11 Noise and vibration

A noise and vibration assessment has been prepared by a specialist acoustic consultant as part of this environmental assessment. The potential construction and operation phase noise and vibration impacts are discussed in this chapter, with the full noise and vibration report provided as working paper 2, Appendix F.

11.1 Existing noise environment

11.1.1 Definitions

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analyses of the varying noise over sampling periods, typically taken as 15 minutes. The descriptors provided below are used throughout this chapter:

- The maximum noise level (L_{Amax}) is the maximum noise level measured over a sample period.
- The L_{A1} level is the noise level which is exceeded for 1 per cent of the sample period. During the sample period, the noise level is below the L_{A1} level for 99 per cent of the time.
- The L_{A10} level is the noise level which is exceeded for 10 per cent of the sample period. During the sample period, the noise level is below the L_{A10} level for 90 per cent of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.
- The equivalent continuous sound level (L_{Aeq}) 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. This measure is also a common measure of environmental noise and road traffic noise.
- The L_{A90} level is the noise level which is exceeded for 90 per cent of the sample period. During the sample period, the noise level is below the L_{A90} level for 10 per cent of the time. This measure is commonly referred to as the background noise level.
- The assessment background level (ABL) is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10 percent) background level (L_{A90}) for each period.
- The rating background level for each period is the median value of the assessment background level values for the period over all of the days measured. As such, there is a rating background level value for each period – daytime, evening and night time.

11.1.2 Background noise levels and energy average noise levels

To determine the potential need to mitigate against noise from construction and operation, the existing noise environment was first determined. Existing ambient background noise levels were measured at 17 sites along the proposed alignment in late May and early June 2005. These sites are shown in Figure 11.1, and were chosen as representative locations that may be affected by construction and / or operational noise as a result of the Proposal.

Based on results of the on-site noise monitoring, the L_{A90} noise level can be calculated and this is representative of the 'background' noise level. As noted above, the L_{A90} noise level can be converted into a rating background level.

Due to the variation in L_{A90} noise levels (and therefore rating background level) along the corridor, the Proposal has been divided into two sections for the purpose of assessing potential construction and operational noise impacts:

- Upgrade section from Campbell Close, Sapphire to Unwins Road (south Woolgoolga). The existing rating background noise level for this section of the Proposal has been calculated at rating background level 45dBA for both daytime and night time periods.
- Bypass section from Unwins Road (south Woolgoolga), to Arrawarra Beach Road (Arrawarra). In this rural area the existing rating background noise levels have been calculated as 35dBA during daytime and 32dBA at night time. An exception occurs in the area near the Woolgoolga Creek Road where the daytime noise levels drop to 32dBA.

The results of the ambient noise survey are shown in Table 11.1 and are rounded to 0.5dBA. Fourteen sites were surveyed to assess the level of existing traffic noise. A further three sites were chosen to measure background noise at representative locations potentially affected by long-term construction works.

TABLE 11.1 AMBIENT NOISE SURVEY RESULTS

SITE	LOCATION	ENERGY AVERAGE NOISE LEVELS	
		DAY (7am to 10pm) $L_{Aeq,\ 15hr}$ (dBA)	NIGHT (7am to 10pm) $L_{Aeq,\ 9\ hr}$ (dBA)
1	2/786 Pacific Highway	60	57.5
2	817 Pacific Highway, Korora	63.5	62
3	8 Apini Place, Sapphire Beach	60	58.5
4	18 Woodhouse Road, Moonee Beach	55.5	54.5
5	20 Hoys Road, Moonee Beach	68	65
6	26 Tiki Road, Moonee Beach	53	49.5
7	9 Smiths Road, Emerald Beach	58.5	55
8	9 Bream Close, Emerald Beach	52.5	54
9	53 Emerald Heights Drive, Emerald Beach	58	55.5
10	5 Pine Crescent, Sandy Beach	59.5	57.5
11	6 Wattle Place, Sandy Beach	57	53
12	11 Hearnes Lake Road, Woolgoolga	56.5	57
13	5 Ryan Crescent, Woolgoolga	Not used	Not used
14	Go Bananas Motel, 53 Clarence Street	67	66
15	127 Woolgoolga Creek Road, Woolgoolga	Not used	Not used
16	18 Gresham Drive, Woolgoolga	Not used	Not used
17	2921 Pacific Highway, Woolgoolga	58.5	57

Arrawarra rest area

A rest area for cars and heavy vehicles adjacent to Arrawarra interchange forms part of the Proposal and is described in Chapter 7. The closest residential receivers to the rest area are situated in two groups, one to the north and one to the east of the rest area. The closest

residence to the proposed rest area in each group is approximately 600 metres (northern group) and 275 metres (eastern group). These residences and their proximity to both the existing highway and the proposed rest area are illustrated in Figure 11.1.

During the ambient noise survey there was no monitoring undertaken at either of the northern or eastern groups of residences. The ambient noise levels at those locations would be similar to levels at residences that are setback an equivalent distance to the existing highway. Table 11.2 outlines the derived rating background level based on measured ambient noise levels at other residences along the alignment that are similar distances from the highway to those of the northern and eastern residential clusters.

TABLE 11.2 DERIVED RATING BACKGROUND LEVELS AT NORTHERN AND EASTERN RESIDENTIAL CLUSTERS

LOCATION	DISTANCE FROM HIGHWAY (METRES)	RATING BACKGROUND LEVEL (dBA)	
		DAY (7am to 10pm) L_{A90} (dBA)	NIGHT (7am to 10pm) L_{A90} (dBA)
Eastern residences	250	43	33
Northern residences	350	45	35

11.2 Operation noise assessment

11.2.1 Criteria for operation noise

Criteria for assessment of road traffic noise are set out in the NSW Government's *Environmental Criteria for Road Traffic Noise*. The NSW Roads and Traffic Authority (RTA) has also published the *Environmental Noise Management Manual* to assist in implementing the criteria.

Under the *Environmental Criteria for Road Traffic Noise*, road developments are classified as either "new road" or "redevelopment of an existing road". Practice note (i) of the *Environmental Criteria for Road Traffic Noise* describes the circumstances under which each of these applies. Applying this practice note to the Proposal, the upgrade section of the Proposal would be classified as "redevelopment of existing freeway / arterial road" and the bypass section of the project would be classified as a "new freeway or arterial road corridor". The criteria set out in Table 11.3 would therefore apply. Further details regarding the application of the *Environmental Criteria for Road Traffic Noise* and the *Environmental Noise Management Manual* are provided in Section 3.1 of working paper 2 (refer Appendix F).

TABLE 11.3 CRITERIA FOR OPERATIONAL TRAFFIC NOISE FOR RESIDENTS

DEVELOPMENT TYPE	NOISE LEVEL CRITERION		WHERE CRITERIA ARE ALREADY EXCEEDED
	Day (7am-10pm)	Night (10pm-7am)	
New freeway or arterial road	55dBA ($L_{Aeq, 15\ hr}$)	50dBA ($L_{Aeq, 9\ hr}$)	The new road should be designed as not to increase existing noise levels by more than 0.5dB.
Redevelopment of an existing freeway or arterial road	60dBA ($L_{Aeq, 15\ hr}$)	55dBA ($L_{Aeq, 15\ hr}$)	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2dB. 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.

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Refer Figure 11.1

Arrawarra rest area

There are no specific criteria for assessing noise from rest areas so the most relevant methodologies have been reviewed and a conservative approach adopted. The criteria adopted are:

- Vehicle noise on ramps that are public roads have been assessed under the *Environmental Criteria for Road Traffic Noise*, which requires assessment of L_{Aeq} noise levels as defined in Table 11.2 above.
- For night time use of the rest area the *Environmental Noise Control Manual* sleep arousal guidelines require that the typical maximum noise level (denoted as L_{A1}) associated with noise from heavy vehicles at the rest area (engines starting / doors closing) should not exceed the night time background L_{A90} noise level by more than 15dBA. For the Arrawarra rest area, this criterion equates to 48dBA for the northern group of residences and 50dBA for the eastern group of residences.
- The rest area itself has been defined as an "industrial" operation and noise levels generated within the rest area have been assessed in accordance with the *Industrial Noise Policy*. This policy requires that the L_{Aeq} noise level associated with the proposed operation (over a typical 15 minute period at any time) should not exceed the background L_{A90} noise level by more than 5dBA. In the case of the northern group of residences, this criterion is 48dBA $L_{Aeq, 15\ min}$ daytime (7am to 10pm) and 38dBA $L_{Aeq, 15\ min}$ night time (10pm to 7am). In the case of the eastern group of residences, this criterion is 50dBA $L_{Aeq, 15\ min}$ daytime (7am to 10pm) and 40dBA $L_{Aeq, 15\ min}$ night time (10pm to 7am).

Modelling procedures and noise catchment areas

Modelling procedures and modelling scenarios are detailed in working paper 2 and include information on noise source heights, *ROADent* (software) modelling inputs and modelling scenarios. Two models were created, corresponding to the existing alignment and proposed design, with the following scenarios modelled:

- Existing conditions. Existing noise levels were calculated and used to test the integrity of the noise models by comparing the predicted levels with measured levels from noise loggers.
- Year 2011 "Future existing". In this scenario noise levels were calculated for traffic on the existing road network immediately prior to the anticipated opening of the proposed works.
- Year 2021. Noise levels were calculated for the Proposal 10 years after anticipated opening.

Predicted traffic flows are required in order to determine potential noise impacts during operation of the Proposal. Traffic and transport is discussed in Chapter 10 of this report. Predicted traffic flows that have been used to model noise for 2011 with the existing alignment and 2021 with the Proposal are shown in Table 4-4 and Table 4-5 of working paper 2. Predicted 2021 flows on ramps and local access roads are shown in Table 4-6 and Table 4-7 of working paper 2.

