property access roads. The Hume Highway, which is a four lane dual carriageway, runs north-south through the project area. The highway is known as the Hume Motorway north of its intersection with Mereworth Road, and forms part of the main inland arterial route between Sydney, Canberra and Melbourne. The Illawarra Highway travels along the south-eastern project area boundary.

Existing sources of night lighting in the vicinity of the project area are the cement works and feed mill. Due to its height, the lights from the cement works in particular can be seen in the surrounding area and from the Hume Highway at night. Other existing sources of night lighting in the immediate vicinity of the project area are minimal due to its rural setting, with likely sources being rural residential properties, farm machinery and vehicles on roads. Motorists travelling north-south along the Hume Highway provide a moderate source of lighting in the evening hours.

The regional and local context of the project area is illustrated in Figures 1.1 and 1.2 respectively (refer to Chapter 1).

**Photograph 16.1** **The project area, looking south towards the product stockpile area from south of Oldbury Creek on 'Mereworth'**

## 16.3 Method

The VIA involved seven stages, in accordance with the GLVIA, as listed below.

1. View type and context – the existing baseline landscape was described noting its character and complexity.

2. Visibility baseline assessment – the zone of visual influence of the project was established through the use of computer generated zones of theoretical visibility, based on topographical data, or through fieldwork analysis. This established the locations where views of the project, including project-related infrastructure, may be possible. Site visits were then conducted to establish the types and locations of receptors within this theoretical zone.

3. Viewpoint and photomontage selection – key public and private viewpoints of the project area were selected and the project's level of exposure to them determined.

4. Magnitude of change - the magnitude of visual change and the changes arising from the project were assessed and the need for project modifications or other mitigation measures evaluated. Evaluation of the magnitude of change at each viewpoint was based on the following criteria:

    a) whether the impact is temporal or permanent – impacts that are for a limited duration are considered less significant than those which occur for an extended period or are permanent;

    b) scale of change – the loss or addition of features in the view and changes in the proportion of the view affected by the proposal;

    c) degree of contrast – level of integration of new features with existing or remaining landscape elements, having regard to form, scale, height, colour, and texture;

d) distance of the viewer from the altered elements in the landscape – close proximity to an altered landscape will increase the significance for private residences. In the case of motorists, mid ground changes can be greater than foreground elements as they can result in longer viewing times;

e) viewing direction – whether the change is to the primary view from the receptor;

f) extent of view affected – impacts that are visible over a greater portion of a view are more significant than those where only a part of the view is impacted. Intervening topography and vegetation will also affect the magnitude of change; and

g) length of viewing time – views from a residence are constant whereas some views from roadways as experienced by motorists are generally brief dependent upon speed and viewing direction.

5. Visual sensitivity – the capacity of the landscape to absorb change without a loss of quality (its visual sensitivity) was determined. This included consideration of the visual sensitivity of the receptor to the change, which was assessed based on a combination of:

a) importance of the view – changes to views from private residences or main tourist roads are considered more sensitive than from secondary roads;

b) length of view – the transient nature of a view by motorists from a road is considered less sensitive compared to a long-term view from a private residence;

c) receptor viewer expectation – communities where development results in changes in the landscape setting or valued views; and

d) location and context of the viewpoint – natural and modified elements that make up the visual landscape and contribute to the composition, and hence sensitivity of a viewscape.

6. Evaluation of significance – the significance of change in the landscape is a function of the magnitude of change when considered against the view type/context and the sensitivity of a receptor. Typically, a noticeable change in the landscape in an unmodified rural or natural landscape would be considered to be significant, whereas a change in an already heavily modified landscape would be considered slight or moderate (refer to Table 16.3).

7. Mitigation – the modified and mitigated project (if applicable) was assessed and final visual impacts are described and illustrated and their significance documented.

Table 16.3 illustrates how the magnitude of a change in the landscape is assessed and its significance rated, against the sensitivity of a receptor determined in stage 5 of the VIA.

**Table 16.3 Evaluation of significance matrix**

| Magnitude of change | Visual sensitivity | | |
|---|---|---|---|
| | High | Moderate | Low |
| High | Substantial | Moderate/ Substantial | Moderate |
| Medium | Moderate/ Substantial | Moderate | Low/ Moderate |
| Low | Moderate | Slight/ Moderate | Slight |
| Negligible | Slight | Slight | Negligible |
| Key: | Significant (red) | Not significant (green) | |

The primary assessment tools for determining the significance of potential visual impact were the site inspections, photographs of views from selected viewpoints and photomontages. These tools enabled the level of change in view to be determined and to assess visual impacts, taking into consideration the nature of the landscape, topography, the distance between the viewpoint and the proposed installation, as well as the type of view experienced.

The outcomes of the VIA are presented below.

## 16.4 Impact assessment

### 16.4.1 Critical viewpoint

Based on the outcomes of stages 1-3 described in Section 16.3, seven viewpoints in and surrounding the project area were identified for further analysis. The tasks undertaken in these stages included a desktop analysis, a line of sight analysis to the surface infrastructure area to confirm potentially affected viewpoints of varying degrees as a result of the project, and a site survey to confirm these viewpoints.

