16. Noise and vibration

16.1 Assessment approach

A noise and vibration assessment was undertaken in September 2006. This study included an assessment of the potential noise and vibration impacts associated with construction and operation of the proposed upgrade. The study identified sensitive locations and assessed potential noise and vibration impacts against noise and vibration criteria developed by the NSW Department of Environment and Climate Change (previously the Department of Environment and Conservation and the NSW Environment Protection Authority) and the RTA.

The approach taken to the assessment of noise impacts included quantifying the existing acoustic environment through noise monitoring, establishing project-specific noise criteria, and establishing noise models for the construction and operation phases. The results of the noise models were assessed and recommendations developed to reduce noise impacts where they are considered likely to occur. An assessment of potential vibration during construction was also undertaken to determine potential impacts on sensitive receivers and infrastructure.

This chapter presents a summary of the key noise components associated with the proposed upgrade. Details of assessment methodology and outcomes of the noise modelling and analysis are provided in Technical Report 3 – *Noise and Vibration Assessment* (NSW Roads and Traffic Authority 2007b) in Volume 2.

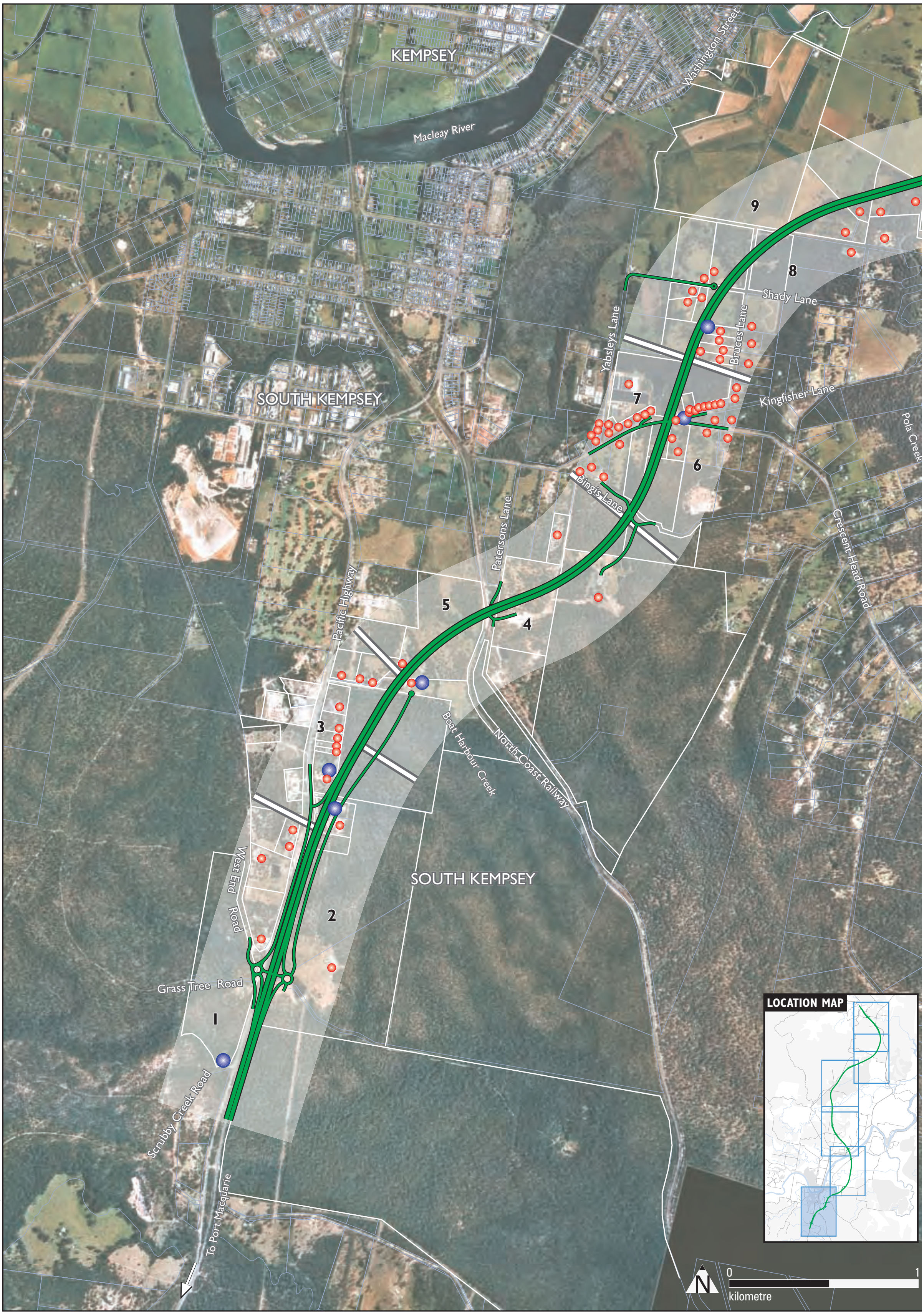
16.2 Existing noise environment

The existing noise environment surrounding the proposed upgrade includes areas that are exposed to low levels of road traffic noise where residential development is sparse, including the area near Collombatti Rail and rural-residential land to the south-east of the proposed upgrade. Other sections of the proposed upgrade exposed to higher levels of traffic noise associated with the existing Pacific Highway include South and East Kempsey and Frederickton, from the proposed Macleay River crossing to east of Frederickton, and from Barraganyatti through to the existing dual carriageway north of Eungai Rail.

To facilitate the assessment of noise impacts, the proposed upgrade was divided into 31 separate noise catchments comprising the study area. Each of the 31 noise catchments was defined by similar noise exposures and extends around 300 metres from the proposed upgrade. Noise monitoring was undertaken along the proposed upgrade at representative locations to determine the existing acoustic environment surrounding the proposed upgrade corridor. Measurements were taken of background noise levels and existing traffic noise levels, where appropriate. The 31 noise catchments and noise monitoring locations are shown in Figure 16-1.

Residences in the study area include both one-storey and two-storey dwellings. Many of these, particularly in low-lying areas, are elevated above-ground by up to 2 metres. A total of 116 residences are located within or adjacent to the proposed upgrade corridor, including five two-storey or elevated one-storey residences. A number of residences would be raised in level as part of the proposed upgrade to mitigate against flood impacts, details of these adjustments would be confirmed during detailed design.

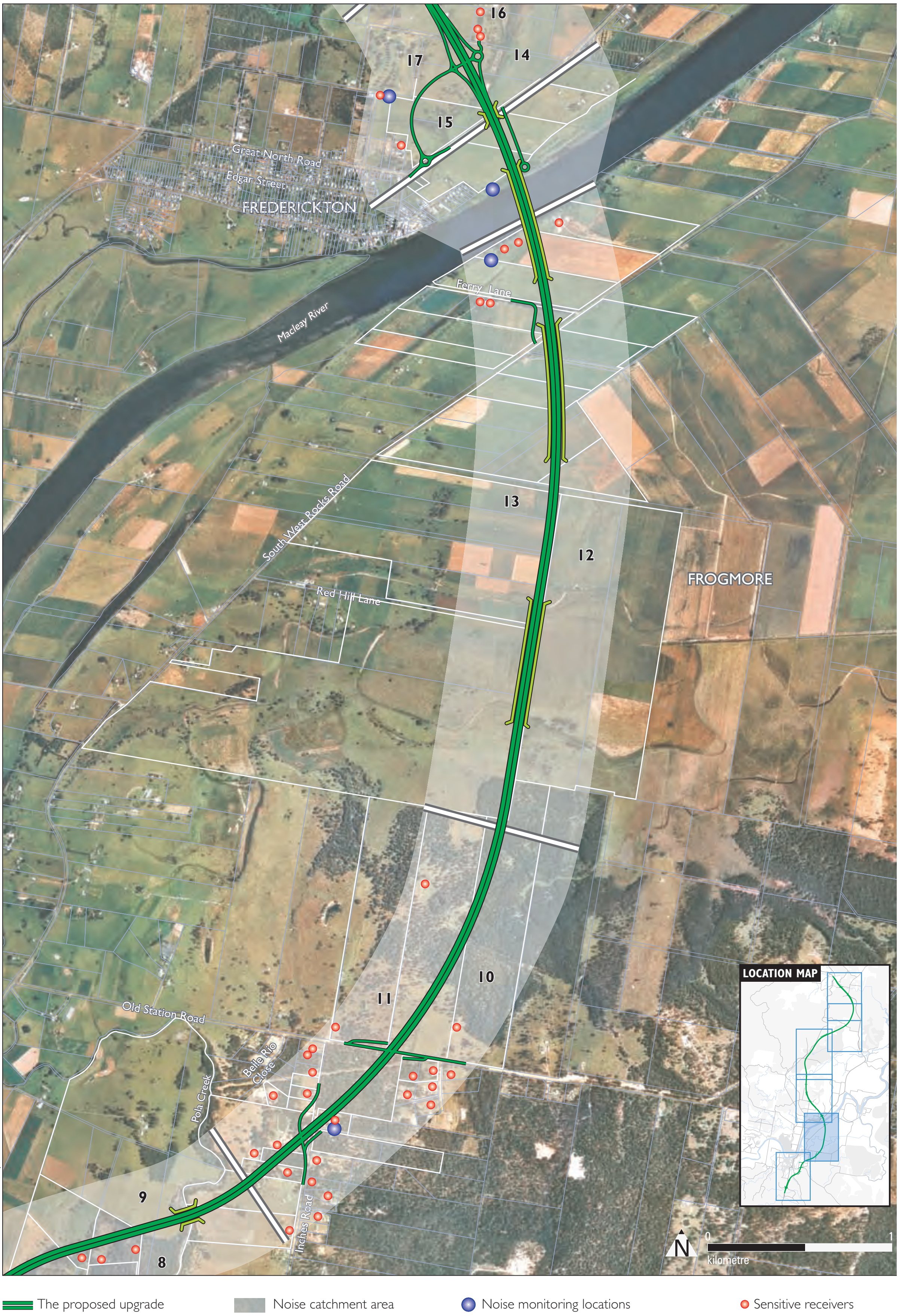
Figure 16-1a Noise catchment areas and location of noise monitoring



