Roads and Traffic Authority of NSW

Oxley Highway to Kempsey
Upgrading the Pacific Highway

Environmental Assessment

MAIN VOLUME

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16. Noise and vibration

This chapter describes acoustic characteristics of the existing environment assesses the noise and vibration impacts of the Proposal and outlines the measures proposed to mitigate potential impacts.

The information presented in this chapter is drawn from the *Noise and Vibration Working Paper*, prepared by Wilkinson Murray and provided in **Volume 3** of this Environmental Assessment.

The Director-General's environmental assessment requirements identify noise and vibration to be a key issue. **Table 16-1** indicates where the aspects of the Director-General's environmental assessment requirements that relate to noise and vibration are addressed, either in this chapter or in other chapters (in *italics*).

Table 16-1 Noise and vibration

Environmental assessment requirements	Where addressed
Noise and Vibration – including but not limited to:	
• Construction noise and vibration including construction traffic noise and blasting impacts.	**Section 16.4**
• Operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers	**Section 16.1.5** and **16.5**
• The assessment(s) must take into account the following guidelines as relevant: *Environmental Criteria for Road Traffic Noise* (EPA 1999), *Environmental Noise Management Manual* (RTA, 2001), *Environmental Noise Control Manual* (EPA, 1994), *Assessing Vibration: A Technical Guideline* (DEC, 2006); and *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC1990).	**Sections 16.1**, **16.4** and **16.5**

16.1 Assessment approach

16.1.1 Relevant guidelines

A noise and vibration assessment was undertaken for the Proposal which took into account the guidelines listed in **Table 16-1** and relevant guidelines published since the release of the Director-General's environmental assessment requirements which include:

- The former Environment Protection Authority (1999) *Environmental Criteria for Road Traffic Noise* – in regard to road traffic noise assessment criteria and assessment of barrier heights and noise monitoring and modelling methods.
- The RTA (2001) *Environmental Noise Management Manual* – in regard to noise monitoring and the operational road traffic noise assessment, particularly maximum noise levels and the assessment of barrier heights.
- The former Department of Environment and Climate Change (2009) *Interim Construction Noise Guideline* – in regard to construction noise.
- The former Department of Environment and Conservation (2006b) *Assessing Vibration: A Technical Guideline* – in regard to construction vibration.

- The Australian and New Zealand Environment and Conservation Council (1990) *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* – for guidance on airblast overpressure and vibration criteria.
- The former Environment Protection Authority (2000) *NSW Industrial Noise Policy* – in regard to background noise monitoring.
- The former Environment Protection Authority (1994) *Environmental Noise Control Manual* – in regard to sleep disturbance.

16.1.2 Methodology

The assessment identified sensitive locations and assessed potential noise and vibration impacts against noise and vibration criteria developed by DECCW and RTA. The methodology for the assessment of noise impacts included quantifying the existing acoustic environment through noise monitoring, establishing Proposal-specific noise criteria, and establishing noise models for the construction and operation phases. The results were assessed and recommendations developed to reduce noise impacts where they are predicted to occur. An assessment of potential vibration during construction was also undertaken to determine potential impacts on sensitive receivers and infrastructure.

To assist with the description of the existing noise environment and assess the potential impacts of the Proposal on residences and other sensitive receivers (eg schools), a series of noise catchment areas were assigned to those areas where residences and other sensitive receivers are located along the Proposal. A noise catchment area is an area where receivers are likely to have similar noise exposure to traffic noise on the basis of factors such as topography, the highway design (cuttings, embankment, intersections, etc), setbacks and types of residences. The 22 noise catchment areas identified in the Proposal area are shown in **Figure 16-1**.

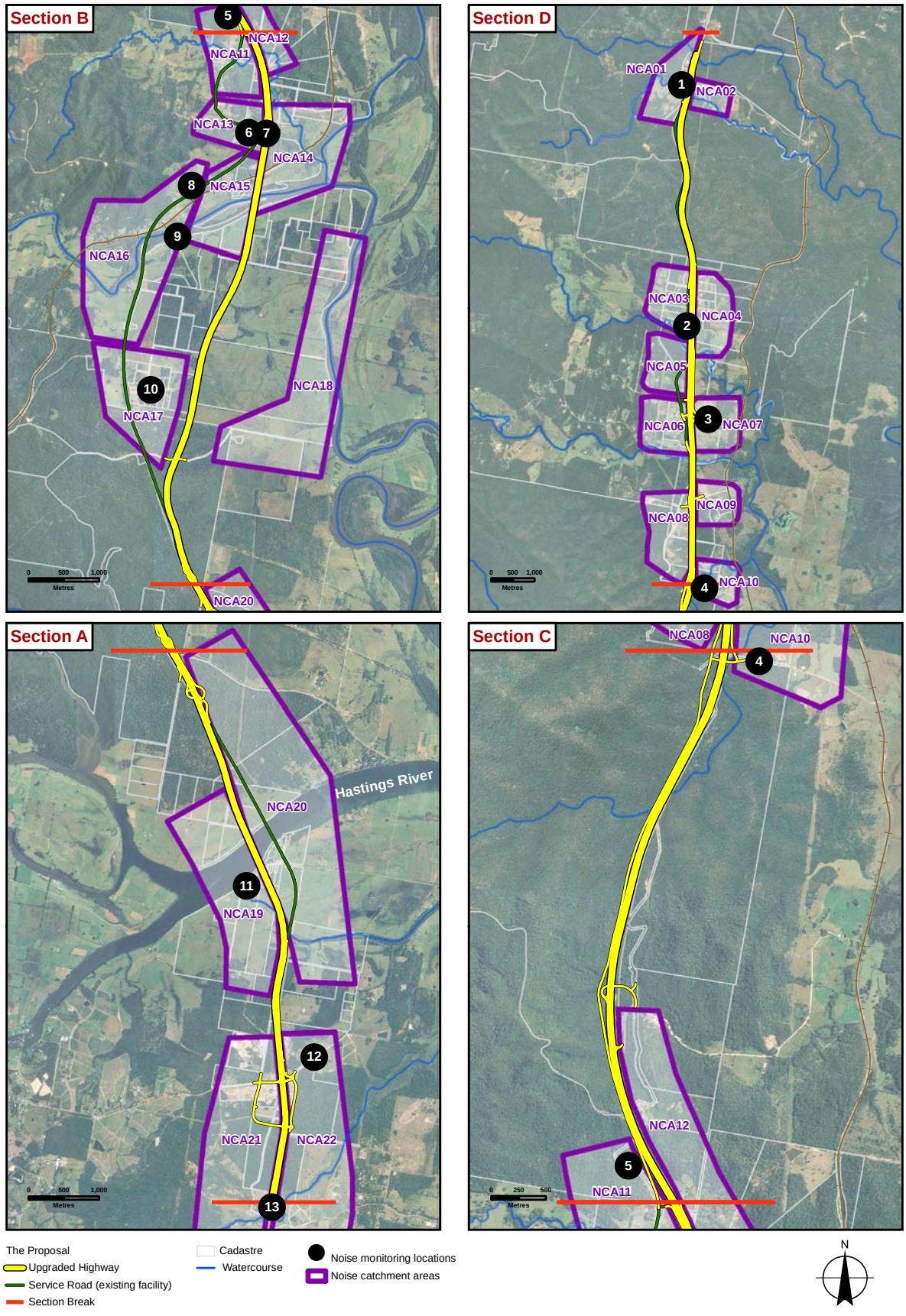
In the *Noise and Vibration Working Paper* the noise catchment areas and monitoring locations were numbered sequentially from the north to the south of the Proposal. To align with the general Proposal description elsewhere in this Environmental Assessment, these noise catchment areas and monitoring locations are discussed from south to north.

The assessment also assigned numbers to all potential receivers in the vicinity of the Proposal, which were identified by a combination of aerial photographic interpretation and ground-truthing to distinguish between residences and other structures such as sheds. As a result a total of 352 residences and other sensitive receivers were identified and have been considered in this assessment. The location of all numbered potential receivers is shown in Appendices D and E of the *Noise and Vibration Working Paper*, prepared by Wilkinson Murray, provided in **Volume 3** of this Environmental Assessment. The identified receivers will be further validated during the detailed design phase.

For the purpose of the noise and vibration assessment the Proposal has also been broken down into the following sections based on a consideration of existing and predicted noise environment and location of residences and other sensitive receivers:

- Southern upgrade section – from Oxley Highway to Fernbank Creek, the Proposal entails the duplication of the existing highway to a dual carriageway.
- Hastings River deviation section – from Fernbank Creek to the proposed Blackmans Point Road interchange, the Proposal would deviate to the west of the existing highway.

Figure 16-1 Noise catchment areas and monitoring locations



Note: 2004 Aerial photography, Cadastral boundaries are indicative only.

- Telegraph Point bypass section – from the proposed Blackmans Point Road interchange to the proposed Haydons Wharf Road half interchange, the Proposal would deviate to the east of the existing highway.
- Northern upgrade section – from the proposed Haydons Wharf Road half interchange the Proposal largely entails duplication of the existing highway to a dual carriageway. A minor deviation would occur within Maria River State Forest.