Based on preliminary noise modelling, approximately 740 residences were identified as potentially affected by the Proposal. Noise levels have been predicted at each location 10 years after opening of the Proposal. For ease of reference, specific areas or sections of the Proposal have been defined as noise catchment areas (refer Figure 11.2). There were 23 noise catchment areas identified as part of the assessment.

11.2.2 Operational noise assessment results

To ensure the Proposal meets the requirements of the *Environmental Criteria for Road Traffic Noise*, a sensitivity factor of 1dBA has been added to all predicted noise levels for the 2021 design noise model to ensure that any variation in noise levels due to potentially increased speeds or traffic volumes are provided for.

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Refer Figure 11.2

Initial noise modelling was undertaken based on the Proposal being surfaced with a hessian-dragged tyned concrete surface. Results of this initial noise modelling indicated that more than 360 residences would require implementation of noise management measures and that noise barriers would have been required over most sections of the alignment. The majority of the residences requiring treatment were located along the southern upgrade section.

Further modelling indicated that, with a low-noise pavement surface, less than 140 of the modelled residences would require noise mitigation measures and that the majority of residences would experience a reduction in noise levels compared to existing noise levels. The low-noise surface was therefore adopted as an appropriate noise control measure over the majority of the Proposal from the commencement at Sapphire to approximately 700 metres north of Bark Hut Road on the bypass section. North of Bark Hut Road the pavement wearing surface would be concrete or a similar material. The pavement design may be refined during the detailed design stage.

Table 11.4 outlines the results of noise modelling, by noise catchment area, on the number of residences where the criteria would be exceeded and discusses general management measures proposed to meet the criteria. The results include the 1dBA sensitivity and consideration of a low-noise pavement to 700 metres north of Bark Hut Road and concrete pavement north of that point. The results provided in Table 11.4 are based on noise modelling results that do not consider the introduction of noise barriers.

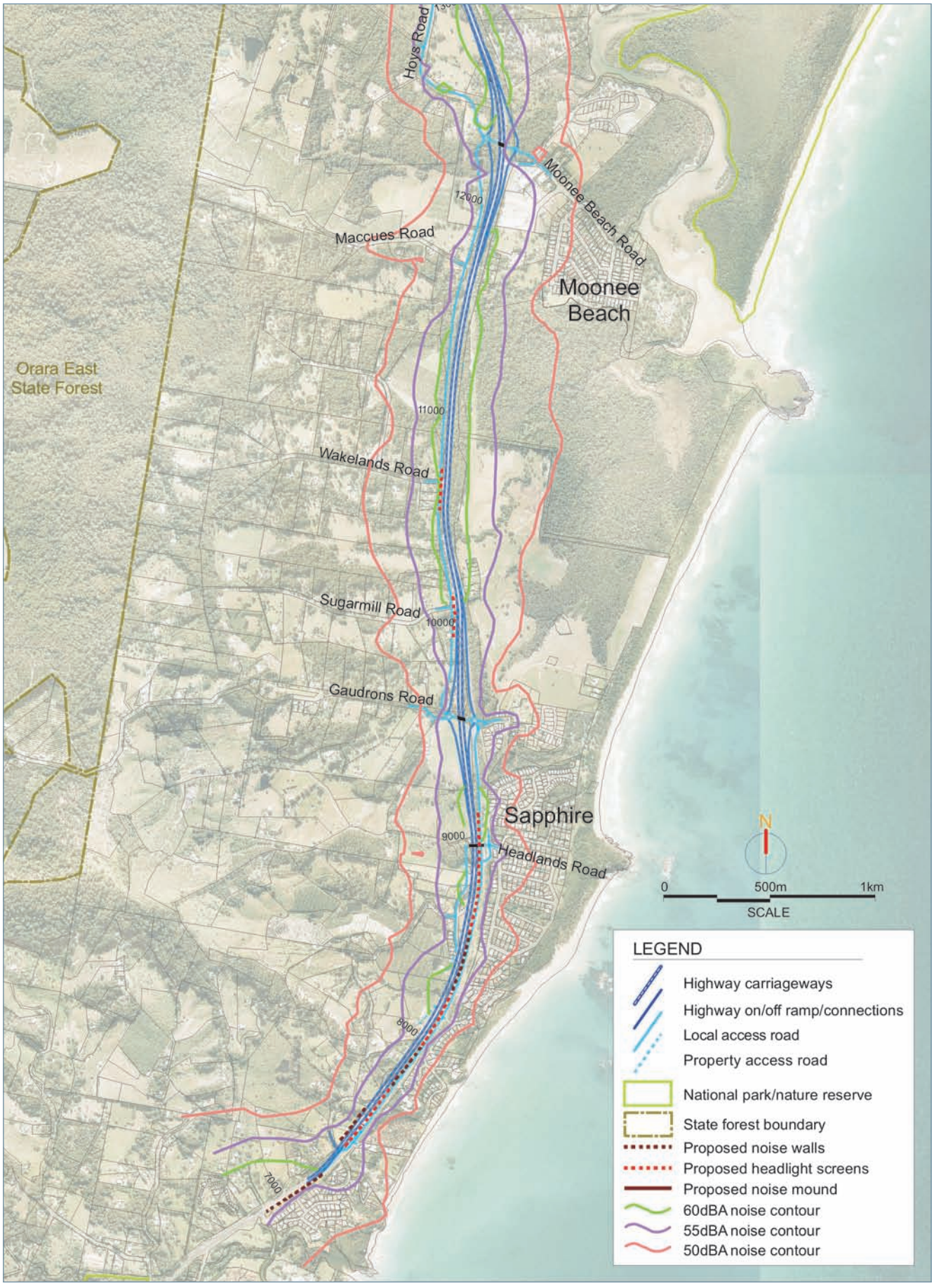
TABLE 11.4 NOISE MODELLING RESULTS BY NOISE CATCHMENT AREA[1]

NOISE CATCHMENT AREA (NCA)	NCA DESCRIPTION	RESULTS	PROPOSED MITIGATION MEASURES
Western side of the proposed highway			
1	Southern limit of Proposal to Gaudrons Road.	Eleven residences are predicted to have noise levels that exceed the criteria.	One noise barrier is proposed within this NCA. Architectural treatments are proposed at six residences where noise levels are predicted to exceed the criteria with the noise barriers in place and where barriers are not considered appropriate given the separation between dwellings or where houses are situated high above the road.
2	Gaudrons Road to north of Maccues Road.	Noise levels are predicted to fall by approximately 2-5dBA.	Noise mitigation measures are not required within this NCA.
3	South of Moonee Beach interchange to Killara Avenue overpass.	Noise levels are generally predicted to fall by approximately 1-2dBA. However, the noise level at one residence within this NCA is still predicted to be acute.	Architectural treatment is proposed at the one residence.
4	Killara Avenue overpass to north of Smiths Road.	Noise levels are generally predicted to fall by approximately 2-3dBA. However, the noise level at three residences within this NCA is still predicted to be acute.	Architectural treatments are proposed at the three residences.

NOISE CATCHMENT AREA (NCA)	NCA DESCRIPTION	RESULTS	PROPOSED MITIGATION MEASURES
Western side of the proposed highway			
5	North of Smiths Road to north of Graham Drive South.	Three residences are predicted to have acute noise levels.	Architectural treatments are proposed at the three residences.
6	North of Graham Drive North to north of Blackbutt Avenue.	Residences closest to the alignment are predicted to have exposure to noise levels that exceed the criteria.	Noise barriers proposed at two locations. Architectural treatments are also proposed at four residences.
7	North of Blackbutt Avenue to south of Greys Road (Bypass section).	All residences are predicted to have noise levels within the criteria, with noise levels 1-4dBA less than future levels for the existing highway (the do-nothing scenario).	Noise mitigation measures are not required within this NCA.
8	South of Greys Road to Newmans Road (Bypass section).	Nine residences are predicted to have exposure to noise levels that exceed the criteria.	Noise barriers proposed at three locations. Architectural treatments are also proposed at three residences.
9	Newmans Road to northern limit of Proposal.	Four residences are predicted to have exposure to noise levels that exceed the criteria.	A noise barrier would be inefficient at this location and it would not be possible to meet the base criteria at these residences. Architectural treatments are proposed at the four residences.
Eastern side of the proposed highway			
10	Northern limit of Proposal to Arrawarra interchange.	Noise levels are predicted to increase by 1-2dBA. However, all levels are within the criteria.	Noise mitigation measures are not required within this NCA.
11	Northern Bypass section to south of Newmans Road.	Sixteen residences are predicted to have noise levels that exceed the criteria.	Noise barriers proposed at four locations within this NCA. Architectural treatments are also proposed at three residences.
12	South of Newmans Road to Greys Road.	Three residences are predicted to have noise levels that exceed the criteria.	Noise barriers are not an efficient means of controlling noise at this location due to the local topography. Architectural treatments are proposed at the three residences.
13	Greys Road to South Woolgoolga interchange.	Residents in this NCA have exposure to noise from a different direction. In applying the precautionary principle, the new noise source is considered significant, as defined in Practice Note (i) of the Environmental Noise Management Manual. The "new road" criteria would apply at the western façades of the residences. Three residences are predicted to have noise levels that exceed the criteria.	Architectural treatments are proposed at the three residences.