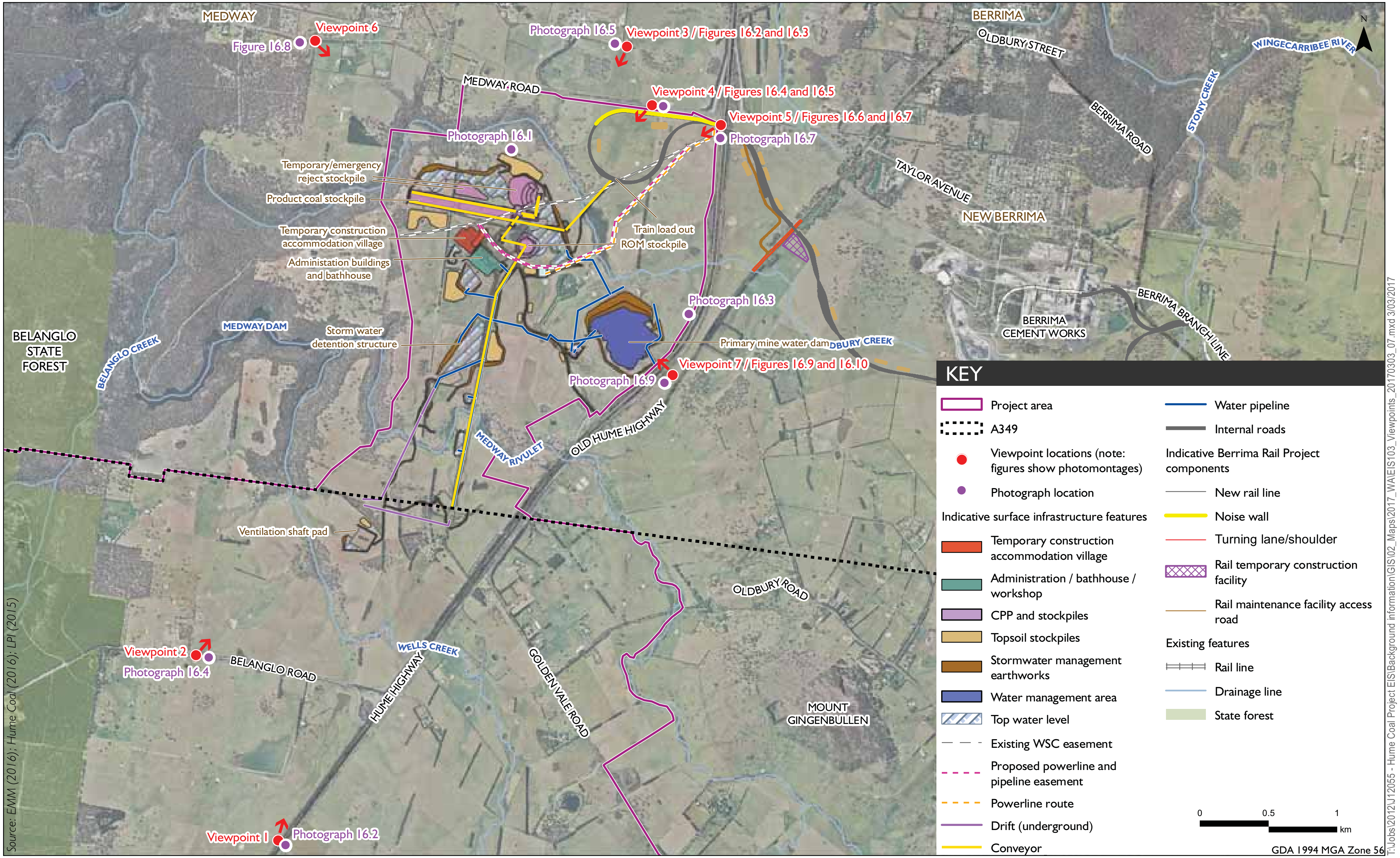
Following this process, the seven locations were chosen as they are considered to have the greatest potential to experience a visual impact due to exposure to surface infrastructure. Additionally, these locations are representative of likely visual impact to surrounding private residential landowners or potential exposure to project-related surface infrastructure for motorists travelling in the vicinity of the mine.

Each of the seven assessed viewpoints and three photomontage locations are illustrated in Figure 16.1.

### 16.4.2 Viewpoint analysis

The outcomes of the visual analysis for each viewpoint are presented in Table 16.4. A series of photomontages have been produced to illustrate the project infrastructure within the landscape from each of the relevant assessed viewpoints (ie viewpoints 3, 4, 5, 6 and 7). Photomontages were not produced for viewpoints 1 and 2 as the project-related infrastructure will not be seen from these locations (as described in Table 16.4 below). The existing view from viewpoints 1 and 2 are shown in Photographs 16.2 and 16.4, and the view from the Hume Highway adjacent to the surface infrastructure area (near the PWD) is shown in Photograph 16.3.

The photomontages present the existing landscape and the unmitigated view once project infrastructure is constructed. For viewpoints 3, 4, 5 and 7, the views in years 5 and 15 (relative to when the trees were planted) are also presented, which illustrate the growth of the tree screen. For viewpoint 6, the relevant year presented is year 5 (the tree screens won't be seen so the view in year 15 would be the same as year 5). These photomontages are presented in Figures 16.2-16.10.




## Viewpoint, photomontage and photograph locations

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Figure 16.1

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## Table 16.4 Viewpoint analysis results

| Viewpoint | Viewpoint details | View type and context | Visual sensitivity | Magnitude of change | Evaluation of significance |
|---|---|---|---|---|---|
| 1 | **Hume Highway -** looking north towards surface infrastructure area.<br>Closest position on the highway south of the surface infrastructure area that a motorist travelling north could safely stop to view the surface infrastructure in a forward facing manner. | Typical rural setting with a large expanse of predominantly flat, cleared farmland. Minimal amount of tree planting exists in the foreground with increased mature tree planting present in the background.<br>Refer to Photograph 16.2. | **Moderate** - due to it being a major highway, although noting the transient nature of the view by motorists, and its rural landscape character. | Viewers at this location will not have views of the project due to:<br>• distance from the highway at this point to the surface infrastructure area;<br>• the topography; and<br>• intermittent tree planting within the landscape<br>No change to the view will occur.<br>Views towards the project surface infrastructure area from the Hume Highway travelling north (beyond this viewpoint) will also be limited, with significant stretches of mature vegetation on the western side of the highway providing a natural landscaped buffer. | **Negligible** - topography and vegetation will prevent views of the project. |
| 2 | **Belanglo Road** – on the northern side looking towards the project surface infrastructure area in a north-easterly direction, approximately 1.5 km from the nearest surface infrastructure (upcast ventilation shaft). | Views screened by topography and existing tree planting within the landscape<br>Refer to Photograph 16.4. | **Low to moderate** – for motorists and residents respectively, in consideration of its rural landscape character and the transient view for motorists. | Viewers at this location will not have views of the project infrastructure due to:<br>• the distance from the infrastructure;<br>• the topography; and<br>• existing intermittent tree planting within the landscape, with a row of pine trees obstructing views of the project.<br>There will be no changes to the view from this location. | **Negligible** - the project will not be seen due to intervening topography and vegetation. |
| 3 | **Private residence on Medway Road** - on the northern side of the road approximately 980 m north of the surface infrastructure area. | Immediate views represent a typical rural setting with a large expanse of predominantly flat and cleared farmland. A ridgeline incorporating scattered vegetation exists in the background. | **High** - due to the residential nature of the receptor and rural nature of the view. | **Medium** change in view. Viewers from this location will have partial views of the coal loading facility. Existing and new tree planting along Medway Road will provide substantial screening to a majority of the surface infrastructure (refer to the photomontages in Figures 16.2 and 16.3). Therefore the change will be moderate from an open rural landscaped setting to a densely planted vegetated screen once the trees have grown to full maturity with intermittent views of the coal loading facility. | **Moderate to high** - as the coal loading facility will be partially seen and the open views will be altered. However, once the tree screen has matured, the impact will reduce to a **moderate** level (refer to Figure 16.3). |
| 4 | **Medway Road** - on the northern side looking in a south-westerly direction, approximately 460 m west of the Hume Highway overpass. | The landscape is dominated by predominantly flat grazing land with scattered vegetation throughout. Mature tree planting exists between the house and Medway road and in the background. | **High** - due to the residential nature of the receptor and its rural landscape character. The topography is predominantly flat with existing vegetation providing limited capacity to absorb change. | The magnitude of change is considered to be **medium** at this viewpoint and will commence during the construction phase. The mature vegetation that exists between this viewpoint and the surface infrastructure area will provide a significant level of screening to the visible project components (refer to the photomontages in Figures 16.4 and 16.5). | **Moderate to high** – There will be intermittent views of the construction phase of the project. The tree planting that has already been planted will provide some screening of the noise wall and will reduce the visual impacts to **moderate to low**. |