16.1.3 Noise monitoring

Noise monitoring was undertaken at 13 locations for a continuous seven day period between 9 December 2006 and 23 December 2006 to define the existing noise environment in noise catchment areas along the Proposal. Ten sites were surveyed to assess the level of existing traffic noise while a further three sites were surveyed in order to measure background noise at representative locations which may be potentially affected by prolonged construction works. The monitoring locations are described in **Section 16.3.2** and shown in **Figure 16-1**.

16.1.4 Road traffic noise modelling

Road traffic noise levels for the existing highway alignment were assessed, and road traffic noise levels for the Proposal predicted, using procedures and prediction algorithms based on the United Kingdom (UK) Department of Environment's (1998) *Calculation of Road Traffic Noise*. Prediction procedures were modified to suit Australian conditions and implemented using *ROADent* proprietary software. The models were constructed to take into account the effects of highway surfaces and gradients, traffic volumes and speed, topography, ground attenuations, view angle corrections, screening and reflection coefficients.

Noise levels were calculated using the existing model inputs for locations where noise loggers had been left during the ambient noise survey. The model was validated to within an agreement of 2 dB(A) during both day and night periods and to a distance of 350 metres from the existing highway. Beyond this distance other non-traffic noise sources potentially become dominant and atmospheric conditions may influence the accuracy of predicted road traffic noise levels. The validation confirmed that the model was accurate.

The following predictive models were calculated:

- Year 2006 – existing conditions (used for calibration / validation of the model).
- Year 2016 – existing conditions at the nominal year of opening (used for calculating 'future existing' noise levels to establish 'allowance criteria').
- Year 2016 – along the Proposal in the nominal year of opening.
- Year 2026 – along the Proposal 10 years after opening.

The day and night time traffic volumes and the percentage of heavy vehicle movements for the existing, future existing and the Proposal were calculated for years 2016 and 2026 using known 2004 traffic volumes as detailed in **Chapter 18 Traffic and transport**.

As discussed in **Chapter 18 Traffic and transport,** the projected traffic growth for the Oxley Highway to Kempsey section of the Pacific Highway is based on a 4 per cent annual increase. This is based on recorded traffic volumes between 1995 and 2004.

Since the projections were calculated, further analysis of this data by the RTA along with recent unpublished data from isolated traffic counts undertaken by the RTA indicates that the actual long term growth rate could be lower, at approximately 2 per cent. The difference is attributed to a marked increase in traffic volumes using the Pacific Highway, in particular B-doubles, in the period of 2001 to 2004. Therefore the projections upon which this assessment is based should be viewed as a worst case scenario and would be refined during the detailed design phase as more information becomes available.

This modelling did not include the predicted traffic movements on those sections of the service road network that would use existing local roads as shown on **Figure 6-1a** to **Figure 6-1b** and **Figure 6-2a** to **Figure 6-2q**. Discussion regarding the applicability of this modelling to these sections is provided in **Section 16.5.2**.

Details of the traffic noise modelling, along with the results of the modelling are contained in the *Noise and Vibration Working Paper* in **Volume 3** of this Environmental Assessment. A summary of the results of the traffic noise modelling is provided in **Section 16.5**.

16.1.5 Meteorological influences

An assessment of meteorological conditions in the local area was undertaken to determine whether the conditions would influence the behaviour of noise from the Proposal.

The assessment found that seasonal weather influences produce relatively predictable wind direction patterns in the study area. For example, dominant north-easterly winds flow in the summer months, and a higher proportion of southerly winds are dominant during winter.

Fog and low cloud can act to reflect emitted noise back down towards ground level. This reflection can increase noise levels for receivers some distance from the noise source. However the Proposal area is not subject to regular fog events and as such not prone to these increased noise levels due to fog events.

The assessment concluded that whilst some meteorological conditions have the potential to influence noise behaviour, there would be no appreciable changes to the predicted noise impacts of the Proposal as a result of those meteorological conditions.

16.2 Noise and vibration criteria

16.2.1 Construction noise criteria

Construction noise has been assessed with consideration to the *Interim Construction Noise Guideline* (Department of Environment and Climate Change 2009). Standard construction hours under this guideline are:

- Monday to Friday – 7am to 6pm.
- Saturday – 8am to 1pm.

As outlined in **Section 7.5.3**, construction would normally be limited to the following hours:

- Between 6am and 6pm Monday to Friday.
- Between 7am and 4pm Saturday.

There would be no works outside these hours, or on Sundays or public holidays, except:

a) For works that do not cause construction noise to be audible at any sensitive receivers.

b) For the delivery of materials required outside these hours by the Police or other authorities for safety reasons.

c) Where work is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

d) For any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.

e) Where the work is identified in the construction noise and vibration management plan and approved as part of the construction environmental management plan.

f) As otherwise agreed by the DECCW.

Local residents and the DECCW must be informed of the timing and duration of work approved under items (d) and (e) at least 48 hours before that work commences. Hours of work would be addressed in the construction noise and vibration management plan, which would be finalised in consultation with the Department of Planning and the DECCW.

The *Interim Construction Noise Guideline* provides for identification of noise management levels for construction noise at residential receivers. The noise management levels are calculated based on the rating background level at nearby residential locations, where the rating background level is the median measured background noise level. The noise management levels are determined as follows:

dB(A):
Is the A-weighted sound level. The A-weighting approximates the human response to noise.

- Standard construction hours:
  - Noise affected level = rating background level plus 10 dB(A).
  - Highly noise affected level = 75 dB(A).
- Outside standard construction hours, noise affected level = rating background level plus 5 dB(A).

The noise management levels apply at the boundary of the most affected residences or within 30 metres from the residence where the property boundary is more than 30 metres from the residence.

The *Interim Construction Noise Guideline* states that:

dB(A) Leq:
Is the equivalent continuous sound level, which is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment.

- The noise affected level represents the point above which there may be some community reaction to noise. Where the noise affected level is exceeded all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact.
- The highly noise affected level represents the point above which there may be strong community reaction to noise and is set at 75 dB(A). Where noise is above this level, the relevant authority may require respite periods by restricting the hours when the subject noisy activities can occur, taking into account:
  - Times identified by the community when they are less sensitive to noise (such as mid-morning or mid-afternoon for works near residences).

- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

In accordance with the *Interim Construction Noise Guideline*, the Proposal specific construction noise management levels (or construction noise criteria) for residences in the four sections outlined in **Section 16.1.2** are shown in **Table 16-2**. The background levels at residences within 500 metres of the existing highway that currently experience some road traffic noise are higher than those at residences further than 500 metres from the existing highway. As such, the construction noise criteria are also higher for those residences within 500 metres of the existing highway.

Table 16-2 Construction noise management levels for residences

Location		Rating background noise level L_{90} dB(A)	Construction noise criteria dB(A) $L_{eq(15min)}$		
			Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Southern upgrade section	Residences closer than 500 m	45 (day) 40 (evening and night)	55	45	45
	Residences further than 500 m	36 (day, evening and night)	46	41	41
Hastings River deviation section		45 (day) 40 (evening and night)	55	45	45
Telegraph Point bypass section		36 (day, evening and night)	46	41	41
Northern upgrade section	Residences closer than 500 m	45 (day) 40 (evening and night)	55	45	45
	Residences further than 500 m	36 (day, evening and night)	46	41	41

Construction noise criteria as specified in the *Interim Construction Noise Guideline* at other potentially sensitive receivers are shown below in **Table 16-3**.

Table 16-3 Construction noise criteria at other potentially sensitive receivers

Time period	Management level [1] $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational facilities	Internal noise level - 50 dB(A)
Hospital wards and operating theatres	Internal noise level - 40 dB(A)
Places of worship	Internal noise level - 45 dB(A)
Active recreational areas (such as sports grounds or playgrounds)	External noise level - 65 dB(A)
Passive recreational areas	External noise level - 60 dB(A)

Note: 1 Applies at all times when the sensitive receiver is being utilised

16.2.2 Construction vibration criteria

The DECCW publication *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation 2006b) considers impacts of vibration on building occupants (human comfort) and on the building structure (building damage).

The German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures*, British Standard *BSI BS 7385-2: 1993 Evaluation and measurement for vibration in buildings — Part 2: Guide to damage levels from groundborne vibration* and British Standard *BS 6472 – 1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* provide guidance for determining vibration criteria to ensure human comfort and prevent damage to buildings.

The criteria derived from these documents are summarised in **Table 16-4**.

Table 16-4 Construction vibration criteria

Receiver	Human comfort vibration criteria Peak particle velocity (mm/s)	Building damage vibration criteria Maximum component peak particle velocity (mm/s)
Residential buildings during day time	0.28	5
Residential buildings during night time	0.20	5
Offices and commercial buildings during day	0.56	-
Heritage buildings	n/a	2.5

16.2.3 Construction blasting criteria

The *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment and Conservation Council 1990) is adopted by DECCW to provide the criteria for the assessment of annoyance due to blasting. This guideline states that at any residence or other sensitive location:

Peak particle velocity: This term is used for the measurement of vibration. In the case of the Proposal this measure may relate to vibration from heavy traffic, pile driving or blasting.