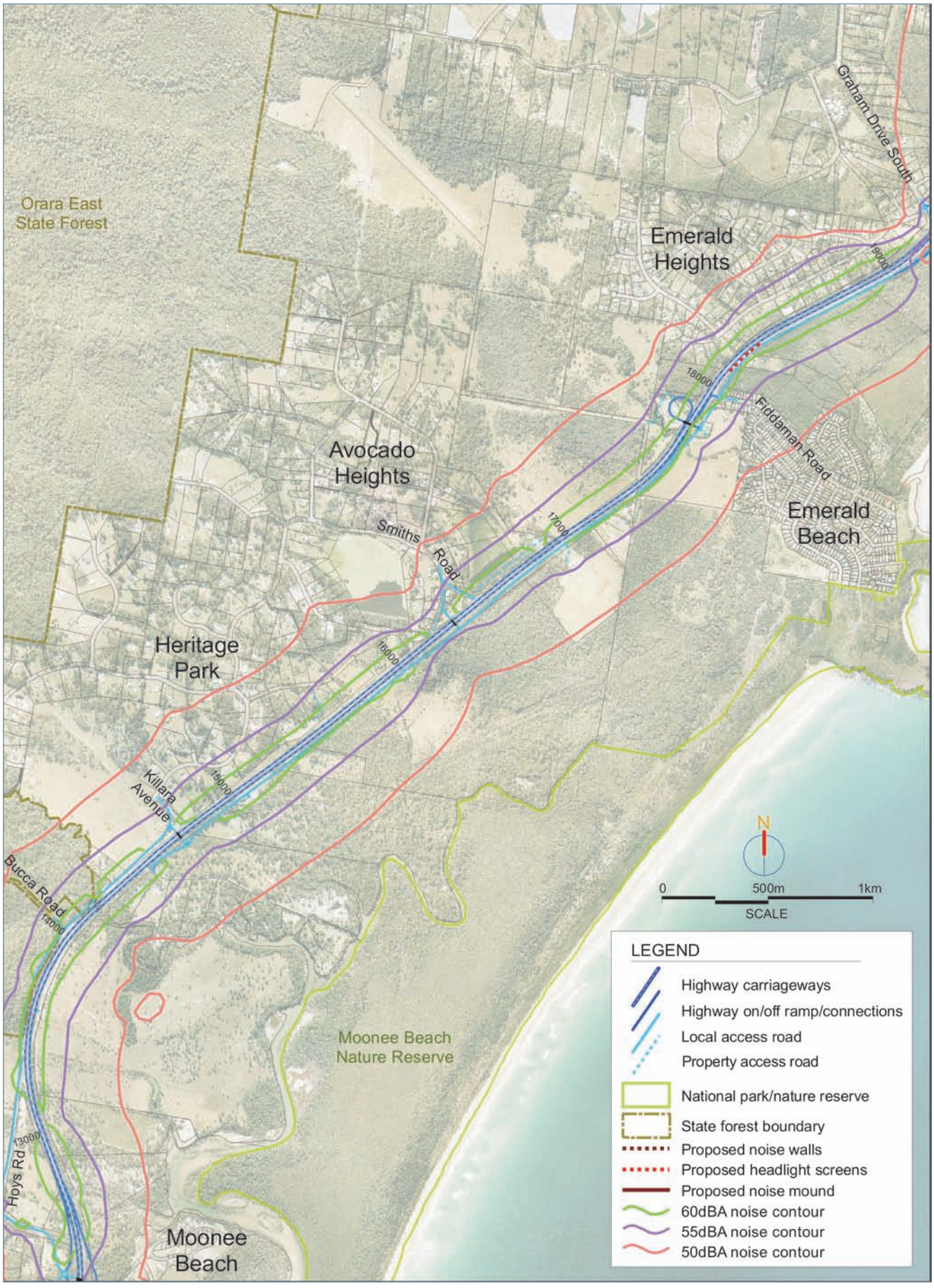
NOISE CATCHMENT AREA (NCA)	NCA DESCRIPTION	RESULTS	PROPOSED MITIGATION MEASURES
Eastern side of the proposed highway			
14	South Woolgoolga interchange to north of Sandy Beach.	Noise levels are predicted to fall by between 3-6dBA.	Noise mitigation measures are not required within this NCA.
15	North of Sandy Beach to north of Emerald interchange.	Noise levels are predicted to fall in this NCA. However nine residences are still predicted to have acute noise levels.	Noise barriers proposed at two locations within this NCA. Architectural treatments are also proposed at five residences.
16	Emerald Beach	There would be very little change in noise levels for residences in this NCA, although one residence is predicted to experience a slight increase in noise to an acute level.	Architectural treatment is proposed at the one residence.
17	South of Emerald Beach to Killara Avenue.	Noise levels are predicted to fall by 2 5dBA.	Noise mitigation measures are not required within this NCA.
18	Killara Avenue to north of Moonee Beach interchange.	Noise levels are predicted to fall by 2-3dBA. However, one residence is predicted to experience a slight increase in noise to an acute level.	Architectural treatment is proposed at the one residence.
19	Moonee Beach interchange.	Residences would experience a net reduction in noise levels of 2-3dBA.	Noise mitigation measures are not required within this NCA.
20	South of Moonee Beach interchange to Gaudrons Road	Five residences are predicted to retain acute noise levels despite a general reduction of 1-2dBA in this NCA.	Architectural treatments are proposed at the five residences.
21	South of Gaudrons Road to southern limit of Proposal.	Three groups of residences are predicted to have noise levels that either exceed Environmental Criteria for Road Traffic Noise allowance or are acute.	Noise barriers proposed at three locations within this NCA. Architectural treatments are also proposed at four residences. Existing Highway
Existing highway			
22	North of Newmans Road.	Noise levels are predicted to fall by 5-10dBA.	Noise mitigation measures are not required within this NCA.
23	South of Newmans Road.	Noise levels are predicted to fall by typically 3-9dBA. However, six residences are predicted to retain acute noise levels.	Assess the need to implement architectural treatments between six months and one year after opening the project.

[1] Noise barrier details and the extent of architectural treatments would be further refined during the detailed design of the project and may vary from those nominated in the table.



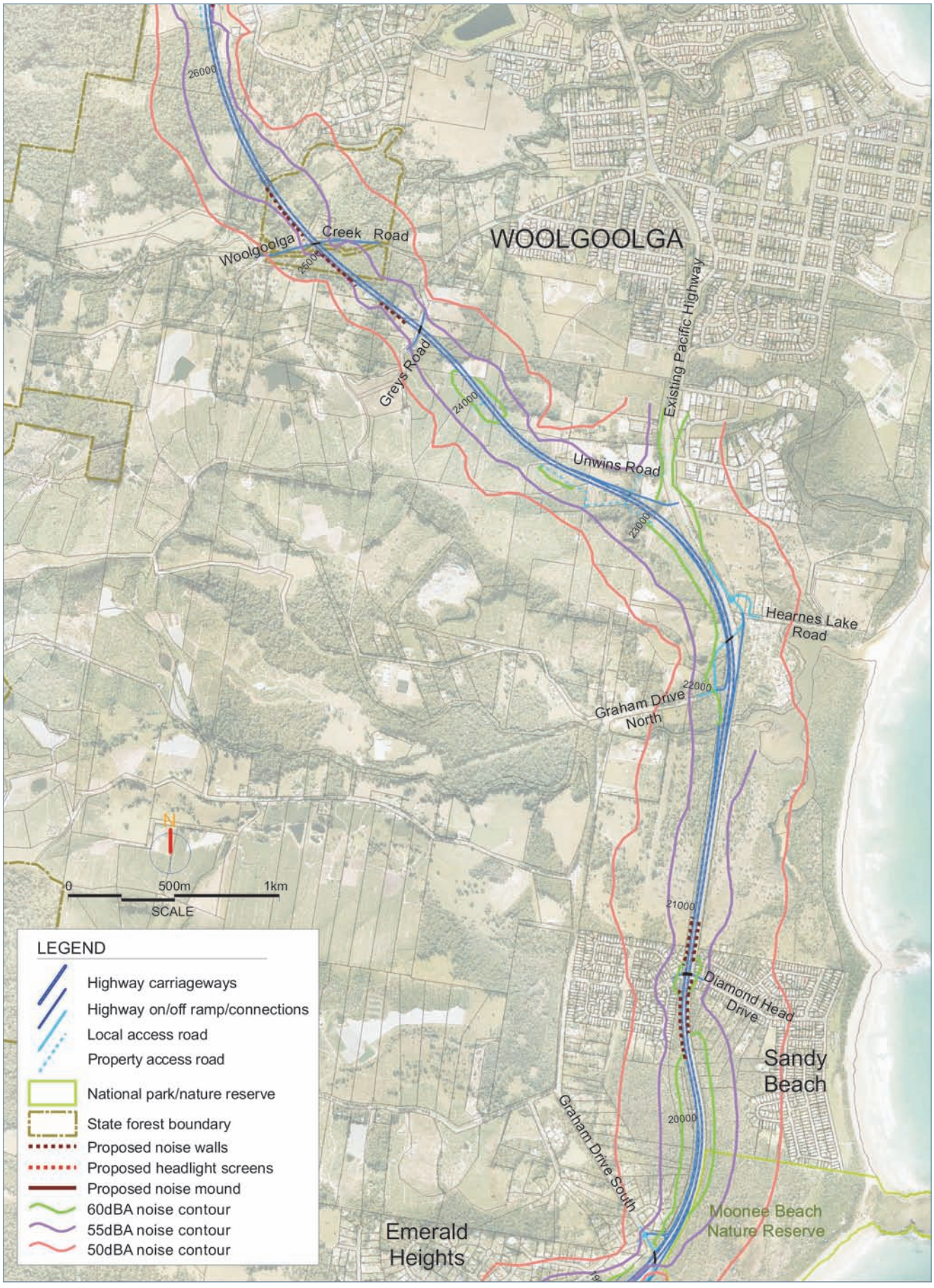
Source: Aerial photography 2005 (Roger Dwyer & Associates) Cadastral Boundaries May 2007 (CHCC)