### Table 16.4 Viewpoint analysis results

| Viewpoint | Viewpoint details | View type and context | Visual sensitivity | Magnitude of change | Evaluation of significance |
|---|---|---|---|---|---|
| 5 | **Hume Highway** – on the western side facing south-west near the overpass with Medway Road, on the north-eastern corner of the project area. | Dominated by flat grazing land with scattered vegetation throughout. It provides a scenic rural view from the Hume Highway. Mature tree planting exists in the background. | **Moderate** - due to the landscape having little in the way of modifications, although cleared land, fences and electricity power poles are visible. It is also a main tourist road and the distance between the road and the infrastructure is at its closest point. | **Medium** - Due to the viewpoint's higher elevation, views of surface infrastructure will be possible, in particular the stockpiles, overland conveyor system and coal loading facility. The stacker will also be visible, which will be up to 20 m high. Infrastructure will appear as new visual elements within the landscape and will be visible from its construction in Year 1 to the end of operations in Year 21 (refer to the photomontages in Figures 16.6 and 16.7).<br>However, only temporal glimpses of the project will be possible to passing motorists as they travel through this viewpoint. This is due to the speed at which motorists travel on the highway (which has a speed limit of 110 km/hr) and the distance to the visible components, being approximately 1.4 km. It is also unlikely that motorists and passengers travelling northbound on the Hume Highway would look back towards the site. Views from southbound traffic will generally be obstructed by existing trees between the north and south bound lanes on the highway. | **Moderate** unmitigated visual impacts. To reduce impacts the visible components of the surface infrastructure area will be coloured in natural tones that are compatible with the surrounding landscape. |
| 6 | **Medway Road -** on the southern side and towards the north-western end of the road approximately 1.6 km from the surface infrastructure area. The relevant viewing direction is facing south-east. | The landscape is dominated by flat open paddocks and presents a rural character. Mature tree planting exists in the background and along the eastern and southern property boundary of this rural residential property. | **Moderate to high** - due to its rural-residential character. | Viewers from this location will have intermittent views of the project due to the topography and mature tree planting, resulting in a **low** magnitude of change.<br>The existing and proposed views from this viewpoint are shown in the photomontage in Figure 16.8. | **Moderate to low** - only a very small portion of the stockpile and reclaimer will be seen due to intervening topography, distance and vegetation. No further mitigation measures are proposed. |
| 7 | **Old Hume Highway** – eastern side of the highway adjacent to the surface infrastructure area. | The landscape is dominated by mainly flat open paddocks and presents a rural character. Existing mature tree planting exists in the background and surrounding Mereworth House and garden. | **Low** - due to the transient nature of the view by motorists. | Viewers from this location will have limited views of the project due to the topography, distance and mature tree planting, resulting in a **medium** magnitude of change (refer to the photomontages in Figures 16.9 and 16.10). | **Moderate to low** - due to distance and existing mature tree planting in the background. Prior to the tree planting maturing there will be intermittent views of the project during construction. Once matured the tree screen will reduce the visual impact to **low**. |

Photograph 16.2 Viewpoint 1 – Hume Highway looking north towards the surface infrastructure area

Photograph 16.3 Typical view from the Hume Highway adjacent to the project area, travelling north with vegetated buffers on the western side of the highway (source: Google streetview)

**Photograph 16.4 Viewpoint 2 – Belanglo Road looking north-east towards the surface infrastructure**



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**Viewpoint 3 photomontage - existing and unmitigated view**

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Figure 16.2



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**Viewpoint 3 photomontage - year 5 and year 15**

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Figure 16.3



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**Viewpoint 4 photomontage - existing and unmitigated view**

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Figure 16.4



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**Viewpoint 4 photomontage - year 5 and year 15**