- The maximum peak particle ground velocity should not exceed 5 millimetres per second for more than 5 per cent of blasts in any year, and should not exceed 10 millimetres per second for any blast.
- The maximum overpressure due to blasting should not exceed 115 dB for more than 5 per cent of blasts in any year, and should not exceed 120 dB for any blast.

The *Interim Construction Noise Guideline* also suggests that blasting be restricted to between 9am and 5pm on weekdays and between 9am and 1pm on Saturdays.

16.2.4 Operational road traffic noise criteria

Criteria for assessment of road traffic noise are set out in the *Environmental Criteria for Road Traffic Noise* (Environment Protection Authority 1999), which provides target noise levels that are desirable where feasible and reasonable. The RTA has also published the *Environmental Noise Management Manual* (RTA 2001) to assist in implementing the *Environmental Criteria for Road Traffic Noise*.

The two types of development in the *Environmental Criteria for Road Traffic Noise* relevant to the Proposal are 'new freeway or arterial road corridor' and 'redevelopment of an existing freeway/arterial road' and the criteria relevant to these are set out in **Table 16-5**.

The noise level criteria in **Table 16-5** apply to the predicted noise level at opening of the Proposal, which for the purposes of this assessment has been adopted as the year 2016, and at a time 10 years after opening of the Proposal, which has been adopted as the year 2026.

Table 16-5 Operational noise criteria for residences

Type of development	Criteria			Proposal section
	Day (7am-10pm) dB(A)	Night (10pm-7am) dB(A)	Where criteria are already exceeded	
New freeway or arterial road corridor	$L_{Aeq(15hrs)}$ 55	$L_{Aeq(9hrs)}$ 50	The new road should be designed so as not to increase existing noise levels by more than 0.5 dB(A). Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.	Hastings River deviation section Telegraph Point Bypass section Part of the northern upgrade section (within Maria River State Forest)
Redevelopment of existing freeway/arterial road	$L_{Aeq(15hrs)}$ 60	$L_{Aeq(9hrs)}$ 55	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB(A). Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.	Southern upgrade section Part of the northern upgrade section (Haydons Wharf Road half interchange to Maria River State Forest)

16.2.5 Maximum noise level assessment criteria – sleep disturbance

There are no specific criteria relating to sleep disturbance in the *Environmental Criteria for Road Traffic Noise*, however it provides some guidance in assessing the likelihood of sleep arousal due to traffic noise impacts. The *Environmental Criteria for Road Traffic Noise* states that the "*relationship between maximum noise levels and sleep disturbance is not currently well defined*". It also states that a review of research into the issue recognises that the maximum noise level of an event, the number of occurrences, the duration of the event, and the emergence above background or ambient noise levels are key factors in sleep disturbance.

The *Environmental Criteria for Road Traffic Noise* advises, in terms of maximum noise levels, that:

L_{Amax}: Is the maximum noise level over a sample period.

- Maximum internal noise levels below 50 to 55 dB(A) are unlikely to cause a wakening reaction.
- One or two noise events per night with maximum internal noise levels of 65 to 70 dB(A) are not likely to significantly affect health and wellbeing.

Practice Note (iii) of the *Environmental Noise Management Manual* (RTA 2001) provides a protocol for assessing maximum traffic noise levels. The practice note requires the evaluation of expected increase in maximum noise events and defines a 'maximum noise event' as any passby for which the L_{Amax} minus the $L_{Aeq(1hr)}$ is greater than or equal to 15 dB(A).

16.3 Existing ambient noise environment

16.3.1 Context

As described in **Chapter 10 Land use and property**, land uses within the Proposal area generally consist of residential, rural, commercial, industrial, state forests, national parks and reserves. Rural land use, state forests and conservation areas are the dominant land uses. Residential areas are largely in the villages of Telegraph Point and Kundabung, with scattered residential and rural-residential development in other parts of the Proposal area, particularly south of the Hastings River. Commercial and industrial land uses are scattered along the existing highway, particularly south of Telegraph Point.

The Proposal area contains large areas of state forests (Cairncross, Ballengarra and Maria River state forests) and conservation areas (Rawdon Creek and Cooperabung Creek nature reserves and Kumbatine National Park). There are two operating quarries in the area in the vicinity of Sancrox Road and to the east of the existing highway on Yarrabee Road.

A total of 352 sensitive receivers have been identified in the vicinity of the Proposal. These sensitive receivers include residences, a motel at Kundabung, primary school at Telegraph Point and church in Telegraph Point.

16.3.2 Monitoring locations

Noise monitoring was carried out at 10 sites to assess the level of existing traffic noise and a further three sites in order to measure background noise at representative locations which may be affected by prolonged construction works. In addition to determining the existing acoustic environment, the monitoring results were used to calibrate the noise model and develop relevant noise goals for the Proposal. The noise monitoring sites are listed in **Table 16-6** and were shown in **Table 16-1**. Note that the noise monitoring site numbering runs in reverse, from south to north, to be consistent with the remainder of this Environmental Assessment.

Table 16-6 Noise monitoring locations

Site	NCA	Location	Purpose
13	NCA21	Billabong Drive, west of the existing highway, south of Billabong Koala Park	Model validation and noise criteria derivation
12	NCA22	Cassegrain Winery, east of the existing highway	Model validation and noise criteria derivation
11	NCA20	Glen Ewan Road, west of the existing highway near the Hastings River	Model validation and noise criteria derivation
10	NCA17	Moorside Drive, Telegraph Point, east of the existing highway	Construction noise criteria derivation
9	NCA16	Hacks Ferry Road, Telegraph Point, east of the existing highway	Construction noise criteria derivation
8	NCA16	Cooperabung Drive, Telegraph Point, west of the existing highway	Model validation and noise criteria derivation
7	NCA13	Haydons Wharf Road, Telegraph Point, east of the existing highway	Model validation and noise criteria derivation
6	NCA13	Wyndell Close, Telegraph Point, west of the existing highway	Model validation and noise criteria derivation
5	NCA11	Cooperabung Drive, Telegraph Point, west of the existing highway near Ballengarra State Forest	Model validation and noise criteria derivation
4	NCA10	Mingaletta Road, Kundabung, east of the existing highway	Construction noise criteria derivation
3	NCA07	Kundabung Road, Kundabung, east of the existing highway	Model validation at great distance from highway
2	NCA03	Ravenswood Road, Kundabung, west of the existing highway	Model validation and noise criteria derivation
1	NCA01	Scrubby Creek Road, west of the existing highway, north of Maria River	Model validation and noise criteria derivation

Note: NCA = noise catchment area

16.3.3 Monitoring results

Detailed monitoring results are available in the *Noise and Vibration Working Paper*, prepared by Wilkinson Murray, provided in **Volume 3** of this Environmental Assessment. The monitoring results and are also summarised below and in **Table 16-7**.

Generally the monitoring results have identified that:

- For locations relatively close to the existing highway, the noise environment is dominated by highway traffic noise and show elevated noise levels during both the day and night.
- For locations distant from the highway (monitoring sites 3, 4, 9 and 10) the noise levels are typical of a rural environment.

Table 16-7 Noise monitoring results

Site	Monitoring period (December 2006)	Day $L_{eq, 15hr}$ dB(A)	Night $L_{eq, 9hr}$ dB(A)	Rating background level dB(A)		
				Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
13	15 – 23	64	62.5	51	44	40
12	15 – 22	58.5	58	49	44	42
11	15 – 23	61.5	56	47	47	42
10	15 – 23	55	51	36	40	39
9	15 – 23	54	48	39	39	39
8	9 – 23	63.5	61	51	46	43
7	15 – 19	58	57.5	47	45	43
6	9 – 16	53.5	51	43	43	43
5	15 – 23	63.5	63	51	47	43
4	15 – 23	55	49	36	36	36
3	15 – 22	52	50.5	36	38	36
2	15 – 23	56	55	43	43	41
1	15 – 23	58	56	47	47	46

16.4 Construction noise and vibration impacts

The Proposal would involve a range of construction activities. The methods of construction and potential staging of construction (if any) would be determined during the detailed design and construction phases once the delivery methods are determined.

Construction activities generating noise would progressively move along the Proposal route. Therefore, the predicted noise impacts would typically be for a limited time at any one location, and would not be continuous over the whole construction period for the Proposal. Exceptions would include the construction of bridges, interchanges, and sites of major cuts and fills and associated minor construction compounds. However, while construction noise generation from these activities would be over a longer period it is still appropriate to assess the potential impacts of these activities along with the more general construction activities.

The Proposal would require the establishment of batch plant (concrete and asphalt) and a main construction compound(s), which would be present for longer durations, in some cases for the duration of construction of the Proposal, but these would not be permanent. The potential impacts from these locations have been considered separately below.

16.4.1 Assessment of construction noise

General construction activities

Table 16-8 provides a list of typical construction activities that could be undertaken for the Proposal, typical plant and equipment that could be utilised for each activity and the predicted sound pressure level (or construction noise level) that could be heard at 30 metres and 150 metres from the construction activity.