Source: Technical Report 3 - Noise and Vibration Assessment

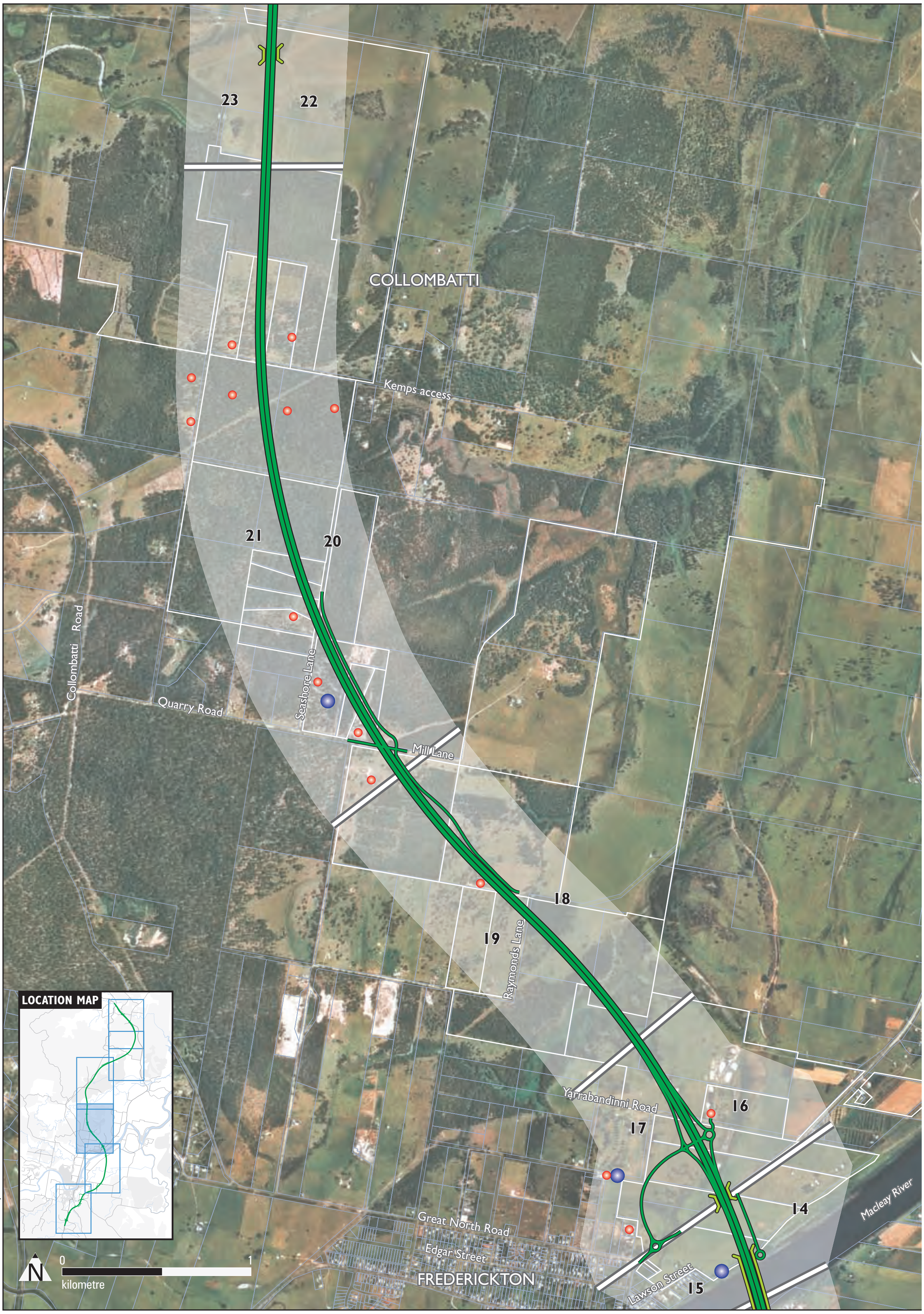
The proposed upgrade | Noise catchment area | Noise monitoring locations | Sensitive receivers

Figure 16-1b **Noise catchment areas and location of noise monitoring**



Source: Technical Report 3 - Noise and Vibration Assessment

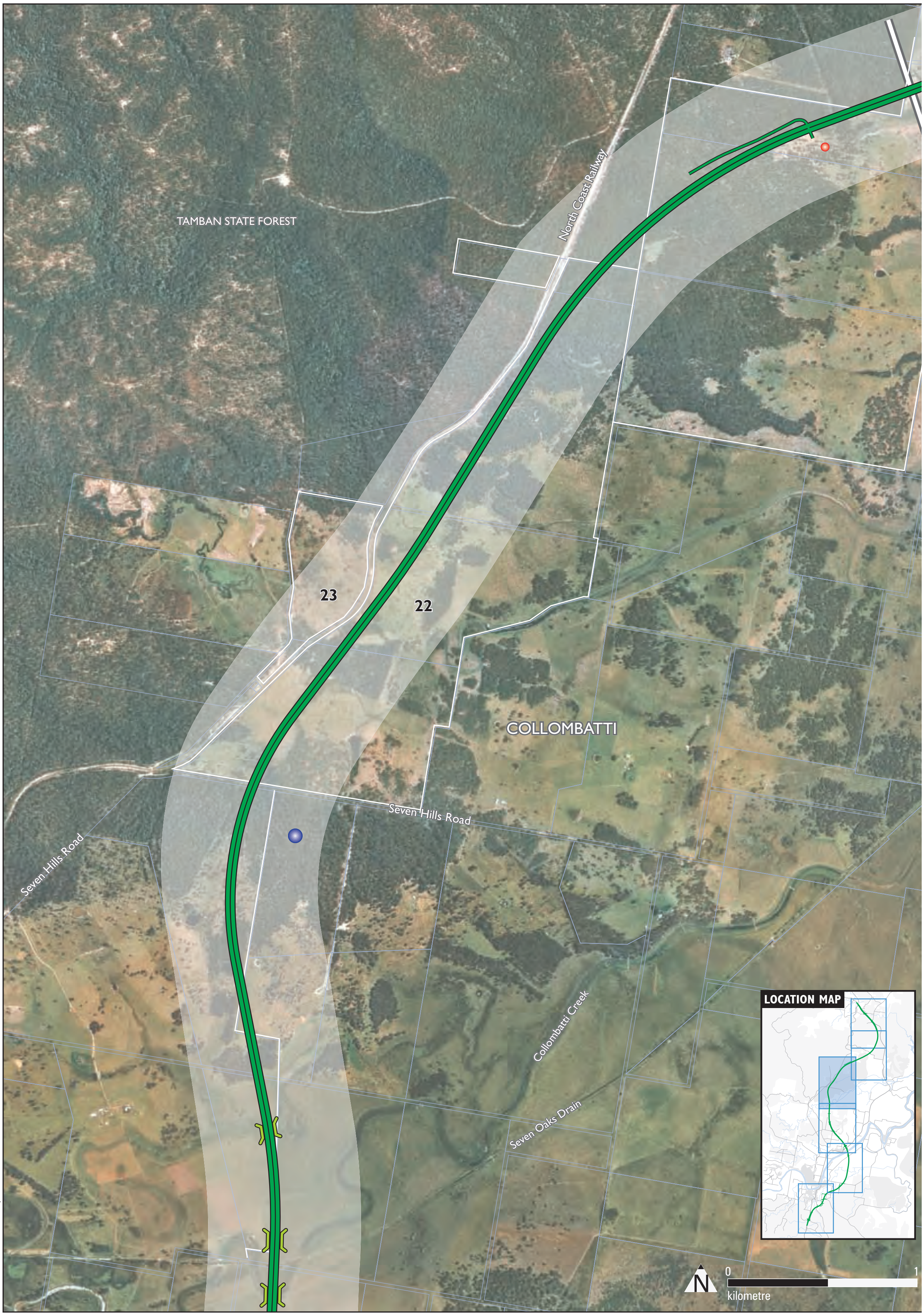
Figure 16-1c **Noise catchment areas and location of noise monitoring**



The proposed upgrade | 14 Noise catchment area | Noise monitoring locations | Sensitive receivers

Source: Technical Report 3 - Noise and Vibration Assessment

Figure 16-1d **Noise catchment areas and location of noise monitoring**



Source: *Technical Report 3 - Noise and Vibration Assessment*

The proposed upgrade | 22 Noise catchment area | Noise monitoring locations | Sensitive receivers

Figure 16-1e **Noise catchment areas and location of noise monitoring**

The proposed upgrade | 22 Noise catchment area | Noise monitoring locations | Sensitive receivers

Figure 16-1f **Noise catchment areas and location of noise monitoring**

Source: Technical Report 3 - Noise and Vibration Assessment

The proposed upgrade | 24 Noise catchment area | Noise monitoring locations | Sensitive receivers

A number of other noise sensitive receivers that may be potentially affected by traffic noise generated by the proposed upgrade were identified in the study area. These include:

- Kempsey Seventh Day Adventist Church, 108 Crescent Head Road, Kempsey.
- Kempsey Adventist Primary School, 108 Crescent Head Road, Kempsey.
- Frederickton Public School, Great North Road, Frederickton.
- Frederickton Golf Course, Yarrabindinni Road, Frederickton.

The assessment identified numerous residential and other sensitive receiver locations along the existing Pacific Highway that would receive a net noise benefit as a result of the proposed upgrade. The non-residential locations include:

- Kempsey East Public School, Innes Street, Kempsey.
- East Kempsey Cemetery, Naiooka Street, Kempsey.
- Frederickton Uniting Church, Macleay Street (Pacific Highway), Frederickton.
- Frederickton Cemetery, Great North Road, Frederickton.
- Bellimbopinni Public School, Pacific Highway, Bellimbopinni.

Sensitive receivers and the 116 identified residences are shown in Figure 16-1a to f.

16.3 Assessment criteria and methodology

16.3.1 Construction noise and vibration

What is L_{10}?

L_{10} is the noise level that is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{10} level for 90% of the time.

What is dB(A)?

dB(A) or decibel(s) (A-weighted) is a unit used to measure noise levels that are adjusted by an electronic filter to approximate the response of a human ear.

Construction noise

Construction noise impacts were assessed in accordance with the NSW *Environmental Noise Control Manual* (ENCM, Environment Protection Authority 1994) and Australian Standard AS2436 – 1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*.

The ENCM provides guidelines for assessing noise generated during construction works. Construction noise criteria for the proposed upgrade were developed based on the ENCM. Noise level restrictions applicable to construction are based on the length of duration of construction as follows:

- For a construction period of 4 weeks or less, the L_{10} noise level measured over a period of not less than 15 minutes during construction activities must not exceed the background noise level for the noise catchment area by more than 20 dB(A).
- For a construction period of more than 4 weeks and not exceeding 26 weeks, the L_{10} noise level measured over a period of not less than 15 minutes during construction activities must not exceed the background noise level for the noise catchment area by more than 10 dB(A).

These goals are consistent with the recommendations in the RTA's *Environmental Noise Management Manual* (the ENMM, NSW Roads and Traffic Authority 2001b).

The ENCM also states that construction works should be limited to the following times:

- Monday to Friday, 7am to 6pm.
- Saturday, 7am to 1pm if inaudible at residential premises, otherwise 8am to 1pm.
- No construction work to take place on Sundays or public holidays.

It may be necessary for construction activities to be undertaken at times outside of those specified above for safety and operational reasons. Work outside these hours may also be undertaken where no construction noise would be audible at any sensitive receivers, in emergency situations, where such work is agreed in negotiations between the RTA or the construction contractor and any potentially affected sensitive receivers, or where the work had been identified and approved as part of the Construction Noise and Vibration Management Sub-Plan and the Construction Environmental Management Plan. Should this situation arise, nearby residents and businesses likely to be affected would be notified in advance.

Criteria for construction noise are subject to review by the Department of Environment and Climate Change. If applicable, revised criteria would be considered by the construction contractor.

The construction plant and equipment likely to be used by the contractor to carry out necessary construction work for the proposed upgrade, and construction activities include:

- Corridor clearing – bulldozer, excavator, chainsaw, tub grinder/mulcher and dump trucks.
- Bulk earthworks – bulldozer, scraper, backhoe, rock crusher, pug mill, excavator, rock breaker, dump and road trucks, compactor and water cart.
- Bridges – mobile crane, pile driving rig, bored piling rig, generator, concrete pump, agitator, pumps, concrete truck, compressor, jackhammer and welding equipment.
- Drainage – backhoe, excavator, compactor and dump truck.
- Pavement – batch plant, paver, road truck, concrete saw, asphalt truck/sprayer, agitator and roller.
- Construction compound(s) – front-end loader, dump truck, compressor, welding equipment, light and heavy vehicles and generator.
- Blasting – air track drill.
- Rock crushing – rock crusher, bulldozer and tracked excavator.

The typical plant and equipment likely to be used during construction and the expected sound power levels (dB(A)) associated with these are summarised below.

Typical construction plant and equipment

Trucks	108 dB(A)
Jackhammer	113 dB(A)
Bulldozer	116 dB(A)
Vibratory roller	118 dB(A)
Rock breaker	120 dB(A)
Pile driver	137 dB(A)

Construction vibration

Construction vibration and blasting impacts have been assessed in accordance with the following standards and guidelines:

- Assessing Vibration: a technical guideline (NSW Department of Environment and Conservation 2006b).
- German Standard DIN 4150-Part 3: 1999 Structural vibration – Effects of vibration on structures.
- British Standard BS7385: Part 2 Evaluation and measurement of vibration in buildings.
- Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council 1990).