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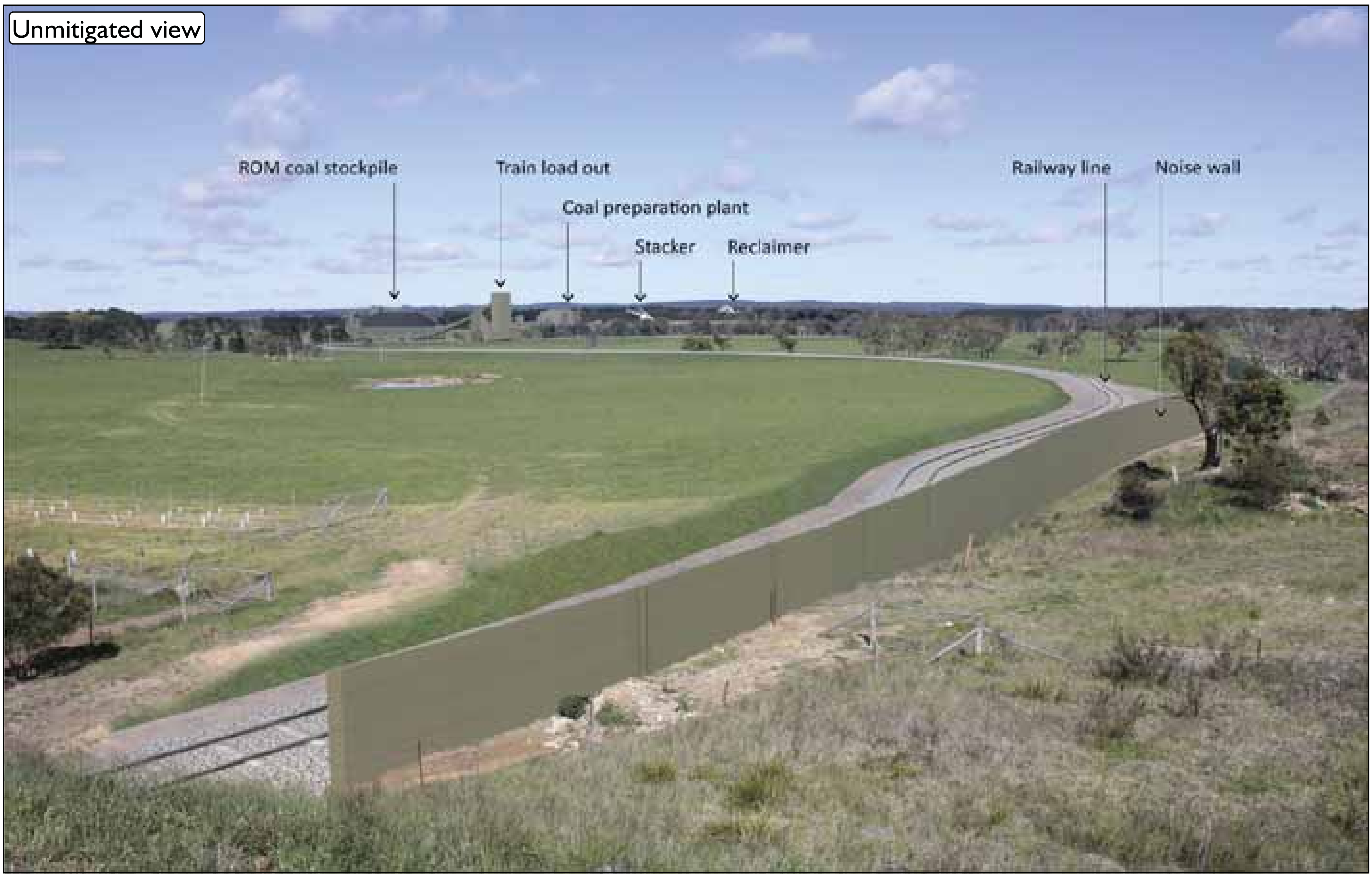
Figure 16.5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**Viewpoint 5 photomontage - existing and unmitigated view**

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Figure 16.6

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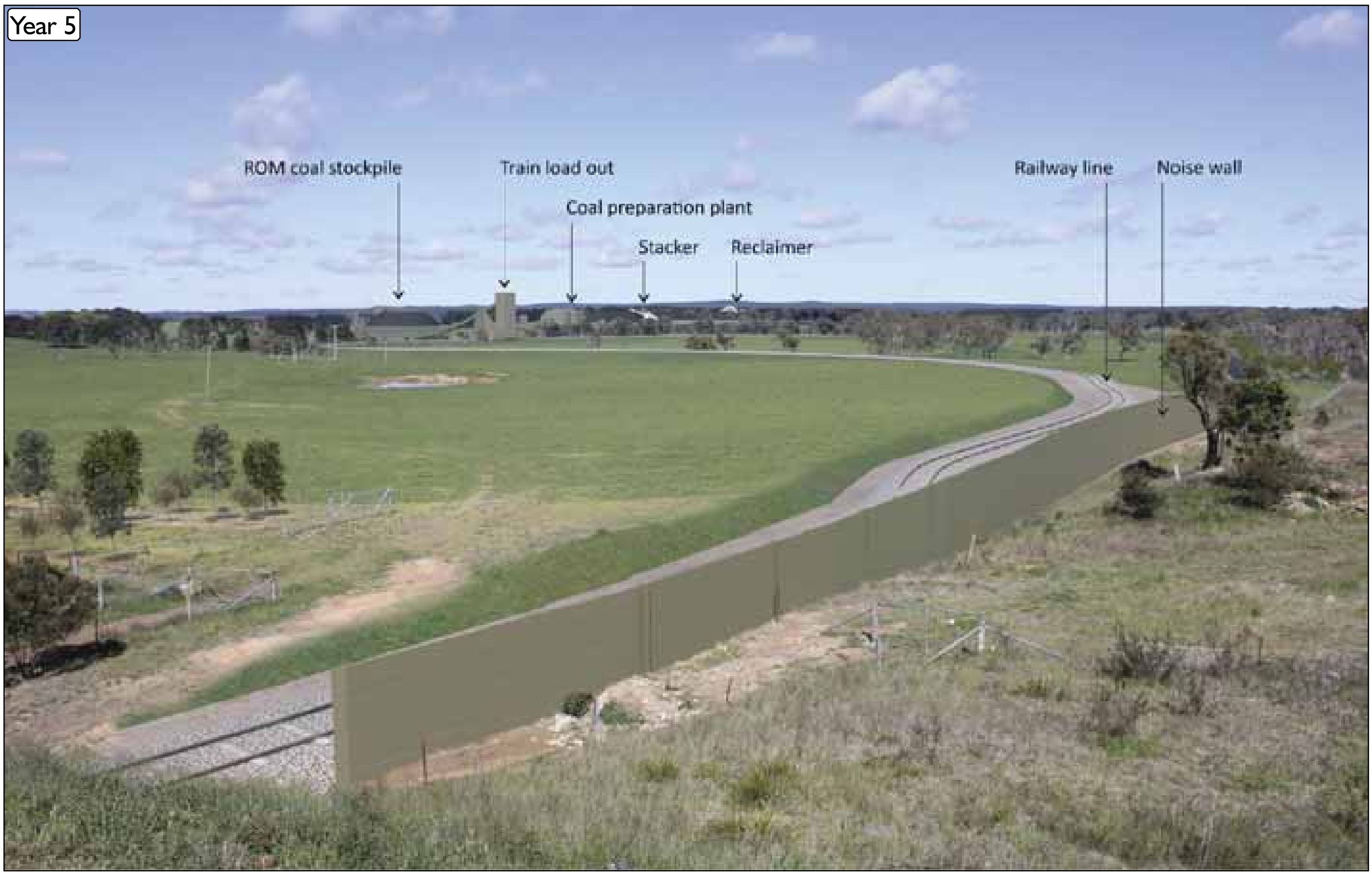