The construction noise level that could be heard at any particular residence or sensitive receiver would vary depending upon a number of factors including:

- The intensity of construction activities.
- The location of construction activities.
- The high mobility of individual equipment, which would alter the orientation of the noise source with respect to individual receivers.
- The type of equipment used.
- Existing local noise sources.
- Intervening topography.
- Prevailing weather conditions.

Sound power level:
Is the capacity of an object to produce sound.

Sound pressure level:
Is the measured sound level resulting from an object producing sound, as heard at a location, for example a residence.

The predicted sound pressure levels provided in **Table 16-8** should be viewed as being conservative for the following reasons:

- They are based on typical maximum sound power levels for individual pieces of plant and equipment. During any given period of construction, the plant and equipment being used would operate at maximum sound power levels for only brief stages. At other times, the plant and equipment would typically produce lower sound levels while carrying out activities not requiring full power.
- They assume that all typical plant and equipment required for a construction activity would be operating at its maximum sound power level at the same time, which is unlikely.
- They also assume that all typical plant and equipment would be present at a particular location at the same time, which is unlikely.

Table 16-8 Predicted noise levels for construction activities

Activity	Typical equipment used per activity	Maximum sound power level dB(A)	Predicted sound pressure levels dB(A)	
			30 m	150 m
Site establishment	Excavators, chainsaws, mulching plant/chipper, cranes, generators.	110	64-74	39-49
Removal of corridor vegetation	Excavator, mulcher, chainsaw, trucks, grader, combination backhoe front end loader.	111	65-75	40-50

Activity	Typical equipment used per activity	Maximum sound power level dB(A)	Predicted sound pressure levels dB(A)	
			30 m	150 m
Bulk earthworks	Road trucks, compactor, grader, steel, multi tyred and vibratory rollers. Concrete pour, including trucks and concrete vibrator. Asphalt paving plant, backhoe, sweeper, compressors, generators.	114 [1]	68-78 [1]	43-53 [1]
Drainage works	Excavator, trucks, grader, combination backhoe front end loader.	111	65-75	40-50
Bridge and interchange works	Piling rigs and cranes.	115 [2]	69-79 [2]	44-54 [2]
Milling and paving	Road trucks, compactor, steel, multi tyred and vibratory rollers. Concrete pour, including trucks and concrete vibrator, asphalt paving plant, backhoe, profiler, sweeper, compressors, generators.	113 [3]	67-77 [3]	42-52 [3]
Landscaping of exposed areas	Excavator/bobcat, powered hand tools, air compressor, spoil, material or concrete truck, jackhammer (for concrete embedded parts).	109	63-73	38-48

Notes: 1 Add 6 dB(A) when using rock breakers / hammers or air track drills (for blast holes)
2 Add 5 dB(A) when using driven piles
3 Add 3 dB(A) when using jackhammers and concrete saws

The potential impacts of general construction activities on residences and other sensitive receivers with respect to the established construction noise management levels (noise criteria) is provided below.

Southern upgrade section (Oxley Highway to Fernbank Creek)

The relevant noise management level (noise criteria) for residences within 500 metres of the existing highway in this section is 55 dB(A) during the day. The predicted construction noise levels indicate the criteria would generally only be met for residences greater than about 150 metres from the construction activity. In this section, there are no known residences within 150 metres of the proposed construction activities.

There are no other sensitive receivers (eg schools or churches) likely to be impacted by construction noise in this section.

Hastings River deviation section (Fernbank Creek to the proposed Blackmans Point Road interchange)

The relevant noise management level (noise criteria) for all residences in this section is 46 dB(A) during the day. The predicted construction noise levels indicate the criteria would generally only be met for some construction activities at residences greater than about 150 to 200 metres from the construction activity. In this section, there are approximately seven known residences within approximately 200 metres of the proposed construction activities.

There are no other sensitive receivers (eg schools or churches) likely to be impacted by construction noise in this section.

Telegraph Point bypass section (proposed Blackmans Point Road interchange to the proposed Haydons Wharf Road half interchange)

The relevant noise management level (noise criteria) for all residences in this section is 46 dB(A) during the day. The predicted construction noise levels indicate the criteria would generally only be met for some construction activities at residences greater than about 150 to 200 metres from the construction activity. In this section, there are approximately 11 known residences within approximately 200 metres of the proposed construction activities, of which one would be demolished as part of the Proposal.

There is a primary school located west of the existing highway in Mooney Street, which is approximately 1.8 kilometres west of the Proposal. A church is located in Telegraph Point, which is approximately 1.4 kilometres west of the Proposal. The predicted construction noise levels would meet the criteria for these locations.

Northern upgrade section (proposed Haydons Wharf Road half interchange to Stumpy Creek)

The relevant noise management level (noise criteria) for residences within 500 metres of the existing highway in this section is 55 dB(A) during the day. The predicted construction noise levels indicate the criteria would generally only be met for residences greater than about 150 metres from the construction activity.

In this section, there are approximately 40 known residences (including one motel) within approximately 150 metres of the proposed construction activities, of which six would be demolished as part of the Proposal. The majority of these are located in areas of relatively short duration construction activities (eg highway duplication), although a number are located in the vicinity of longer duration construction activities (eg cuts or overbridges) and would be exposed to construction noise for longer periods.

There are no other sensitive receivers (eg schools or churches) likely to be impacted by construction noise in this section.

Batch plants, crushing plants and construction compounds

Onsite batch plants (concrete and asphalt) could be required during construction of the Proposal. Batch plants would also require workforce offices and other facilities. Rock crushing plants could be required to produce sized aggregates for concrete and asphalt production as well as select road base material. The construction contractor would require site compounds for offices, car parking, toilets and lunchrooms, and storage areas for plant and construction materials. The contractor could use multiple site compounds to minimise traffic movements and locate resources adjacent to major construction activities. Batch plants, crushing plants and site compounds could be co-located.

Based on the typical plant and equipment required at a batch plant and major construction compound the predicted sound pressure levels (or construction noise level at a receiver) at a distance of 30 metres and 150 metres are shown in **Table 16-9**.

Table 16-9 Predicted noise levels from batch plants and compounds

Activity	Predicted sound pressure levels dB(A)	
	30 m	150 m
Batch plants / major compounds	67-77	42-52
Rock crushing plants	69-79	44-54
Minor compounds	Up to 75	Up to 49

The location of the batch plants, crushing plants and construction compounds would be determined at the detailed design stage and would be consistent with the ancillary facilities site selection criteria identified in **Section 7.6.7**. The location of the batch plants would also be influenced by the staging option and construction delivery method to be adopted.

Comparing the predicted construction noise levels with the noise management levels (noise criteria) for all sections of the Proposal indicates that batch plants, crushing plants and compounds should be preferably located at least 150 metres from any residence or sensitive receiver. This is consistent with the ancillary facilities site selection criteria identified in **Section 7.6.7**. However, it is possible that minor compounds could be required at distances less than 150 metres away from residences due to the location of major works such as overbridges and construction noise would require implementation of appropriate management measures including consultation with the affected receivers.

16.4.2 Construction vibration

Vibration levels

The vibration levels for several typical construction activities, and the equipment used in these activities, were calculated for distances of 10, 20 and 30 metres from the activity. The results from these calculations are summarised in **Table 16-10**.

Table 16-10 Typical construction equipment vibration levels

Construction equipment	Peak particle velocity vibration level (mm/s) at indicated distance		
	10 m	20 m	30 m
Concrete sawing	0.5	0.3	0.2
4-tonne vibratory roller (high)	2.0-2.4	0.4-1.2	0.2-0.8
Hydraulic hammer (30 tonnes)	3	1.5	0.4
Impact pile driver	3.3	0.95	0.45

Predicted vibration levels at residences

The typical vibration levels for the Proposal are predicted to comply with the vibration criteria for building damage.

There are approximately 22 residences (including one motel) within about 50 metres of the proposed construction activities, of which seven would be demolished as part of the Proposal.

The typical construction vibration levels could exceed the construction vibration criteria of 0.28 millimetres per second for human comfort (residences) during the daytime for some of these residences. It is possible that at some residences close to the construction activities that there could be vibration levels which are perceptible. This is most likely to relate to the use of hydraulic hammer, impact piling and vibratory rollers. The impacts are expected to be temporary as the construction activity moves away from the residences.

16.4.3 Blasting vibration and overpressure

There are a range of cuttings across the alignment which would require excavation. The majority of these are likely to be excavated utilising conventional techniques such as ripping by bulldozers. Depending on the rock types encountered there could be a requirement to undertake blasting. The type of construction techniques used for rock removal in the deep cuttings in the Cooperabung Hill and Maria River State Forest would be influenced by the rock type, together with the proximity of surrounding residences. The construction technique would be determined during the detailed design phase and following further geotechnical investigations.

The potential airblast overpressure and ground vibration impacts of blasting were assessed using the methods contained in *Noise and Vibration Working Paper*, prepared by Wilkinson Murray, provided in **Volume 3** of this Environmental Assessment.