FIGURE 11.3a PREDICTED NOISE LEVELS AT 2021 (INCLUSIVE OF NOISE BARRIERS)



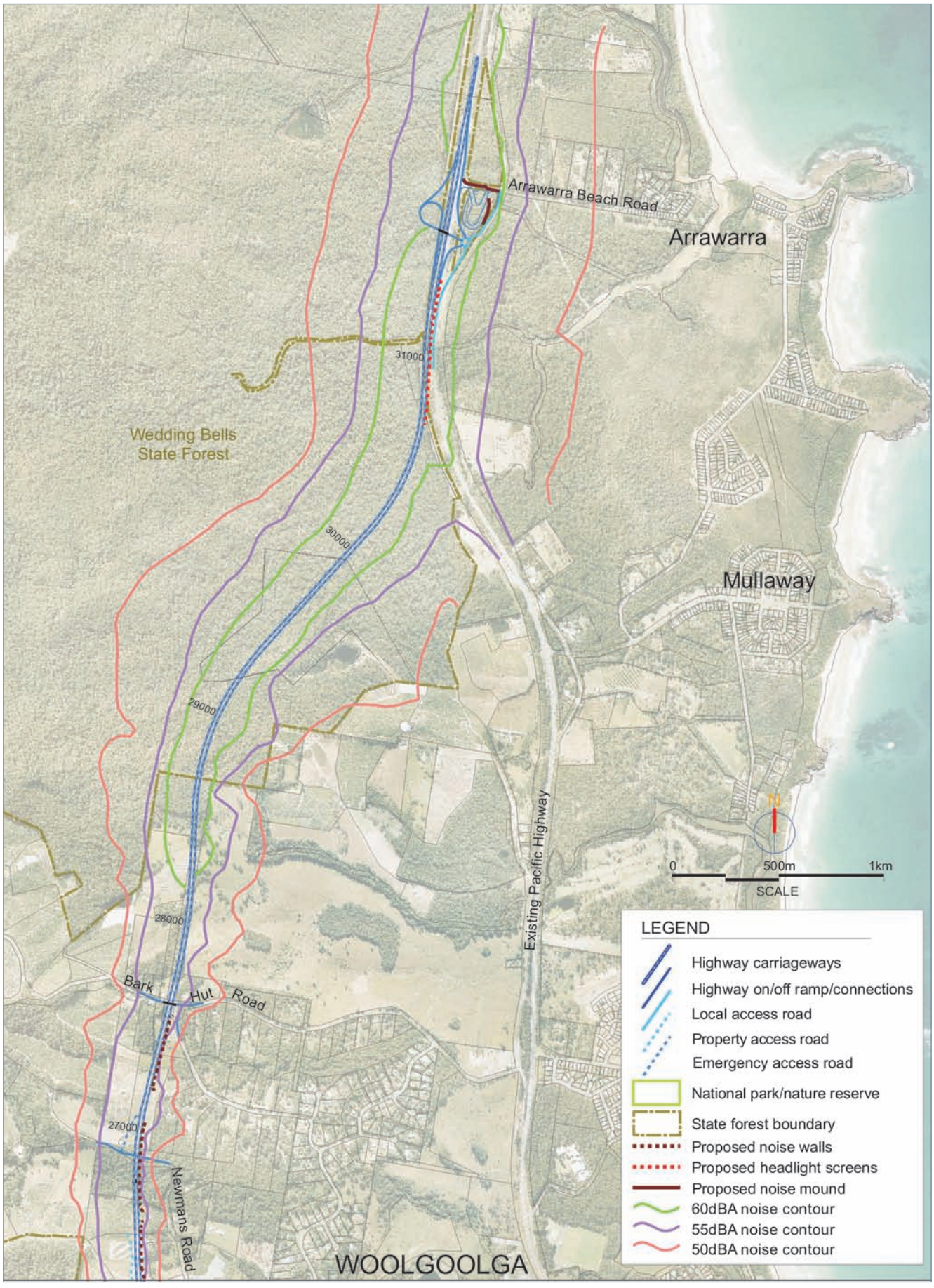
Source: Aerial photography 2005 (Roger Dwyer & Associates) Cadastral Boundaries May 2007 (CHCC)

FIGURE 11.3b PREDICTED NOISE LEVELS AT 2021 (INCLUSIVE OF NOISE BARRIERS)



Source: Aerial photography 2005 (Roger Dwyer & Associates) Cadastral Boundaries May 2007 (CHCC)

FIGURE 11.3c PREDICTED NOISE LEVELS AT 2021 (INCLUSIVE OF NOISE BARRIERS)



Source: Aerial photography 2005 (Roger Dwyer & Associates) Cadastral Boundaries May 2007 (CHCC)

FIGURE 11.3d PREDICTED NOISE LEVELS AT 2021 (INCLUSIVE OF NOISE BARRIERS)

Operational noise management measures (noise barriers and architectural or 'on property' noise reduction treatments) form part of the Proposal and as such are detailed in Chapter 7. The extent and height of noise barriers and the number of architectural noise reduction treatments proposed to meet the *Environmental Criteria for Road Traffic Noise* criteria are outlined by noise catchment area. The predicted noise levels and locations of proposed noise barriers are illustrated in Figures 11.3a to 11.3d. The proposed noise management measures would be reviewed and refined, where necessary, following community consultation and as part of the development of the detailed design.

The predicted change in traffic night-time noise levels from 2011 to 2021 are discussed within the noise catchment areas. For this assessment, the noise catchment areas were combined into receptors west of the upgrade section, east of the upgrade section and those located adjacent to the bypassed section of the existing highway in the Woolgoolga area (approximately between Unwins Road and Arrawarra Creek). Predicted noise level changes are discussed below and assessed with the proposed operational noise management measures in place. Figure 11.4 provides an illustration of the results in the form of frequency histograms.

For the residents located to the west of the upgrade section, the predicted change in night time noise levels are summarised as follows:

- Approximately 60 residences would experience a decrease of 3 to 6dBA inclusive.
- Approximately 143 residences would experience a decrease of 1 or 2dBA.
- Approximately 32 residences would experience no change in levels.
- Approximately 45 residences would experience an increase of 1 or 2dBA.
- Approximately 12 residences would experience an increase of 3 to 7dBA inclusive.

For the residents located to the east of the upgrade section of the Proposal, the predicted change in night time noise levels are summarised as follows:

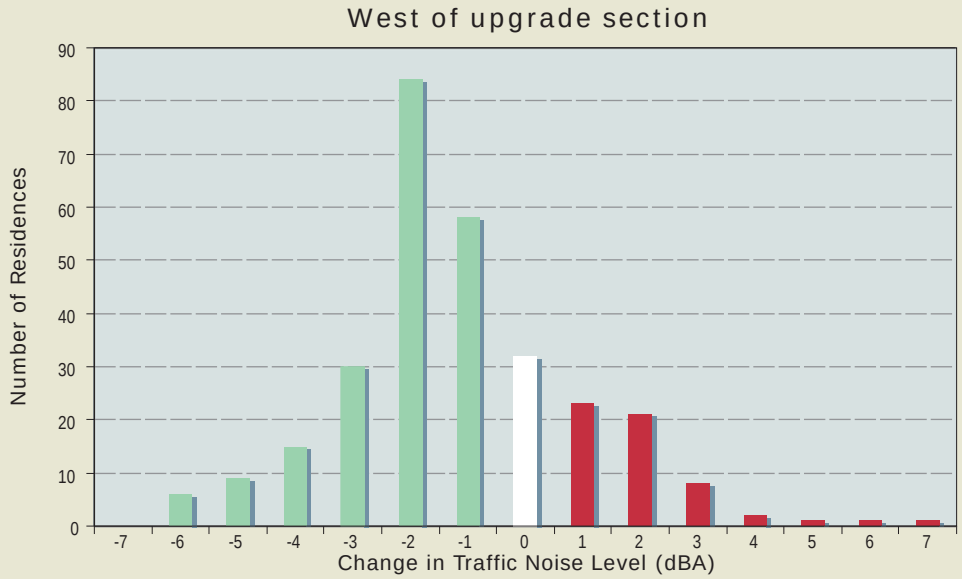
- Approximately 70 residences would experience a decrease of 6 to 10dBA inclusive.
- Approximately 225 residences would experience a decrease of 1 to 5dBA inclusive.
- Approximately 37 residences would experience no change in levels.
- Approximately 20 residences would experience an increase of 1 to 3dBA inclusive.
- No residences would experience an increase of greater than 3dBA.

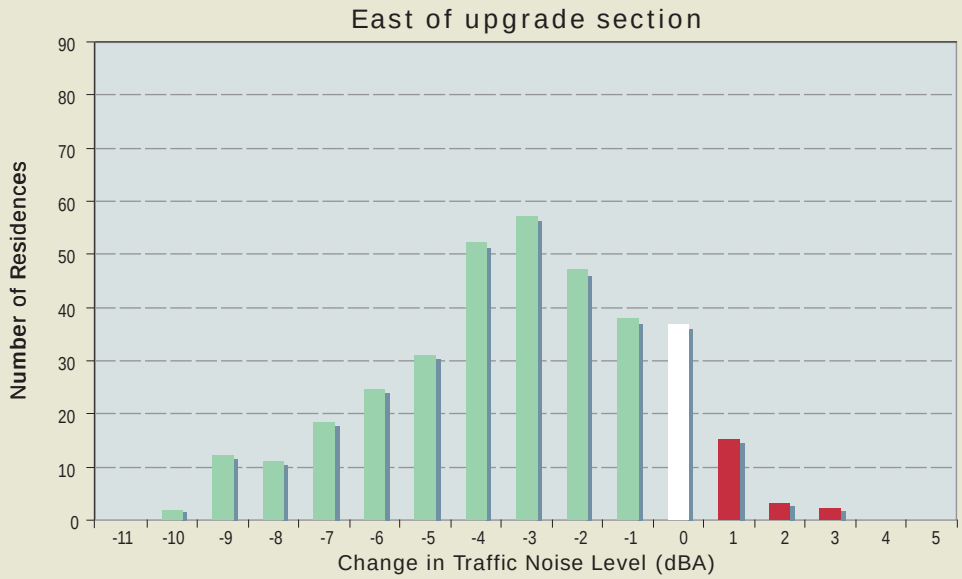
For the residents adjacent to the existing highway in the Woolgoolga area, the predicted change in night time noise levels are summarised as follows:

- All residences would experience a decrease in levels.
- Approximately 56 residences would experience a decrease of 6 to 10dBA inclusive.
- Approximately 40 residences would experience a decrease of 1 to 5dBA inclusive.

