6 Sites and surrounds

6.1 Project location and character

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

The project area is located within a mixed setting. It is surrounded by grazing properties, small-scale farm businesses, scattered rural residences, large and small industries and major transport infrastructure such as the Hume Highway. The project area contains predominately cleared agricultural land, with over a third of the area comprising the existing Berrima Branch Line.

Photographs 6.1 to 6.3 illustrate varying sections of the project area. Photograph 6.1 shows some of the visual amenity tree planting program already undertaken by Hume Coal in the foreground.

Photograph 6.1 Looking south from Medway Road towards the maintenance siding location in the background, east of the Hume Highway

Photograph 6.2 **Old Hume Highway looking north towards the southern end of the maintenance siding location and associated access road**

Photograph 6.3 **Medway Road looking south towards the proposed rail loop. Embankment of former railway to Berrima Colliery in the foreground.**

6.2 Biophysical environment

6.2.1 Climate

The Southern Highlands has a temperate climate, with a warm summer and cold winter. It experiences four distinct seasons and uniform rainfall (BoM 2012). The nearest weather station to the project is in Moss Vale (Station number 068045). Mean monthly minimum and maximum temperatures range between 12°C and 24°C in summer and 2°C to 12°C in winter. The area experiences a mean rainfall of 970 mm with more cloudy days than clear throughout the average year. Figure 6.1 shows the mean monthly temperature and rainfall over the last 100 years, sourced from the Moss Vale weather station.

The NSW and ACT Regional Climate Modelling (NARCLiM) Project has released climate prediction maps for 2060–2079 (OEH 2015a), which is well beyond the duration of the rail project. By this time, the project area may expect increased overall temperatures with colder nights, less rainfall in spring and more rainfall in the autumn months.

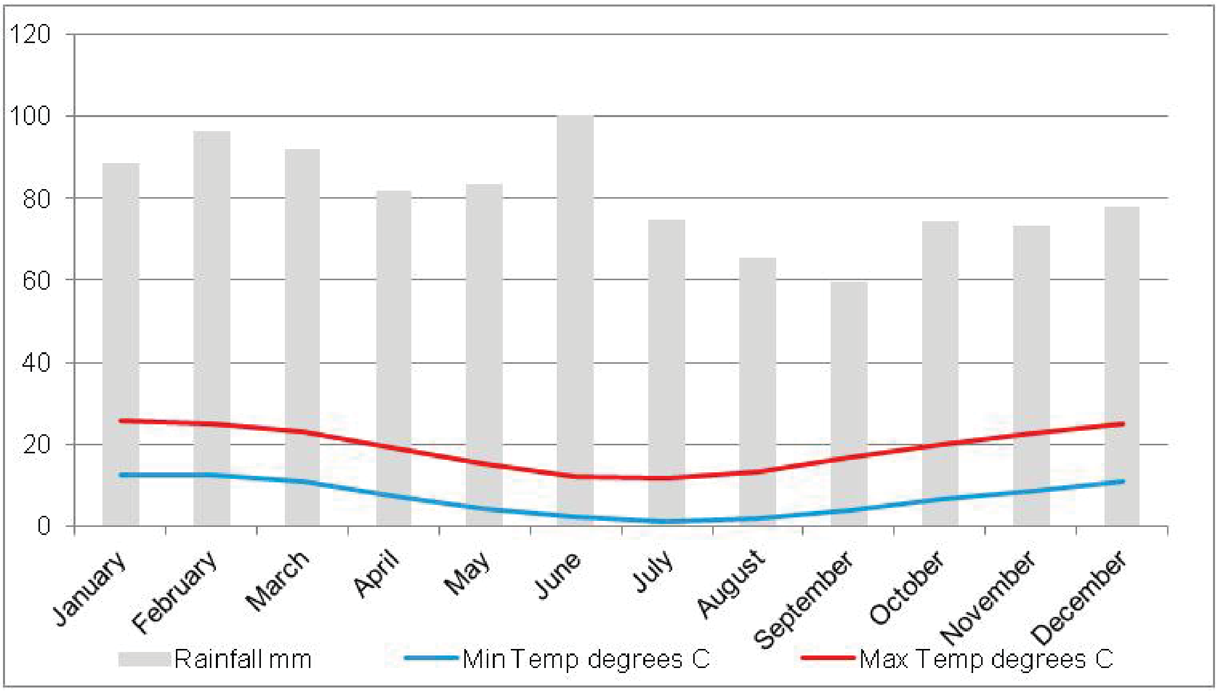
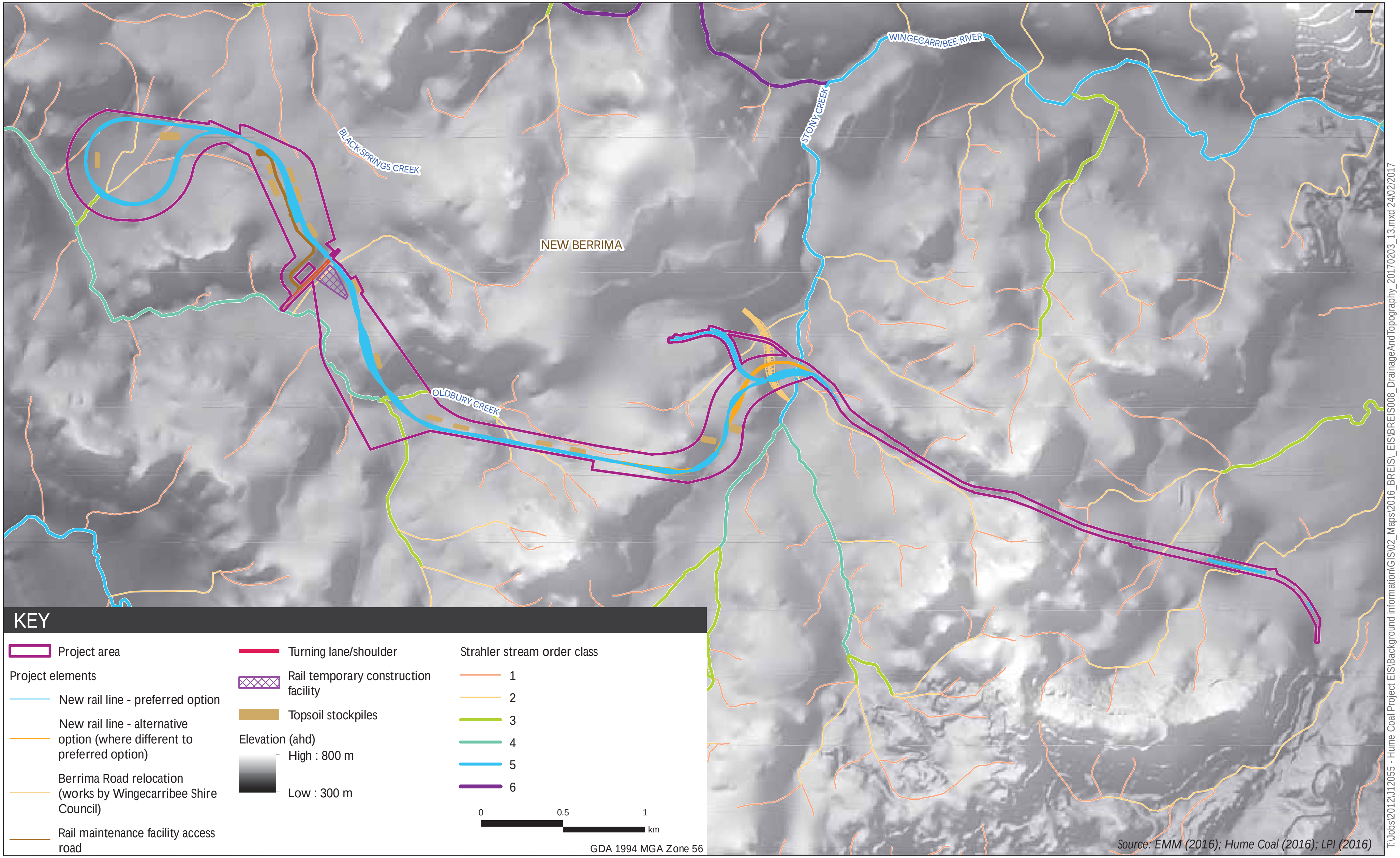


Figure 6.1 Mean rainfall and temperature in Moss Vale (Station 068045) 1914 – 2014

6.2.2 Topography and landform

The project area is situated on the elevated, relatively flat Woronora-Nattai Plateau of the Southern Highlands. Elevations range from about 650 m to 690 m Australian Height Datum (AHD) (see Figure 6.2). The project area is characterised by low rolling hills, with generally low to very low local relief.

The primary topographic feature is the residual intrusive peak of Mount Gingenbullen around 2 km south of the project area. Mount Gingenbullen is a 70 ha flat-topped mountain with a dolerite intrusion. It is a product of the more erosion resistant characteristics of the Jurassic. Tertiary basalts present in the environment are also more erosion resistant when compared to the surrounding sedimentary sandstones and shales.



Drainage and topography

Berrima Rail Project

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Figure 6.2

EMM HUMECOAL

6.2.3 Geology

The project area is in the Southern Coalfield, on the south-western edge of the Permo-Triassic Sydney Basin. The Sydney Basin primarily consists of sediments deposited in a 'basin' environment, which were deposited between two major 'fold belts'; the Lachlan Fold Belt to the north-east and the New England Fold Belt to the west, both of which constrain this central depositional trough. Initially, sediments were deposited into the basin from the north and interspersed with several sequences of coal seams. The Illawarra Coal Measures contains some 10 recognised coal seams, some of which are of economic importance, in particular the Bulli and Wongawilli Seams.

The marine sedimentary rocks of the Shoalhaven Group form the immediate base of the Illawarra Coal Measures, which is, in turn overlain by the Triassic aged Narrabeen Group, the Hawkesbury Sandstone and the Wianamatta Group, the latter being the uppermost unit in this regional context. Hawkesbury Sandstone dominates the natural topography of the Sydney region and is typically composed of medium to coarse grained quartzose sandstone with a clay matrix. The Hawkesbury Sandstone is up to 200 m thick in certain areas of the Sydney Basin.

There are numerous igneous intrusive and extrusive rocks in the regional area including Jurassic aged micro-synenite at Mount Gibraltar and silling at Mount Gingenbullen, as well as Tertiary aged basalts at Robertson.

The *Moss Vale 1:100,000 Geological Sheet* (Trigg and Campbell 2009) shows that the majority of the project area is covered by Quaternary deposits, interspersed with Bringelly Shale and Ashfield Shale. Table 6.1 summarises the descriptions of each geological unit mapped in the project area, which are also illustrated in Figure 6.3. Bringelly Shale is the most recent deposit in the sequence, which was deposited in an alluvial plain and cut by streams flowing from west to east and have formed discontinuous beds of sandstone. It is similar to Ashfield Shale but generally has higher sandstone content. Surficial Bringelly Shale occurs on crests in the eastern parts of the project area.

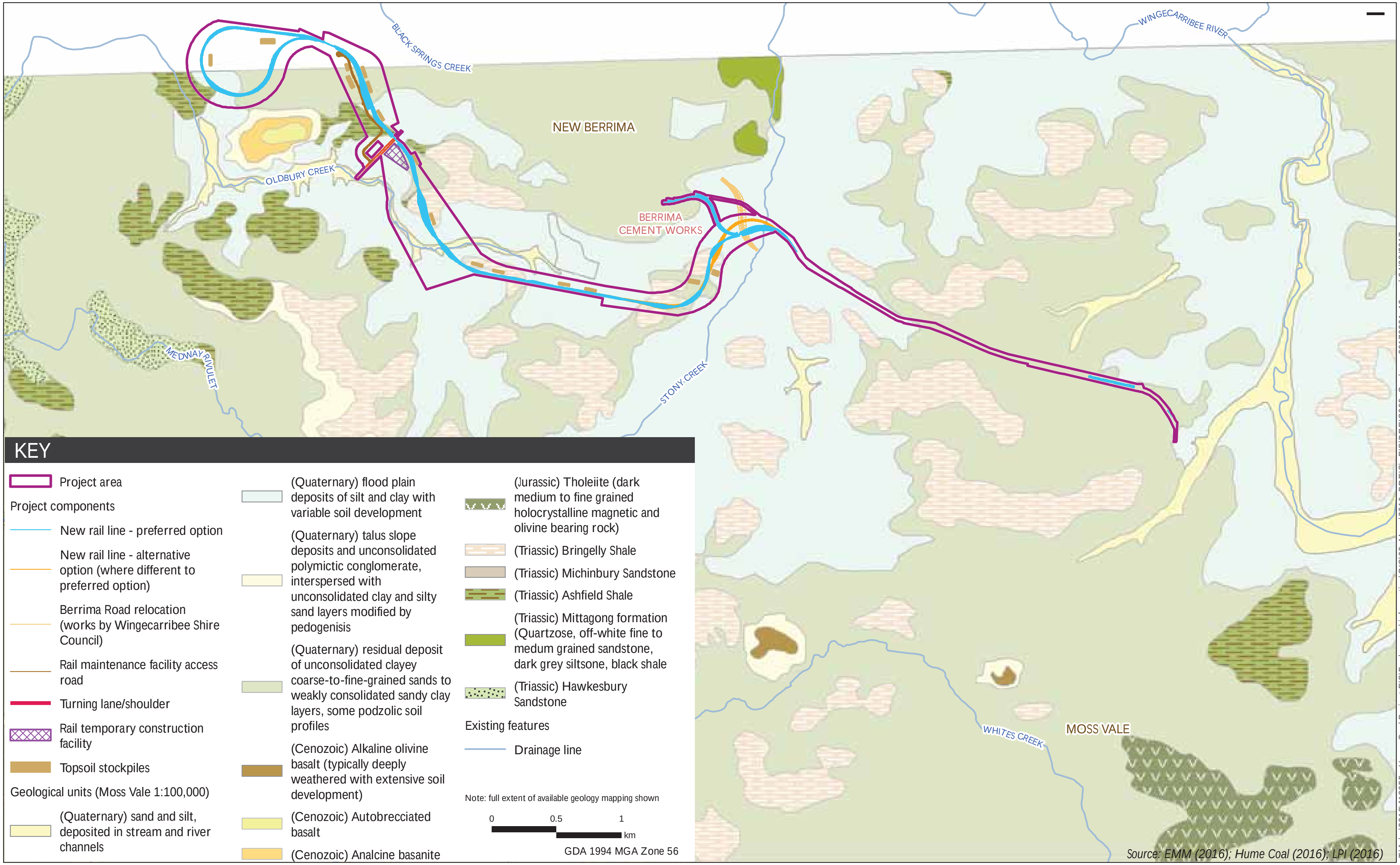
Table 6.1 Geological Units mapped in project area

Age	Code	Name	Description
Cenozoic Quaternary	Qa	Alluvium	Sand and silt, deposited in stream and river channels
	Qap	Alluvium	Flood plain deposits of silt and clay with variable soil development
	Qr	Residual Deposits	Residual deposits of unconsolidated clayey course- to fine-grained sands to weakly consolidated sandy clay layers; some podzolic soil profiles
Mesozoic Triassic (Wianamatta Group)	Rwb	Bringelly Shale	Bringelly Shale – Light to dark grey, sideritic claystone to siltstone, dark grey carbonaceous claystone, laminite, sandstone to siltstone, quartz-lithic very fine-to medium-grained sandstone, coal. Plant fragments and fossil roots abundant
	Rwa	Ashfield Shale	Ashfield Shale – Dark grey to black, sideritic claystone to siltstone and sandstone/siltstone laminite. Plant fossils rare

Notes: 1.Map Unit Descriptions (Moss Vale 1:100,000 Geological Sheet).

6.2.4 Surface water resources

The project area is within the broader Wingecarribee River catchment, which is a component of the broader Warragamba Dam and Hawkesbury-Nepean catchments. The Wingecarribee River flows north-west before it reaches its confluence with the Wollondilly River north of Tugalong. The main drainage features in the project area are Oldbury Creek (a 4^{th} order stream in accordance with the Strahler system of stream order) and its tributaries and Stony Creek (5^{th} order) and its tributaries. Oldbury Creek and its tributaries flow through the western and central portions of the project area and Stony Creek flows across a portion of the project area between the Berrima Feed Mill and the Berrima Cement Works. Stony Creek drains directly into the Wingecarribee River to the north of the project area.



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Geology of the project area

Berrima Rail Project

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Figure 6.3

EMM HUMECOAL

6.2.5 Soils

The project area is made up of a number of soil landscapes which are defined in the *Soil and Land Resources of the Hawkesbury-Nepean Catchment* (DECCW 2008). The soil landscapes in the project area are Kangaloon, Lower Mittagong and Moss Vale. The Lower Mittagong erosional landscape occurs on rises and low hills and comprises Yellow, Brown and Red Podosols, Yellow Earths, Red and Brown Earths and Soloths. The Kangaloon transferral landscape occurs on foot slopes and plains and comprises Yellow Podosols and Humic Gleys. The Moss Vale erosional landscape occurs on lower hill slopes and comprises Yellow, Brown and Red Podosols, Yellow Earths, Red and Brown Earths and Soloths. Soil and land resources are described in further detail in Chapter 14.

6.2.6 Biodiversity

The project area has largely been cleared of vegetation and used for agricultural purposes for approximately the last 150 years. It therefore contains predominantly cleared land, with the eastern portion comprising existing rail infrastructure (the Berrima Branch Line). The majority of the disturbance footprint associated with the project (refer to Figures 2.5 and 2.6) is characterised by exotic pasture. Some larger patches of native vegetation occur; however many are small and highly fragmented, comprising only small pockets of isolated trees. These remaining patches are currently in use for grazing and have a highly degraded understorey.

Prior to clearing, the project area would have comprised tall open forest and open woodland communities dominated by Eucalyptus species such as scribbly gum (*E. sclerophylla*), white stringybark (*E. globoidea*) and black ash (*E. sieberi*). These vegetation communities are likely to have been maintained by regular anthropogenic and natural bushfires.

Two native and one exotic vegetation community are present in the project area as follows:

- Broad-leaved Peppermint Narrow-leaved Peppermint grassy woodland;
- Snow Gum Woodland; and
- Cleared land.

The Broad-leaved Peppermint Narrow-leaved Peppermint grassy woodland has some representative species of ‘Southern Highlands Shale Woodland in the Sydney Basin Bioregion’, which is listed as an endangered ecological community (EEC) under the TSC Act. The Snow Gum Woodland has a representative canopy species of 'Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions; which is listed as an EEC under the TSC Act.

Of the native plant species recorded in the project area, Paddy’s River Box (*Eucalyptus macarthurii*) is listed as an endangered species under the NSW TSC Act and the EPBC Act. Sixteen Paddy's River Box were recorded in the project area; however the project design was modified so that impacts are minimised on these species. One individual tree will be removed under the preferred project option, whilst the alternative option will avoid all direct impacts to the species. Further discussion on biodiversity in the project area is provided in Chapter 12.

6.3 Socio-economic factors

6.3.1 Land ownership

The project area covers approximately 181 ha. All of the land in the project area is freehold land, of which approximately 127 ha is owned by Hume Coal and its subsidaries, and 44 ha is owned by Boral. The remaining 10 ha is government owned land associated with roadways (the Hume Highway, Old Hume Highway and Berrima Road).

Land tenure in the project area is illustrated in Figure 6.4.

6.3.2 Existing rail infrastructure and use

The Main Southern Rail Line, which is operated by the ARTC, currently operates through Moss Vale. The rail line continues north to Mittagong and south-west to Goulburn. At Moss Vale Junction, a rail line branches to the east to Wollongong and Port Kembla. Approximately 1.7 km north of Moss Vale Junction is the Berrima Junction, which consists of multiple sidings and a branch line which extends to the west of the ARTC main line for approximately 4 km to the Berrima Cement Works.

Boral own and operate the Berrima Cement Works, located on the fringe of New Berrima. The cement works have been operating since 1929 and produce cement products (cement and clinker) for sale in NSW, the ACT and for export. The cement works have approval to produce up to 1.56 Mtpa of cement products annually which are dispatched by rail and road transport.

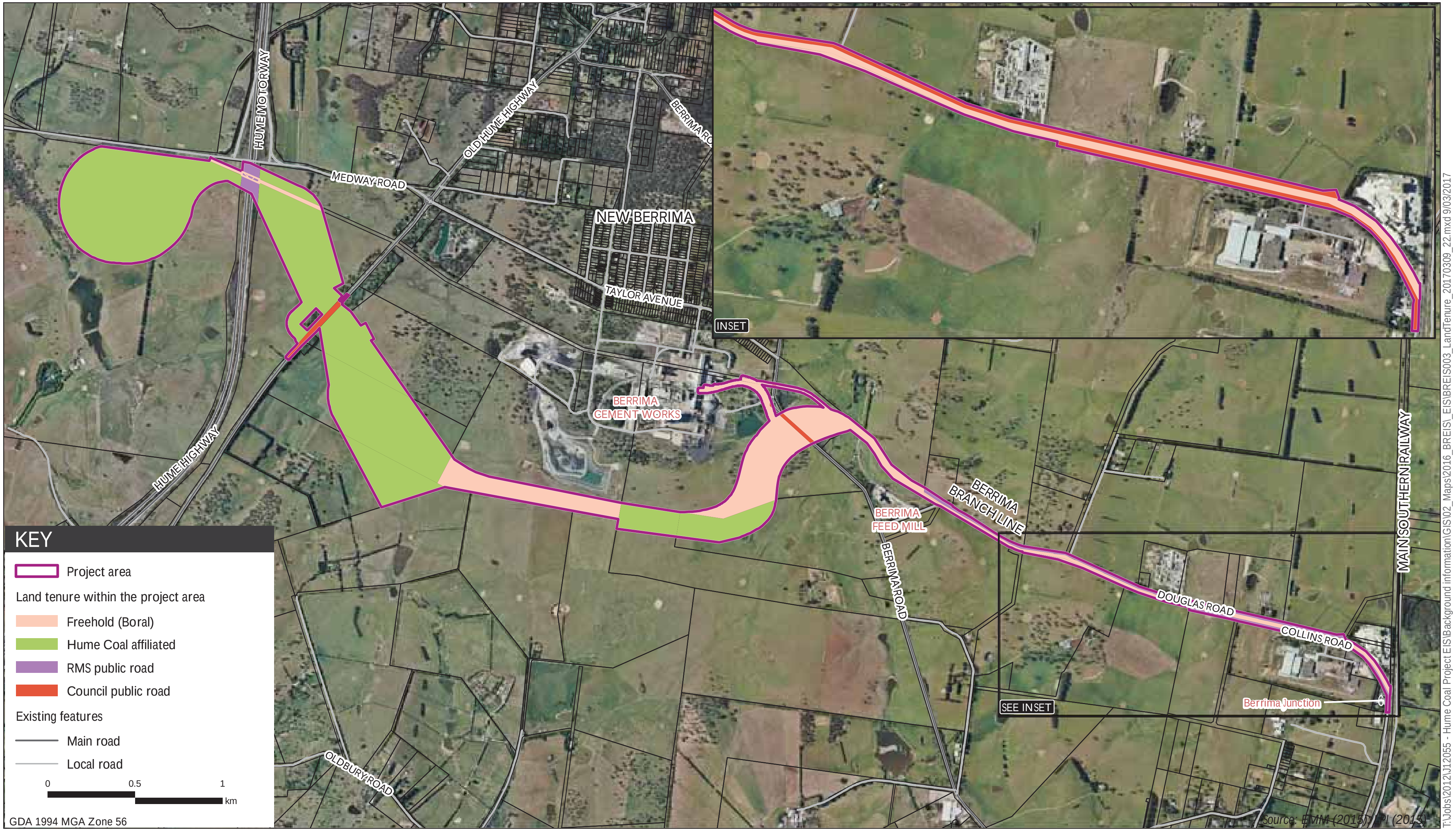
Inghams also uses the Berrima Branch Line to transport grain to supply their Berrima Feed Mill. The feed mill is located on Berrima Road on the fringe of New Berrima, and has been operating for approximately 15 years. Omya currently transports limestone from Marulan South Limestone Mine to their Moss Vale plant via the Berrima Branch Line for use in the production of bulk products for glass, agriculture, mining and manufacturing industries.

Boral advised Hume Coal that train movements along the Berrima Branch Line associated with the operations of existing users are approximately 120 weekly train movements, 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 has been calculated as 21 minutes (refer to Section 8.2.5), the maximum daily capacity of the Branch Line is 68 train movements. The practical capacity is then calculated by taking 65% of the maximum capacity, which equates to 44 train movements. Therefore 26 train movements per day represents 59% of the practical operating capacity of the line, or 38% of the maximum line capacity.

6.3.3 Existing land uses

With the exception of the Berrima Branch Line, the main land uses within and adjacent to the project area are currently agricultural, industrial, rural residential and residential. The land use within the project area where the new rail loop and rail line will be constructed is improved pasture for grazing, with a number of roads also traversing the area.

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



Land tenure in the project area

Berrima Rail Project

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Figure 6.4

In addition to those industries described above in Section 6.3.2 (Boral, Inghams and Omya), a number of other industrial and manufacturing facilities exist in the locality, contributing to the industrial nature of the area. These facilities comprise logistics/distribution, brickworks, metal fabrication, mining equipment manufacture and quarries, including those listed below:

- Southern Regional Livestock Exchange – The livestock exchange is positioned on Berrima Road around 2.5 km from the centre of Moss Vale. The saleyard turns over approximately 60,000 head of cattle per year.
- Dux – The Dux hot water plant is located on Collins Road in Moss Vale, and produces both solar and electric hot water heaters.
- Joy Global – a large mining machinery supplier, located off McCourt Road, Moss Vale, manufactures and services machinery for the underground coal mining industry.
- Harper Collins – a large book distribution centre, located in Moss Vale.
- Cromford Pipe – manufacturer of PVC and HDPE pipe, located on Douglas Road Moss Vale, manufacturing 25 mm to 800 mm diameters.
- Resource recovery centre – The WSC resource recovery centre is off Berrima Road, Moss Vale and comprises a waste recycling, collection and transfer facility.

None of the industries listed above use the Berrima Branch Line.

Notably, a large part of the project area lies within the Moss Vale Enterprise Corridor (MVEC); an area of land between Moss Vale and New Berrima set aside for employment generating development under the Wingecarribee LEP.

6.3.4 Community profile

The main regional centres in the area are Moss Vale, Bowral and Mittagong, where retail and community facilities, infrastructure and services are concentrated. The villages of New Berrima and Berrima are also located in the general area (refer to Figure 1.1).

The Wingecarribee LGA has experienced moderate population growth over the last decade with a total increase in population of 9.8% to an estimated 47,584 people in 2014. Wingecarribee's population is older than the NSW average with approximately 37% of the population aged over 55 compared with 27% of the NSW population. Approximately 8% of the LGA's population is aged between 25 and 34. This is significantly lower than the NSW average of 14%. The disproportionate distribution of different age groups within the LGA is indicative of two trends – an ageing population and migration of working age people to larger centres because of limited local employment opportunities.

In general, there are higher or consistent levels of education, health, wellbeing and income within the Wingecarribee LGA compared with NSW.

There is a relatively low unemployment rate in the Wingecarribee LGA, reported at 3.6% in March 2015 compared with 5.9% across NSW. The main industries of employment are health care and social assistance, retail trade and manufacturing. Between 2001 and 2011, there was significant growth in employment in mining (73.6%), public administration and safety (34.0%) and administrative and support services (33.1%).

The most common occupations in Wingecarribee are professionals, technicians and trade workers.

Population forecasts for the Wingecarribee LGA predict that the area will continue to experience population growth to 2031. This is due to its high amenity, its strategic location between Sydney and Canberra, and its diverse economy. Currently, there is a good supply of affordable housing with a number of additional release areas identified by WSC to accommodate future predicted population growth. In addition, there is a good supply of a range of community facilities and services available to the public including schools, recreation facilities and emergency services.

6.4 Cultural factors

6.4.1 Aboriginal heritage

Field investigations have identified a number of Aboriginal sites in the project area, comprising subsurface artefact deposits, a grinding groove site and a potential scar tree. A number of potential archaeological deposits (PADs) have also been identified. PADs are the predicted extent of subsurface Aboriginal objects (typically stone artefacts) in a particular area and are thus not technically Aboriginal sites until Aboriginal objects are identified. Test excavation has been carried out in these areas to confirm the presence or otherwise of archaeological deposits.