The effects of ground vibration on buildings near construction sites can be broadly defined into the following categories:

- Disturbance to building occupants.
- Effects on building contents.
- Effects on building structures.

In many cases, it is the concern of the resident about possible building damage that increases the potential annoyance caused by vibration-generating construction activities.

Vibration criteria for human disturbance are generally more stringent than those for effects on building contents and building structural damage. Hence, compliance with the more stringent limits for human comfort would ensure compliance is also achieved for the other two categories.

The construction equipment most likely to cause significant vibration include pile drivers, hydraulic rock breakers, jackhammers, bulldozers, vibratory rollers and trucks.

Blasting produces ground-borne vibration and air blast overpressure, can both cause discomfort, and at higher levels, damage to property.

The ANZECC guideline *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (1990) is widely accepted by industry and the Department of Environment and Climate Change. The guideline establishes ground vibration and air blast overpressure criteria for potentially affected locations.

In accordance with the guideline, blasting activities would, as far as practicable, only be carried out from Monday to Saturday between 9am and 3pm. Should blasting be required outside of these times, the necessary approvals would be obtained and the number of blasts would be limited. Blasting at night would be avoided as far as practicable.

16.3.2 Operational traffic noise

Road classification

The Pacific Highway between Kempsey and Eungai is classified as a freeway/arterial road in accordance with the NSW *Environmental Criteria for Road Traffic Noise* (ECRTN, NSW Environment Protection Authority 1999a), as it carries through-traffic bound for another locality and is subject to heavy and continuous traffic flow.

The majority (28 catchments) of the proposed upgrade would be classified as a 'new' road as defined in the ECRTN, as it would comprise road on a corridor that has not previously been a freeway or arterial road, with three catchment areas redeveloped freeway/arterial road.

At the points that the proposed upgrade would connect with the existing highway in South Kempsey and Barraganyatti, the proposed upgrade would be classified as a road 'redevelopment' under the ECRTN, as the traffic carrying capacity and the alignment of the existing highway would be improved. This definition is supported by the NSW Roads and Traffic Authority (2001b) *Environmental Noise Management Manual*'s definition of road 'redevelopment'.

These road classifications apply to the proposed upgrade based on the designated noise catchment areas as follows:

- New freeway or arterial road – noise catchment areas 2–28 and 31.
- Redeveloped freeway or arterial road – noise catchment areas 1, 29 and 30.

Traffic noise criteria

Road traffic noise impacts addressed in this report have been assessed in accordance with the NSW ECRTN and the RTA's ENMM.

The traffic noise criteria for the road classifications that apply to the proposed upgrade are detailed in Table 16-1.

Table 16-1 Criteria for road traffic noise

Road classification	Criteria dB(A) Day	Criteria dB(A) Night	Where criteria are already exceeded[1]
New freeway or arterial road	$L_{Aeq(15h)}$55	$L_{Aeq(9h)}$50	The new road should be designed so as not to increase existing noise levels by more than 0.5 dB(A).
Road redevelopment (freeway/arterial road)	$L_{Aeq(15h)}$60	$L_{Aeq(9h)}$55	The redeveloped road should be designed so as not to increase existing noise levels by more than 2 dB(A).

Source: Technical Report 3 – Noise and Vibration Assessment

Note:

1. *Only applicable where all reasonable and feasible noise mitigation measures have been considered*

The criteria apply to the majority of noise catchment areas along the proposed upgrade. However, the relevant road traffic noise criteria are exceeded under existing conditions in noise catchments 1 and 29. In these areas, if feasible and reasonable noise mitigation measures cannot achieve the road traffic noise criteria, the applicable criteria become 64 dB(A) and 63 dB(A) for day and night-time periods respectively.

The ECRTN also sets guidelines for the assessment of traffic noise impacts on sensitive land uses, such as schools, hospitals, places of worship and recreational areas. The road traffic noise criteria for sensitive land uses are detailed in Table 16-2.

Table 16-2 Criteria for road traffic noise at sensitive land uses

Sensitive land use	Criteria dB(A) Day	Criteria dB(A) Night	Where criteria are already exceeded[3]
Existing school classroom	$L_{eq(1h)}$45[1]	–	Where existing traffic noise exposure exceeds the criteria, the proposed road should be designed so as to not increase existing road traffic noise exposure by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads.
Place of worship	$L_{eq(1h)}$40[1]	$L_{eq(1h)}$40[1]	
Active recreation	$L_{eq(1hr)}$60[2]	–	
Passive recreation	$L_{eq(1hr)}$60[2]	–	

Source: Technical Report 3 – Noise and Vibration Assessment

Notes:

1. *Internal noise criteria*
2. *External noise criteria*
3. *Only applicable where all reasonable and feasible noise mitigation measures have been considered*

Noise prediction modelling

The traffic noise prediction model used for this assessment was based on a method developed by the United Kingdom Department of the Environment entitled *Calculation of Road Traffic Noise (1988),* known as the CoRTN (1988) method. This method has been adapted for Australian conditions.

Distances between vehicles and sensitive receivers, relative road heights and topographic contours were incorporated into the noise model. This allowed an evaluation of the shielding provided by the topography between the proposed upgrade and receivers. In some cases, where residences are more than approximately 200 to 300 metres from the proposed upgrade, prevailing winds and weather conditions may influence predicted and actual levels.

Road traffic noise levels were predicted for all residences in the noise catchments using noise contour maps. In addition, further noise modelling was completed at 116 residential premises identified along the route and the following noise sensitive receivers (daytime only):

What is L_{Aeq}?

L_{Aeq} is the equivalent sound pressure level (i.e. the steady sound level that, over a specific period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring).

$L_{Aeq(1h)}$ is the L_{Aeq} noise level for a 1 hour period; correspondingly, $L_{Aeq(9h)}$ and $L_{Aeq(15h)}$ are the L_{Aeq} noise levels for 9 and 15 hour periods.

- Kempsey Seventh Day Adventist Church.
- Kempsey Adventist Primary School.
- Frederickton Public School.
- Frederickton Golf Course.

Noise levels were predicted for the completed proposed Upgrade project for:

- 2011, the year the proposed upgrade is expected to open.
- 2021, 10 years after the opening.

16.4 Changes to the acoustic environment

16.4.1 Construction noise and vibration

Construction noise

Major construction activity for the proposed upgrade is expected to last approximately 3 years, during which time construction noise would vary depending on the activities being undertaken. Noise levels at sensitive receivers would vary significantly over the duration of the construction program due to the temporary nature of the construction activities and the large range of plant and equipment that may be used. With the exception of the major bridge construction, construction activities would generally not be located in any one place for more than 26 weeks at a time. Noise levels experienced at sensitive receivers would depend on the location of the receiver relative to the construction activity, shielding by topography or structures, and the type and duration of activity undertaken.

The noisiest construction activities would be earthworks, drainage and bridge construction, which all involve the use of heavy plant, such as piling rigs, cranes, bulldozers and scrapers. Earthworks and construction of major structures, such as the Macleay River bridge, would probably have the longest duration at any location. Some blasting may be required for cutting excavation.

Although the progress of works along a linear project such as the proposed upgrade is such that the acoustic centre will change as the work progresses, the total duration of the construction of the proposed upgrade as a whole exceeds 26 weeks. Chapter 171 of the ENCM provides no specific guidelines where the construction period will be greater than 26 weeks, however it is generally accepted that noise levels should aim to achieve the following goal:

- The L_{10} measures over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 5dB(A).

The range of noise levels that would be potentially experienced at receivers was calculated for each noise catchment. The noise levels range from the quietest plant items operating in isolation, to a typical configuration of plant items operating concurrently, based on typical distances from construction activities to receiver locations. The predicted range of noise levels at receivers varies from a minimum of 32 dB(A) L_{A90} in noise catchments 13, 14, 25 and 28 to a maximum of 81 dB(A) L_{A90} in noise catchments 19 and 29.

The range of expected noise levels by activity and expected duration at any location is summarised in Table 16-3

Table 16-3 Expected noise levels and duration of construction activities

Activity	Expected duration	Expected noise levels from typical activities L_{A90} (dB(A))
Corridor clearing (grinding/mulching, bulldozer, dump truck, chainsaw)	2–3 weeks[1]	Up to 74–78 (30-50 metres from source)
Bulk earthworks (rock breaking, ripping and rock crushing)	From 2–3 to 6 months	48–81 (30-350 metres from source)
Drainage works	From 2–3 to 6 months	39–77 (50-350 metres from source)
Bridges (driving, bored piling, lifting and setting of bridge girders and other activities)	24 bridges[2]	32–72 (50-350 metres from source)
Pavement[3]	2–4 weeks	38–74 (50–350 metres from source)

Notes:

1. *Dependent on level of clearing required*
2. *Time for bridge construction would vary depending on the size and degree of difficulty; the most significant bridgeworks may take up to 18 months*
3. *Does not include concrete saw cutting*

Noise modelling results indicate that there is potential for construction compound activities to exceed applicable noise criteria at the nearest affected receivers, particularly during site establishment.

The potential compound locations where the least impact would occur include those at Stations 29900 and 31100, where there are no nearby residential receivers. There is a potential for exceedance of noise criteria at one or more receivers in the vicinity of all the other potential site compounds (refer Figure 7-1). 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 have been selected based on project-specific criteria to address noise and other impacts during construction. The ultimate location of the site compounds and other ancillary infrastructure would be determined by the construction contractor and may include alternative suitable sites.

The majority of construction activities along the route, including some site compounds, would be temporary in nature. Therefore, noise impacts would occur over a limited time period as the construction activities progress along the route of the proposed upgrade.

Noise impacts from the crushing operations proposed to be undertaken at four sites along the route (potentially at Stations 700, 2500 and 5200 and Churchill Quarry east of Station 3400) were predicted at the nearest affected receiver. Alternative crushing sites may be selected during the detailed design phase of the project.

Noise from possible crushing activities at Station 700 (noise catchments 1 and 2) would generally comply with applicable noise criteria, with the exception of the RTA-owned property in noise catchment 2. Noise criteria may be exceeded during crushing activities in noise catchment 3 and in the northern parts of noise catchments 4 and 5 (including at the Adventist School). The nearest receivers to the Churchill Quarry and the crushing plant at Station 5200 may also be affected by noise in exceedance of criteria during crushing operations.

Adequate shielding of the crushing plant or pug mill would be incorporated into the site design in these locations.

Construction vibration

Based on indicative recommended minimum buffer distances for the various construction activities likely to produce vibration, and the distances of approximately 30 metres or more from the proposed activities to the nearest residences, it is considered unlikely that vibration generated by construction activity would exceed the set limits for human comfort. All bridge works would be more than 50 metres from residences, so it is not expected that bored piling works would generate vibration in exceedance of human comfort limits. Vibration from driven piles may exceed human comfort limits, depending on the frequency and energy of the blows. Vibration levels from other equipment are unlikely to exceed the set limits.

As compliance with the more stringent human comfort criterion would be expected to be achieved, the structural damage criteria would also be achieved. Therefore, structural damage to dwellings in the vicinity of the proposed upgrade works is unlikely.

What is overpressure?

Overpressure is pressure created by a device or action that is greater than the surrounding air pressure, for example, a shockwave from a blast.

What is a buffer zone?

A buffer zone is established to ensure that a minimum distance limit is set to protect sensitive receivers from vibration and overpressure impacts.

Blasting

Blasting is likely to be required to remove hard rock material from at least two cuttings south of the Macleay River, at Stations 1300 and 3000. At these locations, the nearest buildings are approximately 150–200 metres from the centres of the cuttings. However, 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 overpressure and vibration to acceptable levels. Blast charge and configurations would need to be selected to ensure that the ANZECC Guidelines (1990) adopted by the Department of Environment and Climate Change are not exceeded.