Figure 11.4 outlines the number of residences predicted to experience changes in night time noise levels over those noise catchment areas where there is existing exposure to traffic noise from 2011 to 2021. The noise catchment areas have been combined into residences west of the proposed upgraded section; east of the proposed upgraded section; and the bypassed section of the existing Pacific Highway. Change in noise levels at residences is calculated with proposed barriers in place.

As residences near the proposed bypass section have little or no existing exposure to road traffic noise, the relationship between existing night time ambient noise levels and predicted night time traffic noise levels in 2021 at these residences has been investigated. Section 7.2 of the working paper identifies a measured ambient background LA90 noise level of 32dBA for the bypass section and this level is adopted for the comparison. Figure 11.5 illustrates the difference between the two noise parameters for residents situated along the proposed bypass section.





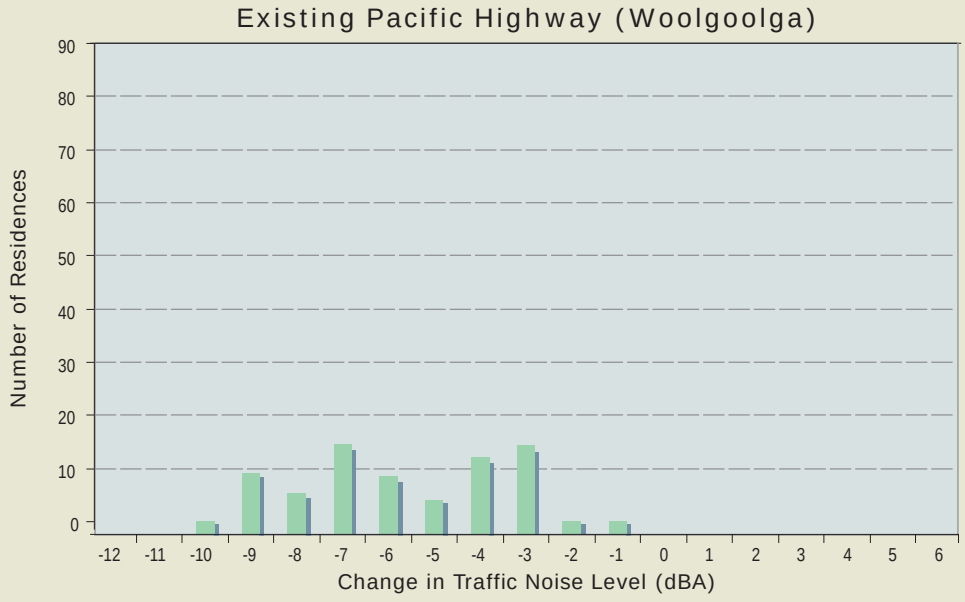


FIGURE 11.4 PREDICTED CHANGE IN TRAFFIC NIGHT-TIME NOISE LEVELS

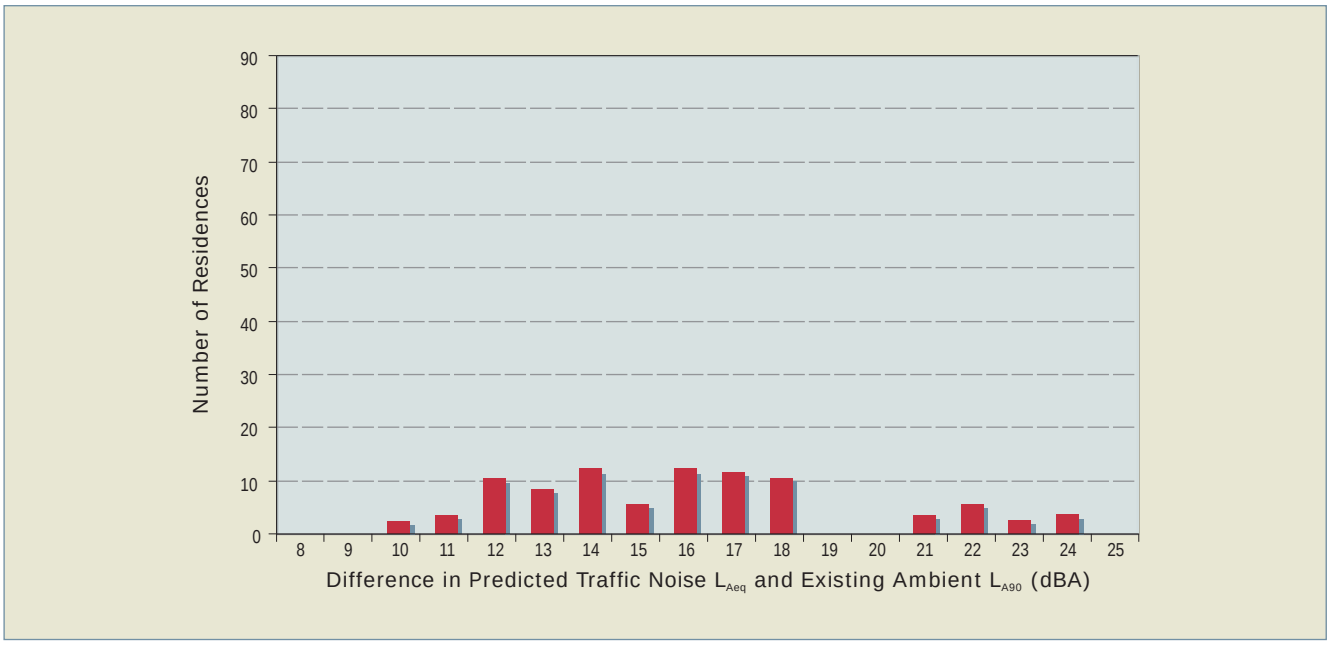


FIGURE 11.5 COMPARISON OF PREDICTED TRAFFIC NOISE WITH AMBIENT BACKGROUND NOISE FOR THE BYPASS SECTION

Traffic noise levels ten years after anticipated opening are predicted to exceed existing ambient background noise levels by between 10dBA and 24dBA at those residences near the proposed bypass section. However noise levels are predicted to be within Environmental Criteria for Road Traffic Noise for new roads at the majority of those residences with noise barriers and a low noise pavement in place. At the 16 residences where Environmental Criteria for Road Traffic Noise are exceeded, architectural treatments are proposed.

Arrawarra rest area

Predicted traffic volumes for assessing patronage of the proposed rest area have been derived from data obtained from an RTA survey carried out at a similar facility at Halfway Creek on the Pacific Highway. The survey outlined patterns of use for heavy vehicles over a weekend and weekday. It is reasonable to adopt a similar pattern of use to the proposed Arrawarra Creek rest area.

The predicted maximum utilisation of Arrawarra Creek rest area at 2021 is identified in Chapter 6 of working paper 2. It indicates that the most noise sensitive situation would be use at night time by heavy vehicles because this is the period of highest predicted usage by heavy vehicles and also the lowest noise criteria.

The noise levels at the northern and eastern residences have been calculated inclusive of noise mounding on the northern and eastern boundaries of the rest area to a height of at least 3.5 metres. The calculated $L_{Aeq,\ 15\ min}$ noise levels include moving vehicles and vehicles at rest and are provided in Table 6-6 of working paper 2. The calculated $L_{Aeq,\ 15\ min}$ noise levels are predicted to be within *Industrial Noise Policy* criterion at both locations.

The L_{Amax} noise levels have also been calculated inclusive of noise mounding and are within the *Environmental Noise Control Manual* guideline levels. The L_{Amax} noise level reaching the northern group of residences is 38dBA and the L_{Amax} noise level reaching the eastern group of residences is 46dBA. The relevant guideline levels for the northern and eastern residences are 50dBA and 48dBA respectively.

The assessment of traffic noise on the redeveloped highway and modelling of the rest area on and off ramps against *Environmental Criteria for Road Traffic Noise* criterion is provided in Section 6.4 of working paper 2. In summary, future existing $L_{Aeq,\ 9\ hr}$ noise levels (ie. predicted noise levels at

2011 without the Proposal) are calculated and form the basis of predictions of the 2021 $L_{Aeq,\ 9\ hr}$ noise levels. These levels are segregated into noise from the upgraded highway and ramps and shown with and without the rest area in operation. When rest area traffic is added to non-rest area traffic on the ramps, the noise level at residences is predicted to increase by approximately 3dBA. This level is at least 14dBA below the predicted noise level produced from traffic on the proposed highway and as such, traffic noise on ramps associated with operation of the rest area would have a negligible impact on residences.

The results indicate that noise from traffic on the highway is dominant at both locations, to the extent that noise from traffic using the ramps is likely to be inaudible.