The archaeological landscape can be considered in relation to the two catchments that it traverses; Oldbury Creek and Stony Creek. Both areas comprise established farmland which has been generally cleared and ploughed with the exception of a few isolated pockets of remnant or regrowth vegetation.

Further information on Aboriginal cultural heritage in the project area and surrounds, and a detailed discussion on the outcomes of the test excavation program, is provided in the Aboriginal cultural heritage assessment in Chapter 10.

6.4.2 Historic heritage

There are a number of historic heritage items and landscapes across the region associated with early European settlement which began in the area in the 1820s, including buildings, streetscapes, gardens and tree plantings that date back to the nineteenth century.

Mereworth House and Garden (built circa 1965) is listed on the Wingecarribee LEP (item I351) and assessed as being of local significance. The western end of the project area is within the broader Mereworth property, although the actual house and garden which is the subject of the heritage listing, is not, being some 700 m further south of the project area. Other registered heritage sites in proximity to the project area include Austermere House and Grounds, the Berrima Landscape Conservation Area and the Burradoo Landscape Conservation Area, which includes Bong Bong Common; the site of the 1820 township of Bong Bong.

Two unlisted historic items were identified in the project area: an old railway bridge recorded during field survey; and the remnants of a garden in the Boral Cement Works on Berrima Road.

Further information on historic heritage in and surrounding the project area is provided in the historic heritage assessment in Chapter 11.

6.5 Other development

As described above in Sections 6.1 and 6.3.3, agricultural, industrial, extractive and manufacturing facilities occur in the locality. The environmental assessment of the project has also considered proposed or recently approved developments in the region with respect to cumulative impacts, as listed below:

- Berrima Cement Works - A modification to the existing development consent was recently approved (modification 9) to allow the use of solid waste derived fuel as an energy source and construction and operation of a fuel storage and kiln feeding system. The modification will result in changes to air emission limits of particulate matter, nitrous oxides and volatile organic compounds.

- New Berrima Clay/Shale Quarry – The Austral Brick Company Pty Ltd (Austral) was granted Project Approval for the New Berrima Quarry in July 2012. This approval allowed the extraction of clay/shale from a resource within the Mandurama property, approximately 1.5 km east of New Berrima and 1.5 km north-east of the Berrima Cement Works, for transportation and use principally at the Bowral brick plant. No construction or extraction operations have been undertaken since Project Approval was granted, and Austral recently sought a modification to the original project approval to allow the relocation of the extraction area. The PAC recommended approval to the modification in November 2015. The quarry location is approximately 4 km from the eastern boundary of the project area.

- Green Valley Sand Quarry – Rocla Materials Pty Ltd (Rocla) received approval on 21 June 2013 for the construction and operation of a sand quarry in an area 28 km south-west of Berrima and 14 km north-east of Marulan. The approval allows the extraction of sandstone, dry and wet processing operations and despatch of sand products to markets on the South Coast, Southern Highlands and Sydney. The quarry is not yet operational.

- Sutton Forest Quarry – SEARs for the Sutton Forest Quarry were issued on 7 February 2014. The SSD proposal involves the establishment of a quarry off the Hume Highway, approximately 20 km south-west of Moss Vale, to extract and process up to 1.15 Mtpa of sand from a total resource of approximately 25 million tonnes. A development application and accompanying EIS has not been submitted for the quarry.

7 Noise and vibration

7.1 Introduction

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

This chapter summarises the NVA, with the full technical report attached in Appendix E.

7.1.1 Assessment guidelines and requirements

The NVA was prepared in accordance with the requirements of the DP&E. These were set out in the SEARs that were issued for the project by the DP&E on 20 August 2015. The EPA, RMS and TfNSW also provided recommended issues requiring assessment for the project. Table 7.1 provides the relevant assessment requirements and the section of the EIS where these have been addressed.

Table 7.1 Noise and vibration - relevant environmental assessment requirements

Relevant authority and assessment requirement	Relevant section
DP&E (SEARs)	
Noise and vibration – including	
- an assessment of the likely rail noise and vibration impacts of the development under the *Rail Infrastructure Noise Guideline* (EPA, 2013) and *Assessing vibration a Technical Guideline* (2006), and having regard to EPA's requirements;	Sections 7.5.3, 7.5.4, 7.5.5
- an assessment of the noise associated with the rail facilities under the *NSW Industrial Noise Policy*, if such an assessment is not undertaken as part of the Hume Coal Project; and	Section 7.5.2 Also refer to the Hume Coal Project EIS (EMM 2017a)
- 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* (2009).	Section 7.5.1
Government Agency Assessment Recommendations	
EPA	
Noise and vibration	
- Noise and vibration impacts from construction activities and operational sources including train movement and rail maintenance;	Section 7.5
- the nature, sensitivity and impact to potentially affected receivers and structures (including heritage items);	Section 7.5 (heritage items are discussed separately in Chapters 10 and 11)
- a strategy for managing construction noise and vibration and out of hours activities, with a particular focus placed on those activities having the greatest potential for adverse noise or vibration impacts;	Section 7.6.2
- noise and vibration impacts along the corridor due to changed rail operations from the upgraded track between the main southern line to Boral Cement;	Section 7.5.3

Table 7.1 Noise and vibration - relevant environmental assessment requirements

Relevant authority and assessment requirement	Relevant section
- details of any change in industrial noise levels likely as a result of improved rail access to industries including Hume Coal, Boral, Inghams and Omya;	Assessment of industrial noise levels from Hume Coal is included in the Hume Coal Project EIS. Improved rail access is for the purpose of the Hume Coal Project development. Increased production at existing industries (Boral, Inghams and Omya) is not being sought as part of this approval.
- noise and vibration impacts from areas proposed to be utilised for coal loading operations and from idling locomotives during 'parking' interaction with passenger services;	Noise and vibration impacts from coal loading operations, including locomotives on the rail-loop, have been assessed as part of the Hume Coal Project EIS, in accordance with the requirements of the RING. This provides for a worst case scenario for potential impacts. Section 7.5.3
- assessment of all reasonable and feasible options to mitigate the impacts of operational rail noise, with particular focus on source control; and	Section 7.6
- taking into account the Interim Construction Noise Guideline (2009), Rail Infrastructure Noise Guidelines (2013), and Assessing Vibration: A Technical Guideline (2006).	Section 7.1.2.
RMS	
The impacts of noise and vibration of the rail line, including	
- Effects of renewing and using the train line that passes under the Hume Highway. Impacts such as: o Undermining/destabilising of the existing bridge foundation and structure; o Vibration effect of train movements; and o Pollution impacts on road users.	No mining is planned in this area, and it is approximately 3 km north of the nearest proposed mine workings. The railway will be constructed generally at-grade through the underpass and will not interfere with the bridge foundations. Section 7.5.5 - Noise and vibration impacts on the road from the rail line are considered highly unlikely. Noise and vibration levels from operation of the rail line are expected to be significantly less than that experienced by road users as a result of operating their vehicle. Potenital pollution impacts are addressed in Chapter 8.

Table 7.1 Noise and vibration - relevant environmental assessment requirements

Relevant authority and assessment requirement	Relevant section
TfNSW	
- Engagement with TfNSW and the relevant rail network owners in the development of methodology for assessing noise impacts associated with the proposed rail operations, in line with relevant NSW noise guidelines and details of noise mitigation strategies.	Noise impacts associated with the proposed rail operations have been undertaken in accordance with relevant NSW noise guidelines, namely the NSW RING. Consultation has been undertaken with Boral (as the owners of the Berrima Branch Line) on the methodology as described in Section 5.6.

The NVA was prepared to address the SEARs and government agency assessment requirements listed in Table 7.1 and was prepared following the appropriate guidelines, policies and industry requirements as follows:

- NSW EPA 2013, *Rail Infrastructure Noise Guideline* (RING);
- NSW EPA 2000, *NSW Industrial Noise Policy* (INP);
- NSW Department of Environment and Climate Change (DECC) 2009, *The Interim Construction Noise Guideline* (ICNG);
- NSW Department of Environment, Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP); and
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline.*

7.1.2 Adoption of leading practice noise reduction measures

Hume Coal is committed to adopting leading practices in the planning, construction and operation of the project. This includes leading practice measures to avoid, minimise and/or mitigate potential environmental and social impacts. In relation to noise mitigation and management, such measures include:

- highly considered lateral placement of the project infrastructure, taking into consideration potential sensitive noise receivers as well as other environmental and physical constraints, including topography;
- use of the latest generation of AC locomotives, and wagons with electronically controlled pneumatic brakes, by Hume Coal to assist in minimising noise generated by train operations;

- minimisation of rail squeal through avoiding tight rail curves (where possible) and effective curve design and construction (eg rail grinding and gauge widening);
- construction of a noise wall along the northern side of the rail loop to attenuate noise levels from loading and rail activities; and
- construction of a locomotive shed at the northern provisioning point to minimise noise from idling locomotives.

7.2 Existing environment

7.2.1 Properties surrounding the project

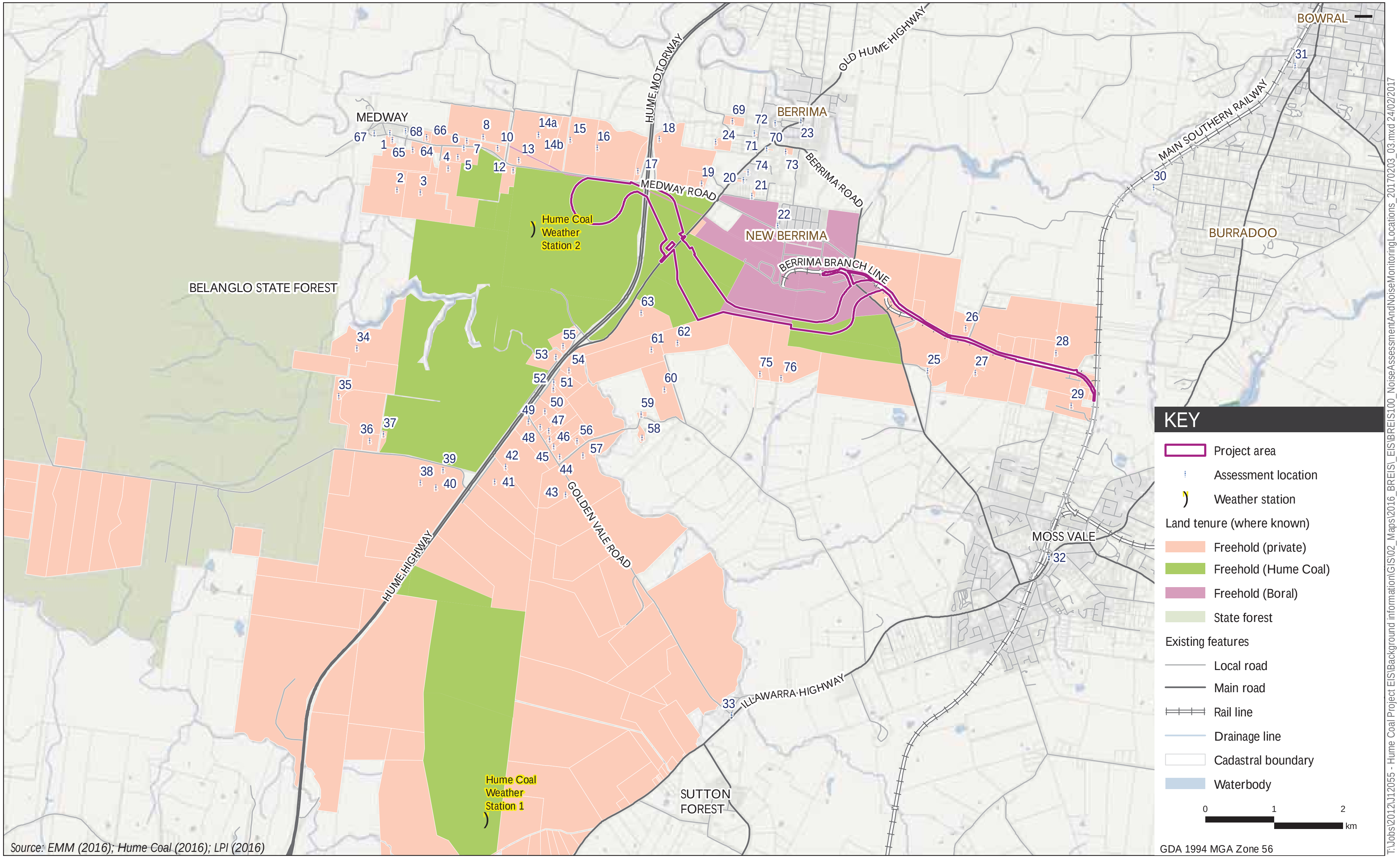
The noise and vibration assessment considered 74 potentially noise sensitive locations (ie residential properties) or 75 dwellings (location 14 was identified as having two dwellings on the property) surrounding the project area. These are consistent with those considered for the Hume Coal Project. They are referred to herein as assessment locations and are shown in Figure 7.1, with details listed in Appendix E. Assessment locations were identified using land titles, aerial photography and verification in the field where locations were visible from public roads.

7.2.2 Background noise survey

Hume Coal commenced a comprehensive long term background noise survey comprising both unattended and attended montiroing in 2011. Noise monitoring was conducted on a seasonal basis at 12 locations relevant to the Berrima Rail Project. Where possible, long term background noise surveys were conducted on a quarterly basis to establish seasonal changes in noise levels. This approach provided a comprehensive sample of baseline noise levels in the area and demonstrates leading assessment practice given it exceeds the NSW INP seven day minimum requirement.

The background noise monitoring locations most relevant to the project are shown in Figure 7.2, along with the noise catchment areas that have been defined around the project area based on the monitoring results, as discussed further in Section 7.2.3.

A summary of existing background and ambient noise levels is given in Table 7.2 for INP day, evening and night periods. 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 adopted RBL for each location is the higher of the INP background noise level threshold, where it applies, and the lowest RBL recorded over all quarterly monitoring periods since 2011. This method has been adopted to conform to INP methods, which generally do not allow RBLs to be set on a seasonal basis.



Representative sensitive receptor locations

Berrima Rail Project

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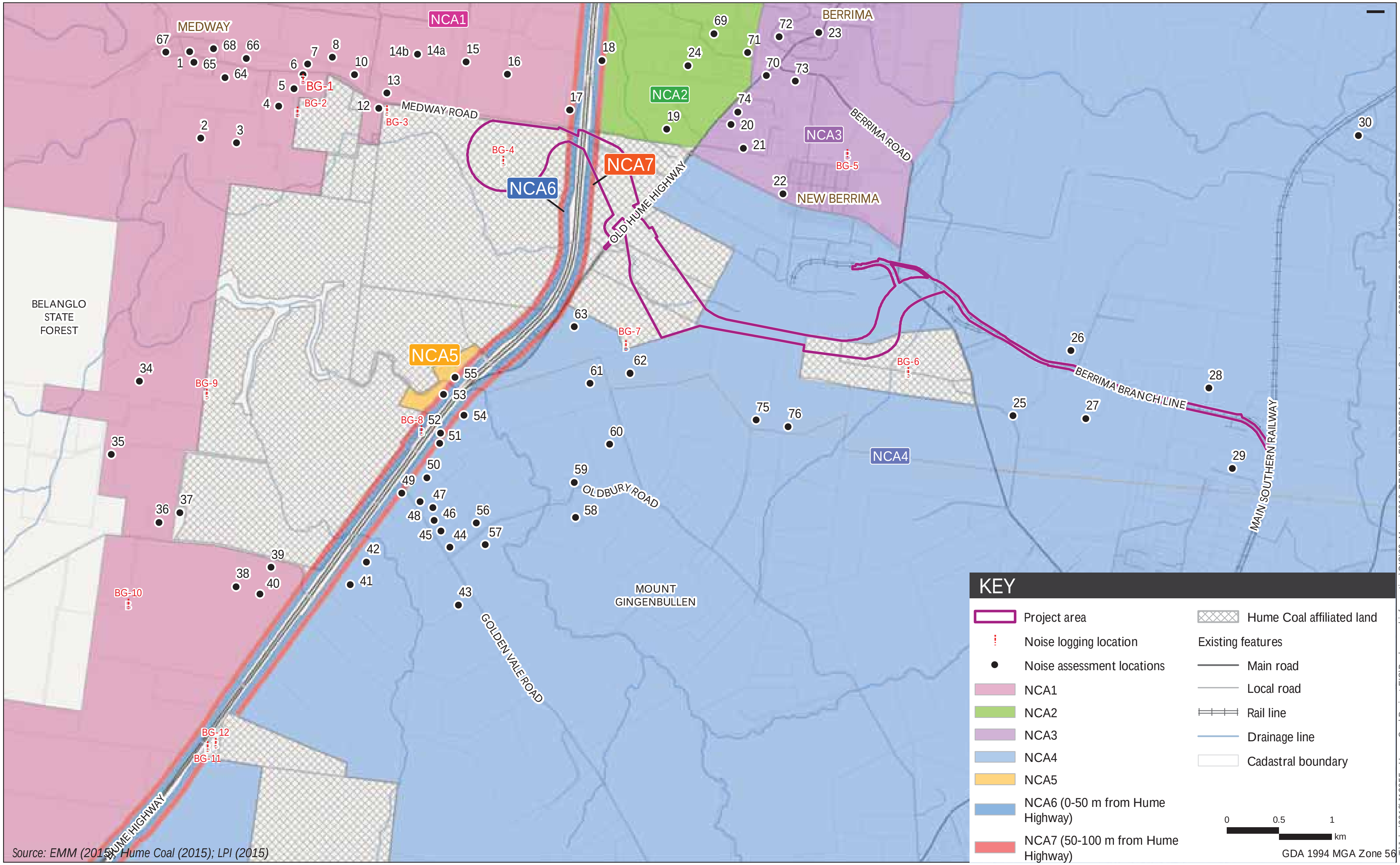
Figure 7.1



Noise catchment areas and monitoring locations

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Figure 7.2

Table 7.2 Summary of existing background and ambient noise levels

Monitoring location ID (Figure 7.2)	Period	Measured background noise level, RBL, dB[1]	Final background noise level, RBL, dB[1,2]	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	36	44	None observed
	Night	33	33	41	None observed
BG3	Day	35 - 39	35	46 - 68	None observed
	Evening	38 - 41	38	46 - 51	None observed
	Night	34 - 36	34	42 - 48	None observed
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	51	60	39[4]
	Night	45	45	54	39[4]
BG7	Day	35	35	45	39[4]
	Evening	39 - 40	39	49 - 50	39[4]
	Night	38	38	46	39[4]
BG8	Day	45 - 48	45	53 - 56	None observed
	Evening	46 - 48	46	54 - 61	None observed
	Night	39 - 44	39	52 - 54	None observed
BG9	Day	28	30	42	None observed
	Evening	32	32	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	48	60	None observed
	Night	37	37	58	None observed
BG12	Day	41 - 50	41	55 - 61	None observed
	Evening	44 - 52	44	55 - 62	None observed
	Night	34 - 39	34	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 dB(A) day, evening and night, has been adopted where applicable.

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

4. Existing industrial noise contribution noted from Berrima Cement Works in attended noise surveys conducted by PEL.

7.2.3 Noise catchment areas

The results of the noise monitoring surveys show the area surrounding the project area to be diverse in terms of existing background noise levels and the noise sources which make up the overall acoustic environment. For example, the Hume Motorway is a significant noise contributor at properties positioned nearby with its contribution reducing as distance from the highway increases. The presence of the 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 commensurate with a rural environment.

To capture the differences in these areas a number of noise catchment areas (NCAs) have been defined which are shown in Figure 7.2. Each NCA contains privately owned land and properties which have similar acoustic environments. Each noise catchment area also has specific industrial noise criteria which has been set using background noise monitoring data most applicable to the area. It is acknowledged that there may be many possible variances in overall background and ambient noise levels within each catchment area. A conservative approach has therefore been taken in adopting RBLs. For example, where multiple unattended noise monitoring locations are within one noise catchment area, the location with the lowest RBLs has been adopted for all properties. This is evident in the assigned RBLs with the majority of noise catchment areas assigned the INP minimum background noise level threshold of 30 dB day, evening and night, which is commensurate with the general rural setting surrounding the project. The adopted RBLs for each NCA are presented in Table 7.3.

Table 7.3 Noise catchment areas - adopted RBLs and estimated existing industrial noise levels

Noise catchment area (adopted noise logger results)	Period	Adopted background noise level, RBL, dB[1]	Estimated existing L_{Aeq} industrial noise contribution, dB
NCA1, NCA2, NCA5 (BG1 and BG4)	Day	30	Nil
	Evening	30	Nil
	Night	30	Nil
NCA3 (BG5)	Day	35	45
	Evening	34	45
	Night	31	45
NCA4 (INP minimum)	Day	30	39
	Evening	30	39
	Night	30	39
NCA6 (BG8)	Day	45	Nil
	Evening	45[1]	Nil
	Night	39	Nil
NCA7 (BG12)	Day	41	Nil
	Evening	41[1]	Nil
	Night	34	Nil

Notes: 1. In accordance with the INP Application Notes, the day RBL is adopted where the evening RBL is measured to be higher than day.

7.2.4 Meteorology

Site specific weather data was obtained from the Hume Coal weather stations No.1 and No.2 as displayed in Figure 7.1. Weather station No. 1 was installed early in the environmental assessment process and data from 2013, 2014 and 2015 calendar years was used where full annual datasets were available in the analysis of prevailing weather conditions. Weather station No. 2 was installed in October 2015 shortly after the Hume Coal Project's surface infrastructure location layout was confirmed. One year of weather data from weather station 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 assessment locations may increase or decrease compared with noise during calm conditions. As per the INP, winds of up to 3 m/s must be considered in noise predictions when they occur for greater than 30% of the time during day, evening or night periods. Winds were analysed to determine the percentage occurrence, finding that winds which trigger the 30% INP threshold from station No. 1 and station No. 2 generally prevail from a similar north-east or westerly direction across the evening and night periods. There are no prevailing winds during the day identified from either weather station.

ii Temperature inversions

Temperature inversions (ie where atmospheric temperature increases with altitude) typically occur during the night-time period in the winter months and can also increase noise levels at surrounding assessment locations. As per the INP, temperature inversions are to be assessed when they are found to occur for 30% of the time (about two nights per week) or greater during the winter months.

Analysis of available weather data found that 'F' class temperature inversions are a feature of the area as they occur for more than 30% of the time and were therefore considered in the assessment.

7.3 Assessment criteria

7.3.1 Construction noise

The ICNG provides two methods for assessing 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 7.4 details noise management levels (NML) for sensitive receptors provided in the ICNG, which have been adopted for the quantitative construction noise assessment.

Table 7.4 Construction noise management levels for residential land uses

Time of day	Management level $L_{Aeq(15\text{-}min)}$	Application
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm, Saturday 8.00 am to 1.00 pm	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • 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. • 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	The highly noise-affected level represents the point above which there may be strong community reaction to noise. • 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: 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); and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise-affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Source: ICNG (EPA, 2009).

The construction NMLs for the proposed construction activity are presented below in Table 7.5.

Table 7.5 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

Table 7.5 Construction noise management levels

NCA	Period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
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.RBLs as per Table 7.3.

7.3.2 Industrial 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 rating background level (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.

Noise from operation of the rail maintenance facility was considered as part of NVA for the rail project, and assessed in accordance with the NSW INP. Noise from rail operations on the Berrima Rail Project between the rail loop and Berrima junction has been assessed in accordance with the RING as required by the SEARs, as discussed in Section 7.3.5.

An extract from the INP that relates to the amenity noise criteria relevant to the rail maintenance facility is given in Table 7.6.

Table 7.6 Amenity noise criteria - Recommended L_{Aeq} noise levels from industrial noise sources

Type of receptor	Indicative noise amenity area	Time of day	Recommended $L_{Aeq(Period)}$ noise level, dB(A)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50

Table 7.6 Amenity noise criteria - Recommended L_{Aeq} noise levels from industrial noise sources

Type of receptor	Indicative noise amenity area	Time of day	Recommended $L_{Aeq(Period)}$ noise level, dB(A)	
			Acceptable	Recommended Maximum
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Notes: *Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.*

Project specific noise level (PSNL) criteria for the operation of the maintenance facility are provided in Table 7.7. The PSNL is generally equal to the lower of the derived intrusiveness and amenity criterion. However, where the amenity criterion is lower than the intrusiveness, it must be demonstrated that the project can satisfy both. This is because the intrusive criterion applies over a worst case 15-minute period, and therefore there is potential for this criterion to be exceeded, even if amenity noise criteria over an entire day (11 hour), evening (4 hour), or night (9 hour) period are satisfied. In most cases, the PSNL is set by the intrusive criteria.

Table 7.7 Project specific noise levels, dB

NCA	Amenity Area	Period	Adopted rating Background Level (RBL)[1]	Intrusive noise criteria[2], $L_{Aeq,15minute}$	Amenity noise criteria[3], $L_{Aeq,period}$	Project specific noise level (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[7] $L_{Aeq,15min}$
		Night	31	36	35[5]	36[7] $L_{Aeq,15min}$
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 7.4.

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 has been corrected in accordance with the INP Application notes due to the high influence of existing road traffic noise levels, ie, measured LAeq.period(traffic) minus 10 dB.

5. The amenity noise criteria has 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 lower than the intrusive, it must also been demonstrated that the intrusive noise criteria can also be satisfied.

7. An $L_{Aeq,15min}$ criterion has been defined for this NCA to streamline the assessment process. This level has been set at $L_{Aeq,period}$ + 2dB which is considered representative given the nature of site operations.

7.3.3 Voluntary land mitigation and acquisition policy

The NSW Government has developed and formally adopted the *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) (NSW Government 2014). 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.

Voluntary mitigation and acquisition rights in the VLAMP are assigned to privately owned dwellings based on the level of predicted industrial noise above the PSNL. This is explained in Table 7.8.

Table 7.8 Characterisation of noise impacts and potential treatments

Residual noise exceeds INP criteria by	Characterisation of impacts	Potential treatment
0-2dB PSNL	Impacts are considered to be **negligible**	The exceedances would not be discernible by the average listener and therefore would not warrant receiver based treatments or controls.
3-5dB above the PSNL in the INP but the development would contribute less than 1dB to the total industrial noise level	Impacts are considered to be **marginal**	Provide mechanical ventilation / comfort condition systems to enable windows to be closed without compromising internal air quality / amenity.
3-5dB above the PSNL in the INP and the development would contribute more than 1dB 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 ability of the building façade to reduce noise levels.
>5dB above the PSNL in the INP	Impacts are considered to be **significant**	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions.

The VLAMP also provides noise acquisition criteria for privately owned land parcels. The policy assigns acquisition rights if the noise generated by an industrial 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.

Accordingly, voluntary land acquisition criteria for the project are presented in Table 7.9.

Table 7.9 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.

7.3.4 Road traffic noise

Table 7.10 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 7.10 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 where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to +2 dB.

7.3.5 Rail noise

i Non-network rail line

The principal guidance for assessing rail traffic on non-network rail lines (such as the Berrima Branch Line) or exclusively servicing industrial sites is provided in Appendix 3 of the NSW EPA 2013 *Rail Infrastructure Noise Guideline* (RING).

The RING (EPA 2013) states that *"rail related activities (such as movement of rolling stock on rail loops or sidings, loading and shunting activities etc.) occurring within the boundary of an industrial premises as defined in an environment protection licence are to be assessed as part of the industrial premises using the NSW INP (EPA 2000)"*. This approach has been adopted for the rail loading activities and train movements confined to the rail loop and the relevant assessment is provided in the EIS for the Hume Coal Project.

Where a non-network rail line exclusively servicing one or more industrial sites extends beyond the boundary of the industrial premises, noise from this section of track should be assessed against the recommended acceptable L_{Aeq} noise levels from industrial noise sources for the relevant receiver type and indicative noise amenity area in Table 2.1 of the INP, as reproduced in Table 7.11. This approach has been adopted to assess rail noise from the spur which connects the Hume Coal rail loop to the public network rail line (including the existing Berrima Branch Line).

Table 7.11 Non-network rail line rail noise trigger levels for residential land uses

NCA	Amenity area	Period	RING criteria[1] (INP amenity noise criteria), dB, $L_{Aeq, period}$
NCA1, NCA2, NCA4 to NCA7	Rural	Day	50
		Evening	45
		Night	40
NCA3	Suburban	Day	55
		Evening	45
		Night	40

Notes: 1. Taken from Table 6 of the RING (EPA 2013).

ii VLAMP implications for non-network rail line

In addition to operational noise from an industrial site, the VLAMP sets voluntary mitigation and acquisition noise criteria for non-network rail lines which exclusively service one or more industrial sites. These criteria apply to the rail spur which connects the rail loop to the public network rail line including the existing Berrima Branch Line.