Given the proximity of some buildings to likely blast sites, blasting would be monitored during to confirm predicted overpressure and vibration levels. Blast design and buffer zones would be modified as appropriate, if required.

To ensure that blasting activities do not cause adverse impacts on the surrounding community, the following measures would be implemented:

- Noise and vibration measurements on a series of smaller test blasts to establish appropriate propagation characteristics for the site to assist in accurately predicting noise and vibration levels once the proposed charge and blast configuration information is determined.
- Surveys on all buildings located inside the buffer zone prior to commencement and after completion of blasting activities.

16.4.2 Operational noise

Residential receivers

Predicted noise levels indicate that, in the absence of further noise mitigation treatment, there would be a number of residences exposed to road traffic noise in excess of the noise criteria.

Predicted traffic noise levels with and without the proposed upgrade in 2011 and with the proposed upgrade in 2021 are summarised in Table 16-4. The predicted noise levels are based on concrete with coarse Hessian drag and tining pavement surface.

This table indicates that after the opening of the proposed upgrade in 2011, 41 residences would experience noise levels above the daytime criteria and 55 residences would experience noise levels above night-time criteria from a total of 116 residences. In 2021, with increased traffic volumes, 66 residences would experience noise levels above the daytime criteria and 85 residences would experience noise levels above night-time criteria.

Table 16-4 **Predicted noise impacts on sensitive receivers (without noise treatment)**

	Daytime $L_{eq(15h)}$				Night time $L_{eq(9h)}$			
		2011		2021		2011		2021
Noise catchment	Applicable criteria	No build	Build	Build	Applicable criteria	No build	Build	Build
1	60	62	58	61	55	60	55	59
2	55	51	52	54	50	49	49	52
3	55	51–69	50–66	54–67	50	49–67	47–64	51–66
4	55	46	51–33	55–68	50	44	48–60	52–65
5	55	31–48	47–61	51–64	50	29–46	44–60	49–62
6	55	–	47–64	52–68	50	–	44–61	48–66
7	55	–	39–60	43–60	50	–	36–57	40–61
8	55	–	49–64	53–69	50	–	46–61	51–66
9	55	–	49–61	53–65	50	–	46–58	50–62
10	55	–	46–54	50–58	50	–	43–51	48–56
11	55	–	43–56	47–56	50	–	40–53	44–57
12	55	46	56	60	50	43	53	58
13	55	45–48	53–58	57–62	50	42–45	50–56	54–59
15	55	57–59	55–56	59–60	50	49–50	53–54	56–57
17	55	46–56	49–57	52–59	50	44–54	48–55	49–56
19	55	–	55–67	56–68	50	–	53–64	54–65
20	55	–	54–58	54–59	50	–	51–56	52–56
21	55	–	48–66	49–67	50	–	46–58	47–64
22	55	–	59	59	50	–	56	57
24	55	–	67	67	50	–	65	65
25	55	–	47	48	50	–	45	45
26	55	36	53	54	50	34	51	51
27	55	42	50	51	50	40	48	49
28	55	47–49	53–54	54–56	50	45–47	50–52	51–53
29	55	48	52	53	50	46	49	50
	60	62–63	64–66	66–68	55	60–62	62–64	64–66
30	60	49–52	52–55	54–57	55	47–50	50–53	51–55
31	60	54–58	57–62	59–64	55	52–56	55–60	57–62
Number of residences exceeding criteria			**41**	**66**			**52**	**85**

Notes:

1. Predicted noise levels are based on concrete with coarse Hessian drag and tining pavement surface.

2. Predicted noise impacts may alter with refinements during detailed design.

Source: Technical Report 3 – Noise and Vibration Assessment

The number of residences exposed to day and night-time noise levels in excess of the criteria under various road surface scenarios in 2011 and 2021 is summarised in Table 16-5.

Table 16-5 **Residences potentially exposed to noise levels in excess of criteria for various road surface types**

	Day $L_{Aeq(15h)}$		Night $L_{Aeq(9h)}$	
Scenario	2011	2021	2011	2021
Dense-graded asphaltic concrete	25	48	41	61
Concrete with light Hessian drag and tining	32	50	42	65
Concrete with coarse Hessian drag and tining	41	66	52	85
Low-noise pavement	15	33	27	46

Source: Technical Report 3 – Noise and vibration assessment
Note: Daytime receivers include noise sensitive receivers.

Predicted traffic noise levels during operation of the proposed upgrade are shown in the form of day and night-time noise contours for the year 2011 and 2021 in Figures 16-2 to 16-13.

As the predicted traffic noise levels indicate that some residential receivers are likely to be exposed to traffic noise levels in exceedance of the relevant criteria, investigation of all feasible and reasonable noise control options is required. Where all reasonable and feasible mitigation options have been exhausted, the proposed upgrade would, as a minimum, be designed so as not to increase existing traffic noise levels by more than 0.5 dB(A) where the new freeway criteria apply and 2 dB(A) where the redeveloped road criteria apply. Mitigation is discussed further in Section 16.5.

For residences and other sensitive receivers that would experience noise levels above the relevant Department of Environment and Climate Change noise goals, various noise treatments would be applied. Noise treatments would include the use of low-noise pavement or noise barriers. These options are expensive, and would generally be used where a sufficient number of properties are grouped together to make the measures cost-effective. Where properties are sparsely distributed, at receiver measures, such as architectural treatments of the residences, would be considered.

Further details of potential at-source and at-receiver noise treatments are provided in Technical Report 3 – *Noise and Vibration Assessment* in Volume 2.

Increase in existing ambient noise levels

The majority of the proposed upgrade would pass through undeveloped 'greenfield' areas where receivers are not currently exposed to traffic noise and the existing ambient noise levels tend to be low.

The ECRTN sets out noise level criteria with the intent of preserving amenity appropriate to prevailing land uses. The criteria for road traffic noise have been developed based on an environmental objective for transport-related noise sources set at the approximate point where 10% of residents are highly annoyed by the noise. However, other factors also influence the choice of criteria, including the practicality of achieving the criteria in high-noise areas and the additional impact associated with the introduction of a new noise source to an otherwise quiet environment.

The level of reaction to the introduction of a new noise source is often not directly predictable. Evidence suggests that reaction to a newly introduced noise source is often higher than reaction to an existing noise source. The results of studies referred to in the ECRTN indicate that where noise exposure is suddenly and substantially increased, a greater reaction than would be predicted from studies of steady noise conditions is experienced.

As already discussed, the proposed upgrade would pass through areas with low levels of existing ambient noise. As such, it is likely that complaints regarding road traffic noise may arise when operation commences. Although future ambient noise levels associated with the operation of the proposed upgrade may comply with the ECRTN criteria, the perception of noise from the increase in ambient noise levels may be exaggerated, resulting in complaints from residents suddenly exposed to an increase in ambient noise.

Maximum noise level assessment

Maximum traffic noise levels at night were predicted using the measured existing L_{max} noise level (predicted maximum noise level) data, and considering the proposed upgrade design and the distance between the road and residential receivers along the proposed upgrade.

The results of these predictions indicate that the maximum noise levels along the existing Pacific Highway would be reduced significantly as a result of the proposed upgrade, since vehicles would bypass more densely populated residential areas. However, as most of the residences along the proposed upgrade route have not previously been exposed to traffic noise, maximum noise levels on sections of the proposed upgrade through presently undeveloped areas would be increased.

The proposed upgrade has been designed to minimise changes in grade and to smooth curves/corners in the road alignment to provide a safer route for road travel. As such, it is expected that the need for heavy vehicles to use engine brakes would be reduced on the proposed upgrade in comparison to current usage on the Pacific Highway. Such a reduction would reduce noise levels during maximum noise events.

Further assessment of maximum noise levels is provided in Technical Report 3 – *Noise and Vibration Assessment* in Volume 2.

16.4.3 Other sensitive receivers

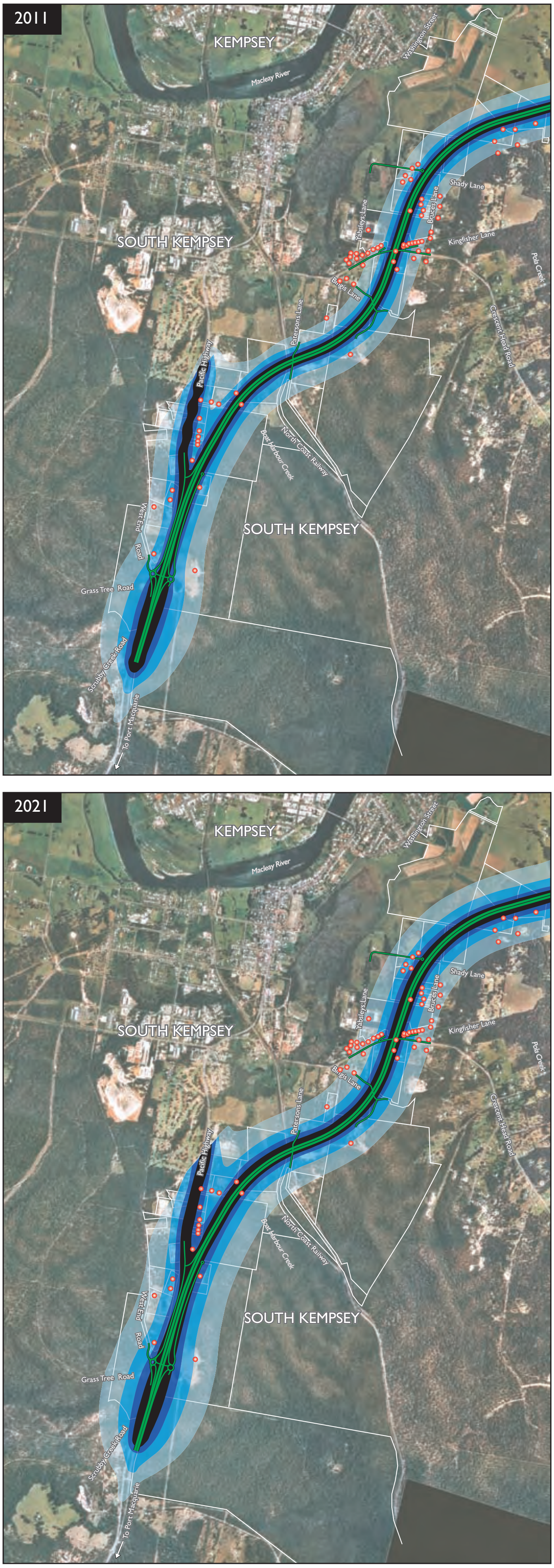
Two schools, a church and Frederickton Golf Course would be affected by traffic noise during operation of the proposed upgrade. Daytime noise levels in outdoor areas, such as school playgrounds, and inside buildings (assuming a 10 dB(A) noise reduction from outside to inside through an open window) were predicted assuming a concrete road surface with coarse Hessian drag and a tining pavement surface. The results of these noise predictions are summarised in Table 16-6.