The proposed noise management measures identified for the rest area would be reviewed and refined, where necessary, following community consultation and as part of the development of the detailed design.

11.3 Maximum noise level assessment

Although there are no specific criteria relating to sleep disturbance in *Environmental Criteria for Road Traffic Noise*, the document recommends that an assessment of such levels be undertaken where impacts may occur during the night. The only guidance offered in terms of acceptable maximum noise levels are:

- Maximum internal noise levels below 50 to 55dBA are unlikely to cause awakening reactions.
- One or two noise events per night with maximum internal noise levels of 65 to 70dBA are not likely to significantly affect health and wellbeing.

The RTA's *Environmental Noise Management Manual* puts forward a protocol for assessing maximum traffic noise levels. In Practice Note (iii) the document states:

At locations where road traffic is continuous rather than intermittent, the $L_{Aeq,9\ hr}$ target noise levels should sufficiently account for sleep disturbance impacts. A "maximum noise event" can therefore be defined as any pass by for which L_{Amax}-$L_{Aeq,\ 1hr}$ is greater than or equal to 15dBA.

The method for assessment of maximum noise levels is provided in working paper 2. In applying the protocol for assessing maximum noise levels from the *Environmental Noise Management Manual*, a conservative estimate of the minimum distance from the highway to satisfy the guidelines in *Environmental Criteria for Road Traffic Noise* is 55 metres. This distance is calculated inclusive of low noise pavement, however is conservative as it does not take into account additional attenuation provided by roadside noise barriers, or areas where the road is in cutting and topographic shielding of noise would occur.

There are three residences at Hunter Close, Sapphire within 55 metres of the highway where noise barriers are not currently proposed. These residences would be considered as part of further assessment of maximum noise impacts during the detail design stage. It should also be noted that with regard to the upgrade section of highway, although the frequency of maximum events is predicted to increase, the actual internal L_{Amax} noise level would decrease by up to 5dBA from current levels due to the introduction of a low-noise pavement. This reduction would not apply to other maxima associated with heavy vehicles such as compression braking; however the redevelopment of the highway in itself would generally reduce the need for such braking.

There are two residences located on the bypass section of the Proposal that would be within 55 metres of the highway. Both of these residences have previously been identified and assessed for mitigation of operational noise.

11.4 Construction noise and vibration assessment

This construction noise and vibration assessment has been undertaken based on the assumption that the equipment used would be similar to that used on other highway projects. An assessment of the actual construction noise and vibration impacts would require information on the actual equipment used, detailed (actual) construction methodology and final locations of construction compounds. At this time, these details have not been determined for the Proposal.

11.4.1 Criteria for construction noise and vibration

Noise

Guidelines for the assessment of construction noise are specified in the Department of Environment and Climate Change's *Environmental Noise Control Manual*. The guidelines indicate that:

- For periods of four weeks or less, the L_{A10} level should not exceed the background (L_{A90}) level by more than 20dBA; and
- For periods greater than four weeks and less than 26 weeks, the L_{A10} level should not exceed the background (L_{A90}) level by more than 10dBA.

Although not clearly stated in the *Environmental Noise Control Manual*, past practice has indicated that, for periods greater than 26 weeks, the Department of Environment and Climate Change would expect that the L_{A10} level should not exceed the background (L_{A90}) level by more than 5dBA.

During the construction period there would be few fixed or constant construction sites. The centre of activity would generally move along the highway alignment as work progresses. Therefore, the criterion for construction periods longer than four weeks, but less than 26 weeks is applicable to this assessment. The exception to this would be at site of bridge construction, where periods of up to 18 months of non-constant activity would occur.

Construction noise from major construction sites such as large interchanges or batching plants and compound sites would occur for a period of more than six months. In these cases, a suitable noise criterion is that the L_{A10} level should not exceed background (L_{A90}) level by more than 5dBA. This noise criterion would also apply in cases where it is impossible or impractical to restrict road construction activities to within the current Department of Environment and Climate Change specified work hours (Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm, no work on Sundays or public holidays).

In addition, where any work is conducted during the night-time period (10pm to 7am), the Department of Environment and Climate Change currently recommends that the L_{A1} maximum noise level should not exceed the background level by more than 15dBA at any residence to avoid sleep disturbance. While there are no specific criteria relating to sleep disturbance in the *Environmental Criteria for Road Traffic Noise*, the document advises that maximum internal noise levels below 50-55dBA are unlikely to cause awakening reactions.

Table 11.5 provides a summary of the project specific noise criteria for the upgrade section and the bypass section of the Proposal.

TABLE 11.5 SUMMARY OF PROJECT SPECIFIC NOISE CRITERIA

SECTION	RBL DAY, (dBA)	RBL NIGHT, (dBA)	CONSTRUCTION NOISE DAY, L_{A10}	CONSTRUCTION NOISE NIGHT, L_{A10}[1]	CONCRETE BATCHING PLANT, L_{Aeq}	L_{Amax}, NIGHT[1]
Upgrade section	45	35	55	40	50	50
Bypass section	35	32	45	37	40	47

[1] No significant construction work is proposed to take place at night. Any night works would be subject to consultation with the Department of Environment and Climate Change.

Vibration criteria (excluding blasting)

The Department of Environment and Climate Change has recently released *Assessing Vibration: A Technical Guideline* (February 2006). It considers impacts from vibration in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). The guideline gives "preferred" and "maximum" vibration levels at buildings exposed to continuous and impulsive vibration. For construction activities, the guideline is to apply the criteria for maximum continuous vibration. Table 11.6 provides a summary of the vibration criteria for both human comfort and building damage.

TABLE 11.6 VIBRATION CRITERIA

RECEIVER	VIBRATION CRITERIA, MAXIMUM PEAK VELOCITY (MM/S)	
	HUMAN COMFORT	BUILDING DAMAGE
Residential buildings during daytime	0.28	10
Residential buildings during night time	0.20	10
Offices during day	0.56	10

Blasting

For assessment of annoyance due to blasting, the Department of Environment and Climate Change has adopted guidelines produced by the Australian and New Zealand Environment and Conservation Council. The fundamental criteria at any residence or other sensitive location are:

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

At sufficiently high levels, blast overpressure may in itself cause structural damage to some building elements such as windows. However, this occurs at peak overpressure levels of about 133dB, well in excess of criteria for annoyance.

For assessment of damage due to ground vibration, *Australian Standard AS2187.2-1993 Explosives – Storage, Transport and Use* specifies recommended levels for peak particle vibration velocity to protect typical buildings from damage. These are:

- 5 mm/sec for "structures that may be particularly susceptible to ground vibration".
- 10 mm/sec for "houses and low-rise residential buildings and commercial buildings not included below".
- 25 mm/sec for "commercial and industrial buildings or structures of reinforced concrete or steel construction".

11.4.2 Equipment and construction compounds

Total sound power levels for various mobile construction activities have been predicted based on the typical construction equipment required for each identified activity. Table 7-3 of working paper 2 identifies the typical equipment used for the following activities:

- Milling and repaving – 113dBA
- Site establishment – 110dBA
- Vegetation removal – 111dBA
- Piling – 115dBA (bored), 120dBA (driven)
- Bridgeworks – 115dBA to 120dBA
- Earthworks – 114 (120)dBA
- Paving – 113 (116)dBA
- Landscaping – 109dBA

The list above indicates typical L_{A10} sound power levels predicted for each activity. The figures in the above list in brackets are for the occasional use of rock breakers, jackhammers and concrete saws. The typical L_{A10} sound power level predicted for a concrete batching plant is approximately 113dBA. The noise level experienced at any residence along the route would depend upon many factors, such as distance between the receiver and the activity (noise source) and the plant required for the activity.

The quietest activities, such as site preparation, would be up to 20dBA quieter than the noisiest activities if earthworks using rock breakers are used. Further, activities being undertaken in a cutting for example, would be quieter than if undertaken on an embankment as the topographical barrier would reduce noise reaching the receiver. Table 11.7 shows the range of noise levels that could be expected from the different construction activities at any one location and their expected duration.

TABLE 11.7 DURATION OF CONSTRUCTION ACTIVITIES AND PREDICTED TYPICAL NOISE LEVELS

CONSTRUCTION ACTIVITY	EXPECTED DURATION	PREDICTED NOISE LEVEL (L_{A10}) AT 30m	PREDICTED NOISE LEVEL (L_{A10}) AT 150m
Removal of corridor vegetation	3-4 weeks	65-75	40-50
Bulk earthworks	3 to 6 months	68-78	43-53
Drainage works	3 to 6 months	65-75	40-50
Bridge or bridge sized structures	30 [1]	68-78	43-53
Paving	3-4 weeks	68-78	43-53

1 Time for bridge construction would vary depending on the size and degree of difficulty; the most substantial bridgeworks may take up to 18 months.

Construction compound sites with nearby residential receivers would be configured such that site sheds and other materials form a barrier to noise generated on-site. The potential locations of site compounds and other ancillary sites (refer Chapter 8) have been selected based on project-specific criteria to address noise and other impacts during construction.

Noise emissions from batching plants and construction compounds are typically dominated by associated vehicle movements and use of plant and equipment. Specific consideration of noise effects and management measures would be completed as part of assessments undertaken at the stage of developing the construction environmental management plan when specific compound sites and activities have been determined by the appointed construction contractor.

The ultimate location of the site compounds and other ancillary infrastructure would be determined by the construction contractor and may include alternative suitable sites.

11.4.3 Construction vibration

Vibration criteria (maximum peak velocity (mm/s)) for construction of the Proposal relate to maximum continuous vibration and are defined in terms of human comfort and building damage. Building damage criteria are determined from *German Standard DIN 4150 and BS 7385: Part 2 – 1993 and British Standard BS 6472*. For residential buildings, the building damage criterion is 10 mm/s. For industrial buildings, the damage criterion is 36 mm/s.