Voluntary mitigation or acquisition rights are triggered where noise emissions from rail traffic which uses a private rail line causes an exceedance of the levels in Table 7.12.

Table 7.12 VLAMP criteria for a non-network rail line

Receptor	Amenity area	Period	Voluntary mitigation criteria, dB, $L_{Aeq, period}$[1]	Voluntary acquisition criteria, dB, $L_{Aeq, period}$[2]
NCA1, NCA2, NCA4 to NCA7	Rural	Day	53	55
		Evening	48	50
		Night	43	45
NCA3	Suburban	Day	58	60
		Evening	48	50
		Night	43	45

Notes: 1. Based on the INP acceptable amenity level plus 3 dB (refer to Table 6 of Appendix 3 of the RING).
2 Based on the INP maximum amenity noise criteria (refer to Table 6 of Appendix 3 of the RING).

iii Network rail line

Environmental noise assessment requirements for rail traffic-generating developments which utilise the public rail network are provided in the RING (EPA 2013). If the project contributes to an increase of existing rail traffic noise levels of more than 0.5 dB and exceeds the trigger levels, feasible and reasonable mitigation is to be considered.

RING noise trigger levels relevant to the project are provided in Table 7.13. The trigger levels apply at 1 m from the most affected facade of residential assessment locations.

Table 7.13 Network rail line airborne rail traffic noise trigger levels for residential land uses

Development	Noise trigger levels, dB		
	Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)	Comment
Rail traffic generating development	65 $L_{Aeq(15hour)}$ OR [1]85 L_{Amax}	60 $L_{Aeq\ (9hour)}$ OR [1]85 L_{Amax}	Feasible and reasonable noise mitigation measures should be implemented where the cumulative rail noise level (existing rail noise plus project related rail noise) exceeds the trigger levels and the project related increase is greater than 0.5 dB. A strong justification on why feasible and reasonable mitigation has not been implemented should be provided if the project related L_{Aeq} noise level increase is greater than 2 dB and the relevant trigger level is exceeded.

Notes: 1. 95th percentile.

The RING (EPA 2011) acknowledges that a proponent is very limited in the range of potential mitigation measures they can offer, given they commonly have little or no control over the operation of the public rail network. Mitigation measures that can be offered include the use of new rolling stock, which is a key commitment of the project. Other common treatments may include receiver based architectural acoustic treatments (eg improved glazing and provision of air conditioning) if this is considered to be a reasonable option.

iv Ground-borne noise from rail operations

For a surface rail project such as the Berrima Rail Project, the effect of ground-borne noise is expected to be negligible since airborne noise emissions will be much greater than ground-borne noise levels. Hence, ground-borne noise was not considered as part of the NVA.

7.3.6 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 7.14 provides the sleep disturbance screening criteria for the residential assessment locations.

Table 7.14 Industrial noise sleep disturbance screening criteria, residential assessment locations

NCA	Adopted RBL, dB[1]	Sleep disturbance criteria dB, L_{Amax}
NCA1, NCA2, NCA4, NCA5	30	45
NCA3	31	46
NCA6	39	54
NCA7	34	49

Notes: 1.Night-time RBLs adopted from Table 2.2.

In addition, for rail operations the RING provides a maximum noise event trigger level of L_{Amax} 80 dB for new rail line developments.

7.3.7 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 7.15.

Table 7.15 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.

There is a low probability of adverse comment or disturbance to building occupants 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.

Impulse and continuous vibration is not likely to be a project risk given the intermittent nature of rail operations.

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.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are listed in Table 7.16.

Table 7.16 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

Notes: Refers to the "Line" in Figure 3.2.

Some construction or tunnelling activities (for example) are considered to have the potential to cause dynamic loading in some structures and therefore transient values in Table 7.16 have been reduced by 50% for assessment purposes, with a vibration screening criteria set at 7.5 mm/s.Further, 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.

7.4 Assessment method

7.4.1 Overview

This section presents the methods and base parameters used to model and assess noise emissions from the project. Both the preferred and alternative project options have been considered. Given that the options are similar in terms of alignment (except in the vicinity of the Berrima Cement Works as shown in Figure 1.3) and the same in terms of track volumes, the predicted noise impacts from each option are very similar. Predicted noise impacts from proposed construction activity, operation of the rail maintenance facility, road traffic and off-site rail traffic are the same for each option. Noise impacts from operation of each option of the project have been presented separately.

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.

Rail noise modelling was undertaken based on ISO 9613.1 algorithms within the Predictor software and using CONCAWE algorithms to account for potential noise-enhancing meteorological conditions as required by the RING. The rail model was calibrated to noise measurements undertaken of existing trains on the Berrima Branch line.

Computer noise modelling included the proposed 4 m high noise wall located north of the rail loop as shown in Figure 1.3.

7.4.2 Construction noise

Noise emissions from site construction have been assessed using ICNG noise criteria.

Table 7.17 details the scenarios considered in the construction noise assessment along with associated sound power levels, hours of activity and indicative scheduling.

Table 7.17 Rail construction activity considered in the impact assessment

Scenario	Construction activity	Indicative timing	Total sound power level, $L_{Aeq,15min}$ dB	Standard construction hours	Out of hours
Rail loop and spur	Site establishment	May-20	116	✓	X
	Strip & stockpile topsoil	May-20	121	✓	X
	Bulk earthworks	Jun-20 to Dec-20	125	✓	X
	Drainage	Jul-20 to Oct-20	113	✓	X
	Rail bridge over the Old Hume Highway	Jun-20	115	✓	✓[1]
	Structural and capping layers	Nov-20 to Feb-21	125	✓	X
	Supply ballast and sleepers	Jan-21 to Mar-21	116	✓	✓[2]
	Track work and signalling	Mar-21 to Sep-21	103	✓	✓[2]
Bridge/culvert on Berrima Road	Bridge/culvert construction	June 20	115	✓	✓[1]

Note: 1. To minimise traffic impacts during construction.
2. For track possessions only.

Each construction activity in Table 7.17 (except bridge construction) was placed at regular intervals along the rail line to depict the variability of construction noise levels given the linear and progressive nature of construction activity. The model assumed all equipment to operate simultaneously throughout a 15 minute period and therefore provides a conservative prediction of construction noise levels. Noise was predicted during calm conditions for proposed construction hours.

7.4.3 Operational noise – maintenance facility

Acoustically significant equipment items considered in the noise model are provided for day, evening and night operations in Table 7.18. Equipment sound power levels have been taken from published manufacturer and supplier data where available or otherwise from an EMM database of similar plant and equipment which is based on measurements at other similar operations.

Table 7.18 Indicative operations equipment quantities and sound power levels

Item and location	Modelled sound power level (Lw), dB $L_{Aeq(15\text{-}min)}$	Quantity			Description
		Day	Evening	Night	
Workshop activity	103	1	0	0	Maintenance activity undertaken in shed (open at northern and southern ends).
Tele handler	95	1	1	1	Located near locomotive and wagon jacking points.
Locomotives (idle to slow moving < 10km/h)	101	2	2	2	Latest generation locomotives. One locomotive located at both the northern and southern provisioning points. Northern provisioning point includes a shed to accommodate the locomotive.
Trucks (deliveries)	103	2	0	0	Both trucks located on internal access road.

7.4.4 Road traffic noise

Construction and operational traffic will generally be travelling either north or south on the Old Hume Highway. As described in Chapter 9, the predicted traffic volume increase as a result of either construction activity (associated with the Berrima Rail Project) or operation of the rail maintenance facility will be minimal relative to existing volumes.

During project construction there will typically be approximately 80 daily vehicle movements (60 truck movements and 20 car or other light vehicle movements) using the Old Hume Highway for access to the main worksites on either side of this road. This represents an increase in daily traffic of approximately 2.9%.

During the operations stage, the rail maintenance facility will generate only minimal additional daily traffic movements from fuel and other rail maintenance deliveries and workforce or visitor car traffic movements. These daily movements will be at most approximately 20 vehicle movements (10 truck movements and 10 car or other light vehicle movements) which represents a daily increase of approximately 0.7% for the route.

The predicted increase in road traffic volumes (of at most 2.9%) would lead to a negligible increase, ie less than 0.5 dB, in road traffic noise levels. Hence, assessment of road traffic noise associated with the Berrima Rail Project has not been considered further.

7.4.5 Rail noise

i Non-network rail noise

Information with regard to existing and proposed rail traffic volumes was supplied by Hume Coal and Boral. This information was based on data available at the time, and an assessment of rail transport demand into the foreseeable future. It is noted that the actual number of train movements on existing rail infrastructure will depend heavily on market conditions and operational activities.

Approval is sought for train movements associated with the other users of the line (currently Boral, Inghams and Omya) of up to 120 per week, and Hume Coal train movements of up to 50 per week, totalling 170 movements per week.

Based on the existing and proposed rail traffic together with the relative noise criteria, it was found that night-time provides the limiting scenario in terms of potential noise impacts from the existing users and Hume Coal trains. The noise criteria for the day and evening periods are 10 dB and 5 dB higher than that of the night period, respectively. This difference in noise criteria provides approximately ten and three times the volume capacity respectively as compared to the night period. Hence, providing substantially more flexibility in train movement volumes for day and evening periods. Rail traffic volumes assumed for the purpose of modelling noise from existing users and the project are provided in Table 7.19.

Table 7.19 Rail traffic volumes adopted in noise model

Period	Existing users	Existing users + Berrima Rail Project
Night[1]	12[2]	16[2]

Notes: 1. Day: Monday–Saturday 7.00 am to 6.00 pm, on Sundays and public holidays 8.00 am to 6.00 pm, Evening 6.00 pm to 10.00 pm, Night: Monday–Saturday 10.00 pm to 7.00 am, on Sundays and public holidays 10.00 pm to 8.00 am.

2. Includes two 'light locomotive' movements (ie locomotive only movement for the purpose of shunting, maintenance or refuelling).

Rail traffic noise predictions have been calibrated to measurements undertaken by EMM adjacent to the existing Berrima Branch Line. The results from operator-attended noise measurements were consistent with those captured of train pass-by events during the long-term, unattended noise monitoring. The results of rail traffic noise monitoring is presented in Section 4.6 of Appendix E.

Assessment of operational noise impacts has been undertaken for both the preferred and alternative project designs as described in Chapter 2.

ii Network rail noise

Once Hume Coal trains leave the Berrima Branch Line they will utilise three separate sections of network lines; the Main Southern Rail Line, the Moss Vale to Unanderra line and the Illawarra line. Potential noise impacts associated with the proposed Hume Coal rail traffic on each of these lines have been considered. Modelling has considered all these sections of rail and includes relevant train speeds as appropriate.

7.4.6 Sleep disturbance

Maximum noise events associated with rail pass-bys have been assessed against the relevant sleep disturbance screening criteria and other relevant guidance. A maximum A-weighted sound power level of 122 dB has been utilised to represent a locomotive pass-by at 20-40 km/h which has been obtained from measurements undertaken at the project area and on similar projects.

Maximum noise levels at each sensitive receptor were calculated under adverse meteorological conditions based on worst case locomotive locations on the Berrima Rail Project rail line as well as operation of the rail maintenance facility.

7.5 Impact assessment

7.5.1 Construction noise assessment

Predicted construction noise levels for the relevant project elements are provided in Table 7.20.

Construction noise levels have been predicted during calm conditions and for proposed construction hours; noting that the only activities that are proposed outside of standard hours are as follows:

- track possession;
- works required by utility providers;
- construction on bridges and other structures that may affect traffic flows or the use of other major infrastructure; and
- oversize deliveries and unloading of machinery.

Track possession will be undertaken for the following activities:

- works at Berrima Junction; and
- installation and commissioning of signals, and connection of the new rail line to the Berrima Branch Line near the Berrima Cement Works.

These activities will be required to occur 24 hours, seven days per week to ensure that works can be completed as soon as possible so that the railway can be handed back to existing users for resumption of normal train operations.

A range of noise levels, up to a predicted highest level, has been provided to represent the variability of noise as construction sequentially progresses along the rail line during the construction phase. Construction activities outside standard hours occur only in the vicinity of the Berrima Cement Works,the Berrima Junction, and the Old Hume Highway where the rail bridge wil be constructed.

Table 7.20 Predicted construction noise levels

Assessment location)	ICNG Noise affected NML, dB (Standard hours / OOH evening / OOH night)	ICNG Highly noise affected NML[1], dB	Predicted construction noise level, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)	Predicted construction noise level above noise affected NML, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)
1	40/35/35	75	up to 34 / <30	0 / 0
2	40/35/35	75	up to 35 / <30	0 / 0
3	40/35/35	75	up to 37 / <30	0 / 0
4	40/35/35	75	up to 39 / <30	0 / 0
5	40/35/35	75	up to 40 / <30	0 / 0
6	40/35/35	75	up to 40 / <30	0 / 0
7	40/35/35	75	up to 40 / <30	0 / 0
8	40/35/35	75	up to 41 / <30	up to 1 / 0

Table 7.20 Predicted construction noise levels

Assessment location)	ICNG Noise affected NML, dB (Standard hours / OOH evening / OOH night)	ICNG Highly noise affected NML[1], dB	Predicted construction noise level, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)	Predicted construction noise level above noise affected NML, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)
10	40/35/35	75	up to 43 / <30	up to 3 / 0
12	40/35/35	75	up to 46 / <30	up to 6 / 0
13	40/35/35	75	up to 45 / <30	up to 5 / 0
14A/B	40/35/35	75	up to 48 / <30	up to 8 / 0
15	40/35/35	75	up to 51 / <30	up to 11 / 0
16	40/35/35	75	up to 53 / up to 31	up to 13 / 0
17	51/46/40	75	up to 66 / up to 36	up to 15 / 0
18	51/46/40	75	up to 50 / up to 33	0 / 0
19	40/35/35	75	up to 53 / up to 43	up to 13 / up to 8
20	45/39/36	75	up to 45 / up to 35	0 / 0
21	45/39/36	75	up to 49 / up to 35	up to 4 / 0
22	45/39/36	75	up to 46 / up to 33	up to 1 / 0
23	45/39/36	75	up to 37 / <30	0 / 0
24	40/35/35	75	up to 44 / up to 33	up to 4 / 0
25	40/35/35	75	up to 48 / up to 40	up to 8 / up to 5
26	40/35/35	75	up to 45 / up to 36	up to 5 / up to 1
27	40/35/35	75	up to 45 / up to 37	up to 5 / up to 2
28	40/35/35	75	up to 66 / up to 56	up to 26 / up to 21
29	40/35/35	75	up to 58 / up to 50	up to 18 / up to 15
30	40/35/35	75	<30 / <30	0 / 0
31	40/35/35	75	<30 / <30	0 / 0
32	45/39/36	75	up to 35 / <30	0 / 0
33	45/39/36	75	<30 / <30	0 / 0
34	40/35/35	75	up to 30 / <30	0 / 0
35	40/35/35	75	up to 32 / <30	0 / 0
36	40/35/35	75	<30 / <30	0 / 0
37	40/35/35	75	<30 / <30	0 / 0
38	40/35/35	75	<30 / <30	0 / 0
39	40/35/35	75	<30 / <30	0 / 0
40	40/35/35	75	<30 / <30	0 / 0
41	40/35/35	75	<30 / <30	0 / 0
42	40/35/35	75	up to 30 / <30	0 / 0
43	40/35/35	75	up to 31 / <30	0 / 0
44	40/35/35	75	up to 33 / <30	0 / 0
45	40/35/35	75	up to 33 / <30	0 / 0
46	40/35/35	75	up to 33 / <30	0 / 0
47	40/35/35	75	up to 34 / <30	0 / 0
48	40/35/35	75	up to 33 / <30	0 / 0
49	51/46/40	75	up to 33 / <30	0 / 0

Table 7.20 Predicted construction noise levels

Assessment location)	ICNG Noise affected NML, dB (Standard hours / OOH evening / OOH night)	ICNG Highly noise affected NML[1], dB	Predicted construction noise level, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)	Predicted construction noise level above noise affected NML, dB $L_{Aeq,15min}$ (Standard hours / Outside standard hours)
50	40/35/35	75	up to 34 / <30	0 / 0
51	40/35/35	75	up to 36 / <30	0 / 0
52	51/46/40	75	up to 36 / <30	0 / 0
53	51/46/40	75	up to 39 / <30	0 / 0
54	40/35/35	75	up to 38 / <30	0 / 0
55	51/46/40	75	up to 40 / <30	0 / 0
56	40/35/35	75	up to 35 / <30	0 / 0
57	40/35/35	75	up to 34 / <30	0 / 0
58	40/35/35	75	up to 38 / <30	0 / 0
59	40/35/35	75	up to 40 / <30	0 / 0
60	40/35/35	75	up to 43 / <30	up to 3 / 0
61	40/35/35	75	up to 50 / up to 31	up to 10 / 0
62	40/35/35	75	up to 54 / up to 37	up to 14 / up to 2
63	40/35/35	75	up to 50 / up to 39	up to 10 / up to 4
64	40/35/35	75	up to 36 / <30	0 / 0
65	40/35/35	75	up to 35 / <30	0 / 0
66	40/35/35	75	up to 37 / <30	0 / 0
67	40/35/35	75	up to 33 / <30	0 / 0
68	40/35/35	75	up to 36 / <30	0 / 0
69	40/35/35	75	up to 42 / up to 30	up to 2 / 0
70	45/39/36	75	up to 41 / up to 30	0 / 0
71	40/35/35	75	up to 40 / <30	0 / 0
72	45/39/36	75	up to 38 / <30	0 / 0
73	45/39/36	75	up to 39 / <30	0 / 0
74	45/39/36	75	up to 44 / <30	0 / 0
75	40/35/35	75	up to 50 / up to 30	up to 10 / 0
76	40/35/35	75	up to 47 / up to 31	up to 7 / 0

Note: 1. *Applies to standard construction hours only.*

Construction noise levels are predicted to satisfy noise management levels for the majority of the assessment locations (ie at two-thirds or 50 of them). However, exceedances of up to 26 dB above the standard construction hours NMLs is predicted at location 28. The highly noise affected level is not predicted to be exceeded at any assessment location. Noise from activities outside standard construction hours is predicted to be above the relevant NML at up to eight assessment locations. However, as noted earlier, out of hours construction will be minimised as much as practicable and, for example, predicted exceedances at locations 28 and 29 will be limited to between 1 to 3 nights in total.

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of all feasible and reasonable work practices to minimise noise;
- inform all potentially impacted residents of the nature of the works to be carried out, expected noise levels and duration and relevant contact details; and
- negotiation with the community where noise from work outside standard hours is predicted to exceed the relevant NML by more than 5 dB.

Recommendations regarding the management of construction noise are provided in Section 7.6.

7.5.2 Industrial noise

The predicted noise levels at each assessment location from operation of the maintenance facility for each meteorological condition are provided in Table 7.21. Given the significant distance to some assessment locations from the rail maintenance facility there are many assessment locations where industrial noise levels are predicted to be negligible. Hence, predicted industrial noise emissions have been provided only where they are greater than 20 dB. Predictions are not provided where noise levels are less than 20 dB at that assessment location.

Predicted noise levels either satisfy the relevant PSNL or generate negligible impact (1 to 2 dB above PSNLs) as defined in the VLAMP.

Table 7.21 Predicted operations noise levels – rail maintenance facility

Assessment location (Figure 7.1)	Predicted noise level, $L_{Aeq,15-min}$, dB			PSNL (D/E/N) $L_{Aeq,15-min}$, dB
	Day (Calm)	Evening (adverse)	Night (adverse)	
14A/B	25	<20	23	35/35/35
15	28	20	26	35/35/35
16	27	<20	24	35/35/35
17	33	24	30	46/46/40
18	31	22	28	46/46/40
19	36	34	34	35/35/35
20	26	22	22	35/35/35
21	30	28	28	35/35/35
22	24	<20	<20	35/35/35
24	25	<20	20	35/35/35
60	21	<20	<20	35/35/35
61	23	<20	<20	35/35/35
62	26	24	24	35/35/35
63	29	22	22	35/35/35
69	22	<20	<20	35/35/35
70	20	<20	<20	35/35/35
73	21	<20	<20	35/35/35
74	25	21	21	35/35/35
75	22	<20	<20	35/35/35

A privately owned land assessment was also undertaken in relation to industrial noise emissions from the rail maintenance facility as per the VLAMP. No additional land parcels were identified as being noise affected.

7.5.3 Rail noise assessment

i Non-network rail line

Predicted rail noise levels from the non-network rail line (incorporating the train movements associated with the existing users of the Berrima Branch Line and Hume Coal trains) at the assessment locations are provided in Table 7.22 based on the assumptions provided in Section 7.4.5. Noise levels from the existing users of the Berrima Branch Line have been predicted and compared to total predicted rail noise levels including the project (ie the addition of Hume Coal trains). Given the significant distance to some assessment locations from the rail line there are many assessment locations where rail noise levels are predicted to be negligible. Hence, predicted rail noise emissions have been provided only where they are greater than 20 dB. Where predictions are not provided it can be assumed rail noise emissions are less than $L_{Aeq,9hr}$ 20 dB at that assessment location.

Table 7.22 Predicted non-network rail noise emissions – night-time (10pm to 7am)

Assessment location	Existing users (Berrima Branch Line only), $L_{Aeq,night}$ (dB)		Preferred (Existing users + Hume Coal trains), $L_{Aeq,night}$ (dB)		Alternative (Existing users + Hume Coal trains), $L_{Aeq,night}$ (dB)	
	Calm	Adverse	Calm	Adverse	Calm	Adverse
16	<20	<20	<20	22	<20	22
17	<20	<20	27	29	27	29
18	<20	<20	24	27	24	27
19	<20	<20	30	33	30	33
20	<20	<20	20	22	20	22
21	<20	<20	23	26	23	26
22	<20	<20	22	25	22	25
24	<20	<20	<20	21	<20	21
25	32	35	34	37	34	37
26	36	38	37	39	37	39
27	33	36	35	37	35	37
28	**42**	**44**	**43**	**45**	**43**	**45**
29	38	40	39	**42**	39	**42**
60	<20	<20	<20	22	<20	22
61	<20	<20	24	27	24	27
62	<20	<20	28	31	28	31
63	<20	<20	26	29	26	29
74	<20	<20	<20	22	<20	22
75	<20	<20	25	28	25	28
76	<20	21	23	26	23	26

Note: 1. Provided only where rail noise levels are predicted to be above the relevant criteria as per the RING.

2. $L_{Aeq,night}$ is $L_{Aeq,9hr}$.

3. RING operational noise criteria is LAeq,9hr. 40 dB (operational), 43 dB (mitigation) and >45 dB (acquisition).

With the addition of Hume Coal trains, the preferred and alternative alignments are predicted to result in a minor increase (+1.4 dB) at locations 28 and 29. Location 28 is predicted to experience rail noise levels of greater than $L_{Aeq(9\text{-hour})}$ 43 dB (up to $L_{Aeq(9\text{-hour})}$ 45 dB under adverse weather conditions) which, in accordance with VLAMP, would trigger voluntary mitigation rights at this location.

Assessment locations predicted to be affected by rail noise from the non-network rail line are shown in Figure 7.3 for the existing users only and Figures 7.4 and 7.5 for the preferred and alternative project alignments, respectively. These figures also include the predicted $L_{Aeq(night)}$ rail noise contours.

Additional noise from rail squeal has been given due consideration and the commitments to minimise this through effective design and maintenance of the track and rolling stock has been described in Section 7.6. Notwithstanding this, potential noise level increases[1] due to rail curves have been considered and accepted industry estimates are:

- +3 dB where the curve radius is greater than or equal to 300 m and less than 500 m; and
- +8 dB where the curve radius is less than 300 m.

The location of the rail curves are a significant distance from the nearest assessment locations namely 62 and 19. These are discussed further as follows:

- 62 (approximately 450 m from the rail line in the vicinity of a curve with a design radius of about 500 m): the predicted $L_{Aeq,9hour}$ at this location is 31 dB. The above accepted industry estimates would suggest no adjustment is required for this curvature. However, even with the inclusion of the maximum +3 dB curve gain the adjusted noise level for this location would be 34 dB and therefore still satisfies the relevant criteria of $L_{Aeq,period}$ 40 dB.
- 19 (approximately 640 m from the rail line in the vicinity of curves with radii of about 250 m): the predicted $L_{Aeq,9hour}$ at this location is 33 dB. With the inclusion of the maximum +8 dB curve gain the predicted noise level of $L_{Aeq,period}$ 41 dB would be 1 dB above the relevant night-time criteria. This is considered a negligible level above criteria and would not be discernible by the average listener. Notwithstanding, relevant controls would be implemented to minimise the occurrence of rail squeal on the Berrima Rail Project. With the proposed mitigation measures described earlier it is likely such increases in noise can be avoided completely or result in at least a 1 dB improvement such that criteria would be achieved.

[1] Sourced from Schall 03: Guidelines for the calculation of sound emission from railroad and tram lines (2006) produced by the German Federal Railway Authority.

Consistent with Appendix 3 of the RING a noise and vibration management plan will be developed for the project. It is noted that the following specific noise measures have been considered in the preliminary design of the project:

- route selection to maximise the distance between the rail line and noise sensitive land uses where practicable;

- construction of a noise wall to the north of the rail loop and a shed at the northern provision point to attenuate noise levels from train movements; and

- procurement of latest generation AC locomotives, and wagons with electronically controlled pneumatic brakes.

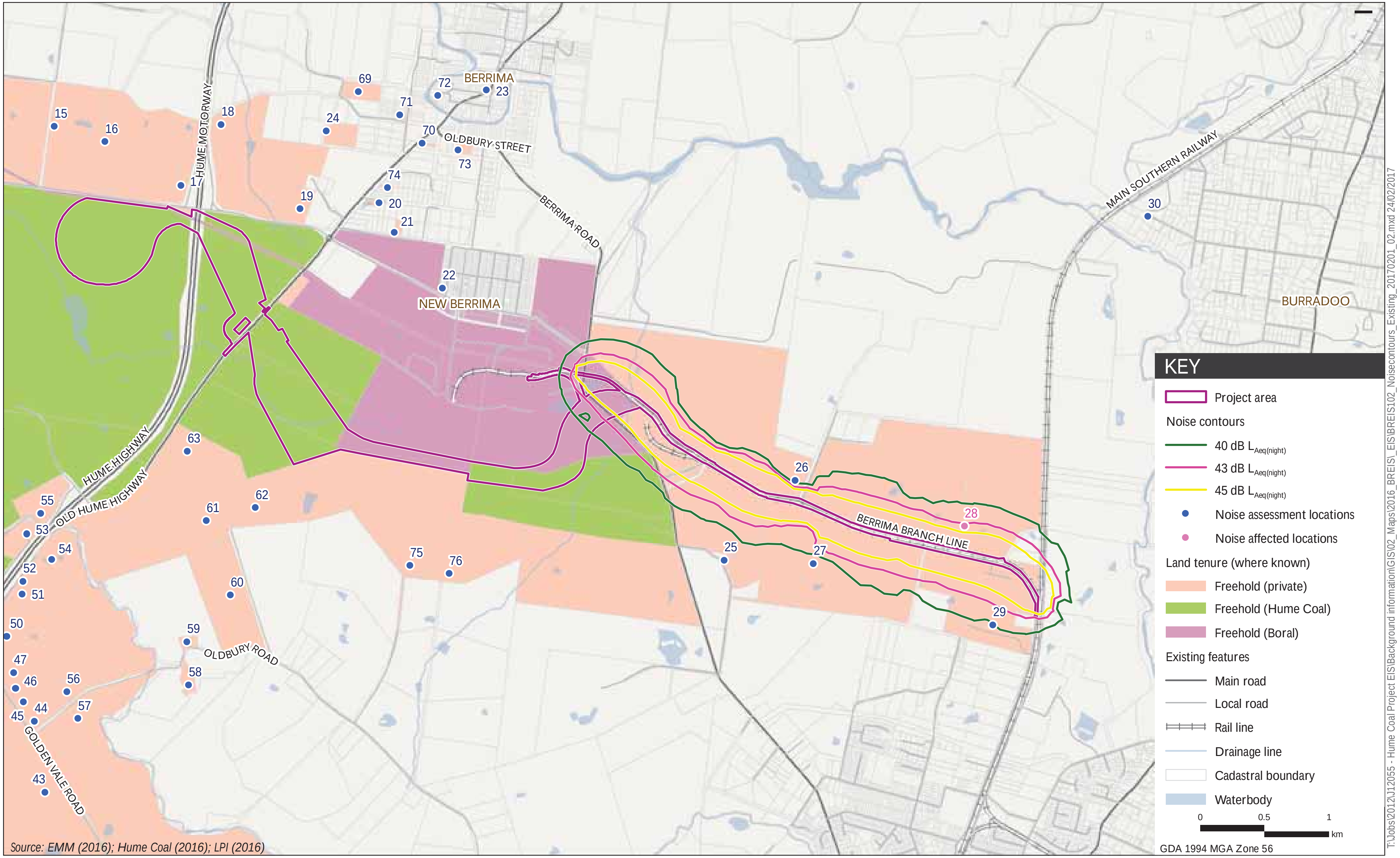
The RING also states that consideration should be given to the following in preparing the rail noise and vibration management plan:

- timetabling of train movements should minimise operation during sensitive periods where possible;

- locomotives should operate at lower speeds to reduce noise emissions; and

- drivers should be trained to minimise engine idling and unnecessary use of train horns as part of operating conditions.