Table 16-6 **Predicted noise levels at other sensitive receivers (2021)**

Sensitive receiver	Applicable criteria $L_{eq}(1hr)$ dB(A)	Outdoor areas $L_{Aeq(15h)}$	Inside worst affected building $L_{Aeq(9h)}$
Kempsey Seventh Day Adventist Church	40	–	44
Frederickton Public School	45/55[1]	57	43
Kempsey Adventist Primary School	45/55[1]	54	44
Frederickton Golf Course	60	59	–

Notes:
Shaded cells indicate levels in exceedance of noise criteria assuming concrete with coarse Hessian drag and tining pavement surface.
1. Criteria for indoors = 45, criteria for outdoors = 55
Predicted noise impacts may alter due to refinements during detailed design
Source: Technical Report 3 – Noise and Vibration Assessment

Figure 16-2 **2011 and 2021 daytime noise impacts – South Kempsey and Crescent Head Road**



N

0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

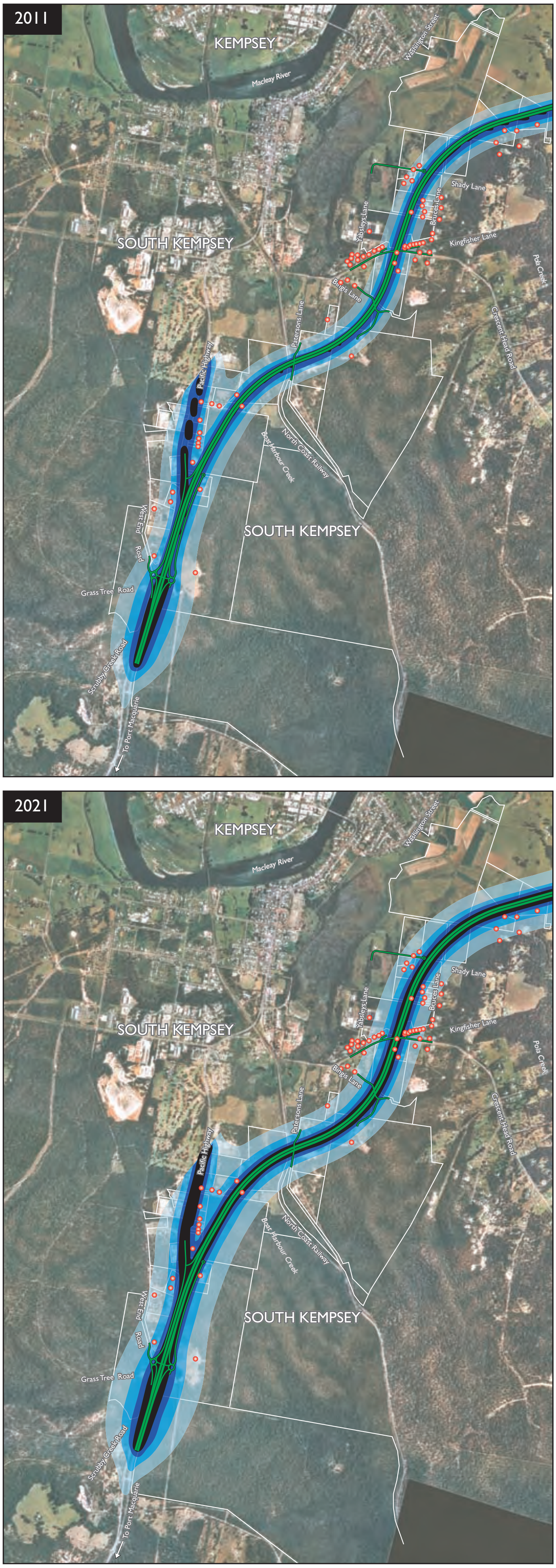
65 dBA

60 dBA

55 dBA

50 dBA

Figure 16-3 **2011 and 2021 night-time noise impacts – South Kempsey and Crescent Head Road**



N
0 1
kilometre

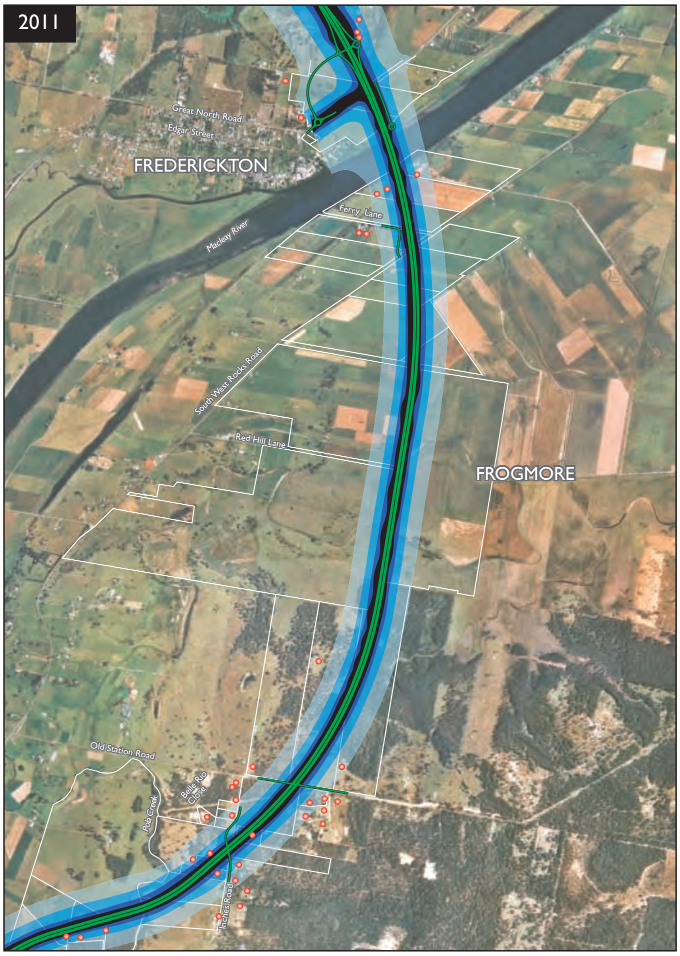
The proposed upgrade

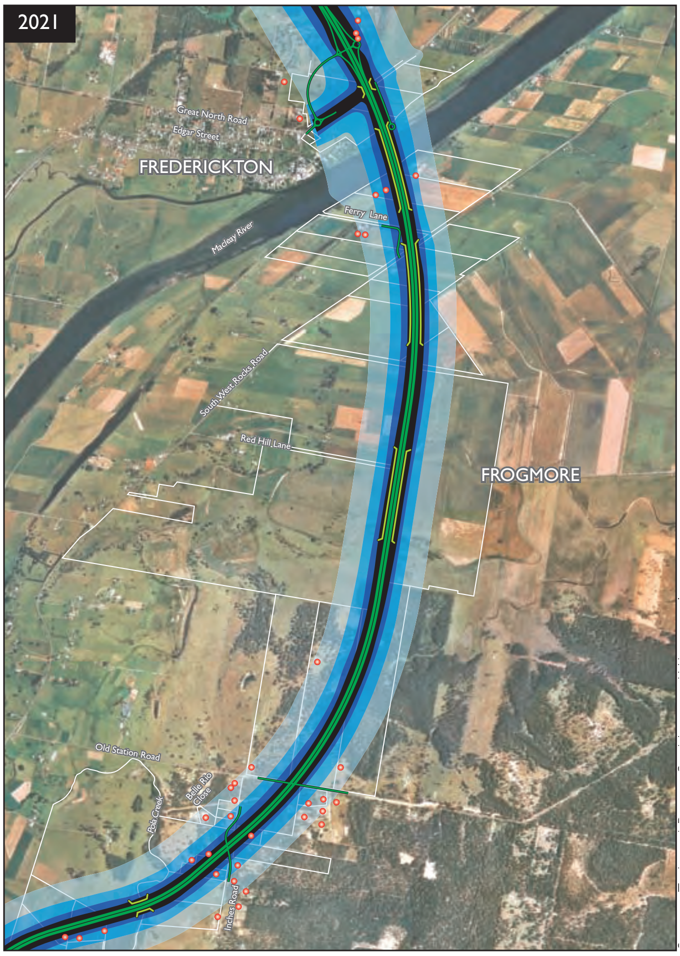
Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

- 65 dBA
- 60 dBA
- 55 dBA
- 50 dBA

Figure 16-4 **2011 and 2021 daytime noise impacts –Inches Road and Frogmore**





N
0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

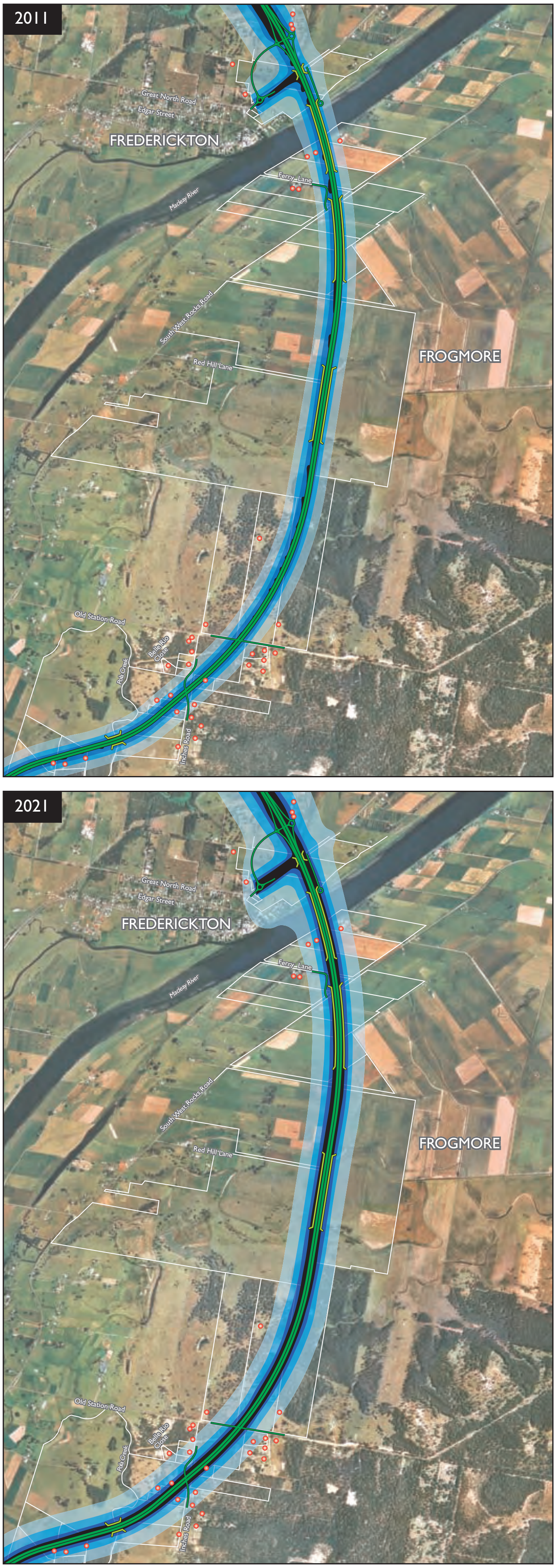
65 dBA

60 dBA

55 dBA

50 dBA

Figure 16-5 **2011 and 2021 night-time noise impacts – Inches Road and Frogmore**