Criteria for human comfort levels, which are taken from *Assessing Vibration: A Technical Guideline*, are considered to be the limiting factor when determining maximum vibration levels and are different for night time (0.20 mm/s), day time (0.28 mm/s) and at industrial buildings (1.1 mm/s).

The vibration levels predicted from construction plant required by the Proposal would not likely cause damage to buildings. It is possible, however, that vibration levels exceeding the criteria for human comfort would occur at some residences close to the proposed alignment. A 30 tonne hydraulic

hammer for example, is considered to typically induce a peak particle velocity vibration level of 3 mm/s, 1.5 mm/s and 1.0 mm/s at 10 metres, 20 metres and 30 metres respectively. A 4 tonne vibratory roller is considered to typically induce a peak particle velocity vibration level of 2.4 mm/s, 1.2 mm/s and 0.8 mm/s at 10 metres, 20 metres and 30 metres respectively. Vibratory impacts during construction are expected to be temporary as the vibration source moves away from residential areas. Proposed mitigation measures in relation to construction vibration are considered in Section 11.5.2.

11.4.4 Blasting vibration and overpressure

Based on the outcomes of the geotechnical investigation undertaken for the proposal, it is expected that blasting may be required at approximately 12 locations along the alignment (refer Figure 11.6). Ground vibration and airblast overpressure levels from blasting are related to the "scaled distance" from the blast, which is defined as:

- Scaled distance = $D/W^{(1/3)}$ for airblast overpressure, and
- Scaled distance = $D/W^{(1/2)}$ for ground vibration,

where D is the distance from the blast in metres and W is the maximum instantaneous charge of explosive, in kilograms of Ammonium Nitrate Fuel Oil equivalent.

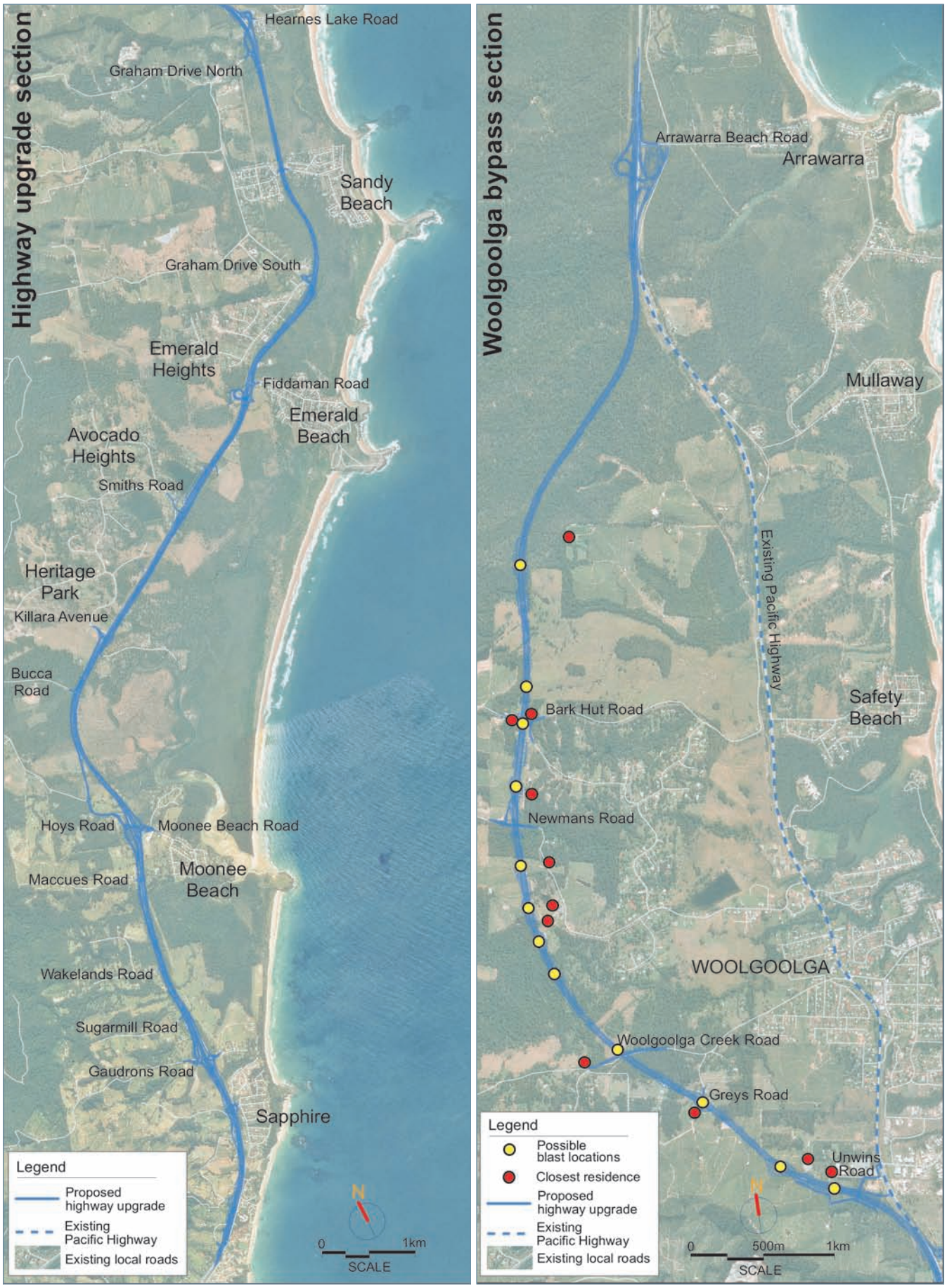
Table 11.8 shows the most likely proposed blast locations, distance to the nearest residential dwelling and maximum instantaneous charge to meet the Australian and New Zealand Environment Conservation Council annoyance guidelines.

TABLE 11.8 MAXIMUM INSTANTANEOUS CHARGE TO MEET ANNOYANCE GOALS

BLAST LOCATION (APPROXIMATE CHAINAGE)	DISTANCE TO CLOSEST RESIDENCE (METRES)	MAXIMUM INSTANTANEOUS CHARGE (kg)	
		95th PERCENTILE	BEST FIT
23.300 km	150	0.1	6
23.700 km	240	0.45	24
24.400 km	60	N/A	0.4
25.100 km	230	0.4	21
25.800 km	330	1.2	63
26.050 km	150	0.1	6
26.300 km	100	0.04	1.7
26.600 km	110	0.05	2.35
27.150 km	100	0.04	1.7
27.600 km	90	N/A	0.6
27.850 km	200	0.25	14
28.700 km	275	0.65	36

With regard to annoyance and discomfort, the calculated maximum instantaneous charges in Table 11.8 may not be cost-effective at locations close to residences (within approximately 150 metres) even when best-practice blasting techniques are implemented. Consideration would be given to alternative methods of removing rock in these locations, including the use of rock breaker equipment. However, alternative methods of removing rock, such as rock breaker equipment are likely to take longer than blasting. Residents may accept some form of short-term vibration impacts (exceeding annoyance goals), subject to building damage goals being achieved, rather than having to experience longer periods of noisy rock breaking activity.

The maximum instantaneous charge blasting configuration for each blasting location would be determined during the detailed design phase. Any decision regarding the use of blasting or rock breaker equipment would be undertaken in consultation with affected residents and the Department of Environment and Climate Change.



Source: Aerial photography August 2000 (LPI NSW)

FIGURE 11.6 POSSIBLE BLAST LOCATIONS

As blasting and seismic details would be determined during the detailed investigation and design phase, it would be necessary to carry out more detailed noise and vibration predictions once this information becomes available. The buffer zones associated with each blast site would be identified and appropriate measures implemented to limit the effects of the blast to acceptable levels. As the annoyance goals are more stringent than the levels for building damage goals, compliance with the annoyance goals would also result in compliance with the building damage goals.

11.5 Proposed management measures

11.5.1 Operational noise

(i) A reasonable and feasible approach will be adopted to limit operational noise impacts in accordance with the NSW Government's Environmental Criteria for Road Traffic Noise. The approach to operational noise impacts will be developed further during detailed design and in consultation with relevant property owners.

(ii) Low- noise pavement will be utilised from the southern limit of works at Sapphire to approximately 700 metres north of Bark Hut Road, Woolgoolga.

(iii) Noise barriers will be installed at the locations and to the specifications identified in the environmental assessment (subject to detailed design).

(iv) Architectural treatments will be provided to properties identified in the environmental assessment as requiring such (subject to further design refinement of the project; and to owner agreement).

(v) Monitoring of operational noise will be undertaken between six months and one year after opening along the proposed highway upgrade and within Woolgoolga. Should the monitoring indicate traffic noise levels exceeding the relevant noise level criteria in NSW Government's Environmental Criteria for Road Traffic Noise; the RTA will investigate and implement further "reasonable and feasible" mitigation measures. The selection of these measures will be undertaken in consultation with affected property owners.

The proposed operation phase noise and vibration management measures are outlined in Chapter 7 and the draft Statement of Commitments (Appendix A).

11.5.2 Construction noise and vibration

In order to appropriately manage construction noise and vibration impacts of the Proposal:

(i) Pre-construction noise monitoring will be undertaken in locations used to identify the background noise levels for the environmental assessment and/or at representative noise sensitive locations.

(ii) Construction activities will be restricted to construction hours for the Proposal. The hours will be 7.00am to 7.00pm Monday to Friday; 7.00am to 4.00pm Saturdays and no work on Sunday or public holidays except in accordance with commitment (iv) below.

