

Chapter 19 Noise and vibration

This chapter presents the approach to and results of the noise and vibration impact assessment for the Proposal. The noise impact assessment considered road traffic noise for the assumed year of opening and ten years after opening, construction noise, and vibration and overpressure from construction blasting. Mitigation measures are proposed to address adverse impacts.

19.1 General noise and vibration impacts from highways

Highway noise arises from both construction and long-term operation of a road. During construction works, airborne noise is generated by construction equipment such as bulldozers, rock-breakers, compactors and generators. Road traffic generates airborne noise due to both the rolling noise of vehicle wheels on the road surface, and engine and exhaust noise of vehicles (especially heavy vehicles such as articulated truck/trailer units).

Airborne noise is generally assessed in terms of the external noise level at a receiver position. Resulting noise levels within buildings will be lower as a result of the sound attenuation provided by the building envelope. Noise and vibration impacts on the community may be categorised as follows, in order of increasing severity:

- community/resident annoyance
- disturbance to community/resident activities (e.g. sleep disturbance)
- adverse effects on human health (e.g. increased blood pressure, heart rate or impaired performance due to lack of sleep).

A comprehensive introduction to traffic noise and a glossary of terms can be found in Section 1 of the *Environmental Noise Management Manual* (ENMM) (RTA 2001c). Working Paper No. 3 provides the basis of this Chapter.

19.2 Existing noise environment

During July 2002, ambient noise measurements were taken along the existing highway and Proposal route. Unattended noise loggers were used to continuously measure noise at two locations for 12 days between 22 July and 1 August 2002. Attended measurements were also made at these and a further 13 locations along the proposed route on 22, 23, 24, 25 July and 1, 2 and 3 August 2002. The measurement sites were as follows:

- School, Station Street, Johns River
- 253 Pacific Highway, Johns River
- 28 Wharf Road, Johns River
- Watson Taylor Road, Stony Creek
- Ross Glen Road, Rossglen
- Camden Haven High School, Kew
- Glen Haven Drive, Kew
- Camden Haven Golf Club, Kew
- 4926 Pacific Highway
- Kew/Kendell STP
- 5301 Pacific Highway
- Blackbutt Road, Herons Creek
- Banks Road, Herons Creek
- Herons Creek Public School, Herons Creek.

The L_{Aeq} , L_{Amax} , L_{A10} and L_{A90} noise indices were measured in free-field conditions over a 15 minute sample period. All measurements were performed in accordance with Australian Standard AS 1055 *Acoustics - Description and measurement of environmental noise*.

The existing noise level is dominated by traffic noise from the Pacific Highway. The ambient noise measurement results are presented in Working Paper No. 3. Traffic volumes were recorded by the RTA at existing traffic monitoring stations throughout the measurement period.

19.3 Noise criteria

19.3.1 Operational noise criteria

The basic noise criteria for the assessment are the *Environmental Criteria for Road Traffic Noise* (ECRTN) (NSW DEC 1999) (see Table 19–1).

Table 19–1 Basic noise level criteria

Type of development	Criteria		
	Day (7am - 10pm) dB(A)	Night (10pm - 7am) dB(A)	Where criteria are already exceeded.
New freeway or arterial road	55 $dBL_{Aeq,15hr}$	50 $dBL_{Aeq,9hr}$	New road designed so as not to increase existing levels by more than 0.5 dB
Redevelopment of existing freeway/ arterial road	60 $dBL_{Aeq,15hr}$	55 $dBL_{Aeq,9hr}$	Redevelopment should be designed so as not to increase existing noise levels by more than 2 dB
Sensitive land use			
Active recreation areas	60 $dBL_{Aeq,15hr}$	-	
Passive recreation and school playgrounds	55 $dBL_{Aeq,15hr}$	-	
Existing school classrooms	50 $dBL_{Aeq,1hr}$ (internal)		

Source: after Tables 1 & 2 ECRTN

In addition, Practice Note IV of the ENMM provides guidance on 'selecting and designing 'feasible and reasonable' treatment options for buildings affected by road traffic noise'. This Practice Note suggests that noise mitigation should be provided if noise levels are *acute*, i.e. greater than or equal to 65 $dBL_{Aeq,15hr}$ (daytime) and 60 $dBL_{Aeq,9hr}$ (night-time).

These criteria have been applied along the proposed route as shown in Table 19–2.