N
0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

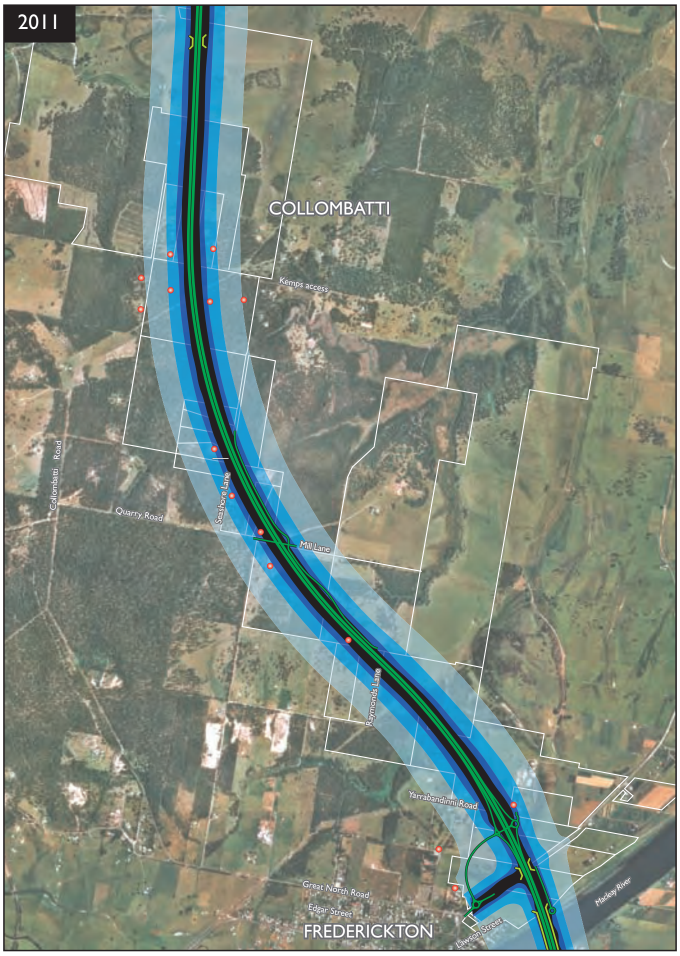
65 dBA

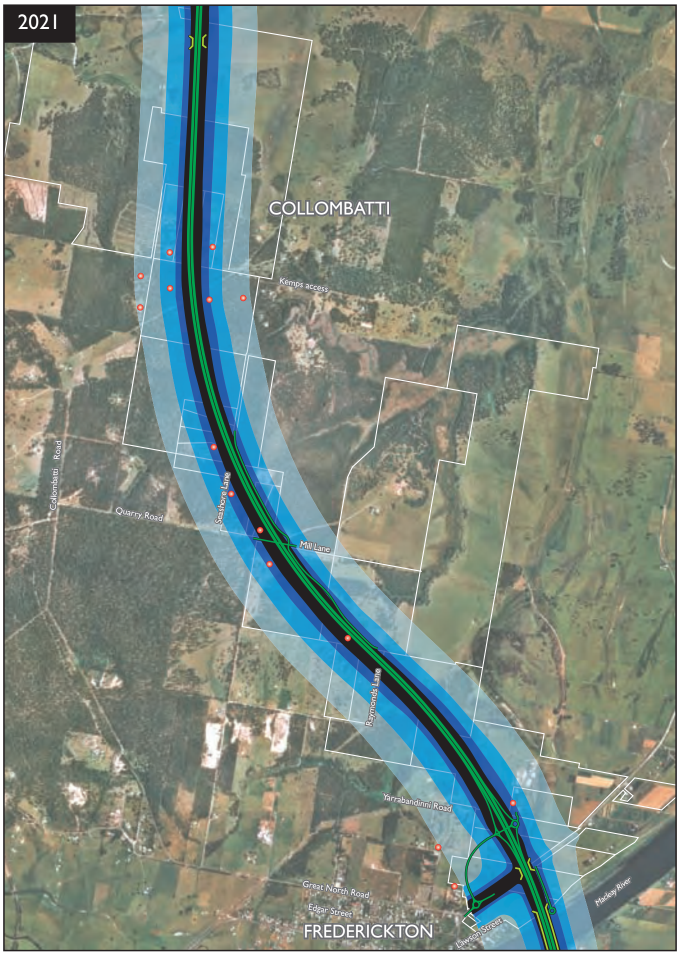
60 dBA

55 dBA

50 dBA

Figure 16-6 **2011 and 2021 daytime noise impacts – Frederickton and Collombatti South**





N
0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

65 dBA

60 dBA

55 dBA

50 dBA

Figure 16-7 **2011 and 2021 night-time noise impacts – Frederickton and Collombatti South**

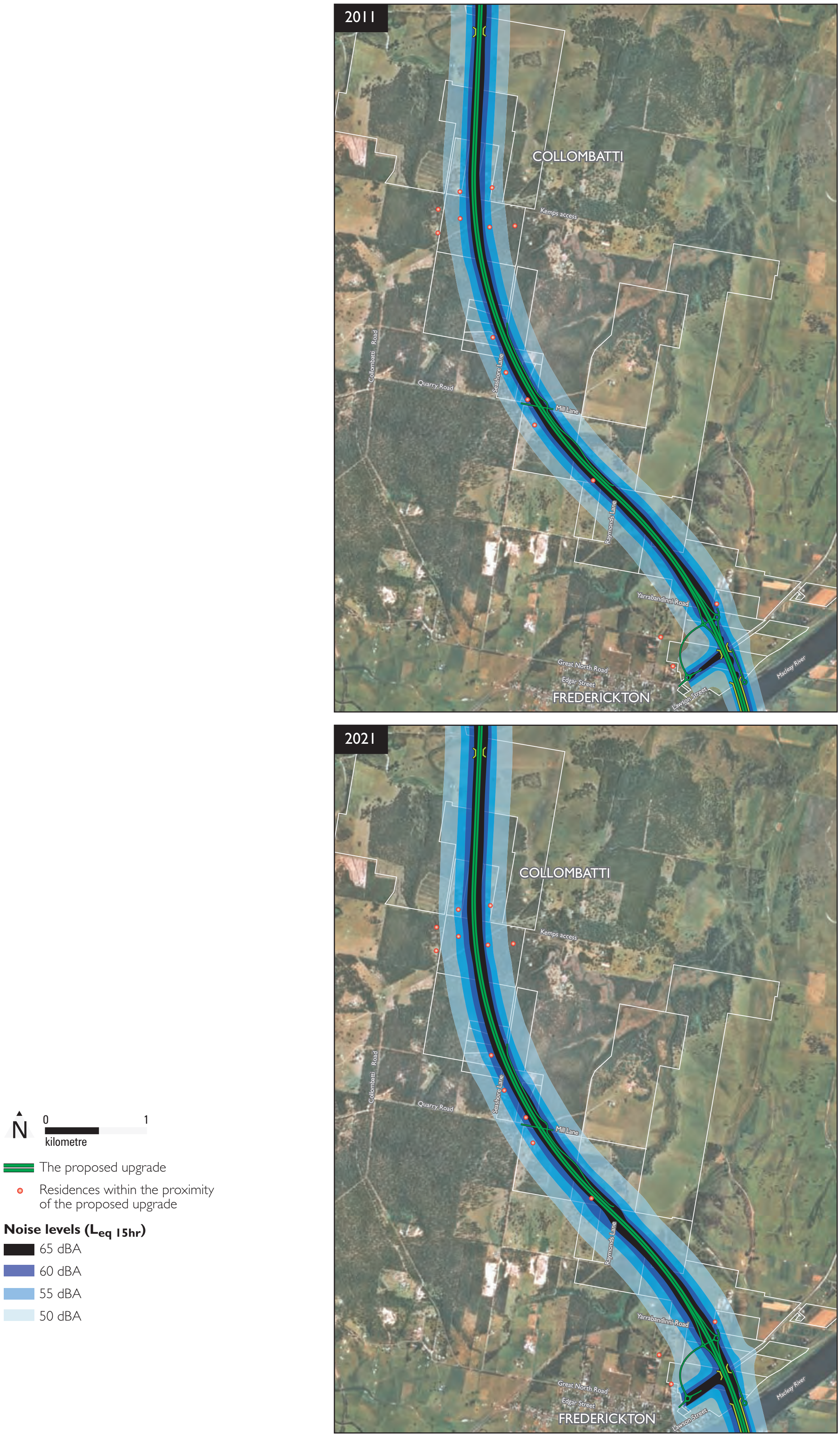
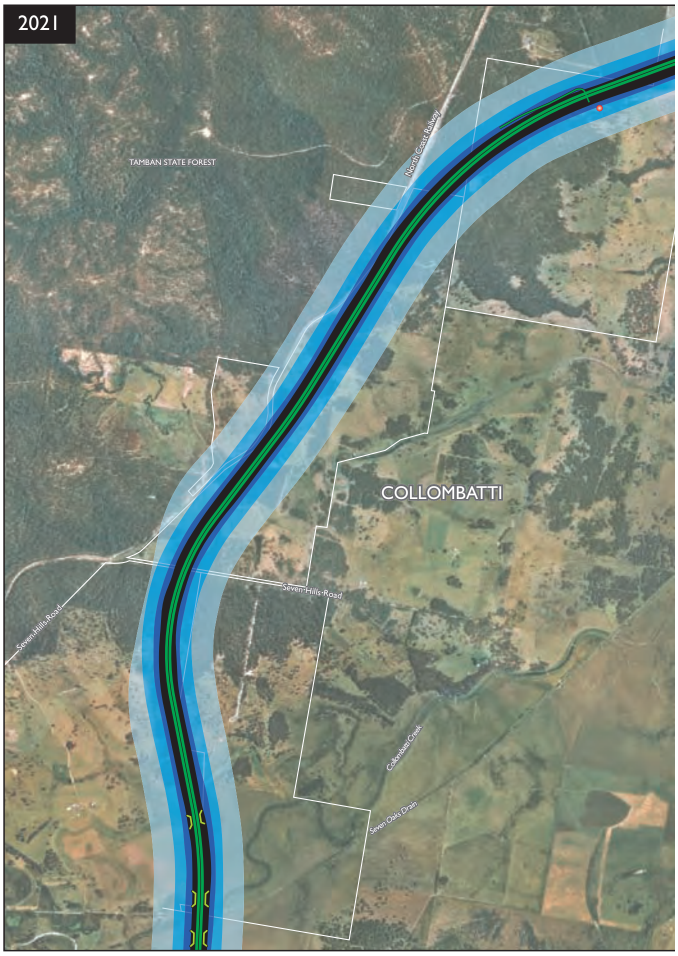