(iii) Rock breaking, rock hammering, sheet piling, pile driving and any similar project activity will be scheduled only between the hours of 9 am to 12 pm and 2 pm to 5 pm, Monday to Friday; and 9 am to 12 pm, Saturday except in accordance with commitment (iv) below.

(iv) Works outside standard construction hours will be limited to:

- Any works that do not cause construction noise to be audible at any sensitive receivers.
- The delivery of materials required outside these hours by the Police or other authorities for safety reasons.
- Emergency work to avoid the loss of lives, property and/or to prevent environmental harm.
- Any other work as agreed after appropriate consultation with affected residents, the Department of Environment and Climate Change, and local council.

(v) All plant and equipment will be well maintained and fitted with adequately maintained silencers which meet the vehicle design specifications.

(vi) Prior consultation and notification will be undertaken with nearby residents that may be affected by noise or vibration generating activities.

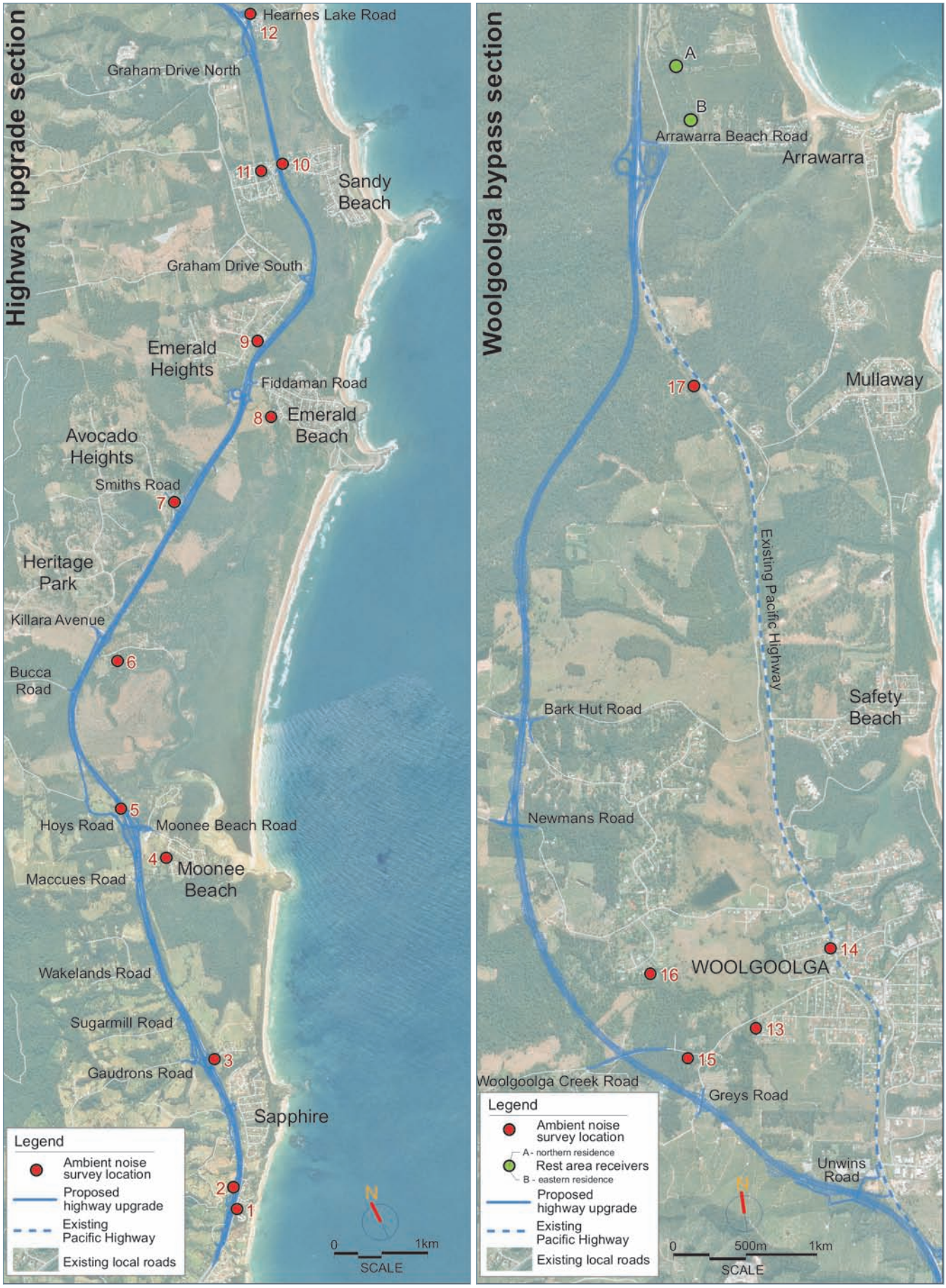
(vii) Public address systems used at any construction site will not be used outside normal construction hours except in accordance with commitment (iv) above. Public address systems will be designed to limit noise spillage off-site.

(viii) Blasting trials will be undertaken if blasting is to be used, with results from the trials used to determine site-specific blast designs to satisfy relevant performance criteria.

(ix) All reasonable attempts will be made to contact sensitive receivers located within 500 metres of a blast location. The contact will be made at least 48 hours before a blast and advice given to the receiver will include a schedule of blast time(s) and a telephone number and contact name.

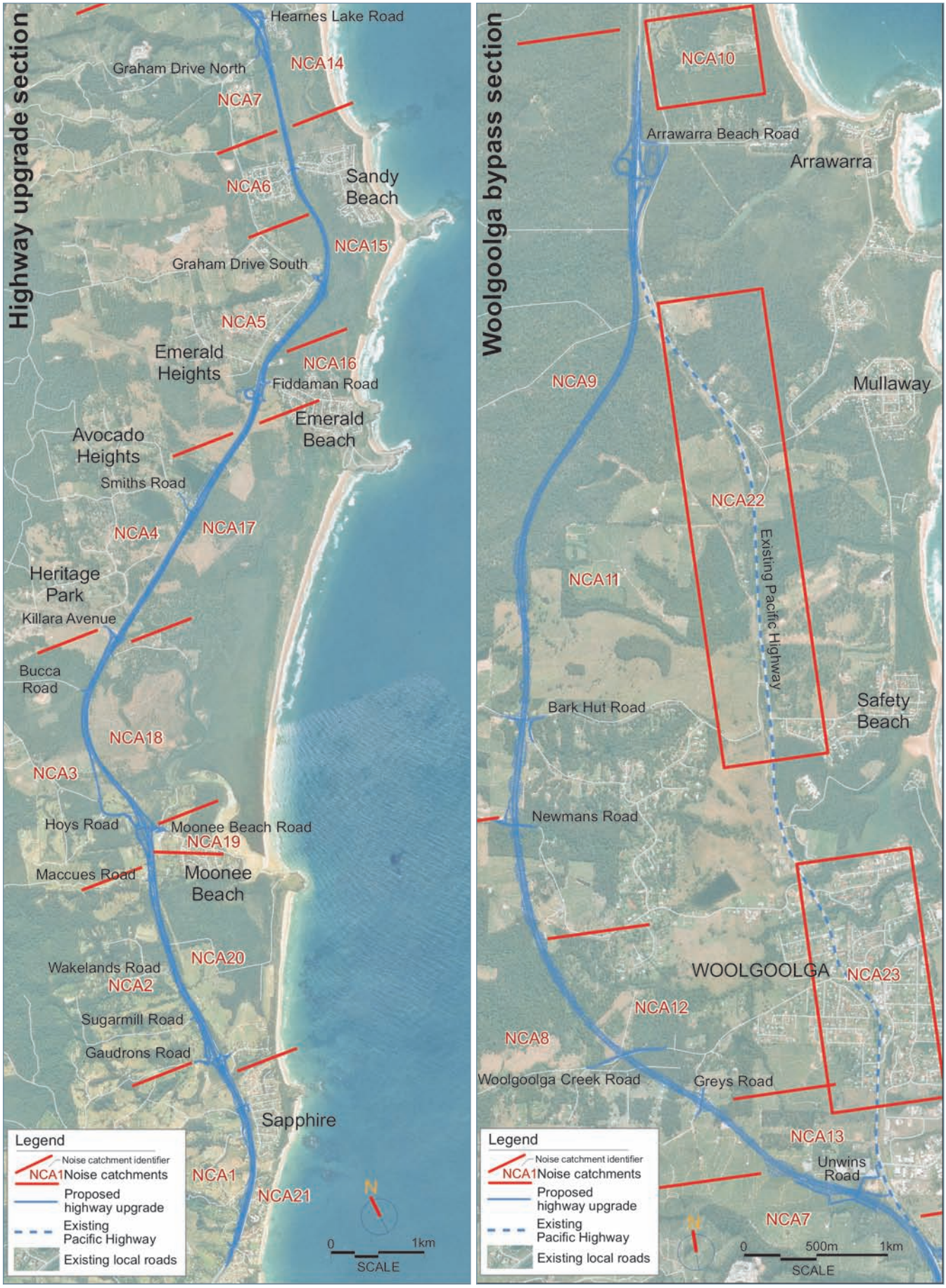
(x) Noise and vibration monitoring will be undertaken during construction to determine the effectiveness of mitigation strategies.

The proposed pre-construction and construction phase noise and vibration management measures are outlined in the draft Statement of Commitments (Appendix A). It should also be noted that commitments P2 to P5 in Appendix A are also relevant to item (vi) above.



Source: Aerial photography August 2000 (LPI NSW)

FIGURE 11.1 AMBIENT NOISE SURVEY LOCATIONS



Source: Aerial photography August 2000 (LPI NSW)

FIGURE 11.2 NOISE CATCHMENT AREAS