Table 19–2 Application of noise level criteria to the route

Station	Area	Criteria
0 – 1100 m	South of Johns River	Redevelopment of existing freeway/arterial road
1100 – 3800 m	Johns River Bypass	New freeway or arterial road
3800 – 14400 m	Watson Taylor Lake	Redevelopment of existing freeway/arterial road
14400 – 16500 m	Kew Bypass	New freeway or arterial road
16500 – 22200 m	Hérons Creek	Redevelopment of existing freeway/arterial road

It should be noted that the road traffic noise criteria are provided as guidelines and are 'non-mandatory'. They provide target levels that it is desired to meet where it is reasonable and feasible to do so. The policy document states that in some instances this may be achievable only through 'long-term strategies such as improved planning; design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage' (ECRTN).

19.3.2 Sleep disturbance criteria

The relationship between event maximum noise levels from road traffic and sleep disturbance is not currently well defined. The ECTRN discuss sleep disturbance in relation to the number of noise events causing awakenings during the night-time period. As the relationship between noise and sleep disturbance is not fully understood, the ECTRN acknowledges sleep disturbance from road traffic and states that the continuation of research into its assessment is important.

The ECTRN identifies that:

- maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions
- one or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.

ENMM provides a protocol for assessing maximum noise levels in Practice Note III (PN-III). PN-III suggests that:

- at locations where road traffic is continuous rather than intermittent, the $L_{eq,9hr}$ (night-time) target noise levels should sufficiently account for sleep disturbance impacts
- however, where the emergence of maximum levels (L_{max}) over the ambient (L_{eq}) is greater than 15 dB(A), the $L_{eq,9hr}$ criteria may not sufficiently account for sleep disturbance impacts.

Therefore, an assessment of the impact of sleep disturbance on residents is made in terms of likely maximum noise levels from road traffic, the extent to which these maximum noise levels exceed the ambient level, and the expected number of noise events from road traffic during the night.

19.3.3 Construction noise and vibration criteria

Criteria for airborne construction noise

Chapter 171 of the *Environmental Noise Control Manual* (ENCM) (NSW DEC 1985) sets out noise criteria for construction projects. The L_{A10} noise parameter is used as the descriptor to assess construction site noise. The relevant criterion depends on the pre-existing L_{A90} noise level and the duration of the construction activities. A summary of these criteria is given in Table 19-3.

Table 19-3 Summary of construction noise criteria

Construction period	Criteria
Four weeks or less	$L_{A10} \leq L_{A90} + 20 \text{ dB}$
Four weeks to 26 weeks	$L_{A10} \leq L_{A90} + 10 \text{ dB}$
Greater than 26 weeks	$L_{A10} \leq L_{A90} + 5 \text{ dB}$
Tonal or impulsive noise	+5 dB penalty

While the total construction period for the Proposal is likely to be greater than 26 weeks, many construction activities would progress along the route during the construction period. Where appropriate, these construction activities may be assessed against the short and medium term guidelines.

Where construction noise is audible at residential premises, the EPA guideline recommends that construction should be limited to the following times:

- Monday to Friday, 7am to 6pm, with a maximum of nine hours per day
- Saturday, 7am to 1pm if inaudible on premises, otherwise 8am to 1pm
- no construction work to occur on Sundays or public holidays.

In addition to the major construction activities and processes, some construction plant may be required to operate continuously (24 hours a day). These items of equipment should be treated as 'semi-permanent' and the lowest criterion is appropriate (i.e. L_{A10} noise level should not exceed the existing L_{A90} background noise level by more than 5 dB). This is broadly similar to the criterion that would be imposed under the *NSW Industrial Noise Policy (INP)* (NSW DEC 2000) for permanent industrial noise sources.

Criteria for groundborne construction vibration

Australian Standard AS 2670 defines limits for both continuous and transient vibration events to minimise the risk of *adverse comment*. These limits are given in the form of multiplying factors to be applied to base curves representing the threshold of human perception. Table 19-4 shows the applicable multiplying factors.

Table 19-4 Continuous/intermittent and transient vibration levels below which the probability of adverse comment is low

Multiplying factors to be applied to base curves*			
Type of building occupancy	Time	Continuous or intermittent vibration	Transient vibration
Critical working areas e.g. precision laboratories	Day	1	1
	Night		
Residential	Day	2 to 4	30 to 90
	Night	1.4	1.4 to 20
Office	Day	4	60 to 128
	Night		
Workshop	Day	8	90 to 128
	Night		

* see Figure 2b AS 2670

Blasting and vibration exposure

Recommended limits for the vibration level and blast overpressure from blasting are found in guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (1990). The criteria for control of blasting impacts at potentially affected residences are summarised in Table 19-5.