A general assessment of construction blasting at potential locations has been undertaken to determine potential impacts on the surrounding residences. Blasting estimations have into consideration Australian Standard *AS2187.2-1993: Explosives – Storage, Transport and Use* and have been based on available information. Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data. Therefore the blasting predictions presented here should only be used as a guide.

The assessment indicates:

- Compliance with the blast overpressure criteria could only be possible at Cooperabung Hill (approximately 600 metres north of the proposed Yarrabee Road vehicular underpass) and within Maria River State Forest (south of the proposed Middle Gate Road overbridge).
- Compliance with the blast vibration criteria could only be possible immediately north of the North Coast Railway, immediately south of the proposed Haydons Wharf Road half interchange, Cooperabung Hill (immediately north of Cooperabung Range Road) and immediately north of the Maria River.

All other locations assessed may not comply with the blast overpressure or vibration criteria due to the proximity of residences. These locations include near the winery, immediately north of the proposed Haydons Wharf Road half interchange and a number of locations in the general area of Cooperabung Hill and Maria River State Forest.

Reducing the charge mass or increasing the distance reduces the airblast overpressure and ground vibration. Ground vibration generally attenuates faster than airblast overpressure, hence airblast overpressure is generally the critical factor which controls the distance within which blasting can occur within the relevant criteria. The assessment indicates that compliance with the airblast overpressure at residences and other sensitive receivers could occur at about 800 metres. At distances less than 800 metres the potential restrictions on the maximum instantaneous charge could make blasting unfeasible.

Compliance with the airblast overpressure and ground vibration criteria collectively may only be feasible at Cooperabung Hill (between approximately 600 metres and 1500 metres north of the proposed Yarrabee Road vehicular underpass) and within Maria River State Forest (south of the proposed Middle Gate Road overbridge).

Where the criteria may not be met, the approximate number of residences and other sensitive receivers within 800 metres of the possible blasting sites requiring specific management are:

- The general area in the vicinity of Cassegrain Winery – four residences, Cassegrain Winery and other nearby industrial activities.
- The general area in the vicinity of the proposed rest areas south of Mingaletta Road – three residences.
- Between the North Coast Railway and proposed Haydons Wharf Road half interchange - 14 residences, of which three would be demolished as part of the Proposal.
- Generally between Cooperabung Range Road and Yarrabee Road – three residences.
- Maria River State Forest (north of the proposed Middle Gate Road overbridge) – eight residences.

Given the proximity of residences in these areas, specific blast management strategies would be required to ensure that the criteria are achieved. Alternative methods of rock removal such as rock hammering and non-explosive rock splitting may need to be considered at these sites where practicable. Potential blasting management measures are discussed in **Section 16.6**.

16.4.4 Staging implications

In preparing this Environmental Assessment, the potential construction noise and vibration impacts of the possible staging option described in **Section 7.3.2** in comparison to the construction of the entire Proposal to a full motorway standard have been considered as outlined below.

Construction activities would be undertaken in accordance with the management measures outlined in **Section 16.6**, and ancillary construction facilities would be in the same location, for both this staging option and the motorway standard upgrade.

Some sensitive receivers could be subject to two separate construction periods for earthworks operations if this staging option is adopted, and the ultimate motorway standard upgrade is constructed at a later date. However, it is also possible that some cuttings could be constructed to the full motorway standard width for this staging option, and as a result sensitive receivers adjoining major cuttings would only be subject to blasting impacts from one construction period.

If adjoining sensitive receivers are provided with treatment for the construction or operational noise impacts of as part of this staging option (as discussed in **Section 16.6.2** below), there is the possibility that those sensitive receivers may not require any further treatment to manage the noise impacts of the construction or operational phases of the ultimate motorway standard upgrade.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the construction noise and vibration impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

16.5 Operational traffic noise impacts

16.5.1 Highway upgrade

A total of 352 residences in 22 noise catchment areas have been identified and operational traffic noise levels predicted. The noise level predictions were made both for daytime (7am to 10pm, $L_{Aeq(15\ hr)}$) and night time (10pm to 7am, $L_{Aeq(9\ hr)}$) for the year 2016, being the nominal year of opening of the Proposal, and the year 2026, being 10 years after opening. **Figure 16-2** shows the night time noise contours for the year 2026, and the location of potentially affected receivers.

The assessment indicates that while there would be an overall improvement to the noise environment in the Proposal area, the noise criteria would be exceeded at 92 residences if noise management measures were not adopted. The properties that would experience an increase in traffic noise are predominantly those properties located in the sections of the Proposal that deviate from the existing Pacific Highway alignment near the Hastings River and the Wilson River floodplain.

Further, those residences in the vicinity of the Hastings River and generally between the Wilson River and proposed Haydons Wharf Road half interchange would experience traffic noise from a new direction, while at the same time experience a decrease in traffic noise from the existing direction. This would result from traffic being removed from the existing highway and moved to the upgraded highway.

Of the 92 residences where noise criteria would be exceeded, 30 would experience ‘acute’ noise levels. Noise levels are defined as acute when they greater than or equal 65 dB(A) during the day and 60 dB(A) at night.

Noise management options for traffic noise are discussed below.

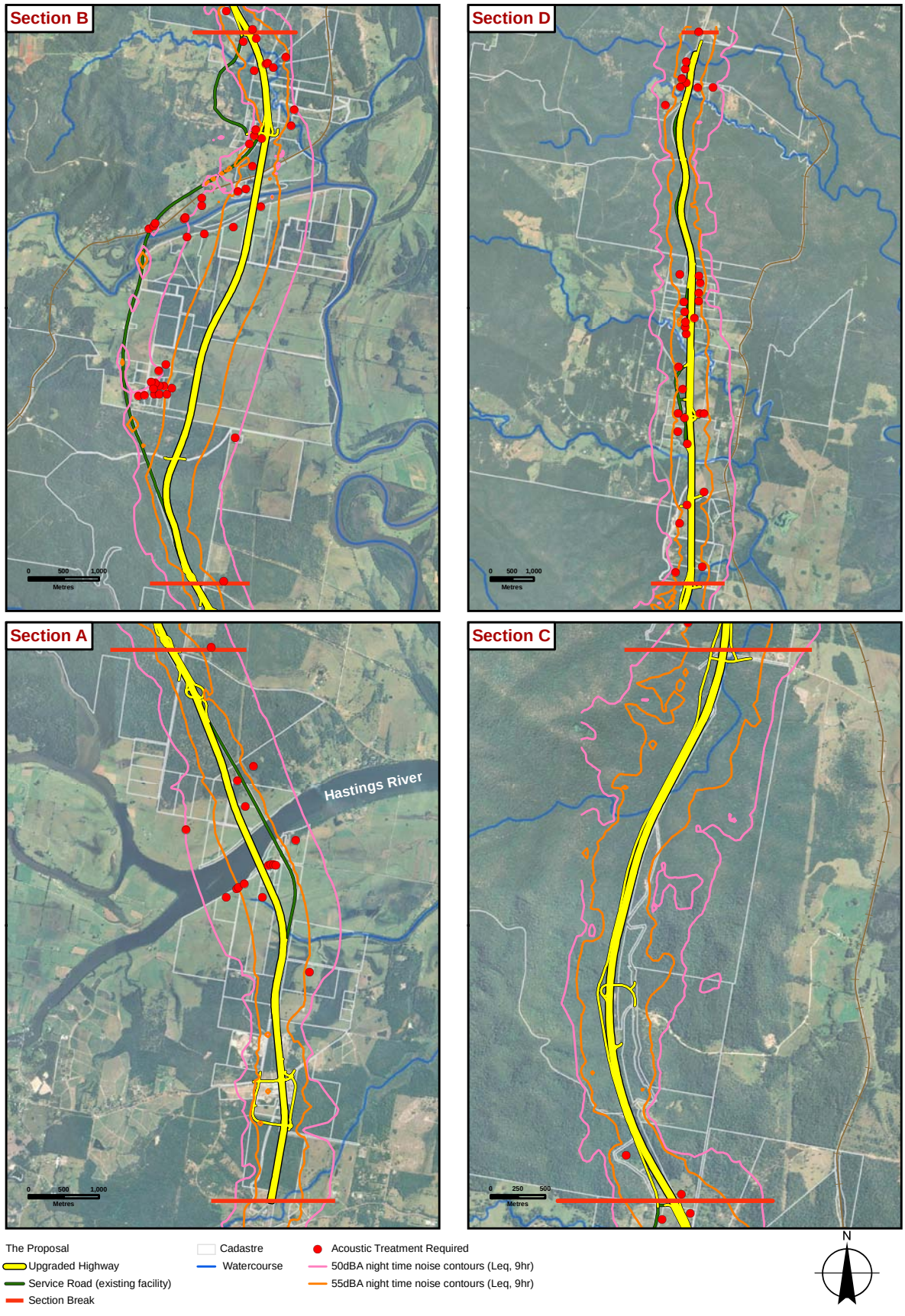
Noise management options

Feasible and reasonable design measures

The *Environmental Noise Management Manual* (RTA 2001) provides guidance for selecting and designing feasible and reasonable noise management measures for reducing the impacts of road traffic noise from new and redeveloped roads on residential land uses.