Where practicable, these measures will be considered during operation of the project; however it is noted that timetabling is set with reference to other priorities, including periods of peak passenger movements and the paths offered by the infrastructure owners (such as the ARTC).



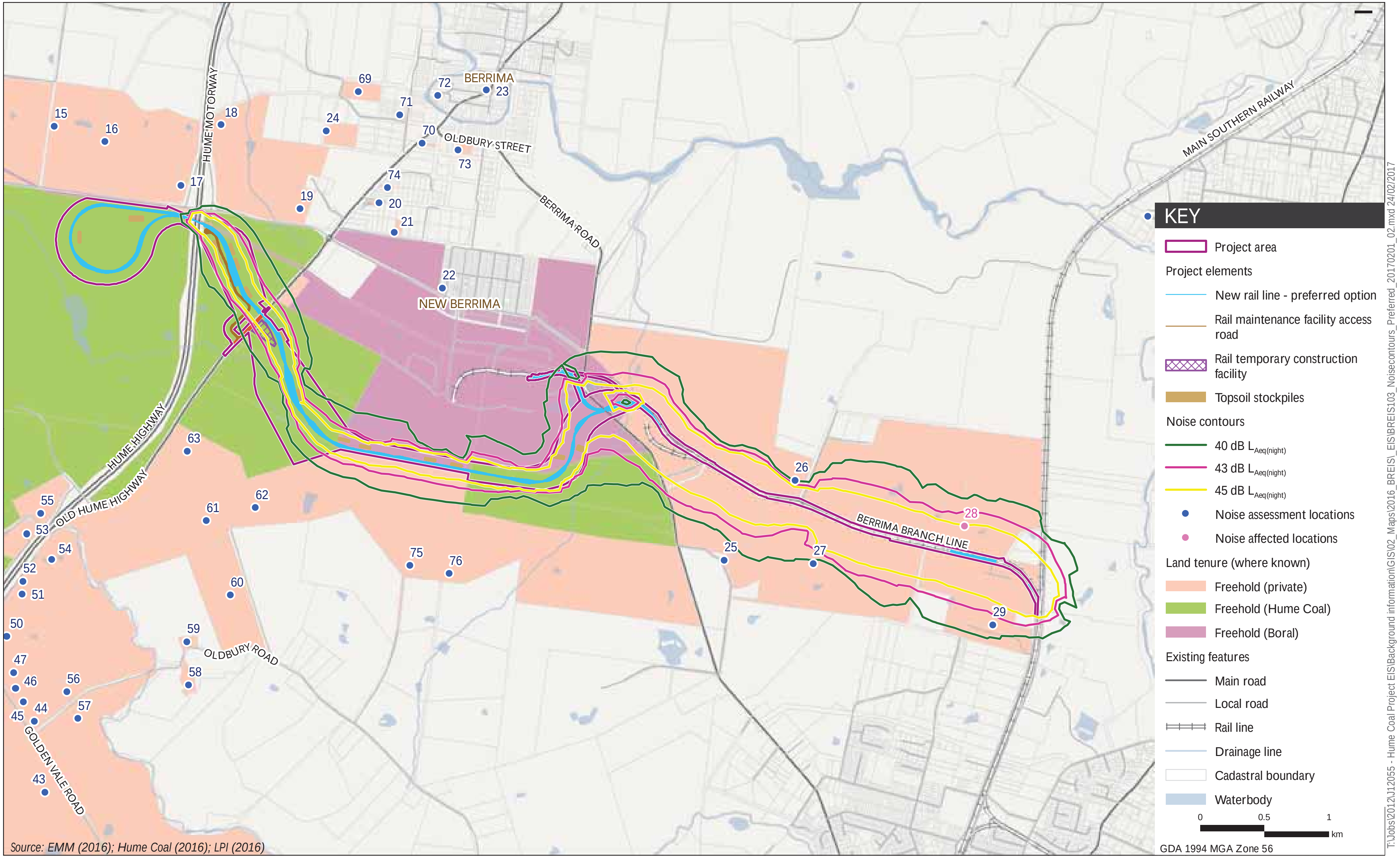
Non-network rail noise - existing users

Berrima Rail Project

Environmental impact statement

Figure 7.3

EMM HUMECOAL



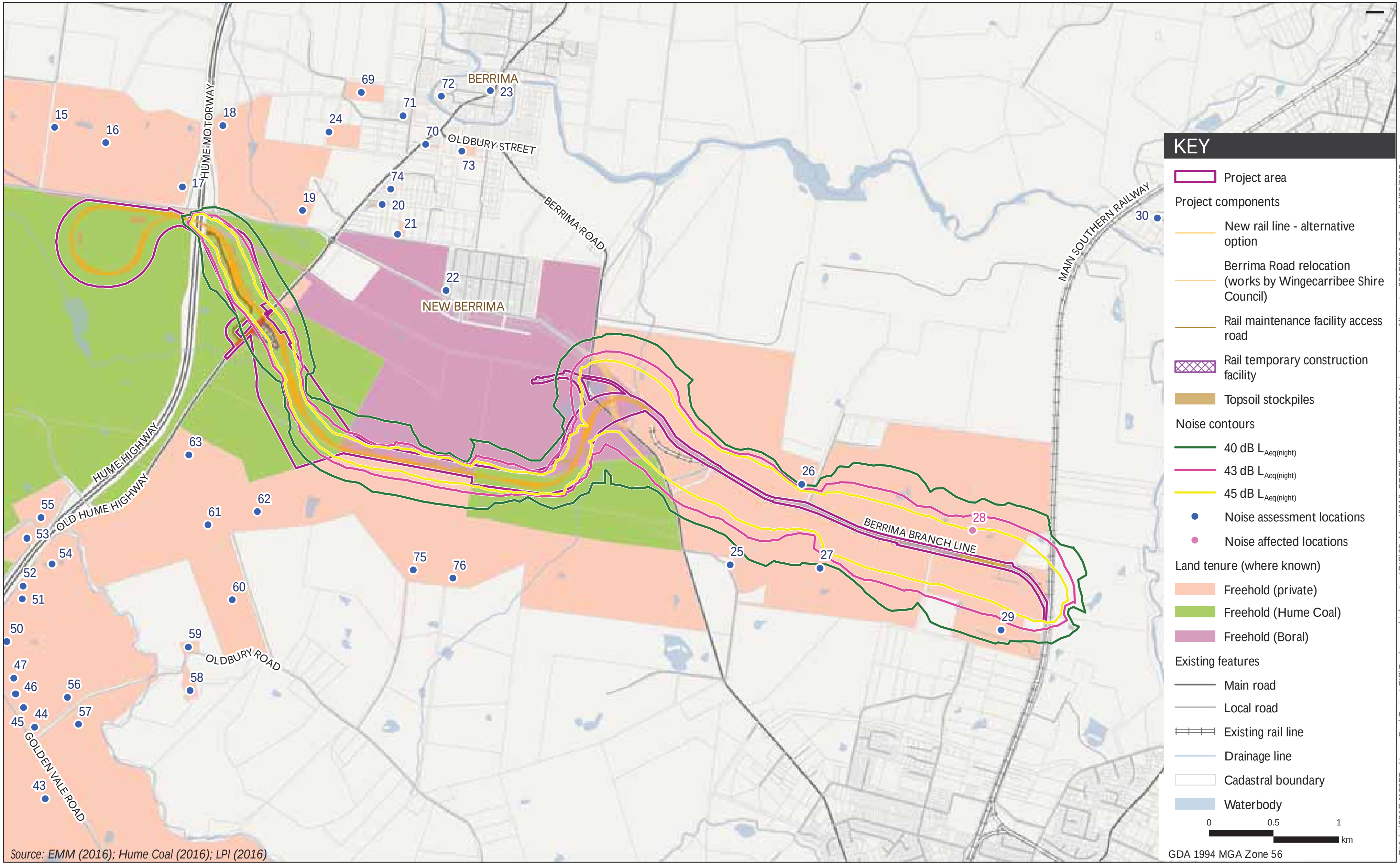
Non-network rail noise impacts - preferred alignment

Berrima Rail Project

Environmental impact statement

Figure 7.4

EMM HUMECOAL



Non-network rail noise impacts - alternative alignment

Berrima Rail Project

Environmental impact statement

Figure 7.5

ii Network rail line – Main Southern Rail Line

Existing rail traffic volumes on the Main Southern Rail Line have been estimated and reported in Chapter 9 (traffic and transport). Existing daily train movements are estimated to be in the order of 52 passenger trains and 58 freight trains.

The predicted maximum Hume Coal train movements during the night-time period (up to four movements) represents an increase in total rail traffic of approximately 11% and an increase in freight rail traffic of approximately 13%. This calculation is based on the assumption that the day/night split for passenger and freight train movements are 85%/15% and 50%/50%, respectively.

This would equate to an increase in the rail-related night-time noise level $L_{Aeq(9\ hour)}$ of less than 0.5 dB at residences located near the Main Southern Railway Line. The RING requires that feasible and reasonable noise mitigation be considered where the project-related increase is predicted to be greater than 0.5 dB. Even though the project-related increase is predicted to be less than 0.5 dB Hume Coal has committed to the use of new rolling stock for the project.

It is noted that parking interaction with passenger services on the Main Southern Railway Line will be minimised through effective scheduling (refer Chapter 9 traffic and transport). Hence, potential noise impacts from idling locomotives on the Main Southern Rail line will be managed.

iii Network rail line – Moss Vale to Unanderra

Existing rail traffic volumes on the Moss Vale to Unanderra Line (which passes through the township of Robertson) have been estimated and reported in Chapter 9 (traffic and transport). Existing freight train movements on this line is approximately 11 per day in each direction (ie 5 to 6 movements during the night-time period). The line is also utilised by a thrice weekly heritage passenger train.

Hume Coal will add up to an additional four train movements (two in each direction) during the night on this line. This would equate to an increase in the rail-related night-time noise level $L_{Aeq(9hour)}$ of approximately 2.5 dB (on average) at residences located near to the Moss Vale to Unanderra line.

It is noted that Tahmoor Coal has development consent to continue mining until 2021, although has recently announced mining will cease in 2018/2019. It is therefore likely that Tahmoor trains (four per day) will not be operating when the Berrima Rail Project commences operations. This would reduce the net increase in rail noise from existing levels.

The RING (EPA 2011) requires that feasible and reasonable noise mitigation be considered where the project-related increase is predicted to be greater than 0.5 dB. It is noted that Hume Coal has committed to leading noise mitigation including the procurement of latest generation AC locomotives, and wagons with electronically controlled pneumatic brakes.

The RING (EPA 2011) also acknowledges that a proponent is very limited in the range of potential mitigation measures they can offer, given they commonly have little or no control over the operation of the public rail network.

Predicted increases in rail noise assume that Hume Coal rolling stock will have the same noise emissions as existing stock that currently utilise these lines. Given that Hume Coal has committed to using latest generation locomotives it is likely that predicted noise increases in total rail noise will be lower than that stated above.

iv Network rail line – Illawarra

As reported Chapter 9 (traffic and transport), average daily train movements are estimated to be 198 including 98 freight train movements. The Hume Coal Project-related rail movements (up to eight per day) represents an increase of approximately 4% in total rail traffic and 8% in freight rail traffic.

The RING states that the geographical extent of the rail noise assessment should ideally be where project-related rail noise increases are less than 0.5 dB. This roughly equates to where project-related rail traffic represents less than 10% of the total line traffic. Hence, noise from Hume Coal related train movements on the Illawarra Line has not been assessed further.

7.5.4 Sleep disturbance

Whilst the frequency of train pass-bys will increase, maximum noise levels at assessment locations nearest to the existing Berrima Branch Line are not predicted to increase as a result of Hume Coal related traffic on this section of track.

Sleep disturbance noise impacts from operation of the project are considered unlikely. External noise levels up to L_{Amax} 56 $L_{A1,1\text{-}min}$, assuming rail curve gain is managed effectively through mitigation measures described earlier, are predicted to occur at the potentially most affected assessment locations from the Berrima Rail Project (ie assessment location 19 which is approximately 640 m from the rail line and assessment location 62 which is approximately 450 m from the rail line)[2]. This predicted level is above the relevant sleep disturbance screening criteria provided in the INP; however, the predicted external level would equate to an internal level of less than 46 dB (assuming a dwelling of standard construction with partially open windows). Therefore, although the INP screening criteria is predicted to be exceeded, the calculated internal noise level is below those that are likely to cause awakening reactions in most people (refer to Section 7.3.6).

7.5.5 Vibration assessment

i Construction vibration

Safe working distances for typical items of vibration intensive plant are listed in Table 7.23. The safe working distances are quoted for both "Cosmetic Damage" (refer to British Standard BS 7385) and "Human Comfort" (refer to British Standard BS 6472-1).

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[2] It is noted that assessment location 17 is located nearer to the project area. However, the noise barrier and cutting in the vicinity of this residence has the effect of reducing noise levels from the railway line.

Table 7.23 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's Construction Noise Strategy (Rail Projects), November 2007.*

The safe working distances presented in Table 7.23 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

In relation to human comfort (response), the safe working distances in Table 7.23 relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods would be acceptable, as discussed in BS 6472-1.

Based on the safe working distances for typical plant items in Table 7.23 and the location of surrounding privately owned residential properties, it is unlikely that human response vibration criteria will be exceeded. For example, the nearest privately owned assessment location (R17) is approximately 200 m from likely construction activity 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.

Notwithstanding the above, construction noise and vibration will be managed by Hume Coal, which will include the preparation of a CEMP that will include management measures for noise and vibration, as discussed further in Section 7.6.

ii Rail vibration at Hume Highway underpass

The rail line will consist of typical track-on-ballast construction and trains will be travelling at relatively low speeds (typically <15km/h) when passing through the Hume Highway underpass. Further, vibration levels from operation of the rail line are expected to be significantly less than that experienced by road users as a result of operating their vehicle. Therefore, it is expected that vibration from trains would have minimal impact on the Hume Highway and road users.

7.6 Monitoring and management

7.6.1 Operational noise

i Feasible and reasonable measures

It is generally accepted that noise mitigation measures should be considered in a hierarchical approach:

1. control noise at the source;

2. once controls at the source are exhausted, control the transmission of noise; and

3. once noise and transmission controls are exhausted, consider mitigation at the receiver.

The RING states the following:

> A noise mitigation measure is feasible if it can be engineered and is practical to build, given project constraints such as safety and maintenance requirements. Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure.

Hume Coal has committed to leading noise mitigation and management, including:

- highly considered lateral placement of the new elements of the project, taking into consideration potential sensitive noise receivers as well as other environmental and physical constraints, and topography;

- use of latest generation AC locomotives, as well as wagons with electronically controlled pneumatic brakes;

- minimisation of rail squeal through avoiding tight rail curves (where possible), and effective curve design and construction (eg rail grinding and gauge widening);

- construction of a noise wall to the north of the rail loop, to attenuate noise levels from rail activities, as shown in Figure 1.3; and

- construction of a locomotive shed at the northern provisioning point to minimise noise from idling locomotives.

As noted in Table 7.1, noise and vibration impacts from coal loading operations, including locomotives on the rail loop, have been assessed as part of the Hume Coal Project EIS, in accordance with the requirements of the RING. The recommendation of the Hume Coal Project noise assessment was the construction of the noise wall to the north of the rail loop. Whilst not a recommendation of the NVA for the project, the noise wall will be required to mitigate noise levels from operation of the rail loop.

Additionally, a noise management plan will be prepared and will detail activities to manage noise emissions from operations.

ii Voluntary mitigation

As provided in Section 7.5.3 and based on operational noise predictions, voluntary mitigation rights are triggered at one residential location (28) in accordance with the VLAMP (as shown in Figure 7.3 and Figure 7.5). As described above, significant commitments have been made with regard to noise control at the source. Consideration has also been given to a noise barrier at this location. A noise mound or barrier could be built to reduce noise; however, given the relatively minor predicted change in noise levels (+1 dB) and the isolated location of this receiver this was not considered a reasonable option. A 1 dB change in noise level from the same type of noise (ie rail operations) is negligible, would not be discernible by the average listener and within field measurement tolerances.

The VLAMP describes the process for obtaining mitigation measures and provides the following in this regard:

- mitigation works can only be carried out by applicants on private land when requested and agreed to by the landowner (or consistent with any ruling of the Secretary if there is a dispute between the applicant and the landowner);
- mitigation measures must be reasonable and feasible and proportionate to the predicted impact; and
- any works must be directed towards reducing the impacts of the development.

7.6.2 Construction

A CEMP that will address noise and vibration management and mitigation options (where required) will be completed prior to construction.

The main objective of the CEMP in relation to noise and vibration will be that as far as practicable construction activities meet the relevant ICNG NMLs and applicable vibration criteria across the project construction period. Noise levels will be monitored during the early stages of construction to validate and/or re-evaluate the predicted noise levels. Where required, noise management and mitigation measures will be reviewed with the aim of reducing construction noise levels below the relevant NMLs.

Where noise levels from works undertaken out of hours are predicted, affected landholders will be consulted prior to and during construction activity, and will be notified of proposed mitigation measures that will be used to manage construction noise levels to below ICNG NMLs.

7.7 Conclusion

The results, findings and recommendations of the noise impact assessment are summarised as follows:

- Noise from construction activity associated with the project is predicted to be below the relevant noise management level at the majority of assessment locations. The ICNG's highly noise affected construction noise level is predicted to be satisfied at all assessment locations.
- One assessment location (28) is predicted to be impacted by noise from the project (including both Hume Coal trains and other users) on the Berrima Branch Line (ie non-network rail line) above the trigger level for voluntary mitigation rights in accordance with the VLAMP.

- Operational noise levels are predicted to satisfy the relevant PSNL in accordance with the INP at all assessment locations with the exception of one location (19) where a negligible 1 dB above the PSNL is predicted.

- The likelihood of sleep disturbance as a result of the project is predicted to be minimal and consistent with current rail operations.

- Operation of Hume Coal trains on the broader public rail network is predicted to cause negligible increase in existing rail noise levels.

- Vibration impacts from construction and operation of the project are predicted to be negligible.

8 Air Quality

8.1 Introduction

Ramboll Environ quantified air pollutant emissions and assessed resultant impacts of existing and future rail movements along the Berrima Branch Line in accordance with:

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

The full air quality impact assessment report is attached in Appendix F, with a summary provided in this chapter.

The SEARs for the project require an assessment of the likely impacts on air quality and greenhouse gas emissions. Table 8.1 lists the relevant assessment requirements and where they are addressed in this chapter.

Table 8.1 Air Quality-related SEARs

Requirement	Section addressed
An assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW	Sections 8.2 to 8.6
An assessment of the likely greenhouse gas impacts of the development	Section 8.7

8.2 Assessment method

8.2.1 Sensitive receptors

The 75 sensitive receptors (ie residential dwellings) assessed by the noise and vibration assessment were also considered by the air quality assessment (Figure 7.1).

8.2.2 Modelling of operations impacts

The US-EPA AERMOD dispersion model was used for a Level 2 assessment as prescribed in the Approved Methods for Modelling (DEC 2005a). Concentrations of pollutants were predicted over a 15 km by 11 km grid and the 75 sensitive receptors in Figure 7.1.

Primary inputs to the model were the existing meteorology and emissions sources in the region; exisiting and proposed rail movements; and the emissions profiles of locomotives proposed to be used. The 2013 datasets from Hume Coal’s and the Bureau of Meteorology’s (BoM) Moss Vale weather stations was used as these were the most complete datasets available.

The CSIRO’s meteorological model ‘TAPM’ was used to supplement the meteorological data. It modelled paramaters not measured at the weather stations such as vertical temperature and wind profile, and substituted gaps in the weather station datasets. Meteorological inputs were prepared in accordance with the Approved Methods for Modelling (EPA 2016).

8.2.3 Estimating construction impacts

Potential construction phase dust impacts were assessed qualitatively using the United Kingdom's Institute of Air Quality Management *Guidance on the Assessment of Dust from Demolition and Construction* (2014) (GADDC).

GADDC provides a progressive approach to assessing air quality risks of construction and demolition projects as follows:

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

Potential dust impacts from construction of the project are summarised in Section 8.4.

8.2.4 Emission sources

The most significant emissions during construction will likely be dust from earthworks, dumping of material and vehicle movements. Emissions during operations will likely be the products of combustion from locomotive engines and dust from train movements and coal wagons.

Project trains will be in addition to existing trains using the Berrima Branch Line associated with Boral's Berrima Cement Works (limestone, cement and clinker), Omya Southern Limestone (limestone) and Ingham's Berrima Feed Mill (grain).

As described in Chapter 1, approval is sought for two slightly different alignments of the rail spur. There will be negligible difference in emissions between the two options.

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

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

8.2.5 Operational emissions assumptions

To enable preparation of a realistic 'worst case' air quality impact assessment, emissions have been quantified based on the highest possible 24-hour emissions for particulates and hourly emissions (for NO_x and VOCs) from rail movements using the following assumptions.

- There will be up to eight project related train movements per day in addition to the existing 26 train movements per working day using the line.

- There will be a peak of three train movements per hour between Berrima Junction and Boral Cement.

- It is conservatively assumed that all existing trains include two 81 Class locomotives which will be on notch settings one when idling and two when on the Berrima Branch Line travelling at 16 km/hr.

- Hume Coal trains will have two locomotives - indicatively of C44aci Class or newer if available at the time of purchase, which will travel at speeds of up to approximately 20 kph when on the branch line and loop.

- Locomotive emissions were estimated based on US-EPA uncontrolled emission factors for the existing Berrima Branch Line, and US-EPA Tier 1+ emission factors for the Hume Coal trains (US-EPA, 2009).

- The time for a single train movement between Berrima Junction and the Berrima Cement Works is 21 minutes for all existing trains, and 32 minutes between the Hume Coal rail loop and the Berrima Junction for Hume Coal trains.

- All existing trains are assumed to spend one hour idling per trip, while Hume Coal trains are assumed to spend three hours idling per trip.

- All Hume Coal train wagons are assumed to be covered (both full and empty wagons) and limestone wagons using the Berrima Branch Line are uncovered.

- Fugitive PM_{10} and $PM_{2.5}$ emissions from the loading of product coal to wagons by Hume Coal are included in the future Berrima Branch Line scenario.

- The US-EPA emission factor for locomotive engines is for PM_{10}. 97% of PM_{10} is assumed to be made up of much smaller $PM_{2.5}$ particles (US-EPA, 2009).

- Emissions of individual VOC species benzene, ethylbenzene, toluene and xylenes were estimated based on the hazardous air pollutant speciation profile presented by US-EPA (2011).

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

Table 8.2 Annual air emissions from the project

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

8.2.6 Assessment criteria

Air quality impact assessment criteria used in the assessment and their sources are in Table 8.3.

Table 8.3 Applicable air quality impact assessment criteria

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
TSP	Annual	90	NSW EPA impact assessment criteria[1]
PM_{10}	24 hours	50	NSW EPA impact assessment criteria[1]
	Annual	25	
$PM_{2.5}$	24 hours	25	NSW EPA impact assessment criteria[1]
	Annual	8	
	24 hours	20	AAQ NEPM long term goal for 2025
	Annual	7	AAQ NEPM long term goal for 2025
NO_2	1-hour	246	NSW EPA impact assessment criteria[1]
	Annual	62	
Benzene	1-hour (99.9th percentile)	29	NSW EPA impact assessment criteria[1]
Toluene	1-hour (99.9th percentile)	360	NSW EPA impact assessment criteria[1]
Xylenes	1-hour (99.9th percentile)	190	NSW EPA impact assessment criteria[1]
Ethylbenzene	1-hour (99.9th percentile)	8,000	NSW EPA impact assessment criteria[1]

Source: 1. Approved methods for the modelling and assessment of air pollutants in NSW (EPA 2016).

8.3 Existing environment

Annual wind roses for data collected by the weather stations are in Figure 8.1.

The ambient air quality data collected by the weather stations are summarised in Table 8.4.

Table 8.4 Summary of ambient air quality parameters

Pollutant	Measurement period	
	Annual average	Maximum 1-hour
TSP	37.6 µg/m³	-
PM_{10}	14.3 µg/m³	-
$PM_{2.5}$	6.3 µg/m³	-
Dust depositon	0.8 g/m²/month	-
NO_2	-	94 µg/m³
O_3	-	199 µg/m³

Note: 24 hour average PM_{10} and $PM_{2.5}$ concentrations are shown as time series plots in Appendix F.

Emissions from neighbouring industrial emission sources have also been explicitly modelled for the analysis of cumulative impacts.

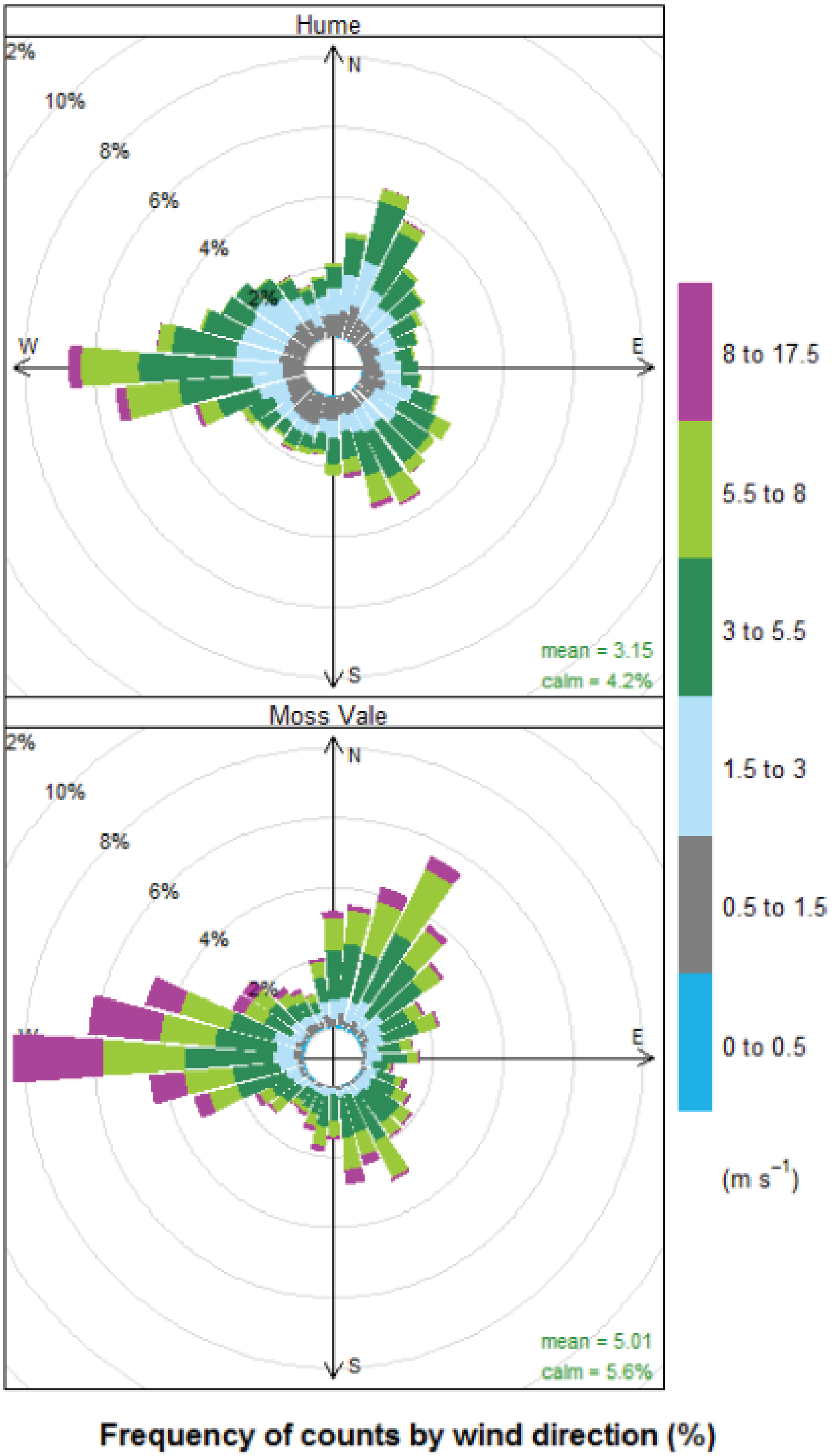


Figure 8.1 Annual wind roses – Hume Coal and BoM Moss Vale – 2013

8.4 Construction impact assessment

A detailed construction dust assessment is required under GADDC if there are receptors less than 350 m from the site. A detailed assessment was undertaken as there are two receptors within this distance. The scale and nature of works and sensitivity of the area are used to determine the risk of dust impacts. Earthmoving is the most significant component of works that could generate dust and people are highly sensitive to the nuisance impacts of dust and the health impacts of PM_{10} matter.