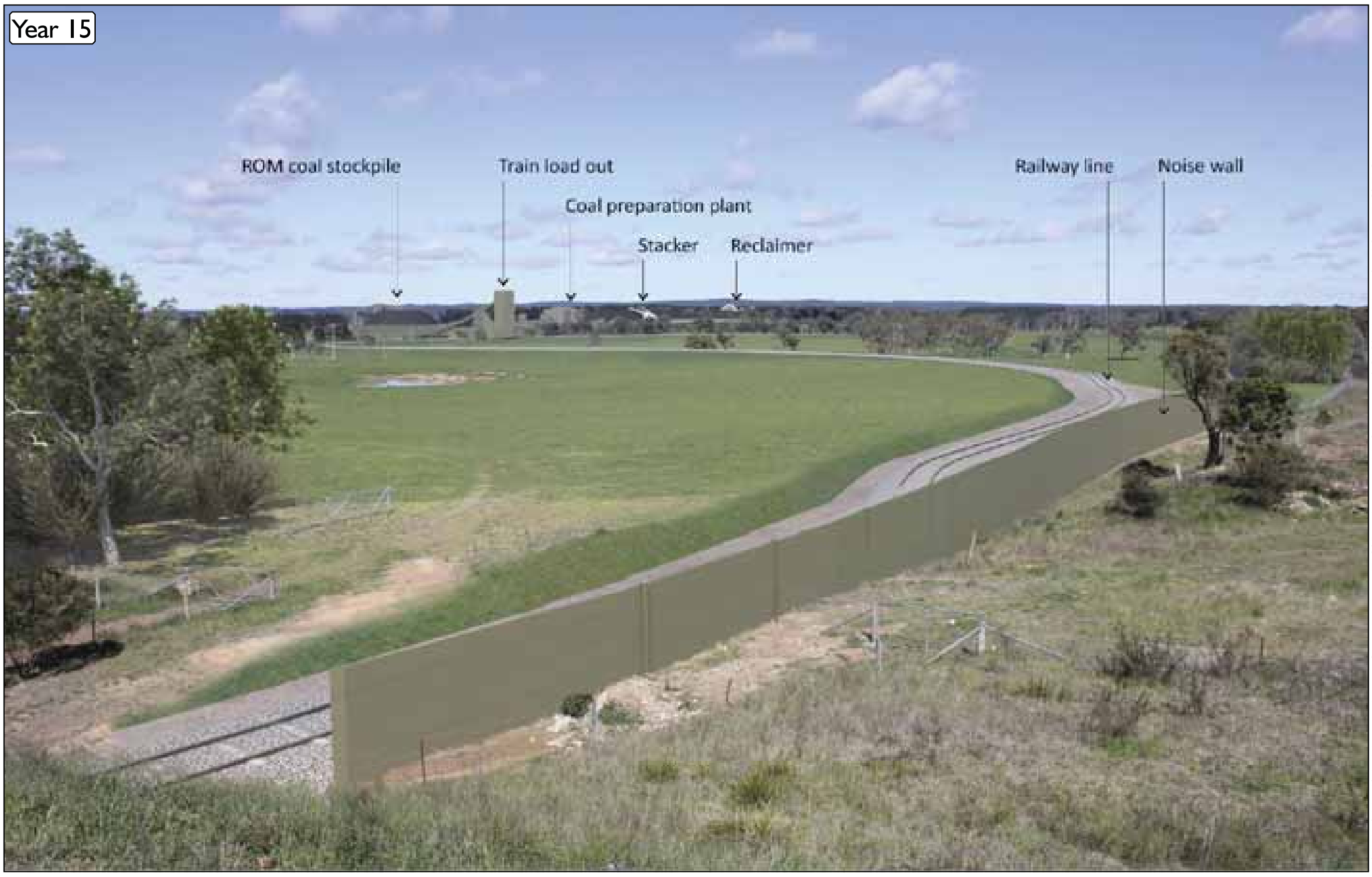




**Viewpoint 5 photomontage - year 5 and year 15**

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Figure 16.7



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Viewpoint 6 photomontage - existing and year 5

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Figure 16.8



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Viewpoint 7 photomontage - existing and unmitigated view

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Figure 16.9



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**Viewpoint 7 photomontage - year 5 and year 15**

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Figure 16.10

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As evident in the results presented in Table 16.4, no viewpoints have been assessed as having a high potential of experiencing a significant visual impact as a result of the project. Two viewpoints; 3 (private residence on Medway Road) and 4 (also on Medway Road), were assessed as having the potential to experience a moderate to high unmitigated visual impact; however the impact will reduce to moderate, and moderate to low respectively, once the tree screens already planted reach maturity.

Viewpoint 5 is predicted to experience a moderate unmitigated visual impact, and viewpoints 6 and 7 a moderate to low impact.

Mitigation measures are further discussed in Section 16.5.

### 16.4.3 Cumulative assessment

#### i Berrima Rail Project

As discussed in Chapter 1, Hume Coal is also seeking approval for the construction and operation of a new rail spur and loop under a separate development application for the Berrima Rail Project. This rail project is also relevant in the cumulative impact assessment.

The cumulative landscape and visual effects that may result from an individual project that is being assessed and how it interacts with the effects of other proposed developments in the area is also particularly important when preparing a visual impact assessment. Further, it is influential in the viewpoint selection. In this instance, the visual effects of the Berrima Rail Project have been considered in the viewpoint assessment, in particular the associated noise wall, railway line and tree planting.

The GVLIA outlines the types of landscape and visual cumulative effects that may need to be considered, including:

- “temporal effects, referring to the cumulative impacts of simultaneous and/or successive projects that may affect communities and localities over an extended period of time;
- the interaction between different types of development, each of which may have different landscape and/or visual effects and where the total effect is greater than the sum of the parts;
- effects of development which have indirect effects on other development, either by enabling it – for example a road development enabling new warehouses to be constructed at a roundabout – or disabling it – for example by sterilising land; both may in turn have landscape and or visual effects.”

As such, these two projects have been assessed cumulatively in the viewpoint analysis (Section 16.4.2) to determine the visual impacts on the locality, which will be the ‘inter-project’ cumulative effects (GVLIA). The photomontages also represent the cumulative impacts of the two projects.

### ii Other industry

The area surrounding the project is predominantly rural-residential in character other than a few industrial and manufacturing developments, including cement works,  metal fabrication, mining equipment manufacture and quarries, as listed below and described in detail in Chapter 5 (site and surrounds).

- Berrima Cement Works.
- Berrima Feed Mill.
- Omya's Moss Vale plant.
- Dux hot water plant.
- Resource recovery centre.

The majority of the facilities listed above are not located within immediate proximity to each other or the project area. It is only the cement works, Omya and the feed mill that would have a visual significance in the locality due to their height. Given the distance between these industrial developments and low concentration of such developments in the area, and that the visual impacts arising from the project-related surface infrastructure at the majority of viewpoints assessed is negligible, it is considered that the cumulative impact of the project and the existing development within the locality will be minimal.