The first step in this process is to ensure that all feasible and reasonable management measures are incorporated into the road design, ie optimising vertical and horizontal alignments within the other environmental and engineering constraints of the Proposal.

Figure 16-2 2026 night time noise impacts and affected receiver locations



Note: 2004 Aerial photography, Cadastral boundaries are indicative only.

The next step is to use Practice Note (iv) of the *Environmental Noise Management Manual* as a guide to review and select feasible and reasonable noise management measures to mitigate traffic noise impacts on residences and other sensitive receivers. These management measures could include low noise pavement surfaces, noise mounds / barriers (at road-side) or architectural treatments. Further details on the assessment of feasible and reasonable noise management measures carried out for the Proposal is contained in the *Noise and Vibration Working Paper*, prepared by Wilkinson Murray, provided in **Volume 3** of this Environmental Assessment.

Low noise pavement surfaces

At speeds of 70 kilometres per hour and above, tyre noise begins to dominate over engine / exhaust noise. In such circumstances, low noise pavement surfaces such as open-graded asphaltic concrete provide some benefit in reducing noise emissions. Low noise pavement surfaces are generally only used where affected residences are grouped in close proximity to the proposed upgrade and where small reductions in noise of 2 to 4 dB(A) are required, and when used in conjunction with other treatments. Low noise pavements are more expensive than other pavement options to install and maintain, and the use of these type of pavements is only considered when it is reasonable and feasible.

Low noise pavements were determined not to be feasible or reasonable at any locations in the proposal due to the isolated nature of the affected residences and the hydrological characteristics of the floodplain areas.

Noise barriers

Noise barriers are most effective if they are near the source or the receiver. Noise barriers are generally only used in areas where affected residences are grouped in close proximity to the proposed upgrade. Noise barrier effectiveness is also determined by height, the materials used (absorptive or reflective), and density.

Barriers can take a number of forms, including free standing walls along roadways, grass or earth mounds or bunds, and using cuttings to lower the road creating noise barriers. Barriers are generally used when other controls at the source (ie low noise pavements) or receiver (ie architectural treatments) are either impractical or too costly.

The majority of the residences where the criteria would be exceeded are generally too isolated, or where other topographical features or constraints would make noise walls or noise mounds along the upgraded highway not feasible or reasonable.

The exception to this is within noise catchment area 17 (south of the Wilson River) where the noise criteria would be exceeded at 13 residences. The assessment identified that a noise wall in this area would need to be approximately 4.5 metres high and 2.2 kilometres long and constructed above the level of the pavement on edge of the upgraded highway embankment.

The investigation concluded that noise walls were not a feasible or reasonable management measure in this area due to:

- The potential impacts on flooding and drainage in the area.
- The potential for floodwaters to scour the road embankment, damage the pavement and potentially destabilise the noise wall on the embankment, creating a safety issue.
- The significant visual impact of the noise wall on the area.
- The difficulties in constructing and maintaining the noise wall.

Architectural treatment

Architectural treatment of 92 residences, where the criteria would be exceeded, was determined to be the most feasible and reasonable noise management measure. The noise management measures that would be implemented to mitigate traffic noise at these residences would be further refined during the detailed design phase in consultation with the affected property owners. This would include detailed operational noise modelling to confirm the findings of this assessment and the requirements for noise mitigation.

Architectural treatments would aim to achieve internal noise levels in habitable rooms 10 dB(A) below the external noise criteria. 10 dB(A) is equivalent to the traffic noise reduction that can be achieved for most building structures with the windows sufficiently open to satisfy minimum fresh air requirements.

Architectural treatments are more effective when they are applied to masonry structures than light timber frame structures. Caution should be exercised before providing treatments for buildings in a poor state of repair, as they would be less effective in these cases. The acoustic treatments provided by the RTA are typically limited to:

- Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut.
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls).
- Upgrading window and door seals.
- The sealing of wall vents, eaves, and roofs.
- The installation of external courtyard screen walls.

Summary of traffic noise impacts and mitigation measures

Table 16-11 outlines the receivers that would be exposed to acute levels and those that may require architectural treatments to meet the criteria for each noise catchment area.

It should be noted that a number of residences (262, 314, 376, 396, 397, 398 and 841) are located within the footprint of the Proposal and would be demolished during construction. These properties would be subject to acquisition in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* as discussed in **Chapter 10 Land use and property**. While these residences have been considered in the noise assessment and are listed in Appendix C of the *Noise and Vibration Working Paper*, they have not been identified as requiring noise mitigation.

Table 16-11 Summary of predicted traffic noise impacts (combined day and night)

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
22	9	This noise catchment area is subject to 'redevelopment' criteria. Noise levels do not vary much from the existing situation, increasing only 1-2 dB(A). Residences in this noise catchment area are not expected to have acute noise levels and accordingly, no noise mitigation is recommended.	N/A	N/A

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
21	30	This noise catchment area is subject to 'redevelopment' criteria. Noise levels do not vary much from the existing situation, increasing only 1-2 dB(A). Residences already have considerable traffic noise exposure and most are not expected to have acute levels and accordingly, no noise mitigation is recommended	N/A	N/A
20	18	This noise catchment area is mostly subject to 'new freeway' criteria. However, some residences are subject to 'redevelopment' criteria in the southern and northern ends of the noise catchment area. 6 residences would be exposed to noise from another direction (ie from the west rather than the east), 3 of which with acute levels. These residences would experience an increase of 8-15 dB(A). 4 residences located to the east of the Proposal would also exceed the criteria and would require noise mitigation to be considered even though they would benefit from a noise reduction of up to 4 dB(A) due to the upgraded highway moving further away. All 10 residences requiring mitigation are considered too far apart to justify road-side noise barriers, especially since traffic noise from the existing highway also contributes to the residences located further east. Architectural treatments would be considered for all 9 residences.	3 residences (82, 83 and 96)	10 residences (82, 83, 84, 85, 93, 96, 103, 106,107 and 860)
19	7	This noise catchment area is subject to both 'redevelopment' and 'new freeway' criteria. Noise levels are predicted to increase by 2-9 dB(A). 6 residences would exceed the criteria including 1 with acute noise levels. All 6 residences are too isolated for road-side noise barriers and architectural treatment would be considered.	1 residence (76)	6 residences (74, 75, 76, 77, 80 and 855)
18	1	This noise catchment area is subject to 'new freeway' criteria. 1 residence located in the south of the noise catchment area would exceed the criteria. It is too isolated for a road-side noise barrier and would be considered for architectural treatment. The other residences in this noise catchment area are located over 1 kilometre away from the upgraded highway and would all comply with the criteria.	N/A	1 residence (850)

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
17	42	This noise catchment area is subject to 'new freeway' criteria. Noise levels are predicted to decrease by up to 15 dB(A) at the residences located along existing highway and exposed from the same façade. However, the residences located between the existing highway and upgraded highway would experience an increase of up to 17 dB(A) at their newly exposed façades. 13 residences are expected to exceed the criteria but would not have acute levels, as they are located further away from the upgraded highway. Most of those residences are located relatively close to each other and road-side noise barriers would normally be considered. However, due to engineering complications associated with constructing a barrier across a floodplain, visual impacts and urban design issues, architectural treatment would be considered.	N/A	13 residences (116, 119, 123, 125, 126, 128, 129, 130, 131, 133, 135, 583 and 846)
16	97	This noise catchment area is subject to 'new freeway' criteria. Noise levels are predicted to decrease by up to 15 dB(A) at the residences located along existing highway and exposed from the same façade. However, the residences located between the existing highway and upgraded highway would experience an increase of up to 7 dB(A) at their newly exposed façade. 2 residences located between the existing highway and the upgraded highway are expected to exceed the criteria and would experience increases in noise levels since the newly exposed eastern façades of those residences are shielded from traffic noise from the existing alignment. In addition, 3 residences located immediately adjacent to the existing highway would exceed the 'new freeway' criteria. The 5 residences are too isolated for road-side noise barriers. In addition, the 5 residences would experience an overall reduction in noise levels regardless of which façade noise impinges on. Therefore, architectural treatment would be considered.	N/A	5 residences (230, 231, 234, 256 and 610)
15	10	This noise catchment area is subject to 'new freeway' criteria. 8 residences would exceed the criteria. Most of these residences would have exposure to noise from a different direction (ie from the east rather than the west) and would experience an increase ranging up to 28 dB(A) in the worst case scenario. All of these residences would require further consideration of noise mitigation. The residences located further back near the existing highway are expected to exceed 'new freeway' criteria and would still experience increases in noise levels since the newly exposed eastern façade of those residences are shielded from traffic noise from the existing alignment. 1 residence is predicted to have acute noise levels. The residences in this noise catchment area are too isolated for road-side noise barrier therefore consideration would be given to architectural treatment.	1 residence (632)	8 residences (204, 205, 209, 266, 270, 271, 311 and 632)