Figure 16-8 2011 and 2021 daytime noise impacts – Collombatti North

Figure 16-9 **2011 and 2021 night-time noise impacts – Collombatti North**



N
0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

65 dBA

60 dBA

55 dBA

50 dBA

Figure 16-10 **2011 and 2021 daytime noise impacts – Barraganyatti**

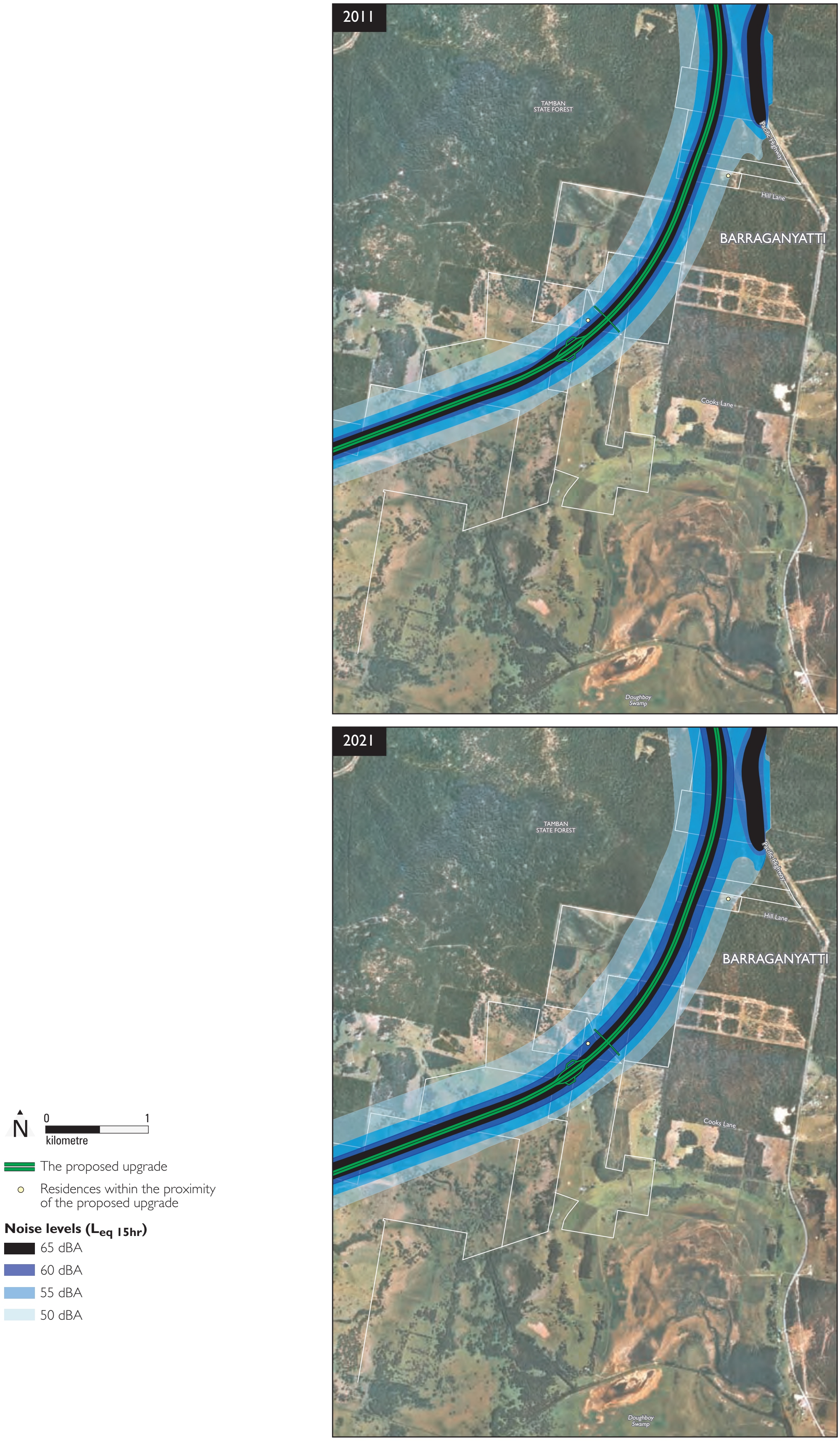
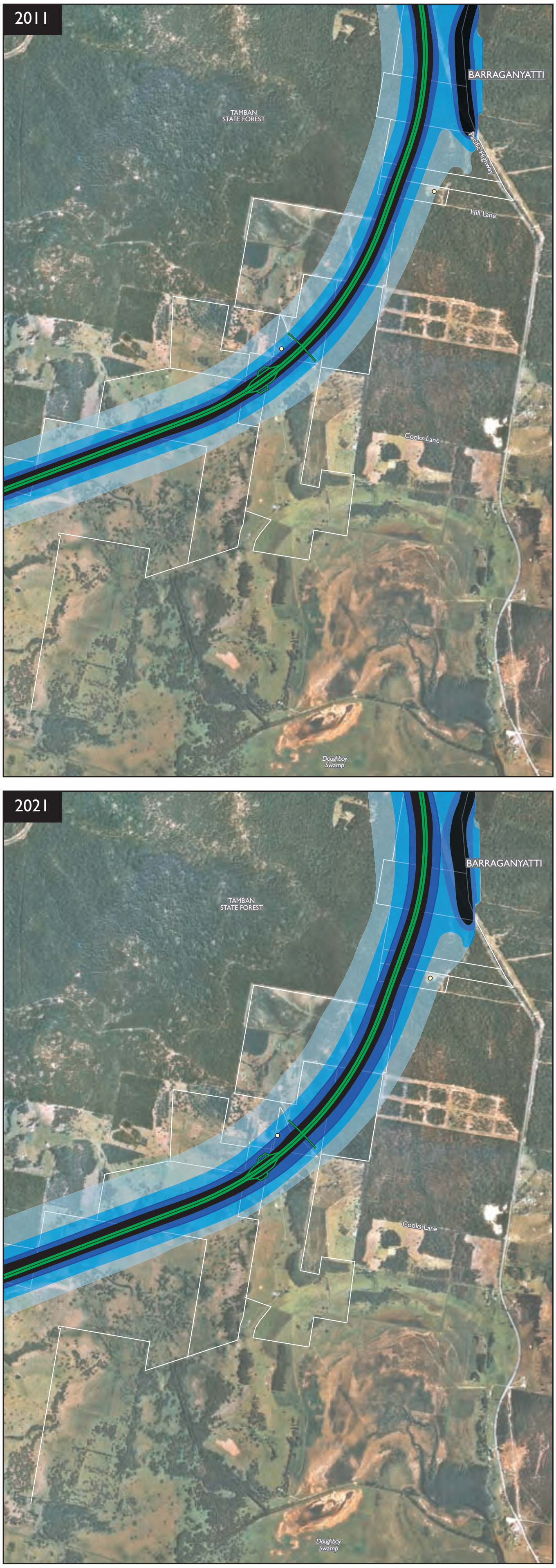


Figure 16-11 **2011 and 2021 night-time noise impacts – Barraganyatti**



N

0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

65 dBA

60 dBA

55 dBA

50 dBA

Figure 16-12 **2011 and 2021 daytime noise impacts – Barraganyatti and Eungai Rail**

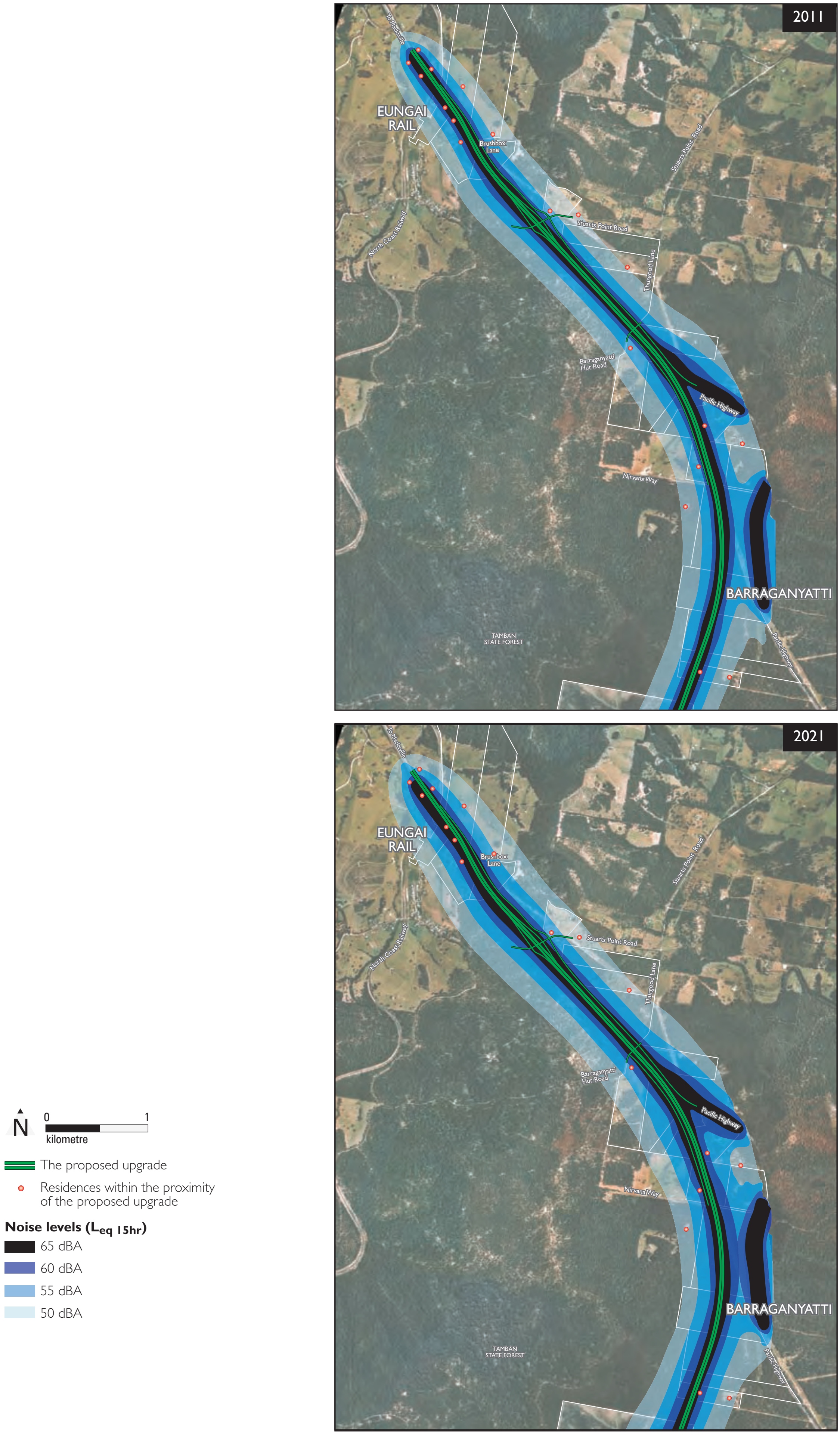
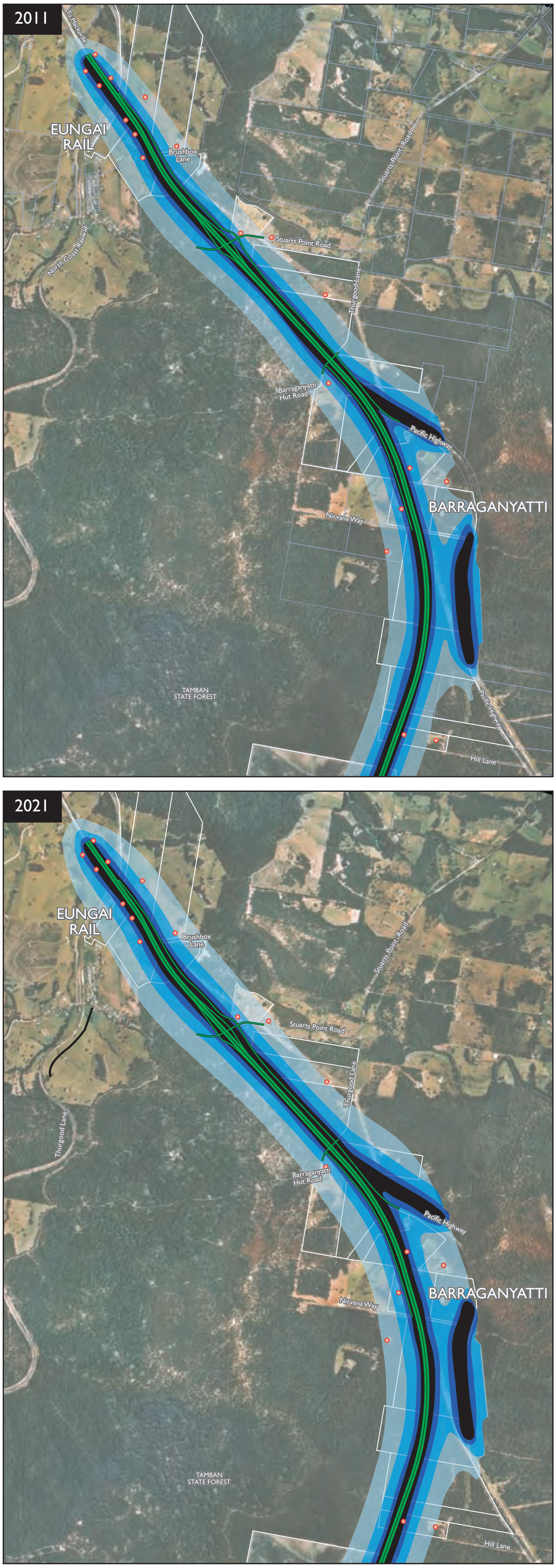


Figure 16-13 2011 and 2021 night-time noise impacts – Barraganyatti and Eungai Rail



N
0 1
kilometre

The proposed upgrade

Residences within the proximity of the proposed upgrade

Noise levels ($L_{eq\ 15hr}$)

65 dBA

60 dBA

55 dBA

50 dBA

As indicated in Table 16-6, traffic noise levels would comply with the relevant criteria at Kempsey Adventist Primary School and Frederickton Golf Course in 2021, 10 years after opening of the proposed upgrade (assuming it is unstaged). Noise levels at Frederickton Public School playground areas and the Kempsey Seventh Day Adventist Church would exceed the noise criteria marginally, by 2 and 4 dB(A) respectively. Further investigation of noise mitigation is required during the detailed design phase to assess appropriate treatment to comply with relevant criteria (see Section 16.5).