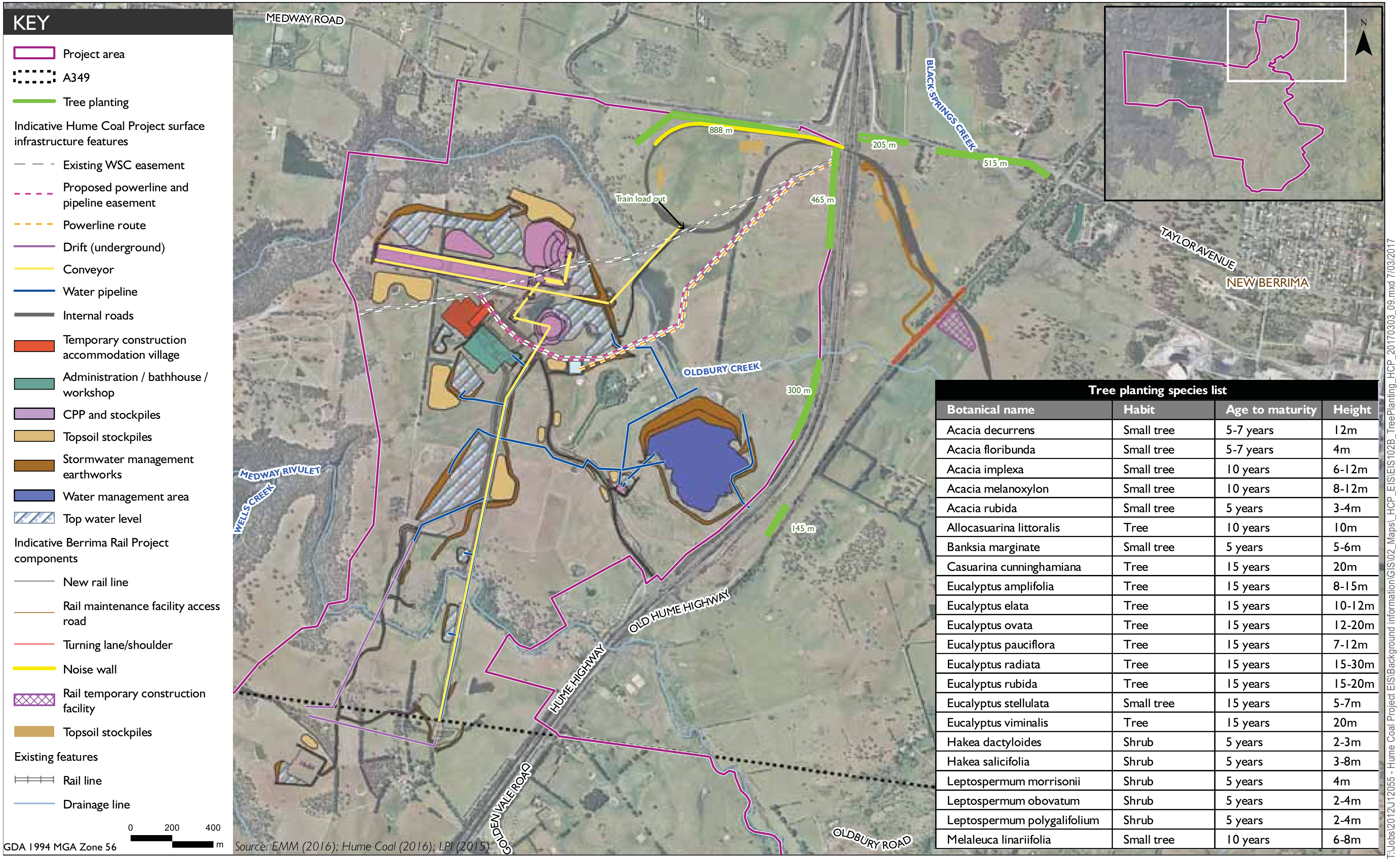
## 16.5 Mitigation and monitoring

### 16.5.1 Screening

Screening in the form of foreground and mid-ground tree and shrub planting is a very effective way of reducing exposure of a receptor to various aspects of the surface infrastructure. Hume Coal has already planted visual screens around the project area. Once established, these trees will provide a permanent and natural screen to the various element of the mine from either roadways or private landholdings.

The location and extent of these tree screens were chosen to mitigate potential views from Medway Road and the Hume Highway. A list of the type of species, age to maturity and maximum growth height of tree species planted is provided in Table 16.5 below. The species chosen include those common to the ecological community into which they have been planted. With planting already complete, there will be sufficient time for some species to reach maturity, or be well progressed towards maturity, by the time construction commences.

Figure 16.11 illustrates the locations of the tree screens planted by Hume Coal.




**Tree planting species list**

| Botanical name | Habit | Age to maturity | Height |
|---|---|---|---|
| Acacia decurrens | Small tree | 5-7 years | 12m |
| Acacia floribunda | Small tree | 5-7 years | 4m |
| Acacia implexa | Small tree | 10 years | 6-12m |
| Acacia melanoxylon | Small tree | 10 years | 8-12m |
| Acacia rubida | Small tree | 5 years | 3-4m |
| Allocasuarina littoralis | Tree | 10 years | 10m |
| Banksia marginate | Small tree | 5 years | 5-6m |
| Casuarina cunninghamiana | Tree | 15 years | 20m |
| Eucalyptus amplifolia | Tree | 15 years | 8-15m |
| Eucalyptus elata | Tree | 15 years | 10-12m |
| Eucalyptus ovata | Tree | 15 years | 12-20m |
| Eucalyptus pauciflora | Tree | 15 years | 7-12m |
| Eucalyptus radiata | Tree | 15 years | 15-30m |
| Eucalyptus rubida | Tree | 15 years | 15-20m |
| Eucalyptus stellulata | Small tree | 15 years | 5-7m |
| Eucalyptus viminalis | Tree | 15 years | 20m |
| Hakea dactyloides | Shrub | 5 years | 2-3m |
| Hakea salicifolia | Shrub | 5 years | 3-8m |
| Leptospermum morrisonii | Shrub | 5 years | 4m |
| Leptospermum obovatum | Shrub | 5 years | 2-4m |
| Leptospermum polygalifolium | Shrub | 5 years | 2-4m |
| Melaleuca linariifolia | Small tree | 10 years | 6-8m |