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
14	9	This noise catchment area is subject to both 'redevelopment' and 'new freeway' criteria. Noise levels are generally predicted to increase by 4-10 dB(A). 1 residence located in the south of the noise catchment area would experience an increase of 20 dB(A). 3 residences are expected to exceed the criteria including 1 with acute levels. 2 of the 3 residences are located near a section of existing highway which is already in cutting up to 5 metres deep and where noise barriers would not be beneficial. Accordingly, consideration would be given to architectural treatment. The residence located in the south of the noise catchment area and exposed to acute levels is too isolated for road-side noise barriers and would also be considered for architectural treatment.	1 residence (259)	3 residences (259, 341, and 647)
13	20	This noise catchment area is subject to both 'redevelopment' and 'new freeway' criteria. Even though almost all residences in this noise catchment area would benefit from a noise reduction of up to 7 dB(A) due to the upgraded highway moving further east, 4 residences would exceed the criteria. In addition, 1 of the 4 residences has exposure to noise from a different direction (ie from the east rather than the west) resulting in an increase of 13 dB(A) at a newly exposed façade. This residence is predicted to be subject to acute noise levels. Road-side noise barriers are not considered feasible due to local topography and the existing cutting. Consideration would be given to architectural treatment.	1 residence (315)	4 residences (315, 322, 323 and 840)
12	8	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by up to 4 dB(A). 6 residences would exceed the criteria, 4 of which would be exposed to acute noise levels. These residences are too isolated from one another for road-side noise barriers to be feasible and consideration would be given to architectural treatment.	4 residences (363, 364, 374 and 375)	6 residences (363, 364, 365, 367, 374 and 375)
11	10	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 1-5 dB(A) with higher increases at the residences closer to the upgraded highway. 3 residences within 250 metres of the upgraded highway would be exposed to levels exceeding the criteria and would need further consideration. 2 of those would also be exposed to acute noise levels. These residences are scattered too far apart along the upgraded highway for road-side noise barriers to be feasible and would be considered for architectural treatment.	2 residences (361, and 373)	3 residences (361, 373 and 377)
10	5	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 4-5 dB(A). 1 residence is expected to be exposed to noise levels exceeding the criteria. This residence is too isolated a road-side noise barrier and architectural treatment would be considered.	N/A	1 residence (688)

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
9	7	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 4-5 dB(A). Only 1 residence is predicted to have exposure to noise levels that exceed the criteria. It is too isolated for a road-side noise barrier and would be considered for architectural treatment.	N/A	1 residence (405)
8	9	This noise catchment area is subject to 'redevelopment' criteria. With the exception of 2 residences that would experience an increase of 3-4 dB(A), noise levels are generally predicted to increase by 4-5 dB(A). 3 residences are predicted to have exposure to noise levels that exceed the criteria. 1 of those residences would show acute noise levels. Due to the scattered nature of the residences, road-side noise barriers would not be feasible and consideration would be given to architectural treatment.	1 residence (399)	3 residences (399, ,683 and 695)
7	22	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 4-5 dB(A). 2 residences would exceed the criteria and would require further consideration for mitigation. Since they are too isolated for road-side noise barriers, architectural treatment would be considered.	N/A	2 residences (438 and 439)
6	10	This noise catchment area is subject to 'redevelopment' criteria. With the exception of 2 residences that would experience an increase of 2-4 dB(A), noise levels are generally predicted to increase by 4-5 dB(A). 4 residences are predicted to have exposure to noise levels that exceed the criteria. This includes 1 residence where noise levels are predicted to be acute. Architectural treatment would be considered over road-side noise barriers since all residences are deemed too isolated for mitigation at the upgraded highway.	1 residence (409)	4 residences (409, 436, 712 and 729)
5	11	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 4-5 dB(A). Most residences would comply with the criteria. 2 residences are expected to exceed the criteria and would require consideration for mitigation. These residences are too isolated to consider road-side noise barriers and would be investigated for architectural treatment.	N/A	2 residences (448 and 459)
4	8	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 4-5 dB(A). All 5 residences located within 200 metres of the upgraded highway would be subject to acute noise levels and would require consideration of noise mitigation. Road-side noise barriers would not be feasible for the 5 residences as they are too scattered along the highway and architectural treatment would be considered	5 residences (471, 478, 480, 484 and 486)	5 residences (471, 478, 480, 484 and 486)

NCA	Total number of receivers	Comment	Receivers exposed to acute levels	Receivers requiring architectural treatments
3	11	This noise catchment area is subject to 'redevelopment' criteria. Noise levels are predicted to increase by 3-5 dB(A). Acute levels are found at 5 residences located within 200 metres of the upgraded highway and would require consideration of mitigation. 1 residence at the north end of the noise catchment area would also require mitigation. All 6 residences are deemed too isolated for road-side noise barriers and architectural treatment would be considered	5 residences (466, 467, 475, 746 and 821)	6 residences (466, 467, 475, 488, 746 and 821)
2	3	This noise catchment area is subject to both 'redevelopment' and 'new freeway' criteria. Noise levels are predicted to increase by 2-3 dB(A). Architectural treatment would be considered for 2 residences.	N/A	2 residences (498 and 500)
1	8	This noise catchment area is subject to both 'redevelopment' and 'new freeway' criteria. With the exception of 1 residence that would experience a fall of 1-2 dB(A), noise levels are generally predicted to increase by 0-2 dB(A). 7 residences would require consideration of mitigation, 5 of which with acute noise levels. Because of the isolated nature of the 7 residences, a road-side noise barrier would not be considered feasible. In addition, the residences are elevated in relation to the upgraded highway and the existing highway is already in cutting up to 7 metres deep which makes this section inappropriate for noise barriers. Architectural treatments would be considered at the 7 residences.	5 residences (503,814, 921, 922 and 923)	7 residences (493, 503, 814, 920, 921, 922 and 923)

Note: NCA = noise catchment area

16.5.2 Service roads

New service roads that would be constructed have been assessed as part of the upgraded highway as discussed above. Those sections of the service road network that would use existing local roads as shown on **Figure 6-1a** to **Figure 6-1b** and **Figure 6-2a** to **Figure 6-2q** are assessed below.

More detailed breakdown of these service road sections is shown in **Table 18-3** and **Figure 18-4** in **Chapter 18 Traffic and transport**. Subject to further assessment and detailed design these existing local roads may require upgrading to meet the required minimum criteria for service roads.

The assessment below is based upon consideration of the road traffic noise modelling undertaken for the Proposal and the predicted local traffic movements provided in **Section 18.2**.

From Fernbank Creek to Blackmans Point Road interchange, the existing Pacific Highway would be used as the proposed service road. Noise modelling for the Proposal indicates that the general noise environment in this area would be dominated by traffic noise from the upgraded highway. Those residences to the east, and some to the west of the existing highway are expected to experience a decrease in road traffic noise levels due to the predicted substantial decrease in the volume of traffic using the existing highway (for example from approximately 11,950 to 5300 vehicles per day north of Hastings River Drive) and relocation of through traffic on the upgraded highway.

From the Blackmans Point Road interchange to the Haydons Wharf Road half interchange, the existing Pacific Highway would be used as the proposed service road. Noise modelling for the Proposal indicates that for the majority of residences located to the west of the existing highway there would be a substantial decrease in road traffic noise due to the corresponding significant decrease in traffic volumes using the existing highway (from approximately 14,400 to 1800 vehicles per day south of the Wilson River), while those located between the existing highway and upgraded highway would continue to be exposed to varying levels of road traffic noise from the Proposal.

Between Haydons Wharf Road interchange and Cooperabung Hill, the service road network would use the existing Cooperabung Drive. Potential road traffic noise impacts are:

- Wyndell Close to Federation Way – noise modelling indicates that for the majority of residences along this section there would be a decrease in road traffic noise levels of up to 7 dB(A) due to the upgraded highway being located further to the east relative to the existing highway. However local traffic along this section of Cooperabung Drive is expected to increase from approximately 272 to 460 vehicles per day, which could potentially result in a minor increase in local road traffic noise levels.
- Federation Way to Sun Valley Road – noise modelling indicates that for the majority of residences along this section there would be an overall decrease in road traffic noise levels due to the upgraded highway being located further to the east relative to the existing highway. While local traffic along this section of Cooperabung Drive is expected to increase from approximately 130 to 220 vehicles per day, this is not expected to result in any significant noise impacts.
- Sun Valley Road to new service road link – noise modelling for the Proposal indicates that the general noise environment in this area would be dominated by traffic noise from the upgraded highway despite the predicted decrease in local traffic from approximately 175 to 50 vehicles per day.

In the vicinity of Kundabung the service road network would use the existing Rodeo Drive and Ravenswood Road. Noise modelling for the Proposal indicates that for the majority of residences there would be an increase in road traffic noise levels of up to 5 dB(A). Local traffic volumes are expected to increase significantly along Rodeo Drive, in particular between Kundabung Road and Smiths Creek Road from 25 to 550 vehicles per day, and decrease slightly on Ravenswood Road.