The sensitivity of receptors, the number of receptors, background PM_{10} concentration and distance of receptors to the dust source are combined to determine the sensitivity of the surrounding environment. The receptors will be within 350 m of the project and the annual mean PM_{10} concentration for the area is taken to be 14.3 µg/m_3, which leads to a low existing sensitivity of the area to dust soiling, human health and ecological effects.

To determine the risk of impacts with no mitigation applied, GADDC requires the combination of the dust magnitude rating with the sensitivity of the surrounding area for construction activities (Table 8.5).

Table 8.5 Dust Impact Risk Rating

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

It is shown in Table 8.5 that without mitigation there could be medium dust soiling, human health and ecological impacts from the project. Therefore, mitigation measures will include:

- all dust and air quality complaints will be recorded, identifying cause(s) and appropriate measures taken to reduce emissions;
- any exceptional incidents that cause dust and/or air emissions, either on or off site, will be recorded, as well as the action taken to resolve the situation;
- regular site inspections will be carried out and inspection results recorded;
- shade cloth barriers will be erected to site fences around potentially dusty activities where practicable;
- a maximum-speed-limit of 20 km/h will be imposed on all internal roads and work areas;
- proper maintenance and tuning of all equipment engines will be undertaken;
- drop heights from loading or handling equipment will be minimised; and

- an adequate water supply will be provided on the construction site for effective dust/particulate matter suppression/mitigation.

8.5 Operational impact assessment

The results of the atmospheric dispersion modelling are summarised in Table 8.6, which shows the maximum predicted project only incremental concentrations across all receptors for the existing and future Berrima Branch Line emission scenarios.

Table 8.6 Maximum predicted concentrations across all receptors – Existing versus future Berrima Branch Line

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

Note: *Criteria for benzene and ethylbenzene is applicable at or beyond site boundary.*

8.6 Analysis of results

8.6.1 Construction impacts

It can be seen from the results presented in Section 8.4 that uncontrolled dust emissions from the proposed construction activities are negligible for demolition, construction and truck track out classifications and medium for earthworks.

8.6.2 Operational incremental impacts

As can be seen from the results presented in Table 8.6, the predicted concentrations from train movements associated with the existing Berrima Branch Line users are well below applicable air quality criteria at all surrounding receptors.

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

8.6.3 Operational cumulative impacts

Cumulative air quality impacts between the Berrima Rail Project, the Hume Coal Project, neighbouring emission sources and existing ambient background levels are assessed in Chapter 9 of the Hume Coal Project air quality impact assessment (Ramboll Environ 2017). Neighbouring emission sources included in the cumulative assessment are:

- Boral's Berrima Cement Works;
- New Berrima Shale Quarry;
- Dux Manufacturing Moss Vale;
- Inghams Berrima Feed Mill;
- Omya Southern Limestone, Moss Vale;
- Southern Regional Livestock Exchange; and
- Wingecarribee Resource Recovery Centre.

The results of the cumulative air quality assessment demonstrate that predicted concentrations of air pollutants will be below applicable air quality criteria at all receptors.

8.7 Greenhouse Gas Assessment

In addition to the assessment of air quality impacts, the SEARs for the project requires the quantification of greenhouse gas (GHG) emissions in accordance with the Australian Government *National Greenhouse Accounts Factors (NGAF) workbook* (DoE 2015).

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

GHG emissions will be from the the following sources:

- direct emissions from fuel combustion (diesel) for transport of coal in Hume Coal-owned locomotives (Scope 1); and
- indirect upstream emissions from the extraction, production and transport of diesel fuel (Scope 3).

Diesel consumed during transportation of product coal from the Hume Coal Project to port has been estimated based on the amount of product coal to be transported, a site to port travel distance of 80 km and a diesel fuel consumption rate sourced from the NSW EPA[3].

Based on peak diesel consumption rates during the operation of the Hume Coal Project and appropriate GHG emission estimation factors (DoE 2015), maximum annual GHG emissions, in units of tonnes of carbon dioxide equivalent (CO_2-e), are as follows:

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

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

8.8 Conclusions

Dust generated during earthworks in the construction phase is predicted to have medium dust soiling, health and egological effects in the local area if mitigation measures are not implemented. Dust management measures will be implemented to avoid dust impacts as much as practical and manage any residual impacts.

Emissions from use of the Berrima Branch Line by trains will increase during operations as Hume Coal trains use the line in addition to existing usage. However, the predicted project only air quality impacts at all receptors are well below air quality criteria for future Berrima Branch Line activities.

The cumulative impacts of emissions from the Berrima Rail Project, the Hume Coal Project, neighbouring emission sources and existing ambient background concentrations will not result in an exceedance of air quality criteria at any receptors.

The maximum annual Scope 1 and Scope 3 GHG emissions from combustion of diesel fuel in locomotives will be approximately 0.0033% of total GHG emissions for NSW and 0.0008% of total GHG emissions for Australia, which represents an insignificant potential greenhouse impact.

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

9 Traffic and transport

9.1 Introduction

The SEARs require an assessment of the likely transport impacts of the project. The specific requirements are provided in Table 9.1.

Table 9.1 Traffic and transport SEARs

Requirement	Where 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.	Section 9.4.1 and 9.4.2 (preferred option), 9.5.1 and 9.5.2 (alternative option) Appendix G
..and the rail network, having regard to TfNSW's and RMS's requirements.	Section 9.4.3 (preferred option) and 9.5.3 (alternative option) Appendix G

The assessment recommendations made by TfNSW and RMS in relation to traffic and transport are shown in Table 9.2, including where they are addressed in the EIS.

Table 9.2 Transport for NSW and RMS assessment recommendations

Recommendation	Where addressed
Transport for NSW	
Detailed design and engineering drawings of the proposed rail spur, rail overbridges, rail loop, potential upgrades to Berrima Junction and other associated infrastructure, including staging likely works construction, operation and decommissioning (of existing Berrima Cement Works rail line).	Conceptual design drawings of project components are provided in Chapter 2 (project description). Detailed engineering drawings will be completed prior to construction.
Details of train operating plans for existing and new users, including likely rail routes and destinations, train size and configuration, service frequency, anticipated train path requirements, expected ramp up periods and peak demand.	Chapter 2 (project description). Anticipated train path requirements are also discussed in Section 9.4.3.
Demonstrated engagement with and confirmation from all relevant rail network owners and coal terminals regarding train path availability and future network enhancements which may be required to support the proposed operations and maintain sufficient capacity for other rail network users over the life of the project.	ARTC, Boral and other existing users of the Berrima Branch Line have been consulted about operating requirements. Refer Chapter 5 (consultation).
Detailed assessment of the proposed project on the capacity, efficiency and safety of the rail networks, including level crossings. The assessment is to consider the cumulative impacts to network users (including and beyond that of the branch line) and recommend mitigation measures in response.	Section 9.4.3 (impacts on the rail network) and 9.7 (mitigation measures). Appendix G

Table 9.2 Transport for NSW and RMS assessment recommendations

Recommendation	Where addressed
Demonstrated engagement with the relevant road authority/ies for the development of interface agreements for proposed road over rail bridges and details of traffic management during construction of the proposed overbridges.	Chapter 5 (consultation). Construction traffic management plans will be developed as part of the project CEMP.
Engagement with TfNSW and the relevant rail network owners in the development of methodology for assessing noise impacts associated with the proposed rail operations, in line with relevant NSW noise guidelines and details of noise mitigation strategies.	Chapter 5.
Roads and Maritime Services	
A traffic impact study is required using Table 2.1 of the RTA's Guide to Traffic Generating Developments.	Sections 9.4.1 and 9.4.2 (preferred option), 9.5.1 and 9.5.2 (alternative option). Appendix G
The effects of traffic volumes and roadway configurations associated with the entry to and exit from the rail line during construction and operation. 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 address these proposals.	Sections 9.4.1 and 9.4.2. No direct access is proposed to the Hume Highway for the project.
The movement of overweight and oversize vehicles on the Hume Highway associated with the project.	This will be determined by the project's construction traffic management plan as part of the CEMP.
The impact of dust pollution on the travelling public.	This will be determined by the project's construction traffic management plan as part of the CEMP. Refer also to Chapter 8 (air quality).
The impact of dust pollution or deposition of fines on the functioning of reflective signs, pavement markers and pavement line marking.	This will be determined by the project's construction traffic management plan as part of the CEMP. Refer also to Chapter 8 (air quality).
The impacts of noise and vibration from the rail line and train movements, including from renewing and using the train line that passes under the Hume Highway, specifically undermining/destabilising of the existing bridge foundation and structure and pollution impacts on road users.	Chapter 7 (noise and vibration).
Changes to the water table that may affect the structural integrity of the Hume Highway.	Chapter 13 (flooding and drainage).

The full technical report is in Appendix G, and is summarised in this chapter.

9.2 Assessment method

9.2.1 Road and traffic impacts

The local traffic impacts that were identified and assessed for the Berrima Rail Project are:

- daily construction stage traffic movements at the rail project worksites;
- daily fuel and maintenance deliveries during project operations; and
- the effects of additional train movements at level crossings along the haulage route.

The assessment of road network and traffic impacts followed the methods in the *Guide to Traffic Generating Developments* (RTA 2002), which was tailored to the specifics of the project.

This involved identifying which roads will be used to access the project area during construction and operations, which were assessed for their capacity (focussing on intersections) and ability to safely accommodate the extra traffic associated with the project.

9.2.2 Rail transport network

The project's impacts on rail transport operations were assessed for four sections of the network as follows:

- the Berrima Branch Line including the proposed extension;
- 1.6 km section of the Main Southern Rail Line between Berrima Junction and Moss Vale;
- 57 km Moss Vale to Unanderra Line (Country South Line); and
- Illawarra Line from Unanderra to the Port Kembla Coal Terminal.

Existing freight train operations were examined and spare capacity for additional freight trains identified over the two main sections of the route: the Berrima Branch Line and the Moss Vale to Unanderra Line.

On the other two sections of the route, timetabling constraints were examined and the future availability of slots for freight trains identified for the short section of the Main Southern Rail Line between Berrima Junction and Moss Vale Junction, and on the Illawarra Line between Unanderra and Port Kembla.

9.2.3 Rail level crossings

An inventory of rail level crossings was prepared over the length of the route to the inner harbour area at Port Kembla. The crossings were classified for the road category (major, local, minor) and the type of safety control used (lights, lights and barriers or sign control only).

The effects of additional freight trains have been assessed for existing and future level crossing safety and the delays to traffic when level crossings are closed to road traffic.

9.3 Existing environment

9.3.1 Road transport network

The existing road network near the project area includes the following roads:

- Old Hume Highway, between Mereworth Road and Medway Road;
- Medway Road and Taylor Avenue; and
- Berrima Road and Douglas Road.

The existing width and condition of the Old Hume Highway north of Oldbury Creek, which is the main access point for the rail infrastructure construction compound and the operational access road for the rail maintenance facility, is shown in Photographs 3.1 and 3.2 of Appendix G. The existing daily and peak hourly traffic volumes using these roads were determined from surveys conducted during June 2015 and February 2016. The results of the surveys are summarised in Table 9.3.

Table 9.3 Existing and future projected traffic volumes on the surrounding road network

Road	Morning peak hour volume (vehicles)	Afternoon peak hour volume (vehicles)	Current daily traffic volume (vehicles)	Year 2020 base daily traffic (vehicles)	Daily traffic with Hume Coal Project traffic (peak construction)	Daily traffic with Hume Coal Project traffic (operations)
Old Hume Highway	99	86	1,100	1,150	1,398	1,482
Medway Road	185	193	2,100	2,200	2,282	2,278
Taylor Avenue	241	227	2,600	2,750	2,860	2,874
Berrima Road	334	440	4,300	4,500	4,602	4,610
Douglas Road	53	79	700	740	766	744

Source: *Traffic volume surveys in June 2015 and February 2016; and the Hume Coal Project EIS Traffic Impact Assessment (EMM 2017a).*

Forecast traffic growth over the years to 2020 is 1% annually. The additional road network traffic volumes are shown in Table 9.3 for the base case scenario (with no development, ie without the Berrima Rail Project and the Hume Coal Project) in 2020, and with the Hume Coal Project construction and operational traffic also included. The daily traffic volumes for the Hume Coal and Berrima Rail projects at peak construction assume the Berrima Rail Project construction workforce of 40 persons is resident at the accommodation village, but do not include the additional daily off site shuttle bus movements which would be required for this workforce to access the Berrima Rail line construction worksites.

9.3.2 Rail transport network

The future project rail operations will use four sections of the rail network:

- Berrima Branch Line;
- Main Southern Rail Line between Berrima Junction and Moss Vale;
- Moss Vale to Unanderra Line; and
- Unanderra to Port Kembla Coal Terminal.

Figures 9.1 to 9.3 show the principal features of each section of the rail route affected by the project. Each of the main railway and branch lines is reasonably well used by freight services on a typical weekday, with additional regular passenger services travelling throughout the daytime (a total of 30 passenger trains daily in each direction) on the Main Southern Rail Line through Moss Vale.

The usage of the Berrima Branch Line associated with the existing users of the line, as advised by Boral, is 120 train movements per week, and up to 26 train movements over a 24 hour period.

The current daily usage of the Moss Vale to Unanderra Line by existing freight trains and the occasional heritage passenger train is between 11 and 12 trains, which are usually:

- 6 grain and other country freight trains;
- 4 Tahmoor underground mine coal trains;
- 1 carrying limestone from Medway Quarry; and
- 1 heritage passenger train (3 times per week).

It is noted that Tahmoor has development consent to continue mining until 2021, although it has recently announced mining may cease in 2018. It is therefore likely that the four Tahmoor trains listed above will not be operating when the Berrima Rail Project commences operations.

9.3.3 Rail level crossing operations and safety

The level crossings on the route from Berrima to Dombarton are shown on Figures 9.1 and 9.2. There are no level crossings on the section between Dombarton and Port Kembla, which is shown on Figure 9.3.

Since 2013, new red level crossing signs have been installed at many level crossings along the route from Berrima to Port Kembla. Other improved safety controls, such as flashing lights, have been installed at Sheepwash Road. Vegetation has been cleared alongside the rail corridor at most of the minor road and private road level crossings, which has also improved safety conditions.

The percentage of level crossings with active safety controls, which include lights and/or safety barriers includes:

- 66% (two out of three) on the major roads;
- 50% (three out of six) on the sealed local roads; and
- 12.5% (one out of eight) on the unsealed local roads and private access roads.

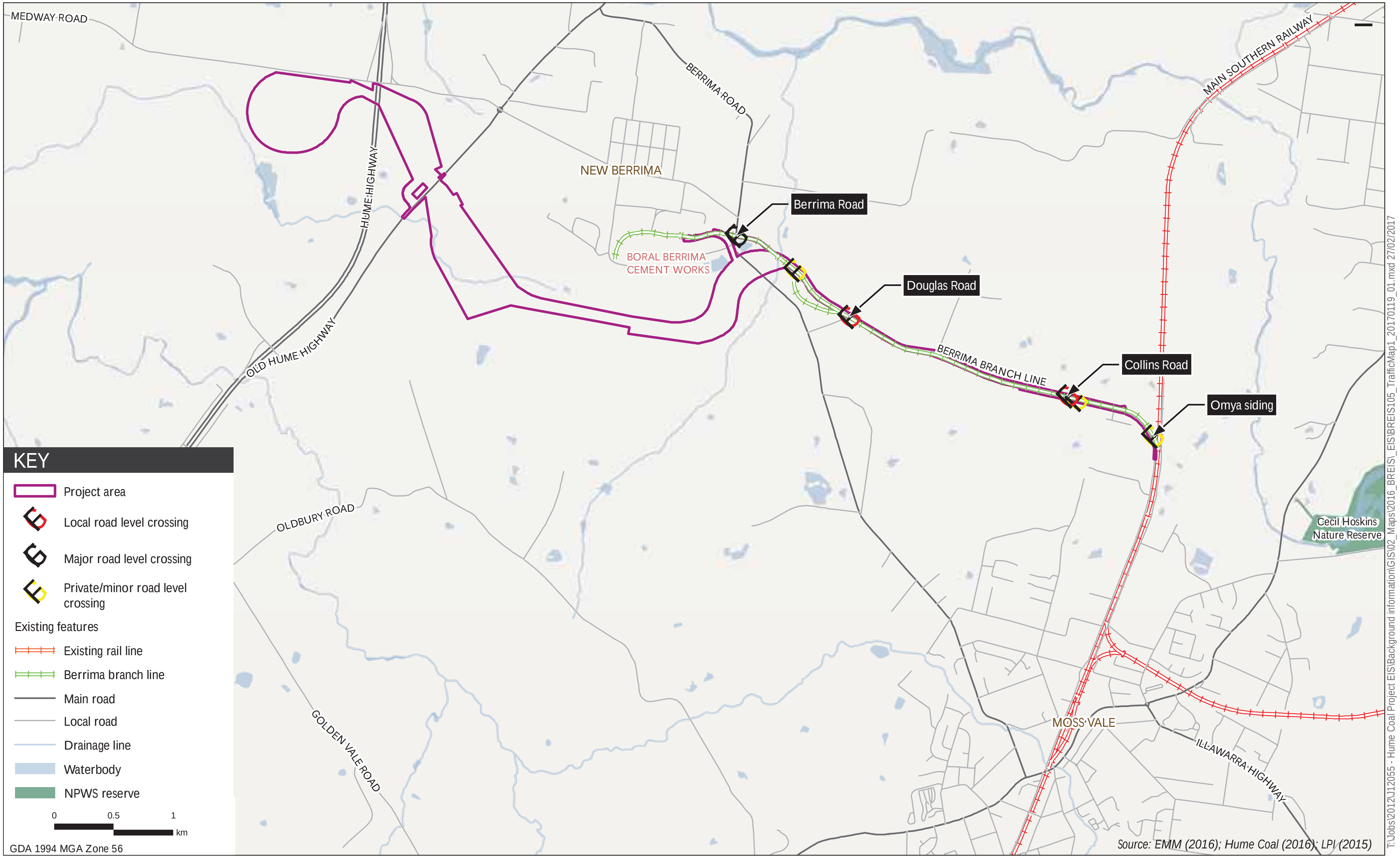
The existing safety controls and recent safety improvements for each level crossing identified on the route from Berrima to Port Kembla are listed in Table 3.2 of Appendix G.

Level crossing upgrades are administered by a working group called the Level Crossing Strategy Council, that is comprised of various stakeholders, including:

- Transport for NSW;
- Roads and Maritime Services;
- Country Rail Contracts (CRC);
- Sydney Trains;
- Australian Rail Track Corporation;
- John Holland Rail (JHR);
- NSW Branch of the Office of the National Rail Safety Regulator;
- NSW Police Force; and
- Local Government and Shires Associations of NSW (LGSA).

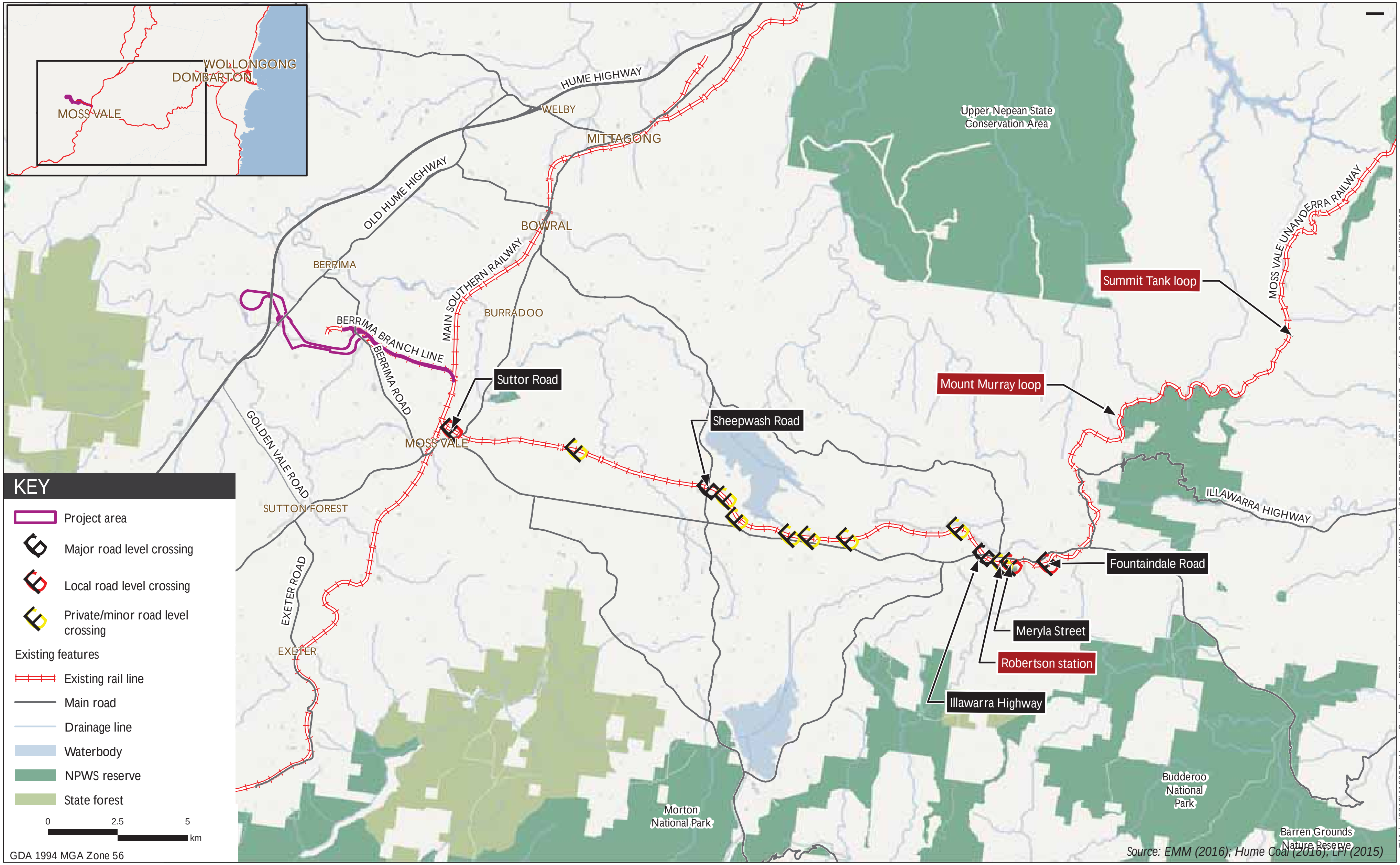
Level crossing upgrades are prioritised using the risk-based ALCAM assessment system, which takes into account a range of factors including the level of road and rail traffic using the level crossing. There is no role for customers of rail infrastructure owners in this process, such as on publically owned railways.

The preferred option will result in the removal of one existing level crossing on Berrima Road. The remaining level crossings on the Berrima Branch Line have very low traffic volumes as well as very low train speeds.

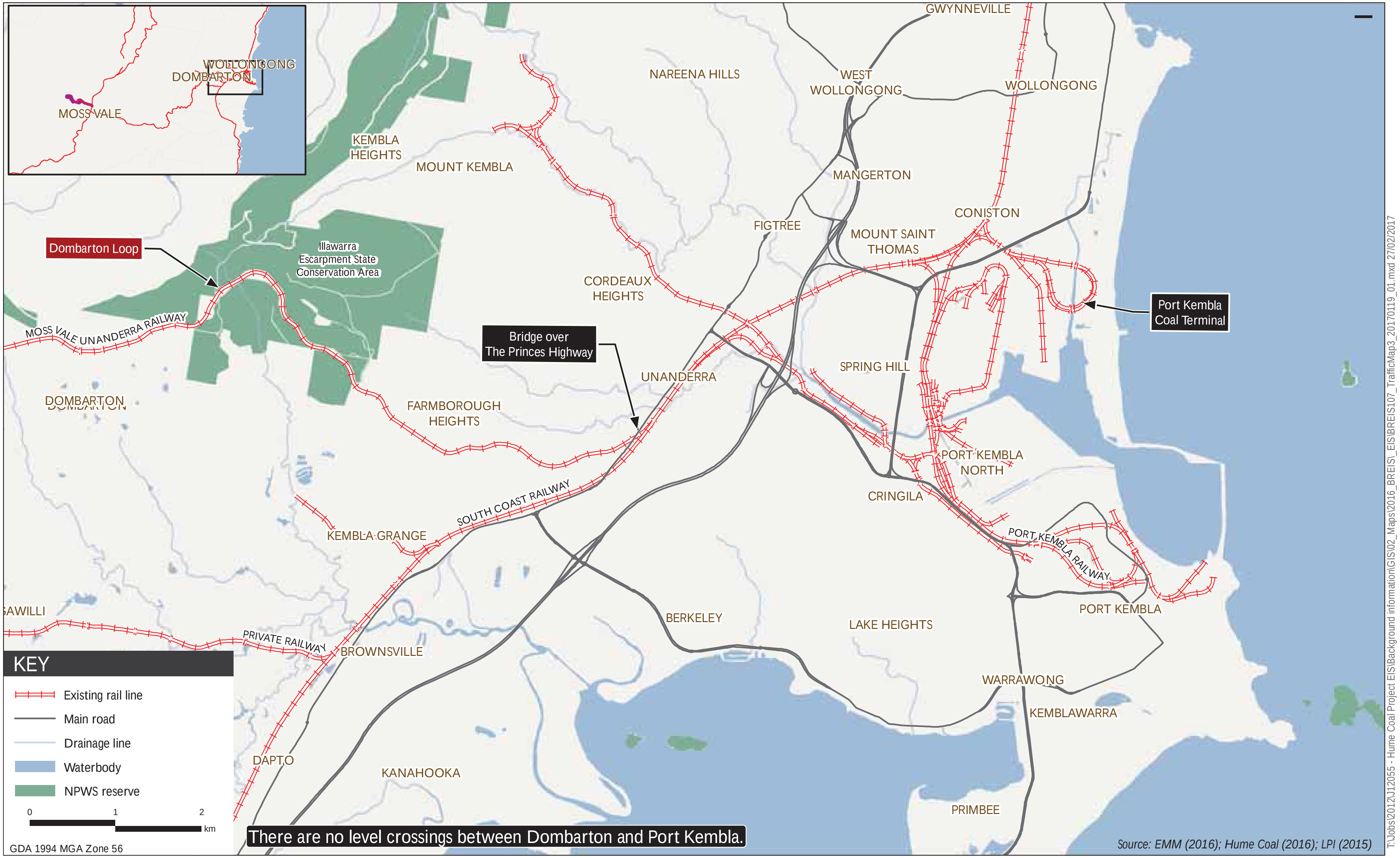


Route of the Berrima Branch Line

Berrima Rail Project
Environmental impact statement
Figure 9.1



Route of the Moss Vale to Unanderra Line to Dombarton
Berrima Rail Project
Environmental impact statement
Figure 9.2



The Illawarra Rail Line between Dombarton and Port Kembla

Berrima Rail Project

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Figure 9.3

9.4 Impacts of preferred option

The preferred rail route is shown in Figure 1.3. Its main construction stage traffic impacts will be at the primary rail infrastructure worksites on both sides of the Old Hume Highway, north of Oldbury Creek. Lesser impacts would occur at additional secondary worksites that will be near the future rail infrastructure works near Berrima Road, Douglas Road and Collins Road.