**Tree planting**

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Figure 16.11

**Table 16.5 Species of tree planting for visual screening**

| Botanical name | Habit | Age to maturity | Height |
|---|---|---|---|
| *Acacia decurrens* | Small tree | 5-7 years | 12m |
| *Acacia floribunda* | Small tree | 5-7 years | 4m |
| *Acacia implexa* | Small tree | 10 years | 6-12m |
| *Acacia melanoxylon* | Small tree | 10 years | 8-12m |
| *Acacia rubida* | Small tree | 5 years | 3-4m |
| *Allocasuarina littoralis* | Tree | 10 years | 10m |
| *Banksia marginate* | Small tree | 5 years | 5-6m |
| *Casuarina cunninghamiana* | Tree | 15 years | 20m |
| *Eucalyptus amplifolia* | Tree | 15 years | 8-15m |
| *Eucalyptus elata* | Tree | 15 years | 10-12m |
| *Eucalyptus ovata* | Tree | 15 years | 12-20m |
| *Eucalyptus pauciflora* | Tree | 15 years | 7-12m |
| *Eucalyptus radiata* | Tree | 15 years | 15-30m |
| *Eucalyptus rubida* | Tree | 15 years | 15-20m |
| *Eucalyptus stellulata* | Small tree | 15 years | 5-7m |
| *Eucalyptus viminalis* | Tree | 15 years | 20m |
| *Hakea dactyloides* | Shrub | 5 years | 2-3m |
| *Hakea salicifolia* | Shrub | 5 years | 3-8m |
| *Leptospermum morrisonii* | Shrub | 5 years | 4m |
| *Leptospermum obovatum* | Shrub | 5 years | 2-4m |
| *Leptospermum polygalifolium* | Shrub | 5 years | 2-4m |
| *Melaleuca linariifolia* | Small tree | 10 years | 6-8m |

The proposed screening and its effectiveness at viewpoints 3, 4, and 7 is summarised below:

- Viewpoint 3 (Medway Road) - The tree planting (along with the noise wall) will substantially screen a majority of the surface infrastructure, once mature, reducing the potential impact to visual amenity at this point from moderate to high, to moderate. The coal loading facility will be partially seen above the tree planting.

- Viewpoint 4 (Medway Road) - The tree planting will substantially screen the surface infrastructure at this viewpoint once matured, reducing the significance of the potential visual impact from moderate to high, to moderate to low.

- Viewpoint 7 (Old Hume Highway) - The tree planting will substantially screen the infrastructure from this viewpoint, reducing the significance of the potential visual impact from moderate to low, to low.

In relation to the other viewpoints:

- Viewpoint 1 and 2 (Hume Highway and Belanglo Road) – the potential for a significant visual impact is negligible and no mitigation measures are necessary.

- Viewpoint 5 (Hume Highway / Medway Road intersection) – appropriate building colours will be used to mitigate the impact to visual amenity, as described in Section 16.5.3.

- Viewpoint 6 (north-western end of Medway Road) – only a small portion of the stockpile and reclaimer will be seen due to intervening topography, distance, and vegetation. No further mitigation measures will be required.

### 16.5.2 Lighting

Australia Standard 4282 (AS4282) *Control of Obtrusive Effects of Outdoor Lighting* sets out guidelines for the control of the obtrusive effects of outdoor lighting and gives recommended limits for relevant lighting levels to contain these effects within tolerable levels.

Lighting protocols for the project will adopt the following principles:

- operational protocols for setting up of mobile lighting plant will require lighting is directed away from external private receptors;
- lighting sources will be directed below the horizontal to minimise potential light spill;
- light systems will be designed to minimise wastage;
- screening of lighting will occur where possible for viewers internal and external to the project; and
- lighting of light coloured surfaces, which have greater reflectivity, will be avoided.

### 16.5.3 Building colours and material

Suitable colours will be chosen for project infrastructure to minimise visual impacts. In particular, to reduce the potential visual impact of moderate from the Hume Highway/Medway road intersection, the visible components of the surface infrastructure will be coloured in natural tones that are compatible with the surrounding landscape.

## 16.6 Conclusions

The project will not have significant adverse visual impacts on the locality. Due to existing mature vegetation in the landscape and the area's topography, the project will be relatively shielded from view. Whilst infrastructure has been specifically sited so that it is generally shielded by existing topography and vegetation, the development of the project will result in some changes to the landscape especially in the early stages prior to maturation of screen landscaping. Such changes will be noticeable to viewers from certain viewpoints surrounding the project area, particularly from Medway Road.

Two viewpoints were assessed as having the potential to experience a moderate to high unmitigated visual impact as a result of the project; viewpoint 3 (private residence along Medway Road) and viewpoint 4 (also along Medway Road). However, in most instances, distance combined with intervening topography and vegetation means that visual impacts will be minimised. Elsewhere, measures will be implemented to reduce exposure to project elements at viewer locations, and/or minimise the contrast between the element concerned and the surrounding landscape. Some of these measures, particularly vegetation screening which has already been planted, will take time to become established and fully effective but, once established, the measures will mitigate visual impacts for both residents in the locality and motorists.

# 17 Closure and rehabilitation

## 17.1 Introduction

This chapter provides a summary of the rehabilitation and closure strategy for the project, which is presented in full in Appendix O.

The overarching rehabilitation objective of the project is to restore the land to its pre-mining land use; that is, an agricultural land use comprising grazing on improved pasture. Being an underground mine, there will be limited need for progressive rehabilitation throughout the operational phase of the project. However, wherever possible disturbed areas no longer required for mining activities will be progressively rehabilitated. This will include drill pads and access tracks. In addition, areas disturbed during the construction phase that are not required during mining, such as the temporary construction accommodation village, will be dismantled and the land rehabilitated.

A number of key aspects of the rehabilitation and closure strategy also relate to the underground workings. Rejects will be progressively disposed of in the mined-out voids, removing the need for a permanent surface emplacement area. Mined-out voids will also be progressively sealed thereby allowing faster groundwater recovery in the area.

### 17.1.1 Assessment requirements and guidelines

The SEARs specified one requirement relating to rehabilitation and closure, requiring the preparation of a rehabilitation and closure strategy, as shown in Table 17.1.

**Table 17.1 Closure and rehabilitation related SEARs**

| Requirement | Section addressed |
|---|---|
| A full description of the development, including:<br>- a rehabilitation strategy, having regard to DRE's requirements. | This chapter, and the Rehabilitation and Closure Strategy found in Appendix O |

Apart from the SEARs, two government agencies requested information relating to closure and rehabilitation to be included in the EIS. These two agencies, the DRE and DPI Water, raised the matters listed in Tables 17.2 and 17.3 respectively.