However due to the proximity of through traffic on the upgraded highway, which is predicted to be over 15,000 vehicles per day by 2016, the overall contribution of local road traffic to road traffic noise in the vicinity is expected to be minimal.

16.5.3 Assessment of maximum noise level – sleep disturbance

The maximum noise levels were measured and assessed in accordance with Practice Note (iii) of the *Environmental Noise Management Manual* (RTA 2001) at two representative locations. These locations are:

- Site 12 – Cassegrain Winery, 40 metres east of the existing highway.
- Site 8 – Cooperabung Drive, Telegraph Point, 80 metres west of the existing highway.

Locations were chosen that were relatively close to the existing Pacific Highway so as to ensure that captured levels were from passing vehicles and not extraneous noise from other sources. Data for the maxima from the night time (10pm to 7am) period was analysed.

Analysis of the recorded measurements reveals that between 10pm and 7am:

- There were 236 maximum external noise events ranging between 70 and 78 dB(A) at site 12.
- There were 81 maximum external noise events ranging between 66 and 73 dB(A) at site 8.

In order to identify the predicted maximum internal noise events, the following conservative adjustments were made to the measured maximum external noise levels with reference to *Environmental Noise Management Manual* (RTA 2001) and *Environmental Criteria for Road Traffic Noise* (EPA 1999):

- 10 dB(A) is subtracted from the measured maxima to conservatively estimate internal noise levels with windows open for ventilation.
- The number of maxima is increased by 95 per cent to account for the projected maximum increase (from 2006 to 2026) in heavy vehicle movements at night.

Therefore the predicted maximum internal noise events (without any mitigation) could range from:

- 60-68 dB(A) at site 12, exceeding both the wakening reaction (50 to 55 dB(A)) noise level and number of events above the health and wellbeing (65 to 70 dB(A)) noise level.
- 56-63 dB(A) at site 8, exceeding the wakening reaction (50 to 55 dB(A)) noise level but not exceeding the number of events above the health and wellbeing (65 to 70 dB(A)) noise level.

There are 14 residences within approximately 80 metres of the Proposal, of which seven are located within the footprint of the Proposal and would be demolished during construction. The remaining seven residences (82, 315, 363, 374, 375, 409 and 503) are generally located between approximately 50 and 80 metres from the Proposal and have been identified for consideration for architectural treatment in **Table 16-11**.

Architectural treatments, subject to condition and structure of the residence, could further reduce internal noise levels by 10 dB(A). For any residence within approximately 80 metres, with application of standard architectural treatment and based on the conservative inputs above, the resultant maximum internal noise levels could be marginally above the wakening reaction noise level, but would be well below the health and wellbeing noise level.

For residences 44, 82, 315, 363, 374, 375, 409 and 503, consideration would need to be given to additional noise mitigation subject to consultation with the affected residents.

16.5.4 Staging implications

In preparing this Environmental Assessment, the potential operational noise and vibration impacts of the possible staging option described in **Section 7.3.2** in comparison to the construction of the entire Proposal to a full motorway standard have been considered as outlined below.

In this staging option, highway and local traffic movements south of Cooperabung Close, as well as between Kundabung Road and Stumpy Creek, would be similar to the ultimate motorway standard upgrade. The resultant operational traffic noise levels and impacts in these areas would be expected to be the same.

However, for the possible staging option, most local traffic would have to use the upgraded highway between Cooperabung Close and Kundabung Road, as the proposed western service road would not become available until the ultimate motorway standard upgrade was constructed. Given the relatively low volumes of traffic predicted to use the proposed service roads, combined with the reduced travel speed of 100 kilometres per hour proposed for the upgraded highway for this staging option, the overall noise levels are predicted to marginally decrease in comparison with the ultimate motorway standard upgrade.

It would therefore be expected that the overall noise impacts of this staging option would be very similar to those of the ultimate motorway standard upgrade. As a result, it is considered that the operational noise management measures proposed in **Section 16.6** would also be appropriate for use in the operational phase of this staging option.

Should the Proposal be delivered in stages, the staging report described in **Section 7.3.3** would detail the operational noise and vibration impacts of the staging option. If any additional or altered impacts are identified, the staging report would further assess these impacts and identify appropriate management measures.

16.6 Management of impacts

16.6.1 Hours of construction

The construction hours proposed in **Section 7.5.3** (6am to 6pm on weekdays and 7am to 4pm on Saturday) will help in completing the project in a shorter time. This reduced construction time will provide benefits through the reduced duration of exposure to construction noise impacts and improved safety to the travelling public through the earlier opening of the upgrade to traffic.

The construction noise and vibration management plan to be developed for the project would include procedures to review the proposed construction hours during the construction of the Proposal. Should an unacceptable impact on receivers be confirmed, in relation to the extended working hours, the RTA will revert back to the standard working hours as described in the *Interim Construction Noise Guideline* and referred to in **Section 16.2.1** of this Environmental Assessment (7am to 6pm on weekdays and 8am to 1pm on Saturday) in the area of concern for that particular construction activity.

16.6.2 Construction noise and vibration management

A construction noise and vibration management plan would be prepared, and would include the following noise and vibration management measures:

- Quiet construction methods, plant and equipment would be selected where reasonable and feasible.
- All plant and equipment properly would be maintained and where available, fitted with appropriate acoustic attenuation, such as mufflers.
- ‘Dampened’ tip rock breakers would be utilised to minimise the transfer of vibration during rock breaking operations where reasonable and feasible.
- Where possible equipment not in use would be switched off in order to avoid unnecessary noise emissions.
- Locations for ancillary facilities would be selected in accordance with the selection criteria identified in **Section 7.6.7**.

- Noise management measures would be implemented, as necessary, around ancillary facilities sites such as site compounds and batch plants. These measures may include local screening, cladding or enclosures where reasonable and feasible.
- Consideration would be given to the installation of operational noise management measures as early as possible in the construction phase, where they would assist in managing construction noise.
- Specific construction noise and vibration management issues would be included in the site induction undertaken by all site personnel prior to them commencing onsite.
- Ongoing consultation with residents potentially affected by the construction of the Proposal would be undertaken throughout the construction phase.
- Consultation with residents would occur when activities are likely to produce high levels of noise or vibration.
- Where possible, schedule high noise or vibration construction activities in the vicinity of residences or other sensitive receivers to minimise disruption.
- Pile driving and rock breaking activities, if required, would occur between 7am and 6pm Monday to Friday and 8am and 12pm on Saturdays. Further time restrictions could be considered where necessary for specific locations.
- A complaints resolution procedure would be implemented so that complaints are investigated and appropriate control measures implemented.
- Noise and vibration monitoring programs would be during the construction phase.

16.6.3 Blasting management

The following blasting management measures would be implemented:

- For locations that would require blasting, site specific testing and blast management strategies would be developed to determine maximum charges, drill hole sizes, spacing and orientation to minimise potential overpressure and vibration impacts.
- Blasting vibration and airblast overpressure would be monitored for each blast.
- Surveys of potentially impacted structures would be undertaken before and after blasting activities.
- No blasting activities would occur during adverse site-specific weather conditions such as temperature inversions.
- Consultation with affected residents would be undertaken regarding the timing of blasting and potential impacts.
- A complaints resolution procedure would be implemented so that complaints are thoroughly investigated and blasting activities ceased or modified where appropriate.
- Blasting, if required, would normally occur between 9am and 5pm Monday to Friday and 9am and 1pm on Saturdays. Further time restrictions could be considered where necessary for specific locations. Any work planned outside normal hours or on public holidays would be undertaken only after prior consultation with and/or notification of local residents and DECCW.

Alternative construction techniques would be investigated for those areas where the blasting criteria cannot be achieved using the management strategies described above.

16.6.4 Proposed operational noise management measures

The relevant traffic noise criteria are likely to be exceeded at 92 residences in 2026 (10 years after the opening of the Proposal). In accordance with the *Environmental Noise Management Manual* (RTA 2001) feasible and reasonable noise management measures were investigated for the affected residences.

The majority of the residences where the criteria would be exceeded are generally too isolated, or other topographical features or constraints would make noise walls or noise mounds along the upgraded highway not feasible or reasonable. The exception to this is within noise catchment area 17 (south of the Wilson River) where the noise criteria would be exceeded at 13 residences. The assessment concluded that due to the engineering complications associated with constructing a noise barrier across a floodplain (including implications for flooding), visual impacts and urban design issues a noise barrier in this area was not feasible or reasonable. A noise mound is also considered not feasible or reasonable for the same reasons, as well as ecological impacts associated with a larger footprint.

Consideration of the use of low noise pavements was also given and it was concluded that it was not a feasible or reasonable noise management measure due to the isolated nature of affected residences and the hydrological characteristics of the floodplain areas.

Feasible and reasonable noise management measures for the 92 residences where the traffic noise criteria would be exceeded was therefore determined to be architectural treatment of these residences. Of these, eight would require consideration in relation to sleep disturbance.

The noise management measures that would be implemented to mitigate traffic noise at these residences would be further refined during the detailed design phase in consultation with the affected property owners. This would include detailed operational noise modelling to confirm the findings of this assessment and the requirements for noise mitigation.