The potential operations stage traffic impacts will occur from fuel deliveries and related workforce and materials traffic access to the rail maintenance facility, as well as additional train movements causing traffic delays at level crossings along the haulage route. Additional train movements from the project are described in Section 2.5.2.

There will also be positive long-term impacts of the project through the construction of a new rail line over Berrima Road and a new spur into the Berrima Cement Works, resulting in the removal of the existing Berrima Road level crossing.

9.4.1 Construction stage impacts to road network

The anticipated construction and operational stage daily traffic movements are summarised in Table 9.4.

Table 9.4 Daily project construction and operations traffic movements

Project construction or operations stage	Daily heavy vehicles (movements)	Daily light vehicle visits (movements)
Project construction traffic movements, including removing surplus soil, importing crushed rock fill, ballast, track, sleepers, bridges, signalling, concrete and other building works for the rail maintenance facility.	30 (60)	10 (20)
Fuel and maintenance deliveries and other external (visitor and delivery) daily traffic movements at the rail maintenance facility during project operations.	5 (10)	5 (10)

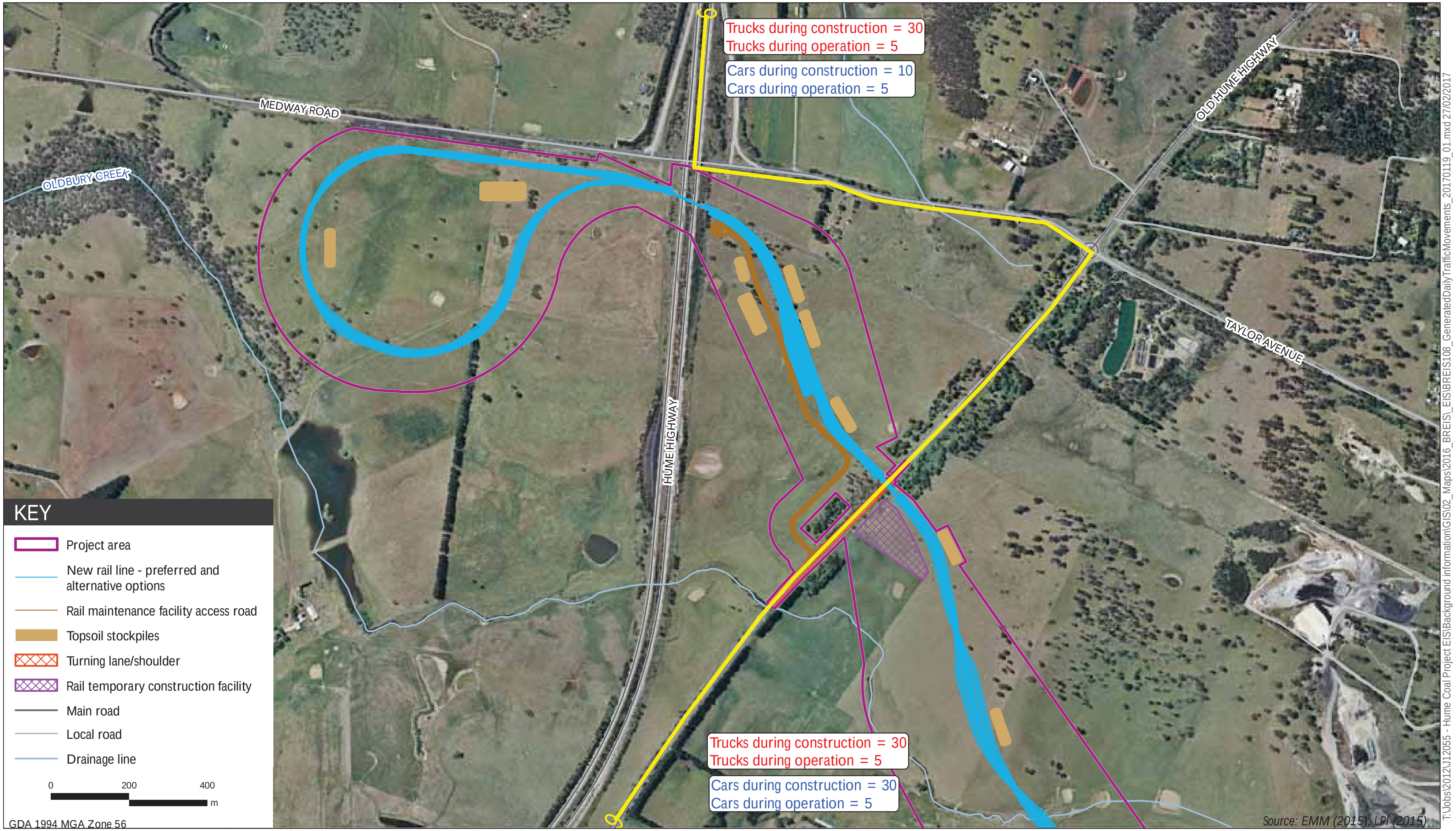
The average daily construction and operations traffic movements for the project and their distribution on the road network are shown in Figure 9.4.

During project construction there will typically be about 80 daily vehicle movements (60 truck movements and 20 car or other light vehicle movements) using the Old Hume Highway for access to the main worksites on either side of this road.

The daily construction traffic increases on the Old Hume Highway will be 2.9%, based on the predicted daily traffic increase of 80 daily vehicle movements (40 daily vehicle movements travelling north and 40 daily vehicle movements travelling south) from the proposed construction access location north of Oldbury Creek.

For construction access, an improved intersection incorporating a turning lane and wider shoulders will be constructed over a 450 m long section on both sides of the Old Hume Highway. This will provide safe left and right turning vehicle access to the rail infrastructure worksites on either side of the Old Hume Highway. The proposed intersection widening is shown in Figure 2.3.

At the secondary worksites where construction access will also be required (refer to Figure 9.5) for the proposed rail infrastructure works, the maximum daily construction traffic volumes will be much less than 80 vehicle movements. The individual construction access arrangements will be managed in accordance with the requirements in the RMS publication *Traffic Control at Work Sites* (RTA 2010), and documented in the CEMP.



Generated project daily traffic movement

Berrima Rail Project

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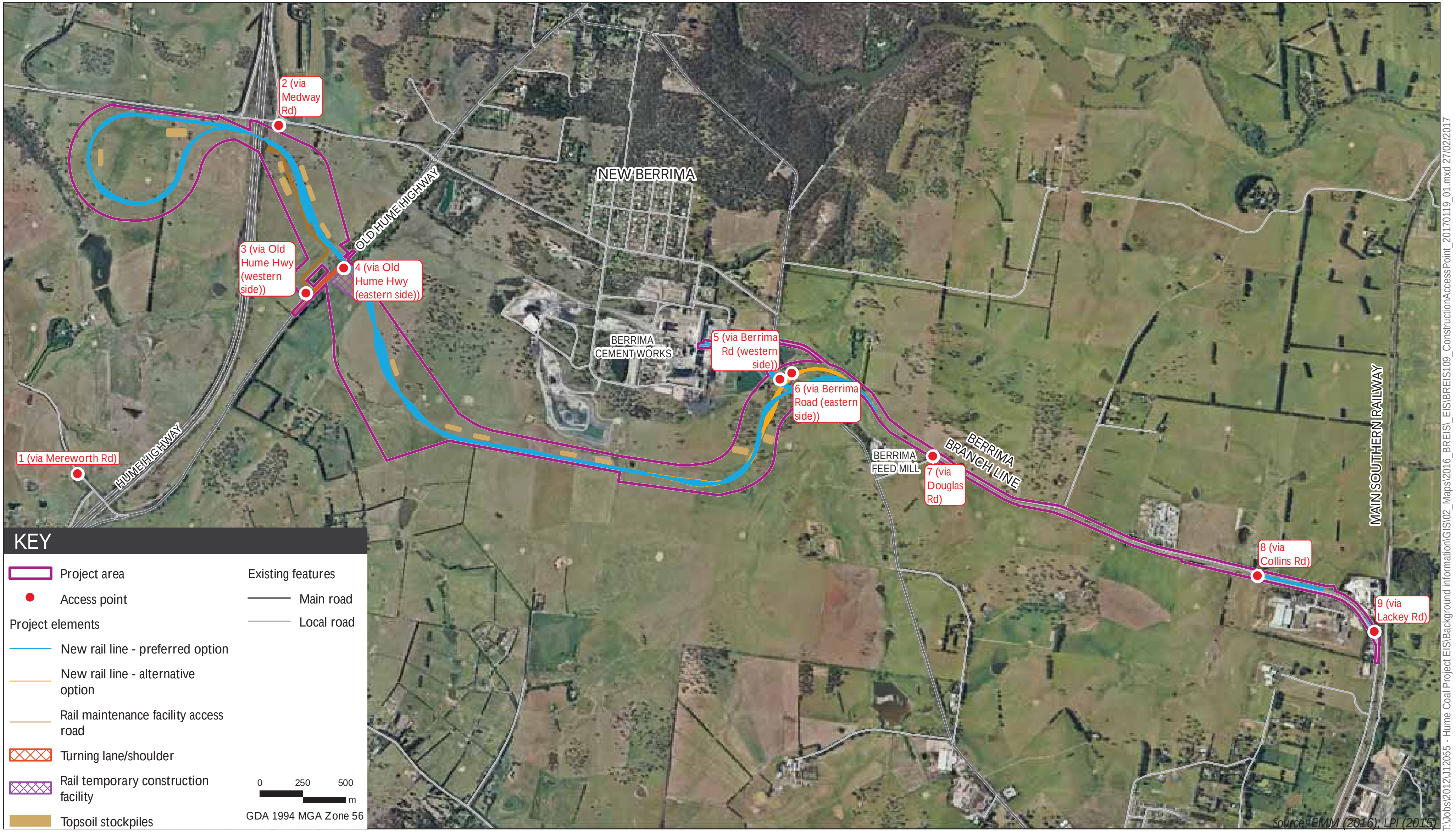
Figure 9.4



Indicative construction phase access points

Berrima Rail Project

Environmental impact statement

Figure 9.5

9.4.2 Operational stage impacts to road network

During the operations stage, the surrounding road network will generate only minimal additional daily traffic movements from fuel and other rail maintenance deliveries and workforce or visitor car traffic movements. These daily movements will be at most about 20 vehicle movements (10 truck movements and 10 car or other light vehicle movements) using the rail maintenance facility access road on the western side of the Old Hume Highway (Figure 9.6).

The daily operations traffic increases would be 0.7% for the route, based on the predicted daily traffic increases of 10 daily vehicle movements travelling north and 10 daily vehicle movements travelling south via the Old Hume Highway, compared to the future base year (2020) daily traffic volume of 1,398 vehicles for the Old Hume Highway at that time, which includes the other Hume Coal Project traffic movements.

For the longer-term operations access, the initial temporary turning lane and wider shoulder of the Old Hume Highway will be reconfigured to provide a channelised lane right turn (short) intersection, referred to as CHR(S), which will provide safe left and right turning access for the proposed traffic volumes to the rail maintenance facility on the western side of the Old Hume Highway (refer to Figure 9.6).

There will be additional traffic safety benefits from the closure and removal of existing railway level crossings along the Berrima Branch Line (refer to Figure 9.1). In particular the preferred rail alignment near the Berrima Cement Works will result in a new rail overbridge crossing Berrima Road, which will permit the closure of the Berrima Road level crossing at the Berrima Cement Works.

The Chelsey Park property is owned by Austral Bricks, and whilst there was previously a house on this property, the house has recently been demolished. Access to the Chesley Park driveway will no longer be available once the new rail line is constructed for both the preferred and alternative options. Should ongoing access be required from the south of the property, Hume Coal will work with the property owner to maintain access of a similar standard to the current driveway.

Future road traffic interruption from the increased number of freight trains (which will typically be four Hume Coal train movements per day in each direction) at the major road level crossings on the route, such as the Illawarra Highway crossing at Robertson, will be up to an extra 24 minutes each day.

In the future, with the added coal and freight trains on the line at Robertson, there will be 31 train movements at the most each day, which will represent 6.3% of the total time each day when the road is closed to traffic, assuming trains from Tahmoor Coal Mine continue to operate contrary to the announced closure in 2018/2019 (which are approximately four per day).

Therefore, the net effect of the additional Hume Coal trains will be to increase the proportion of the total time each day when the Illawarra Highway level crossing (and the other level crossings between Robertson and Moss Vale) will be closed by a passing train, from 4.8% of the total time each day now to 6.3% of the total time in the future.

Should the Tahmoor trains cease to operate in-line with the current 2021 expiry date of the development consent, there will be no net effect of the project on the time each day that level crossings will be closed, as the Hume Coal trains will effectively replace the Tahmoor trains.

These additional delays at level crossings will not be a significant increase to the total length of time each day when the affected level crossings will be closed to road traffic.

Proposed operations stage access for Rail Maintenance Facility

Berrima Rail Project

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Figure 9.6

9.4.3 Operational stage impacts to rail network

Existing train movements using the rail network are described in Section 9.4.2. and additional train movements by existing users and those that will be added by the Hume Coal trains are described in the following section.

i Berrima Branch Line

To transport up to 3.5 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 4 loaded and 4 empty coal train movements daily. In general, this will require four daily coal train paths in each direction on most days of the year. This would represent a peak year of production, with a more typical year requiring between 2 and 3 loaded and empty trains per day.

Table 9.5 shows the combined effects of the future train movements by all operators (including Hume Coal) on the line's capacity.

Table 9.5 Existing and future usage of Berrima Branch Line

Line operations	Daily train movements	% maximum line capacity	% practical operating capacity[1]
Daily maximum operations (existing users)	26	38%	59%
Future maximum daily operations (existing users and Hume Coal)	34	50%	77%

Note: 1. practical capacity is then calculated by taking 65% of the maximum capacity.

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

ii Main Southern Rail Line

Future coal and other freight 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, to cross between the junctions with the Berrima Branch Line on the western side and the Unanderra Line on the eastern side.

These train movements will only occur over a short (1.6 km) section of the Main Southern Rail Line. The additional train 'cross over' movements will occur during slack periods in the existing timetable and will have a minimal effect on the overall Main Southern Rail Line capacity for longer distance passenger and freight train movements. Further, the Main Southern Rail Line consists of triple-track for most of the cross-over distance.

iii Moss Vale to Unanderra Line

The maximum daily usage of the Moss Vale to Unanderra Line by existing freight trains and the occasional heritage passenger train is between 11 and 12 daily train movements in each direction, which are usually:

- 6 grain and other country freight trains;
- 4 Tahmoor mine coal trains;
- 1 train from Medway Quarry carrying limestone; and
- up to 1 heritage passenger train.

These existing daily train movements represent about 50% of the line's current maximum operating capacity, without lengthening any of the passing loops. The addition of up to four loaded and four empty daily coal train movements will increase the use to between 15 and 16 daily train movements in each direction, which will then represent about 70% of the line's maximum operating capacity. However this usage level is unlikely to be reached in practice as the Tahmoor mine coal trains are likely to cease operating between 2018 and 2021, which is before the Hume Coal trains will commence their operations.

The Moss Vale to Unanderra Line has a large number of level crossings on both major roads and local roads between Robertson and Moss Vale. The existing traffic safety control arrangements for these level crossings are discussed further in Section 9.3.

iv Unanderra to Port Kembla Coal Terminal

The availability of multiple lines and grade separation between the passenger and freight lines at Coniston means there are few capacity constraints for freight trains when operating over this section of the route.

v Capacity for additional coal train paths between Berrima Junction and Moss Vale Junction

Network modelling using the OpenTrack modelling software package and current ARTC/TfNSW timetables has confirmed the availability of sufficient capacity on the network between the future mine site and Port Kembla. This modelling has demonstrated *at least* 4 Mtpa of capacity exists, without upgrades to passing loops on the Moss Vale to Unanderra line. This confirms the findings of the Maldon to Dombarton feasibility study which found that around 7 Mtpa of capacity existed along the Moss Vale to Unanderra line at the time, without any upgrades.

9.5 Impacts of alternative option

The alternative route alignment is shown in Figure 1.3. The difference with the preferred rail option is near the Berrima Cement Works, where a new line will not be constructed to the cement works and the level crossing east of the cement works will not be bypassed. The crossing will remain in operation until WSC builds the new road detour alignment for Berrima Road (see Figure 1.3). This will require a temporary diversion of Berrima Road, from the new alignment back to the existing alignment, whilst the Hume rail spur is instated through the road embankment of the new road alignment (provisionally for 2-3 weeks).

9.5.1 Construction stage impacts to road network

The project construction stage daily traffic movements are summarised in Table 9.5.

The alternative option will be about 700 m (or approximately 10%) shorter than the preferred rail route option due to the absence of any new rail line connection to the Berrima Cement Works. Consequently, it will have lower quantities of construction materials and about 10% fewer construction-related daily truck movements, which result in a 2.6% increase in dail traffic on the Old Hume Highway (compared to 2.9% for the preferred option).

9.5.2 Operational stage impacts to road network

The alternative rail option will have the same daily operations stage traffic movements to deliver fuel and other materials to the rail maintenance facility and the same additional traffic delays at level crossings as the preferred route alignment.

The alternative rail option will have lower traffic benefits than the preferred option because the level crossing on Berrima Road will not be bypassed or removed by a new rail line provided for access to the Berrima Cement Works.

9.5.3 Operations stage impacts to rail network

The design differences between the alternative and the preferred rail options will not result in any changes to the future rail operations and train movements for the Berrima Branch Line users and the freight and passenger train movements using other sections of the rail route to Port Kembla. Thus the impacts described in Section 9.4.3 will apply equally to the alternative rail option.

9.6 Management and mitigation measures

9.6.1 Construction traffic management plan

A number of traffic management measures will be implemented during the construction stage. Traffic management and traffic control plans will be required for all construction worksites, including the access from the Old Hume Highway, north of Oldbury Creek, for the main construction worksites. Preliminary intersection designs have been prepared for the construction stage upgrade of the Old Hume Highway and the subsequent modification that will provide a type CHR(S) intersection design for the future rail maintenance facility operations access road.

Construction access requirements for the secondary worksites will be documented in a construction traffic management plan as part of the project's CEMP, which will be prepared in accordance with RMS *Traffic Control at Worksites* guidelines (RTA 2010) and will also specify traffic control measures for:

- the movement of overweight and oversize vehicles on the Hume Highway;
- the impact of dust on the travelling public; and
- the impact of dust pollution or deposition of fines on the functioning of reflective signs, pavement markers and pavement line marking.

9.6.2 Traffic management at level crossings

Future decisions to upgrade railway level crossing safety will be the responsibility of the respective rail line operators; that is the ARTC for the line between Moss Vale and Robertson, and Boral for the Berrima Branch Line.

9.7 Conclusion

This is a rail transport project and therefore impacts on the road transport network will be limited. Road access will be used during the construction stage for multiple project worksites and during the operations stage for fuel and maintenance deliveries to the Rail Maintenance Facility. There will be additional train movements at railway level crossings between Berrima and Robertson.

Peak construction vehicle movements will result in 2.9% daily traffic increases on the Old Hume Highway.

There will be capacity in the Berrima Branch Line to accommodate the new trains associated with the Hume Coal Project, which will represent 77% of its practical operating capacity in combination with existing users. A temporary turning lane and wider shoulder will be constructed on the Old Hume Highway over a 450 m long section north of Oldbury Creek to allow safe construction site access.

The temporary turning lane and wider shoulder on the Old Hume Highway will be reconfigured to provide a type CHR(S) access intersection for longer-term access to the Rail Maintenance Facility. The preferred option will include a new rail bridge over Berrima Road , which will result in significant traffic flow and safety benefits due to the closure and removal of the railway level crossing near the Berrima Cement Works.

Traffic delays caused by additional coal trains at the major level crossings on the route will typically be up to an extra 24 minutes each day. Traffic is delayed for about three minutes each time a level crossing is closed. This represents a daily average added delay of 1.5% when the level crossings would be closed to road traffic.

10 Aboriginal heritage

10.1 Introduction

10.1.1 Scope of the assessment

This chapter summarises the Aboriginal cultural heritage assessment (ACHA) of the project, which is attached in full in Appendix H.

The Aboriginal cultural heritage assessments for the Berrima Rail Project and the Hume Coal Project were undertaken as one cohesive process. This was the most appropriate method for identifying and assessing the Aboriginal cultural heritage values relevant to both projects, primarily because their boundaries overlap. The combined results have been used to characterise the Aboriginal cultural heritage value across a broader landscape than each project alone, while also using information collected in the same manner.

The Aboriginal consultation process, predictive model, archaeological survey, test excavation and analysis for both projects is presented in detail in the Hume Coal Project ACHA (Appendix S of the Hume Coal Project EIS (EMM 2017a)), and is the overarching document from which this ACHA is based on. Notwithstanding, the information relevant to the Berrima Rail Project area is addressed more specifically in this chapter. The cumulative impacts from both projects are also addressed in this ACHA (refer to Section 10.6.4).

The ACHA, including consultation, was undertaken in accordance with the relevant assessment guidelines as follows:

- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (the Code) (DECCW 2010a);
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (DECCW 2010b); and
- *Aboriginal Consultation Requirements for Proponents 2010* (DECCW 2010c).

The SEARs for the project require an assessment of the potential impacts of the project on biodiversity. Table 10.1 lists the relevant assessment requirements and where they are addressed in this chapter.

Table 10.1 Aboriginal cultural heritage – relevant SEARs issued by DP&E

Aboriginal cultural heritage	Section addressed
SEARs requirements	
Heritage — including an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, having regard to OEH's requirements (see Attachment 2).	This chapter addresses Aboriginal cultural heritage. Historical heritage is addressed in Chapter 11.

DP&E also invited other government agencies to recommend matters to address in the EIS, which the Secretary for DP&E took into account when preparing the SEARs. OEH raised matters relevant to the ACHA, and these are listed in Table 10.2 with reference to where they are addressed in this chapter.

Table 10.2 Aboriginal cultural heritage – environmental assessment recommendations

Recommendation	Section addressed
Standard OEH requirements	
1. The EIS must identify and describe the tangible and intangible Aboriginal cultural heritage values that exist across the whole area that will be affected by the project and document these in the EIS. This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (DECCW 2011) and consultation with OEH regional officers.	Sections 10.3 and 10.4. Key correspondence with OEH is provided in Appendix G of the Hume Coal Project ACHA (EMM 2017b)
2. Where Aboriginal cultural heritage values are identified, consultation with Aboriginal people must be undertaken and documented in accordance with the *Aboriginal Cultural Heritage consultation requirements for proponents 2010* (DECCW) The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the EIS.	Section 10.2
3. Impacts on Aboriginal cultural heritage values are to be assessed and documented in the EIS. This EIS must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the EIS must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.	Section 10.6 and 10.7
Project specific requirements	
B. The assessment of cultural heritage values must include a surface survey undertaken by a qualified archaeologist in areas with potential for subsurface Aboriginal deposits. The result of the surface survey is to inform the need for targeted test excavation to better assess the integrity, extent, distribution, nature and overall significance of the archaeological record. The results of surface surveys and test excavations are to be documented in the EIS.	Section 10.4
C**.** The EIS must outline procedures to be followed if Aboriginal objects are found at any stage of the life of the development to formulate appropriate measures to manage unforeseen impacts.	Section 10.7.6
D. The EIS must outline procedures to be followed in the event Aboriginal burials or skeletal material is uncovered during construction to formulate appropriate measures to manage the impacts to this material.	Section 10.7.6

10.2 Aboriginal consultation

10.2.1 Overview

Each private Aboriginal organisation or individual who requested to be registered for consultation within the timeframes of the requirements is referred to as a *registered Aboriginal party* (RAP).

Aboriginal consultation for this project and the Hume Coal Project was conducted as one process. This is primarily because the rail project was originally presented to RAPs as being a part of the Hume Coal Project. Documentation of the following process is provided in Appendix A of the Hume Coal Project ACHA (EMM 2017b).

Eight Aboriginal parties registered their interest in the project and are listed in Table 10.3.

Table 10.3 List of Registered Aboriginal Parties

Organisation	Date of registration
Gundungurra Aboriginal Heritage Association Inc.(GAHA)	07-Sep-12
Cubbitch Barta Native Title Claimants Aboriginal Corporation (Cubbitch Barta)	18-Sep-12
Illawarra Local Aboriginal Land Council (ILALC)	11-Dec-12
Peter Falk Consultancy	01-Aug-13
Northern Illawarra Aboriginal Collective Inc. (NIAC)	08-Aug-13
Koomurri Ngunawal Aboriginal Corporation (KNAC)	20-Aug-13
Buru Ngunawal Aboriginal Corporation (BNAC)	26-Aug-13
Yamanda Aboriginal Association (Yamanda)	11-Sep-13

Three Aboriginal parties that contacted EMM after the two rounds of registration also expressed their interest in being kept updated about the Hume Coal Project. They are:

- Joanne Goulding (contacted EMM on 16 May 2014);
- Moyengully Natural Resource Management Group (contacted EMM on 23 May 2014); and
- Koori Kulcha Experience (Marie Barbaric – also a member of the Illawarra LALC) (first contacted Hume Coal on 3 November 2014 with a request to visit parts of the project area).

The three registrants listed above were incorporated more closely into the consultation process in September 2015 once the project area had been refined and before the test excavation program commenced.

RAPs were initially issued a letter on 17 April 2014 presenting an overview of the Hume Coal Project, outlining the proposed assessment methods and requesting cultural information associated with the project area.

RAPs were also kept updated about the project and assessment methods through letters issued before each stage of the field survey and prior to the commencement of the test excavation program.

Hume Coal and EMM held a consultation meeting with the RAPs on 26 August 2015 where the conceptual design of the project for the preliminary environmental assessment was presented along with a summary of the progress on the ACHA. The next steps in the ACHA process and the proposed test excavation method were also discussed. Additionally, a letter detailing the draft test excavation method was issued to the RAPs on 27 August 2015.

EMM consulted with RAPs to determine whether any socio-cultural heritage values related specifically to the project area regardless of archaeological evidence. To date, no information has been received that identifies specific socio-cultural or historic heritage values unrelated to the Aboriginal sites and objects found in the project area. No historical connection has been identified specifically to the project area.

A draft version of the ACHA, which included all background information, results, draft significance assessment and draft management recommendations, was issued to all RAPs on 30 September 2016. A consultation meeting on 25 October 2016 provided the opportunity for RAPs to discuss the draft assessment and draft management recommendations with representatives of Hume Coal and EMM.

Responses were obtained verbally from RAPs, indicating general agreement with the draft assessment and draft recommendations. The RAPs emphasised that the intangible significance of the environment to the Aboriginal people should receive greater acknowledgement.

Written responses were received from NIAC, Cubbitch Barta, BNAC, KNAC and Yamanda. No new Aboriginal cultural heritage values were raised by RAPs other than those identified in the draft ACHA and at the meeting on 25 October 2016.

Most of the RAP responses were made generally about both the Hume Coal Project and the Berrima Rail Project. Each RAP comment has been addressed in Appendix H. One general comment that is applicable to rail project is the following:

> RAPs expressed that the Aboriginal objects recovered from the project area should not to be held on-site in Hume Coal offices. Instead, Yamanda requested to be custodians of the recovered objects which will be confirmed during the development of the Aboriginal Heritage Management Plan (ACHMP). This would require a care agreement between Yamanda and OEH to allow the transfer of the objects to Yamanda for safekeeping.

10.3 Existing environment

10.3.1 Environmental context

In the past, the availability of resources such as drinking water, flora, fauna, stone material and topography, played a substantial role in the choice of camping, transitory and ceremonial areas used by Aboriginal people. A description of the existing environment within and surrounding the project area is provided in Chapter 6, including information on landform, water resources, soils, geology and vegetation. Additional information relevant to the assessment of Aboriginal cultural heritage is provided below.

The project area has largely been cleared of vegetation and used for agricultural purposes for approximately the last 150 years. The eastern part of the project area, where the new railway line meets the existing Berrima Branch Line, is disturbed terrain as it occurs within the existing railway easement.