16.5 Management of impacts

As discussed above, the ECRTN noise criteria are likely to be exceeded at some residential receivers along the proposed upgrade. As such feasible and reasonable noise mitigation options have been investigated at a broad level. The application of noise mitigation measures would be confirmed during detailed design. This would likely involve one or a combination of the available measures, including low-noise pavements, noise barriers and architectural treatments to reduce noise levels associated with the operation of the proposed upgrade. These mitigation methods and their potential application are discussed below.

16.5.1 Noise mitigation options

The proposed upgrade has been routed and designed to minimise noise impacts. The horizontal and vertical alignment of the proposed upgrade has been designed to minimise vehicle noise by flattening grades and use the natural topography to shield receivers from the road.

Where noise levels associated with operation of the proposed upgrade would be likely to exceed the established project-specific noise levels and/or relevant criteria in some areas, mitigation measures to reduce noise levels need to be considered. The degree of noise impact quantifies the extent of mitigation required, and provides guidance on the mix of noise control measures to be adopted as a mitigation strategy. Flexibility in the control of noise is an important component in achieving desired environmental outcomes.

Three main mitigation strategies are available for the control of noise. These have been described in order of preference, below.

Controlling noise at the source

Surface treatments

At speeds of 70 kilometres per hour and above, tyre noise begins to dominate over engine/exhaust noise. In such circumstances, road surface treatments provide some benefit in reducing noise emissions.

Quieter pavement surfaces (open-graded asphaltic concrete, for example) are porous and use medium to small aggregates, reducing the amount of noise generated by vehicles travelling on the pavement surface. These would only be used in areas where affected residences are grouped in close proximity to the proposed upgrade. Quieter pavement surfaces are discussed in Section 3.7.1 of Technical Report 3 – *Noise and Vibration Assessment* in Volume 2.

The overall noise reduction benefit for quieter pavement surfacing is limited, however, with residences identified as receiving a net acoustic benefit restricted to the first row adjacent to and facing the road alignment.

Quieter pavements are generally considered only where small reductions in noise of 2-4 dB(A) are required, and when used in conjunction with other treatments. Use of low-noise pavements in combination with noise barriers is proposed between Station 3500 and Station 5700, subject to further noise modeling during the detailed design phase.

Land use planning

This includes the development of formal mechanisms by the Department of Planning, councils, the RTA and the Department of Environment and Climate Change to ensure that new development and redevelopment activities take into account noise from existing and proposed road developments. It also includes traffic noise amelioration provisions for residential areas in the Australian Model Code for Residential Development (AMCORD) and the development of a Model Development Control Code.

Strategic options

Road traffic noise levels can be reduced over time, from a strategic perspective, by applying measures such as lower vehicle emission limits, driver education (on issues such as exhaust brake use) and traffic management (such as defined truck routes, where applicable).

Controlling the transmission of noise

Barriers

Noise barriers are most effective if they are near the source or the receiver. Noise barriers would only be used in areas where affected residences are grouped in close proximity to the proposed upgrade. Noise control 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. Noise transmission control is generally employed when source or receiver control is either impractical or too costly. Indicative noise barrier design and locations are illustrated in Figures 16-14 and 16-15 respectively. Noise barrier dimensions would be subject to further review during the detailed design phase.

Figure 16-14 **Indicative design of typical noise barriers**

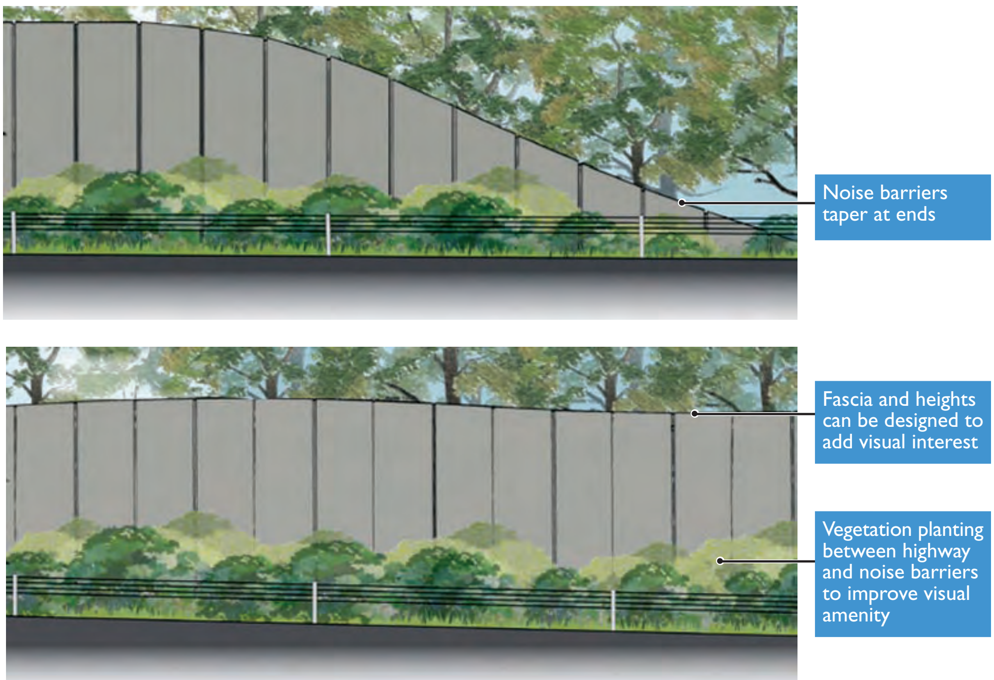
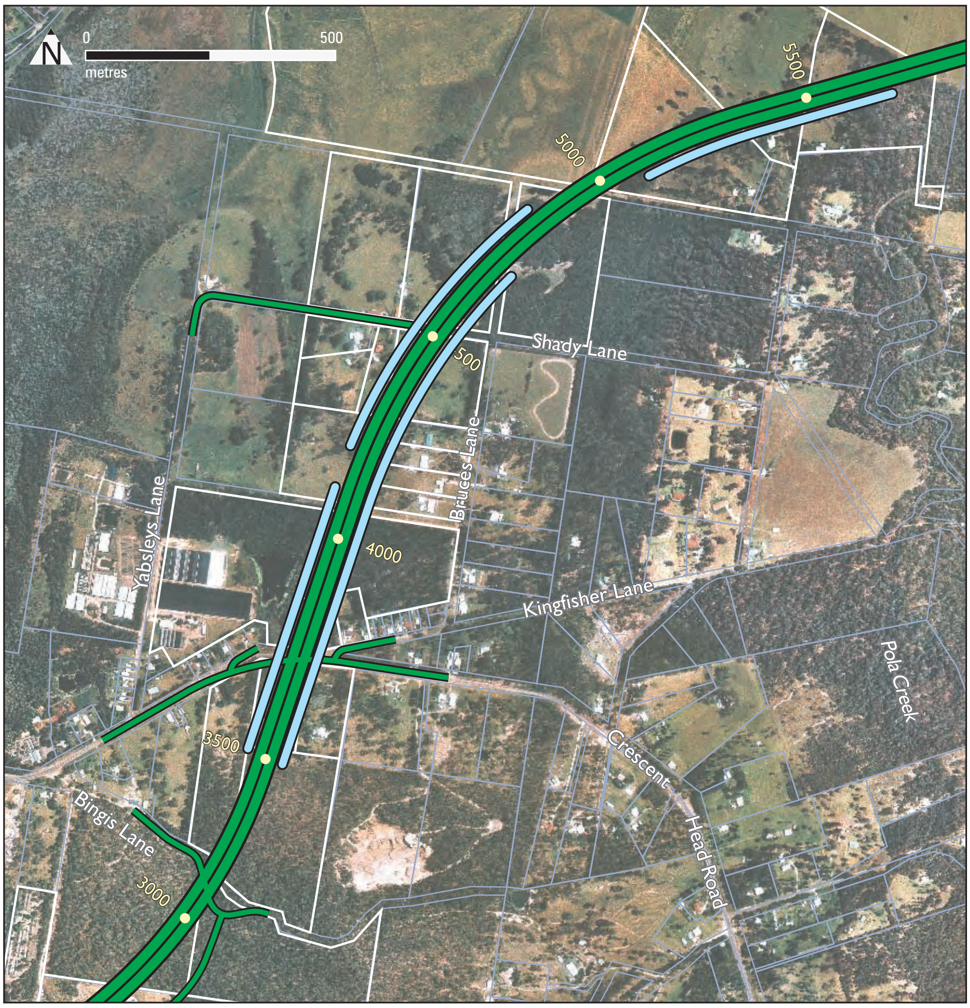


Figure 16-15 **Indicative location of noise barriers**



The proposed upgrade
Properties affected by the proposed upgrade
Proposed noise barrier

Note: Proposed noise barrier locations subject to refinement during detailed design.

Controlling noise at the receiver

At receiver controls are generally the most cost-effective solution for isolated residents where noise barriers and/or low-noise pavement are not considered reasonable or feasible noise control measures.

At receiver controls generally consist of sealing off wall vents, upgraded windows, glazing and solid core doors on the noise exposed façade(s) and provision of air conditioning or ventilation systems to meet the Building Code of Australia requirements for fresh air. For these measures to be effective, the residence must be in a reasonable state of repair with masonry structures performing better.

Noise mitigation strategies

Establishing a final strategy for noise control involves determining noise reduction requirements, identifying specific site characteristics that indicate a preference for specific measures, examining historical mitigation strategies for similar developments, considering the range of noise-control measures available, and considering community preferences for particular strategies.

Details of specific noise mitigation treatments at sensitive receivers are provided in Technical Report 3 – *Noise and vibration assessment* in Volume 2. The RTA would consult with affected landholders in developing a Noise and Vibration Management Plan and appropriate measures to mitigate noise prior to construction.

Noise mitigation at Kempsey Adventist Church

Predicted noise levels at sensitive receivers in 2021 generally comply with the relevant noise criteria, with the exception of the Kempsey Adventist Church. Noise levels inside the Kempsey Adventist Church have been modelled as likely to exceed the internal noise criterion by 2dB(A). This is considered to be a minor non-compliance that can be rectified by closing the church windows during its use and providing mechanical ventilation to meet the ventilation requirements of the Building Code of Australia. Further analysis of the church building would be carried out during detailed design to confirm whether the provision of architectural treatment is reasonable and feasible.

16.5.2 Summary of management measures

Standard and project-specific mitigation and management techniques for noise and vibration impacts arising from the construction and operation of the proposed upgrade are included in the draft Statement of Commitments for the proposed upgrade in Appendix D and are summarised below.

Construction

- Prepare and implement a Construction Noise and Vibration Management (CNVM) Sub Plan in consultation with the relevant authorities, Council and the community. The vibration and construction noise and goals in the plan will be obtained from the relevant guidelines.
- Schedule construction activities that could potentially impact on noise sensitive receivers only between the following hours unless otherwise approved:
  - 7 am to 6 pm, Monday to Friday.
  - 8 am to 1 pm, Saturday.
- Ensure that wherever practical and where sensitive receivers may be affected, driven piles are not used. If driven piles are required, appropriate noise attenuation measures will abe implemented when they are being installed.
- Undertake blasting trials if blasting is to be used.
- Make all reasonable attempts 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.
- Undertake noise monitoring during construction.

Operation

- Implement the requirements of an Operation Noise Management Report detailing the investigation of 'reasonable and feasible' operational noise mitigation methods, where possible operational noise treatments will be implemented prior to construction commencing or in the early stages of the construction phase in consultation with the Department of Environment and Climate Change and affected residents.
- Undertake monitoring of operational noise.
- Assess the adequacy of the implemented traffic noise mitigation measures.