## Table 17.2 DRE comments: standard and project-specific assessment recommendations

| Recommendation | | Section addressed |
|---|---|---|
| Impacts associated with the operational and post closure stages of the project must also be identified in detail and control management measures outlined. The identification and description of impacts must draw out those aspects of the site that may present barriers or limitations to effective rehabilitation and which may limit the mine closure potential of the land. The following are the key issues to be addressed in the EIS that are likely to have a bearing on rehabilitation and mine closure: | | |
| - | An evaluation of current rehabilitation techniques and performance against meeting existing rehabilitation objectives and completion criteria. | Widely accepted rehabilitation techniques are proposed, as described in Section 17.7. A literature review of successful mine site rehabilitation for a grazing land use was also conducted as part of the AIS (refer to Section 7.6.5 of Appendix G).<br>No existing rehabilitation on the site. |
| - | An assessment and life of mine management strategy of the potential for geochemical constraints to rehabilitation, particularly associated with the management of overburden/interburden and reject material. Based on this assessment, the EIS is to document the processes that will be implemented throughout the mine life to identify and appropriately manage geochemical risks that may affect the ability to achieve sustainable rehabilitation outcomes. | Section 17.6.2ii and Appendix K (Hydrogeochemistry Report) of the water assessment report (refer to Appendix E). |
| - | A life of mine tailings management strategy which is to detail measures to be implemented to avoid the exposure of potentially environmentally sensitive tailings material as well as promote geotechnical stability of the rehabilitated landform. | There will not be any tailings generated by the project. Rejects will be disposed of in mined-out voids, removing the need for a permanent surface emplacement area.<br>Section 2.8 in Chapter 2 describes reject disposal. Chapter 7 discusses potential impacts to groundwater from reject emplacement. |
| - | Existing and surrounding landforms (showing contours and slopes) and how similar characteristics can be incorporated into the post-mining final landform design. This should include an evaluation of how the key geomorphological characteristics evident in stable landforms within the natural landscape can be adapted to the materials and other constraints associated with the site. | Figure 5.3 (existing topography), Figure 17.1 (final landform). A comparison between the pre-mining and rehabilitated landform is shown in Figure 17.2. |
| - | Groundwater assessment to determine the likelihood and associated impacts of groundwater accumulating and subsequently discharging (e.g. acid or neutral mine drainage) from the workings post cessation of mining. This is to include a consideration of the likely controls required to prevent or mitigate against these risks as part of the closure plan for the site. | Section 17.6.5, Chapter 7 and the water assessment report (refer to Appendix E). |
| - | An assessment of the biological resources associated with the proposed disturbance area and how they can be practically salvaged for utilisation in rehabilitation (ie topsoil, seedbanks, tree hollows and logs, native seed etc.), including an evaluation of how topsoil/subsoil of suitable quality can be direct-returned for use in rehabilitation. | Appendix F (Land and soil resources report), Section 17.7.1. |
| - | Where an agricultural land use is proposed, the EIS should:<br>▪ demonstrate how Agricultural Suitability Class in the rehabilitated landscape would be returned to the existing Class/es or better.<br>▪ where the intended land use is likely to be grazing, the existing capacity in terms of Dry Sheep Equivalent or similar must be calculated and a timeframe from vegetation establishment be given for the return to agricultural production to at least the existing stock capacity.<br>▪ provide information on how soil would be developed in order to achieve the proposed stock capacity. | See Chapter 9 and Appendix G (Agricultural Impact Statement). |

## Table 17.2 DRE comments: standard and project-specific assessment recommendations

| Recommendation | | Section addressed |
|---|---|---|
| - | Where an ecological land use is proposed, the EIS should demonstrate that the revegetation strategy (e.g. seed mix, habitat features, corridor width etc.) has been developed in consideration of the target vegetation community(s). | An ecological land use is not proposed, therefore not applicable. |
| **Rehabilitation and Mine Closure**<br>DRE's role focuses on ensuring that land mined in NSW is effectively rehabilitated and returned to beneficial post-mining land uses. This is undertaken by requiring mine operators to have strategies in place to ensure the rehabilitation of all mined land, and strategies in place to ensure the rehabilitation of all mined land, and strategies for an orderly transition from a mining land use to an agreed stable and beneficial post-mining use. At the EIS stage, the strategies may be conceptual in nature. Each of the following aspects of rehabilitation planning should be addressed in the strategy: | | |
| - | Post-mining Land Use – the proponent must identify and assess post-mining land use options and provide a statement of the preferred post-mining land use outcome in the EIS, including a discussion of how the final land use(s) are aligned with relevant local and regional strategic land use objectives as well as the benefits of the post-mining land to the surrounding environment, a subsequent landowner, the local community and the state of NSW. | Section 17.3 |
| - | Rehabilitation Objectives and Domains - a set of project rehabilitation objectives and completion criteria that define the environmental outcomes required to achieve the final land use for each domain. The criteria must be specific, measurable, achievable, realistic and time-bound. | Section 17.4 |
| - | If necessary, objective criteria may be presented as ranges rather than finite indicator levels. Subjective criteria may also apply where a gap in technical knowledge is experienced. Further refinement of these criteria will be undertaken and included in the Rehabilitation Management Plan (RMP). | |
| - | Final Landform Design - a drawing at an appropriate scale with final landform contours should be provided which identifies vegetation types, habitat features, contaminated areas, drainage infrastructure, access and internal roads, fencing design and other remaining infrastructure such as sheds, dams, bores and pipelines. | Figure 17.1 |
| - | Scope of Rehabilitation and Decommissioning Activities – The EIS is to include a detailed description of the scope of decommissioning and rehabilitation activities required to meet the nominated closure objectives and completion criteria for each domain. The scope of these activities must be developed in consideration of the existing environment, identification of impacts and constraints as listed above. | Section 17.6 |
| - | Monitoring and Research - Outline the proposed monitoring programs that will be implemented to assess how rehabilitation is trending towards the nominated land use objectives and completion criteria. This should include details of the process for triggering intervention and adaptive management measures to address potential adverse results as well as continuously improve rehabilitation practices. | Section 17.8 and Section 6.3 in the Mine Closure and Rehabilitation Strategy (refer to Appendix O). |
| - | In addition, an outline of proposed rehabilitation research programs and trial, including objectives. This should include details of how the outcomes of research are considered as part of the ongoing review and improvement of rehabilitation practices. | Rehabilitation and Closure Strategy (refer to Appendix O). |
| - | Post-closure maintenance - Describe how post-rehabilitation areas will be actively managed and maintained in accordance with the intended land uses(s) in order to demonstrate progress towards meeting the closure objectives and completion criteria in a timely manner. | Section 17.8 |