The earliest available aerial imagery of the project area is from 1949 (Figure 10.1). It shows that minimal changes to the landscape of the project area have occurred in the last 60 years. By 1949 the project area had been extensively cleared and ploughed to a similar resemblance of the current landscape.

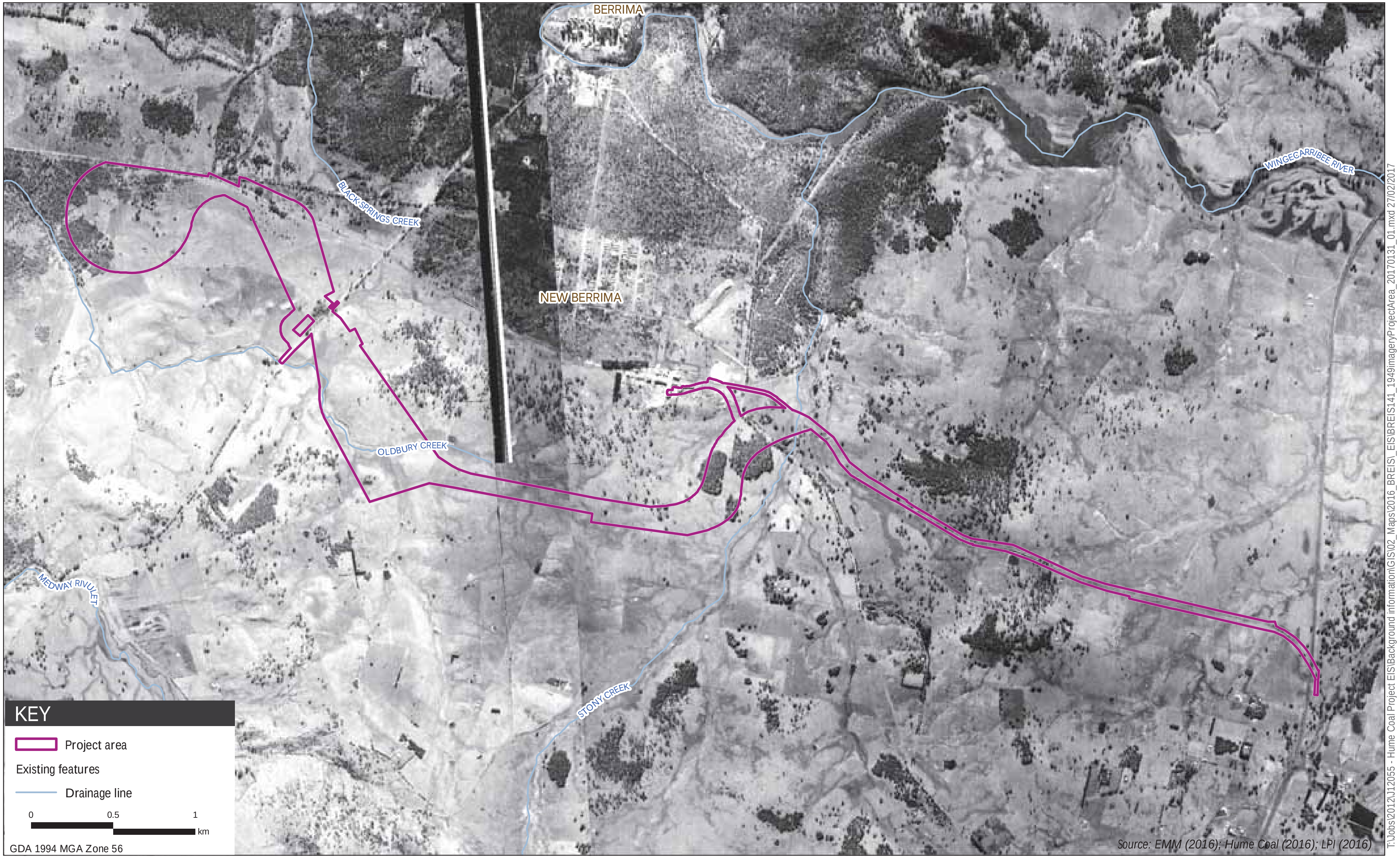
The main activities that are likely to have removed or highly disturbed Aboriginal sites in the project area are the construction of roads, electricity easements, pipelines, water diversion bunds, vegetation clearance and damming of streams. Other activities that are likely to have disturbed Aboriginal sites include repeated ploughing, cropping, fencing and to a lesser extent, livestock grazing.

There are particular landscape features in the project area that are more likely to have been associated with Aboriginal activities than others such as level-to-gently inclined landforms (foot slopes, spur crests and hill crests). Within the general area artefacts are likely to be concentrated along the major perennial streams such as Oldbury Creek and Stony Creek.

Mature trees of suitable age that exhibit carving or scarring (also known as modified trees) are unlikely to occur in the project area as most of the woodland and forest areas have been cleared over the past century. However, remnant vegetation in riparian corridors and isolated pockets within agricultural areas still exist in the project area.

Most of the land in the project area has been cleared of its native vegetation and subsequently ploughing may have displaced Aboriginal stone artefacts more than natural disturbances, but without totally diminishing their cultural and archaeological value. Overall, the extent of displacement depends on the types of ground disturbance, gradient of slope and the type of erosion, such as sheet wash on hill slopes and gullying and scouring adjacent to streams.

Outcropping sandstone is almost non-existent within the rail project area, but occurs in a small area in the rail loop. The project area is unlikely to host rock shelter formations. Grinding grooves have been identified in the sandstone formation at the western extent of the rail loop.



Historic aerial imagery 1949 - project area

Berrima Rail Project

Environmental impact statement

Figure 10.1

10.3.2 Aboriginal heritage context

The project area was probably occupied by the Gundungarra people, although neighbouring groups, such as the Ngunawal and Wodi Wodi, probably moved through the area when invited for activities such as trade and ceremonies.

The region was likely to have been occupied by family groups who moved through the landscape according to the seasonal availability of water and food and other customary activities.

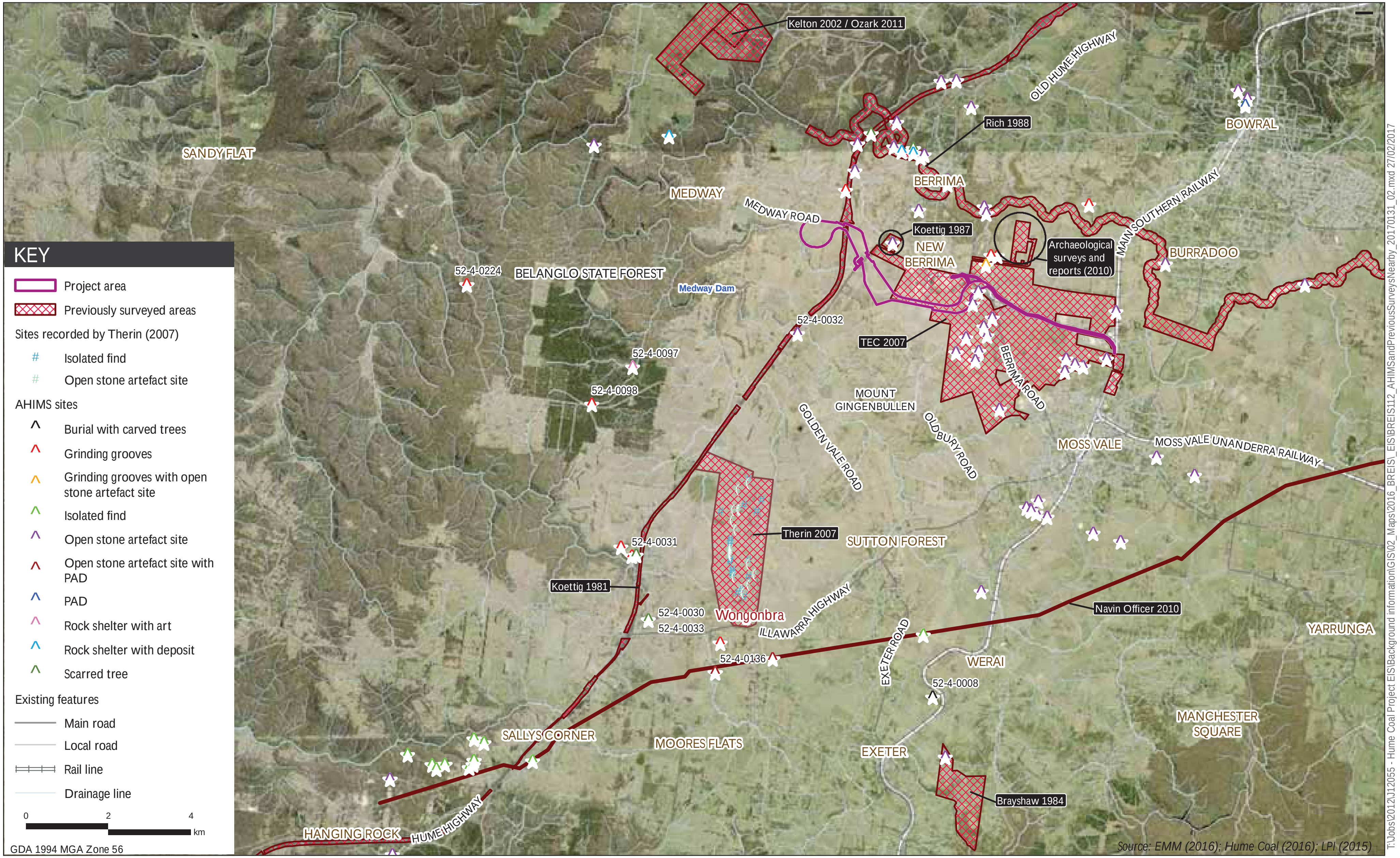
The Aboriginal Heritage Information Management System (AHIMS) register was searched on 1 December 2015 covering 34 km^2 centred on the project area. A total of 89 Aboriginal sites were identified in the search area, the majority of which were to the north and south-east, but none are in the project area. AHIMS sites are shown in Figure 10.2. Copies of the AHIMS searches are provided in Appendix B of the Hume Coal Project ACHA (EMM 2017b).

Of these sites (all of which are not in the project area), eighty percent contain one or more stone artefacts, 13% are axe grinding groove sites, 6% are rock shelters, four of which feature deposits and one which features art. Six percent of the total recorded sites are modified trees. Additionally, one carved tree next to a burial is located within a cluster of old-growth trees 10 km south of the project area in Sutton Forest.

There are three previously registered sites within 500 m of the project area, comprising one isolated find (AHIMS #52-4-0183), one open stone artefact site (AHIMS #52-4-0192) and one grinding groove site with associated stone artefacts (AHIMS #52-4-0175). These sites are near the eastern part of the project area and are likely to be associated with the Aboriginal occupation activities along Stony Creek.

i Previous investigations

There have been a number of archaeological investigations in the Southern Highlands region over the last 30 years for infrastructure and mining developments, which are shown in Figure 10.2. The outcomes of these previous surveys were integrated into the predictive model, which is discussed in Section 10.3.3.



AHIMS results and locations of previous surveys

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Figure 10.2

10.3.3 Predictive model of Aboriginal site location

A predictive model of Aboriginal site location was developed based on consideration of the environmental, archaeological and ethno-historic context, and relevant advice obtained from Aboriginal consultation. The predictive model was used to target specific areas during archaeological surveys and the subsequent test excavation. A summary of the predictive model is as follows:

- **Open stone artefact sites (scatters of artefacts) and isolated finds** are the site types most likely to occur in the project area. These may be on all landforms as background scatter but are most likely concentrated on elevated landforms or raised portions in lower-lying landforms adjacent to ephemeral and perennial streams (typically within 200 m). In the project area they are likley to be found near Oldbury Creek and elevated crests to the west of Stony Creek.

- **Rock shelters (which may contain archaeological deposits, art or engravings)** are likely to be present in areas along rocky scarps and cliff lines. The geology and local relief within the project area is unsuitable to feature these site types.

- **Grinding groove and engraving sites** are most likely to be present on outcropping sandstone in stream beds or adjacent to streams. Grinding grooves may also exist in areas mapped as shale geology where discrete sandstone outcropping occurs; this situation occurs rarely, but where it does exist it takes the form of isolated boulders in stream channels rather than large expanses of sandstone.

- **Modified trees (scarred or carved)** may occur in areas where mature trees of a sufficient age to bear the marks of traditional Aboriginal scarring or carving. They are likely to be confined to areas that have not been cleared. They are most commonly located near streams where native vegetation remains, and may also occur on now-dead trees. These are unlikely to exist in the project area because of extensive historic clearing.

- **Other less common site types** such as ceremonial grounds, mythological sites, and burials can occur anywhere in the landscape and their identification is rare. Burial sites have been historically and orally noted by RAPs in association with hills or at the base of a hill in one instance (Mount Gingenbullen). Generally, they could be identified by mounds of earth, carved trees or stone markers arranged in a conspicuous layout.

10.4 Archaeological survey and test excavation

The survey of the project area was completed concurrently with the surveys undertaken for the Hume Coal Project ACHA. The overall survey program was completed in four stages between May 2014 and September 2015. Stages 1 and 2 sampled the Hume Coal Project area and Stages 3 and 4 sampled the Berrima Rail Project area as well as the surface infrastructure area of the Hume Coal Project.

10.4.1 Survey method

The survey of the project area targeted the project footprint available during the time of survey. The survey did not cover the existing Berrima Branch Line as it is within a disturbed rail corridor and archaeological potential was considered to be negligible. The existing Berrima Branch Line was inspected by car and on foot in certain sections and confirmed to be a highly disturbed area with negligible archaeological potential.

The project area was made up of 21 survey transects that covered the following landform classes:

- hill crest;
- hill slope;
- undulating plain; and
- drainage depression.

The percentage of the ground surface exposed in each landform and the visible ground surface within exposures (as ground exposures are often obscured by vegetation, gravels etc.) influence the survey results.

The average effective coverage results from the survey transects across the project area was relatively low at 3%. The landforms were generally thickly grassed apart from sporadic ground exposures found on cattle tracks, sheet wash erosion, dam walls and occasionally exposed banks in drainage depressions.

Therefore the prediction of subsurface archaeological potential in the project area was largely based on the predictive model rather than the presence of surface artefacts.

The coverage results were comprehensive for grinding grooves in the project area as sandstone outcrops were isolated and rarely obscured by vegetation. The results were also comprehensive for modified trees as all mature trees within the project footprint were inspected.

10.4.2 Sites identified during survey

The survey team recorded 11 new sites in the project area, which are shown in Figure 10.3. Four of the 11 sites were identified within the rail loop boundary of the project area. The 11 sites are summarised in Table 10.4 and examples of the sites recorded are shown in Photograph 10.1 to Photograph 10.4.

Eight of the 11 sites identified were classed as areas of potential archaeological deposit (PAD). PADs are the predicted extent of subsurface Aboriginal objects (typically stone artefacts) in a particular area and are therefore not technically Aboriginal sites until Aboriginal objects are identified (either through field survey or archaeological test excavation). None of the PADs identified in the project area were associated with surface stone artefacts, which was likely to be because of the thick grass covering most of the project area.

PAD was assigned to landforms or portions of landforms which are distinguishable from the surrounding landscape with characteristics favourable to use by Aboriginal people such as elevated areas with good outlook and proximity to fresh water. The 'PAD areas' mapped in Figure 10.3 apply to the inferred extent of subsurface deposits, but the actual extent of the deposit can only be established through subsurface investigation. Examples of PADs HC_176 and HC_177 are shown in Photographs 10.7 and 10.9.

One grinding groove site (HC_138, refer to Photograph 10.1) was identified in the project area near the rail loop. HC_138 comprises three grooves and was identified on a small, flat sandstone outcrop within the stream bed of the 3rd order ephemeral tributary of Oldbury Creek.

One retouched stone flake made from indurated mudstone/tuff (IMT) was identified in a cattle track exposure on a hill spur crest. The site appeared to be heavily eroded on skeletal soils and moderately disturbed by historic clearing and ploughing.

One potential scar tree (HC_158) was identified by a registered Aboriginal party member in the project area. Identification of scar trees can be problematic given the similarity between some cultural scars and those created by natural causes such a branch tears. The site was evaluated against the publication *Aboriginal scarred trees in New South Wales: a field manual* (Long 2005). At present it remains classed as 'potential scarred tree' as it does not show clear attributes based on the field manual.

Photograph 10.1 Location of grinding grooves view west (HC_138)

Photograph 10.2 Close-up of grinding grooves (HC_138)

Photograph 10.3 Potential scar tree (HC_158). View north

Photograph 10.4 PAD HC_147 on a spur crest overlooking Oldbury Creek . View south

Table 10.4 Sites recorded during survey in the project area

Site Name (AHIMS)	Property	Site type	Artefact count	Landform pattern	Landform element	Exposure type	Disturbance
HC_137	Mereworth	PAD	0	Low Hills	Hill crest	N/A	Moderate: cleared and ploughed
HC_138	Mereworth	Grinding grooves	0	Low Hills	Drainage depression	Sandstone bedrock	Low: crack running through stone
HC_139	Mereworth	PAD	0	Low Hills	Foot slope	N/A	Moderate: cleared and ploughed
HC_140	Mereworth	PAD	0	Low Hills	Hill spur crest	N/A	Moderate: cleared and ploughed
HC_145	Mereworth	Isolated find	1	Low Hills	Hill spur crest	Cattle track	Moderate: cleared and ploughed
HC_146	Stonington	PAD	0	Low Hills	Hill spur crest	N/A	Moderate: cleared and ploughed
HC_147	Stonington	PAD	0	Low Hills	Hill spur crest	N/A	Moderate: cleared and ploughed
HC_148	Stonington	PAD	0	Low Hills	Hill spur crest	N/A	Moderate: cleared and ploughed
HC_158	Stonington	Potential scar tree	0	Low Hills	Hill slope	N/A	N/A
HC_176	Boral-owned land	PAD	0	Low Hills	Hill spur crest	N/A	Low: partially cleared
HC_177	Leets Vale and Boral-owned land	PAD	0	Low Hills	Hill crest	N/A	Moderate: cleared and ploughed

Aboriginal survey coverage and results

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Figure 10.3

10.4.3 Test excavation results

i Method

EMM archaeologists, accompanied by Aboriginal site officers, conducted an archaeological test excavation in the Berrima Rail project area from 19 October to 6 November 2015.

The program involved digging 160 50 cm x 50 cm test pits across 6 linear transects in the project area. Transects 7, 8, 9, 10, 11 and 12 (refer to Figure 10.4 to Figure 10.7) were excavated in the rail project area. Transects 5, 6 and 17 are also shown on Figure 10.5. These were excavated for the Hume Coal Project but are shown here to demonstrate the extent of excavation in the wider area. The test pit transects sampled five areas of PAD that were identified during the field survey. Whilst transects 10 and 11 are slightly outside the current disturbance footprint they were laid out at the time of the excavation based on a previous disturbance footprint (see Figure 10.6).

Test excavation overview

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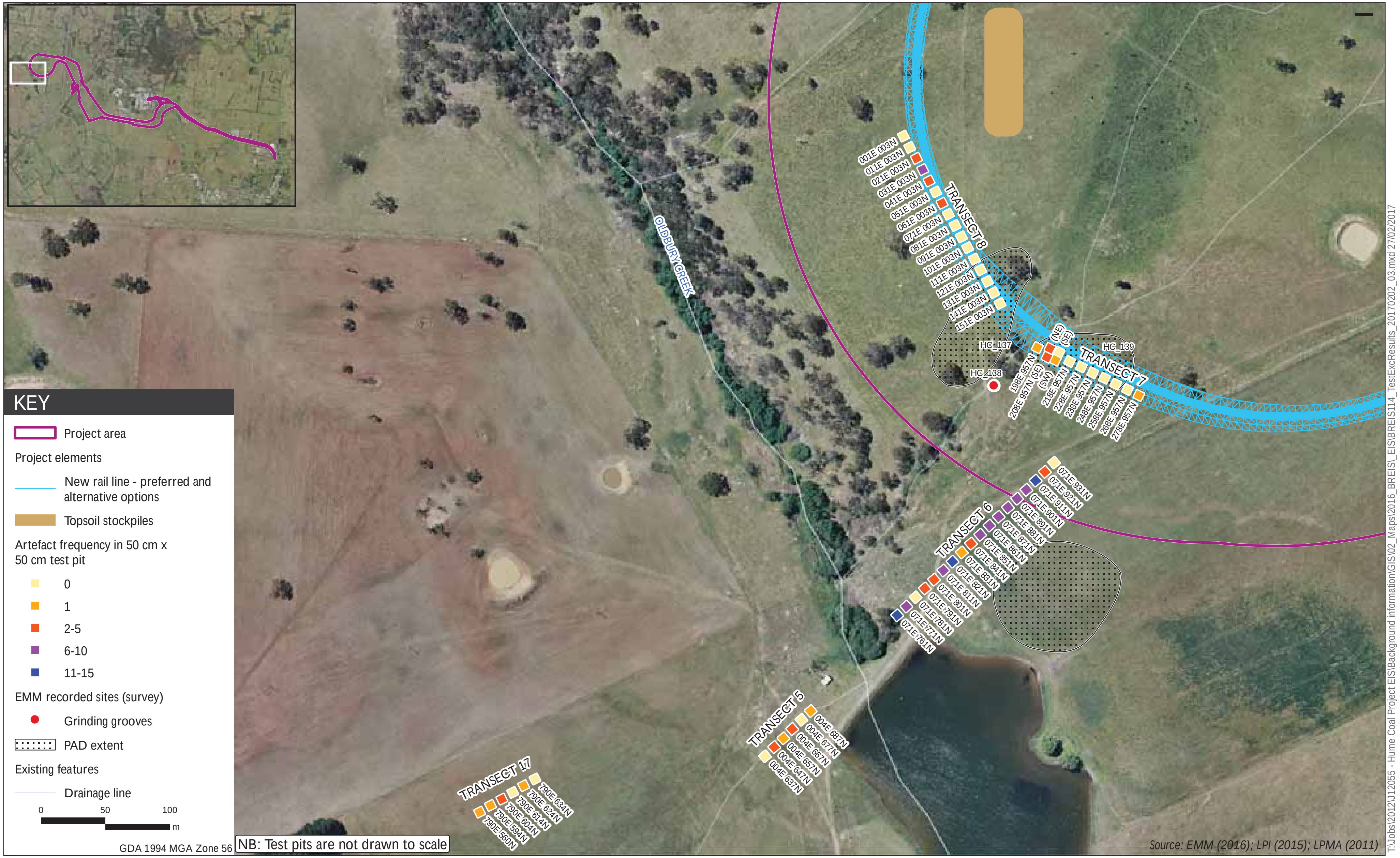
Figure 10.4



Test excavation results - Mereworth (transects 5, 6, 7, 8 and 17)

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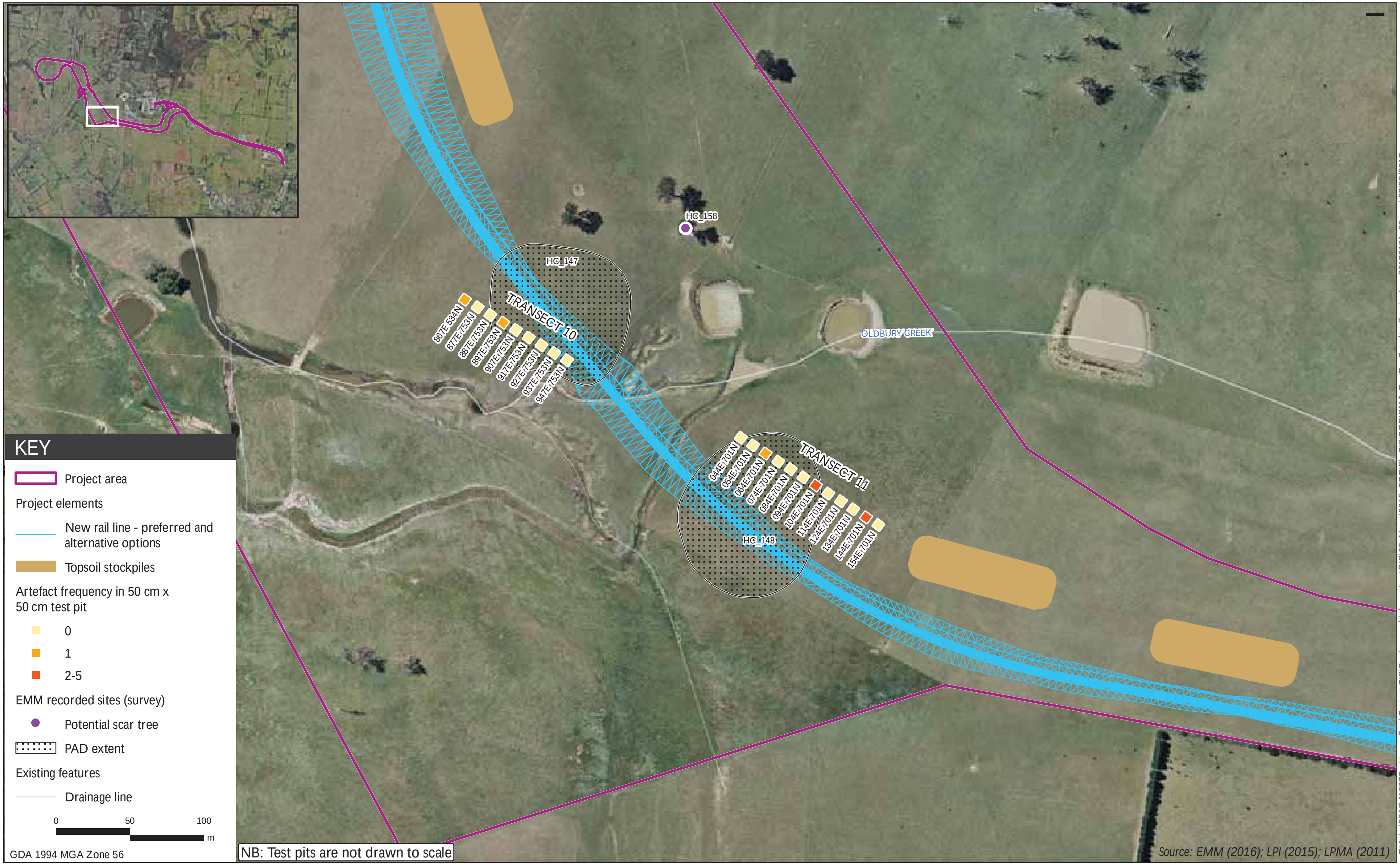
Figure 10.5



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Test excavation results - Stonington (transects 10 and 11)
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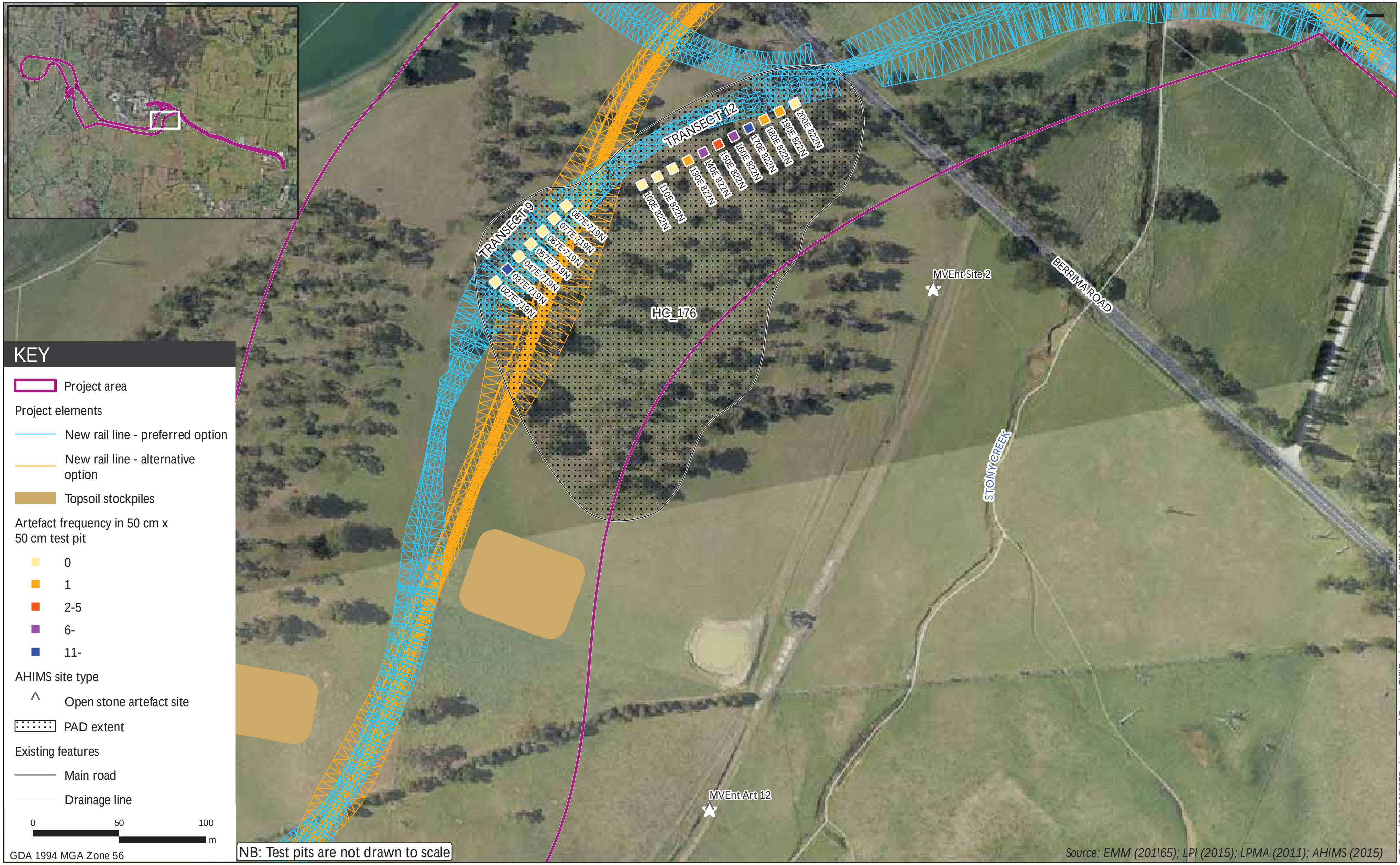
Figure 10.6



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Test excavation results - Boral-owned land (transects 9 and 12)

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Figure 10.7

ii Stone artefacts recovered

Seventy five artefacts were recovered from the test pit transects in the project area. The excavation results are summarised in Table 10.5. A variety of stone artefact types were recovered including complete flakes (19), cores (5) and fragments of broken flakes (48). Additionally, three implements were recovered comprising two Bondi points (test-pit-transects 12 and 7) and one scraper (test-pit-transect 12).

Table 10.5 Test excavation results for the project area

Transect no.	No. of test pits	Total artefacts recovered	Average artefact density/m^2
7	12	8	3
8	16	15	4
9	7	13	7
10	9	2	1
11	12	5	2
12	11	32	12
Total	67	**75**	

Generally, artefact densities were very low to low across the tested areas. The exception to this was the moderate artefact densities identified from test pits in transect 12.

10.4.4 Archaeological sensitivity model

The results of the survey and test excavation helped to develop a model for 'archaeological sensitivity'. The areas of archaeological sensitivity, as shown across the project area in Figure 10.8 represent the inferred distributions of Aboriginal sites in the project area.

The archaeological sensitivity modelling is limited to open stone artefact sites (including isolated finds) for the project area. The areas of archaeological sensitivity are defined as follows:

- Areas of high archaeological sensitivity (none in the project area):
  - Land within 200 m of perennial streams (4th order or above) on level to gently inclined landforms (less than 10% slope);
  - These areas are relatively undisturbed and are in areas of remnant native vegetation. These areas are not likely to have been disturbed by historic clearing or ploughing;
  - These areas are highly likely to feature surface open stone artefact sites, specifically those with PAD; and
  - These areas are highly likely to contain a moderate density subsurface deposit with an average density of 14 artefacts/m^2.
- Areas of moderate archaeological sensitivity:
  - Land within 200 m of perennial streams (4th order or above) on level to gently inclined landforms (less than 10% slope). The exception to this prediction applies to Oldbury Creek on the eastern site of the Hume Highway. Test excavation results in test-pit-transects 10 and 11 indicate this area to have low archaeological sensitivity (see definition below);

- Prominent hill crests or ridges that are over 200 m from perennial streams. Such areas are difficult to define unless physically surveyed, as outlook is likely to be a main influence for occupation. Therefore, sensitivity mapping for these areas are limited to that which has been surveyed;

- These areas are moderately disturbed from historic clearing and ploughing. However, these areas are likely to contain a moderate density subsurface deposit with an average density of up to 14 artefacts/m^2; and

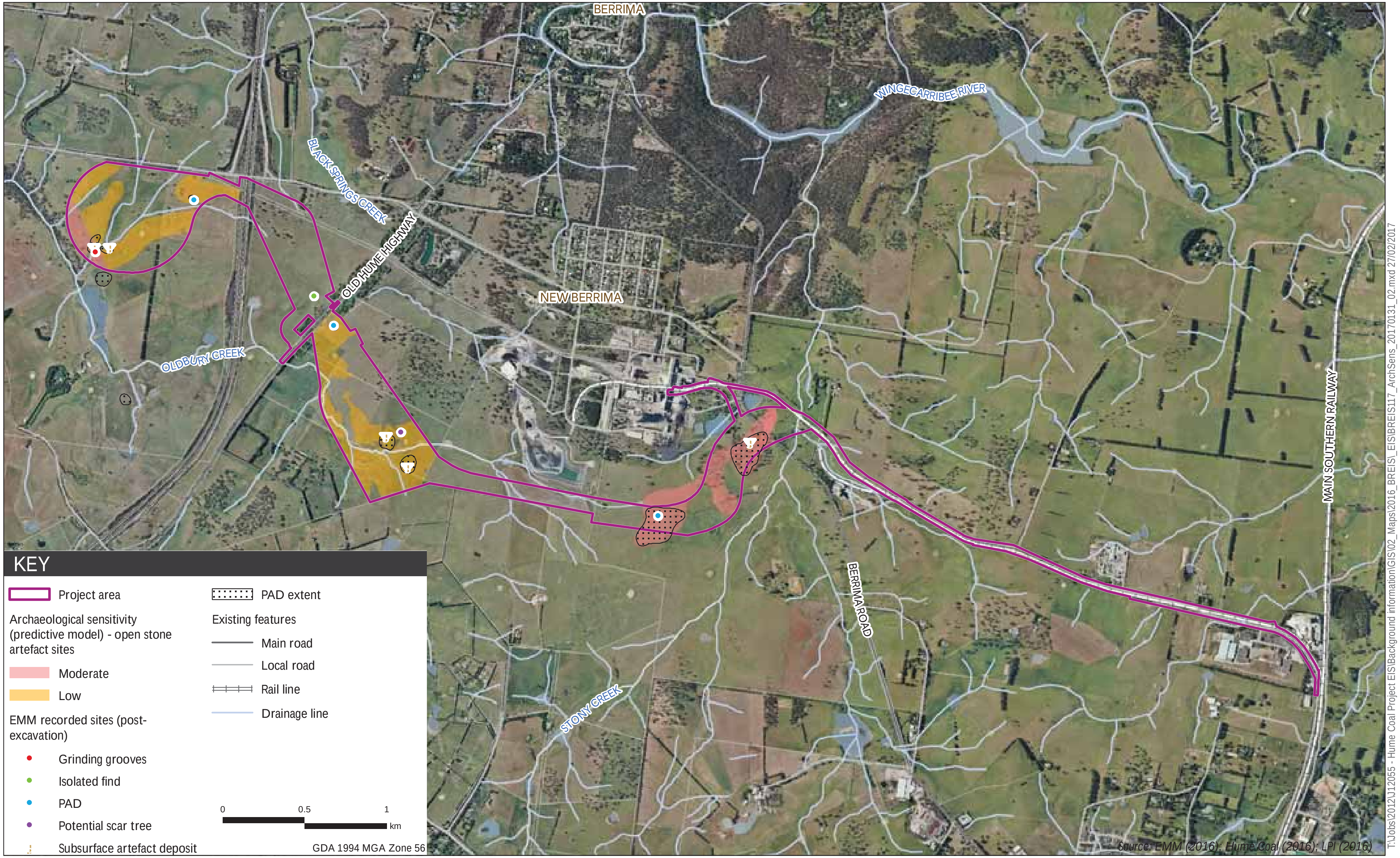
- These areas are highly likely to feature surface open stone artefact sites, but typically as open stone artefact sites.

• Areas of low archaeological sensitivity:

  - Land within 150 m of ephemeral streams (1st to 3rd order) on level to gently inclined landforms (less than 10% slope);

  - Highly likely to feature surface open stone artefact sites, but typically as isolated finds or open stone artefact sites with lower artefact frequencies; and

  - These areas are moderately disturbed from historic clearing and ploughing and are likely to contain a very low density subsurface deposit with an average density of up to 2.7 artefacts/m^2.



Areas of archaeological sensitivity - project area

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Figure 10.8

10.4.5 Implications from archaeological investigation

The test excavation program confirmed that the five tested PADs (HC_137, HC_139, HC_147, HC_148 and HC_176) contain subsurface archaeological deposits. These sites have been re-classified as 'subsurface artefact deposits'.

PADs HC_140, HC_146 and HC_177 were not included in the test excavation program but their predicted deposits can be extrapolated from nearby test excavation results on similar landforms. HC_140 and HC_146 are unlikely to contain subsurface deposits based on the sparse results of the nearby excavations. If artefacts were recovered they are likley to be present in negligible to very low densities that would not warrant mitigation or conservation. As such, these unlikely to be distinguishable from the surrounding areas of low archaeological sensitivity.

PAD HC_177 is part of a prominent hill crest and is within an area of moderate archaeological sensitivity. This area is likely to contain a moderate density subsurface deposit similar to the concentrations recovered from the testing of HC_176 (test pit transects 9 and 12).

The archaeological sensitivity model indicates that the area of moderate density subsurface deposit between HC_176 and HC_177 is likley to extend along the entire crest parallel to Stony Creek as marked by the area of moderate sensitivity in Figure 10.8. As such, it would be beneficial to test whether the areas of PAD in HC_176 and HC_177 do in fact retain higher subsurface artefact densities.

10.5 Significance assessment

10.5.1 Defining heritage significance

Heritage sites, objects and places hold value for communities in many different ways. The nature of those heritage values is an important consideration when deciding how to manage a heritage site, object or place, and balance competing land-use options.

The first overarching significance criterion addressed is the socio-cultural and historic values which pertain to the Aboriginal community. No socio-cultural or historic values have been identified in the project area. The aspects of Aboriginal heritage identified in this ACHA therefore relate to the physical Aboriginal objects. Aboriginal heritage sites with archaeological evidence are all of value to the Aboriginal community as they are a tangible connection to pre-European land use. EMM acknowledges that the registered Aboriginal parties consider Aboriginal objects as culturally significant items.

No sites were identified as having specific socio-cultural or historic value and therefore each site in this report has not been attributed with a socio-cultural or historic significance rating as has been completed for scientific and educational values.

The second significance criterion is the scientific value of identified Aboriginal cultural heritage sites. The scientific values are addressed according to research potential, rarity, integrity, and educational potential. The following scientific values are identified as 'low', 'moderate' or 'high' for each identified site with an overall rating based on the results of each individual assessment. In the overall assessment of significance, research potential and rarity are generally weighted higher. This is because most values contribute to research potential, such as a site's integrity, which largely determines the types of research questions that can be addressed.

10.5.2 Sites and significance

The scientific significance for the 11 sites identified in the project area is summarised in Table 10.6.

Table 10.6 Summary of significances

Site Name	Property	Site type	Description	Significance type	Significance rating
HC_137	Mereworth	Subsurface artefact deposit	Subsurface deposit is sparse on a typical landform in a moderately disturbed context. The site was originally identified as an area of PAD on a broad flat low hill crest and the gently inclined slope that leads into a tributary of Oldbury Creek. Subsequent test excavation identified a sparse artefact deposit in a moderately disturbed topsoil context.	Representative	Low
HC_138	Mereworth	Grinding grooves	Grinding grooves site; made up of three grinding grooves within a 30 cm by 40 cm sandstone exposure. Site is within a drainage depression adjacent to a vehicle track culvert. Grinding groove dimensions are: Grinding grooves 1) measures 25 x 10 cm; Grinding grooves 2) measures 25 x 7 cm; and Grinding grooves 3) measures 7 x 15 cm.	A reasonable example of a rarer site type. Represents moderate educational and research potential. The density of grinding grooves on a small outcrop potentially signifies frequent activity in the area and/or rarity of grinding surfaces.	Moderate
HC_139	Mereworth	Subsurface artefact deposit	Subsurface deposit is sparse on a typical landform in a moderately disturbed context. The site was originally identified on a broad, low but elevated portion of a foot slope adjacent to a tributary of Oldbury Creek. Subsequent test excavation identified a sparse deposit in a moderately disturbed topsoil context.	Representative	Low
HC_140	Mereworth	PAD	This site was identified during archaeological survey as PAD based on the predictive model developed at that stage. Refinements were made after the test excavation program and the site is now considered unlikely to contain subsurface deposits based on the results of nearby excavations. If artefacts were recovered they are likely to be representative of negligible to very low densities that would not warrant mitigation or conservation.	Unlikely to be PAD based on reassessment, that is, unlikely to be distinguishable from the surrounding landscape of low archaeological sensitivity.	Low
HC_145	Mereworth	Isolated find	The site is a single artefact in a moderately disturbed context.	Representative	Low
HC_146	Stonington	PAD	This site was identified during archaeological survey as PAD based on the predictive model developed at that stage. Refinements were made after the test excavation program and the site is now considered unlikely to contain subsurface deposits based on the results of nearby excavations. If artefacts were recovered they are likely to be representative of negligible to very low densities that would not warrant mitigation or conservation.	Unlikely to be PAD based on reassessment, that is, the site is unlikely to be distinguishable from the surrounding landscape of low archaeological sensitivity.	Low
HC_147	Stonington	Subsurface artefact deposit	Subsurface deposit is sparse on a typical landform in a moderately disturbed context. The site was originally identified on a gently inclined hill spur crest overlooking the confluence of Oldbury Creek and one of its minor tributaries. Subsequent test excavation identified a sparse deposit in a moderately disturbed topsoil context.	Representative	Low

Table 10.6 Summary of significances

Site Name	Property	Site type	Description	Significance type	Significance rating
HC_148	Stonington	Subsurface artefact deposit	Subsurface deposit is sparse on a typical landform in a moderately disturbed context. The site was originally identified on a gently inclined hill spur crest overlooking the confluence of Oldbury Creek and one of its minor tributaries. Subsequent test excavation identified a sparse deposit in a moderately disturbed topsoil context.	Representative	Low
HC_158	Stonington	Potential scar tree	Site was identified by Aboriginal site officer. At present the site remains classed as a potential scar tree as it does not clearly show the necessary attributes based on the field manual (DEC 2005) For example, one scar appears to extend from far above the current scar, indicating a branch tear. Also no dry face of the scar is present. Second scar at the base of the tree also extends from far above the current scar, indicating a branch tear.	Probable branch tear.	Low
HC_176	Boral Land	Subsurface artefact deposit	Area of PAD identified on a hill spur crest leading north down-slope towards Stony Creek. Although the site is over 200 m from Stony Creek, it follows a broad level to gently inclined spur crest that provides good outlook over Stony Creek and the surrounding landscape. It is one of the few high points locally overlooking Stony Creek and is likley to have been a good vantage point for Aboriginal occupation. The PAD follows the width of the spur crest to the limit of observed curvature and up-slope to the summit of the crest. Subsequent test excavation identified that the subsurface deposit is relatively high for the local area and represents a good sample of the local archaeology.	Some research potential for artefact assemblage and characteristics; density rare in the local context; however, moderate to low level of site integrity.	Higher moderate
HC_177	Site extends on Leets Vale and Boral land	PAD	Area of PAD identified on the summit of a hill crest overlooking Oldbury Creek. Although the site is over 300 m from Stony Creek, its unique high point in the landscape indicates that it would have been a good vantage point for Aboriginal occupation. The PAD comprises the extent of the summit where its aspect faces south and east towards Stony Creek. Subsurface deposit is likely to be similar to HC_176.	Some research potential for artefact assemblage and characteristics; density rare in the local context; however, moderate to low level of site integrity.	Higher moderate

10.6 Impact assessment

10.6.1 Overview

The construction of the rail loop and railway to the railway bridge, and the construction of stockpile areas will impact Aboriginal cultural heritage values regardless of which of the two options for the Berrima Road interface is selected.

Both options would result in direct impacts to Aboriginal sites. The types of direct impacts are defined as partial loss and total loss. Loss entails complete removal of an Aboriginal site's elements due to surface disturbance such as large-scale earthworks. The total modification of a landscape can also constitute loss, even if artefacts are collected and later returned to the modified surface in their original positions, because the context (an integral part of archaeological site value) is irretrievable.

"Total loss" is when the entirety of a site will be removed as a result of the project. "Partial loss" describes the removal of part of a site.

10.6.2 Impacts to sites

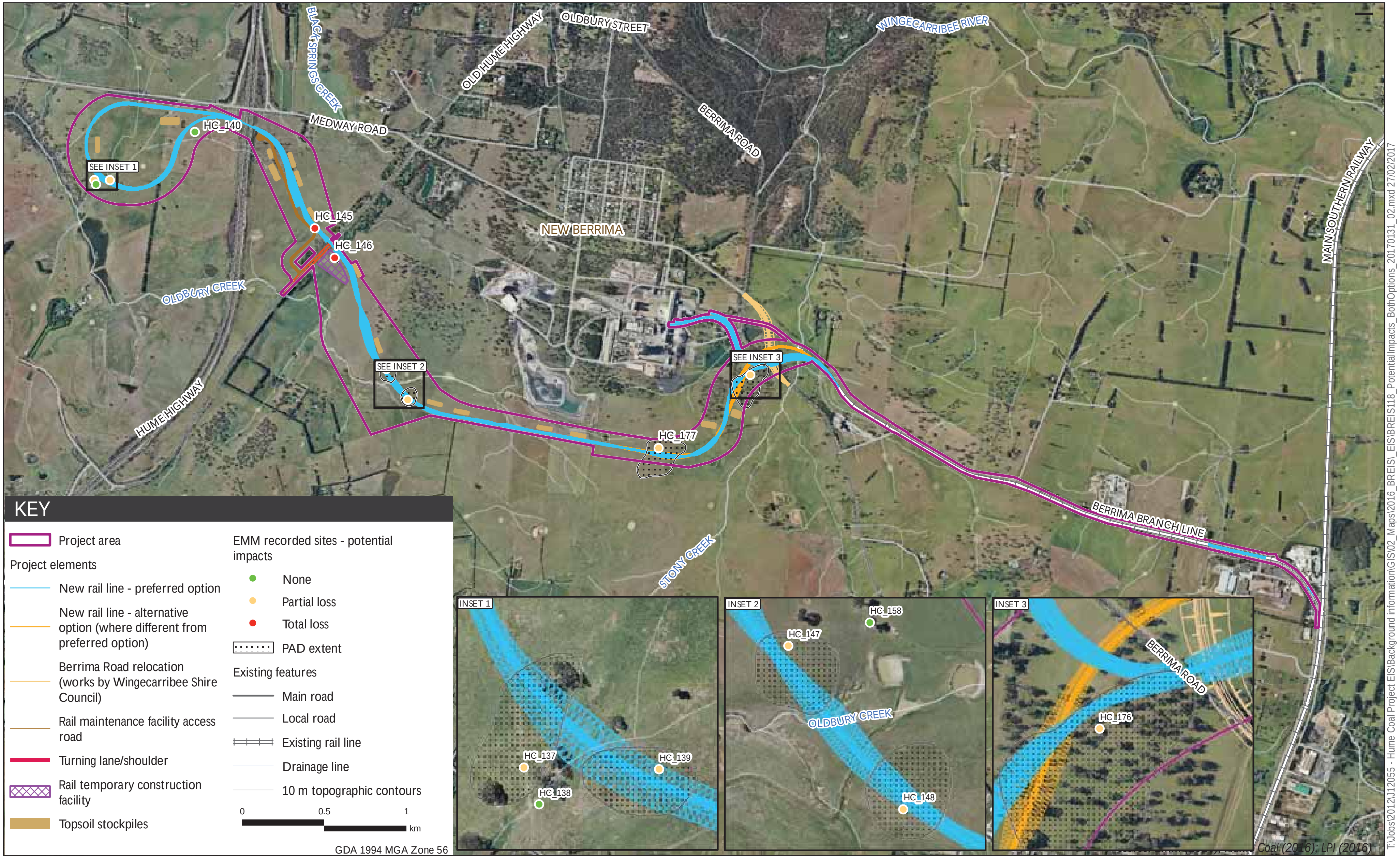
Eight of the 11 Aboriginal sites will be impacted to some degree by the project. Of these, six sites will be partially lost and two totally lost. Three sites out of the 11 will not be impacted. Impacts from both project designs are illustrated in Figure 10.9.

Overall, six sites of low significance will be impacted (four partially and two totally) and two sites of moderate significance will be partially lost. Two sites of low significance (HC_158 and HC_140) will be avoided and the one grinding groove site of moderate significance (HC_138) will also be avoided.

10.6.3 Impacts on archaeologically sensitive areas

The project will impact the archaeologically sensitive areas shown in Figure 10.8 as follows.

- Hume Coal rail loop – this will impact areas of predicted low archaeological sensitivity (including areas of PAD). It is anticipated that the subsurface artefact densities within the impact footprint will decrease even further to the north in conjunction with the increasing distance from Oldbury Creek. The rail loop has been set back over 200 m from Oldbury Creek to avoid areas of high or moderate archaeological sensitivity.
- Railway line – the preferred and alternative railway line routes would affect areas of predicted low archaeological sensitivity (including PADs). The preferred and alternative rail line routes would also affect areas of a prominent hill crest that is predicted to have moderate archaeological sensitivity. Noteably, the alternative option would disturb a greater area of prominent hill crest to the north of Berrima Road, whereas the preferred option would diverge away from this sensitive landform into a swampy plain.
- Topsoil stockpiles – the vast majority of soil stockpile locations have been deliberately situated outside of areas displaying any archaeological sensitivity (low-high). One stockpile will impact a small area of moderate archaeological sensitivity under both options. Research on short term impacts of emplacement areas (in cases where the topsoil is not stripped prior to emplacement) shows that artefacts remain intact beneath layers of soil if separated by a synthetic barrier. However, without a barrier the deposit could degenerate and devalue over time. This would reduce the scientific value of the deposit, which has already been compromised by ploughing. Therefore, the stockpile covering the area of moderate archaeological sensitivity will contribute to the partial loss of the site.



Potential impacts on Aboriginal sites
Berrima Rail Project
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Figure 10.9

10.6.4 Cumulative impacts

There are some industrial, extractive and manufacturing facilities in the locality, such as the former Berrima Colliery, Berrima Cement Works, Berrima Feed Mill, and the Moss Vale Enterprise Corridor, as well as other proposed developments such as the New Berrima Clay/Shale Quarry, the Sutton Forest Quarry and Green Valley Sand Quarry. However, these have isolated disturbance footprints and represent a small cumulative impact on the archaeologically sensitive landscapes in the region.

The most widespread impact in the region is from the historic clearing and ploughing involved in establishing and maintaining open farmland. These activities are likely to have reduced the archaeological integrity of many sites, particularly on shallow soils where ploughing has disturbed the entire soil profile. Deeper archaeological deposits may exist in suitably deep soils but test excavations in the project area indicate that most of the archaeology is confined to the upper soil profile.

An Aboriginal Heritage Impact Permit (AHIP) (#C0001763) has previously been issued to allow continued farming activities (ploughing, sowing crops and harvesting) in parts of the project area. The AHIP permits continued ploughing to occur to HC_137, HC_139, HC_145, HC_146, HC_148 and HC_177 in the project area. Current farming activities represent the continuation of activities that have already occurred historically and repeatedly and as such are not considered to be detrimental to the existing archaeological landscape. Landscape analysis and test excavation results confirm that the project area and surrounding farmland has already been subject to these activities repeatedly which has resulted in a moderately disturbed landscape. Therefore, the continued farming activities are not considered to contribute to cumulative impacts in the project area.

The impact on the archaeological resource at a landscape level is relatively small considering the extensive traces of archaeological evidence throughout the Hume Coal Project area, the Berrima Rail Project area and surrounds. Both project footprints have been specifically designed to avoid archaeologically sensitive areas and will only partially impact the more significant deposits by linear project elements. Both projects will avoid grinding groove sites, rock pools, rock shelters or potential scar trees. It is also very unlikely that subsidence will impact these site types or stone artefact sites. The underground mining method has been designed to result in negligible subsidence impacts.

In summary, the Hume Coal Project and the Berrima Rail Project will have the following combined impacts:

- 20 sites will be directly impacted by the Hume Coal Project surface infrastructure area. This comprises:
  - no sites of high significance;
  - six sites of moderate significance, two of which are of higher moderate significance (HC_135 and HC_151); and
  - 14 sites of low significance.
- Eight sites will be directly impacted by the Berrima Rail Project. This comprises:
  - no sites of high significance;
  - two sites of higher moderate significance (HC_176 and HC_177); and
  - six sites of low significance.

- 89 sites are above the Hume Coal Project underground mine area, but no subsidence impacts are predicted to occur.
- 102 sites are outside the Hume Coal Project surface infrastructure disturbance footprint and underground mine area and the current project disturbance footprint. These sites will be avoided.
- Taking the very low risk of subsidence impacts into account, it is very likely that 191 of the 219 sites (87%) assessed as part of the wider Hume Coal Project ACHA will not be impacted by either project.

10.7 Management and mitigation

10.7.1 Alternatives adopted to maximise avoidance

During the initial stages of the ACHA, desktop constraints analysis and archaeological surveys were undertaken to identify the most archaeologically sensitive areas so that the project could be designed to avoid substantial impacts to Aboriginal sites. Notably, this involved setting the rail loop back beyond 200 m of Oldbury Creek which will considerably reduce the impact on subsurface stone artefact deposits of moderate density.

10.7.2 Management measures

i Aboriginal heritage management plan

An Aboriginal cultural heritage management plan (ACHMP) will be developed in consultation with RAPs and OEH. The ACHMP will provide details of:

- all Aboriginal sites identified for the project;
- management measures and their progress towards completion;
- continued consultation and involvement of registered Aboriginal parties;
- protocols for newly identified sites;
- protocols for suspected human skeletal material; and
- provisions for review and updates of the ACHMP.

ii Avoidance and active management

One grinding groove site (HC_138) close to the margins (within 25 m) of the rail loop will be fenced and sign posted for the duration of the project. 'Avoidance' measures will be applied to the sites of higher moderate significance (HC_176 and HC_177) after they are salvaged if subsurface deposits are found to be to likely to extend beyond the impact footprint.

iii Avoidance and passive management

No active management will be undertaken for HC_140 and HC_158 which will be avoided by the project footprint. HC_140 is directly east of the Hume Coal rail loop but the mapped area of PAD is no longer considered to represent an archaeological deposit warranting further investigation. The potential scarred tree HC_158 is approximately 100 m from the railway footprint and does not require active management.

iv Collection

All surface Aboriginal sites in the project footprint will be collected prior to construction work commencing. The collection will be undertaken by qualified archaeologists and RAP site officers following the method in the ACHA.

v Salvage excavation

Two sites (HC_177 and HC_176) and two additional locations (Additional salvage area 1 and Additional salvage area 2) nearby of moderate archaeological sensitivity will be subject to archaeological excavation. The two additional salvage locations are within the project footprint on a prominent hill crest (refer to Figure 10.10). Importantly, additional salvage area 2 will only be salvaged if the alternative rail option is chosen. The preferred option does not require this measure as it veers away from the sensitive hill crest and continues into a swampy area of low archaeological potential.

The salvage procedure in the ACHA will be followed and salvaged artefacts will be subject to detailed attribute analysis. Following analysis, artefacts will be retained in a keeping place. AHIMS records will be updated with a site impact recording form.

vi Unmitigated impacts

Unmitigated impacts will apply to five sites: HC_137, HC_139, HC_146, HC_147 and HC_148 (Table 10.8). Unmitigated impacts are acceptable because these sites relate to subsurface sites of low significance which do not warrant further investigation or salvage.

The suggested types of Aboriginal site management for both the preferred and alternative options are presented in Figure 10.10.

10.7.3 Site management summary

Table 10.7 provides a summary of Aboriginal sites, impact types and management measures.