Table 19-5 Criteria for the control of blasting impact on residences

Time of blasting	Blast over-pressure level, dB	Ground vibration, peak particle velocity, mm/s
Monday to Saturday, 9am – 3pm	115	5
Monday to Saturday, 6am – 9pm, Monday to Saturday, 3pm – 8pm	105	2
Sunday, Public Holiday, 6am – 8pm Any day, 8pm – 6am	95	1

19.4 Noise modelling and predictions

Noise levels have been predicted using the *Calculation of Road Traffic Noise (CoRTN)*, (UK Department of Transport 1998) road traffic noise prediction methodology. As the CoRTN methodology predicts 18hr or 1hr L_{A10} noise levels (10 percentile, or average maximum), corrections have been derived to convert the basic L_{A10} results to the 15hr and 9hr L_{Aeq} noise levels used by the EPA.

19.4.1 Traffic flow and composition

The noise validations and predictions have been based on traffic flow and composition data provided by the RTA. The projected hourly traffic flow data for the year of Proposal opening (2011) and 10 years after opening (2021) are shown in Table 19-6.

Table 19-6 Projected hourly traffic flow data

Hour beginning	Proposal opening (2011) Total vehicles	Year 10 (2021) Total vehicles	Proportion of daily traffic flow	Percentage heavy vehicles
0	175	228	1.0%	65%
1	163	213	1.0%	66%
2	141	185	0.8%	66%
3	115	150	0.8%	58%
4	124	161	0.8%	50%
5	232	302	1.2%	35%
6	464	605	2.6%	19%
7	729	951	4.0%	14%
8	1,040	1,358	6.1%	11%
9	1,119	1,461	6.6%	10%
10	1,205	1,573	8.1%	9%
11	1,182	1,543	8.1%	9%
12	1,038	1,355	7.3%	10%
13	1,092	1,426	7.5%	11%
14	1,078	1,408	8.0%	10%
15	1,136	1,483	8.4%	10%
16	1,045	1,364	7.7%	11%
17	875	1,143	6.6%	13%
18	595	776	3.9%	19%
19	385	503	2.7%	21%
20	317	413	2.3%	31%
21	260	340	1.8%	33%
22	232	303	1.5%	36%
23	186	243	1.2%	52%
AADV	14,929	19,487	100%	16%

19.4.2 Model calibration and assumptions

A SoundPLAN model of the existing road with measured traffic flows was compared to measured noise levels at 14 control locations to calculate an overall site-specific calibration factor for the noise model.

Overall daytime and night-time calibration factors were calculated by comparing the measured and predicted levels at each of the locations. This analysis resulted in the following calibration factors:

- -0.3 dB, daytime
- +2.5 dB, night-time.

On average, the measured levels were 0.3 dB below the predicted levels during the daytime, and measured levels were 2.5 dB higher than predicted during the night. It is expected that this is a consequence of the large number of night-time truck movements. These calibration factors were taken into account in the subsequent noise modelling.

As the CoRTN methodology predicts 18hr or 1hr L_{A10} noise levels, corrections have been also derived to convert the basic L_{A10} results to 15hr and 9hr L_{Aeq} noise levels used by the EPA. Based on actual site noise measurements of L_{A10} and L_{Aeq} , a correction of -2.7 dB (daytime) and -3.1 dB (night-time) have been applied. This is close to the nominal correction of -3.0 dB.

The noise prediction model takes account of the overall traffic volume and number of heavy goods vehicles, the vehicle speed, road gradient and type of road surfacing. The noise propagation model takes account of losses due to geometrical spreading from the noise source, absorption from the ground and shielding provided by the ground topography and physical noise barriers, where they are provided.

In accordance with the EPA criteria, noise levels have been predicted at 1.0 m from the receiver facade, and a +2.5 dB facade correction has been applied to the noise predictions to take account of reflections of sound from the facade.

The noise model assumes a road noise source emission height of 0.5 m above the road elevation.

The maximum design traffic speed of the proposed road has been assumed to be 110 km/h.

Initially, a 'worst-case' pavement surface has been assumed, corresponding to a tined and dragged concrete road surface. A correction of +3.0 dB was applied for this surface, compared to standard dense graded asphalt surfaces. This was to ensure that the noise mitigation requirements were conservative in their location and extent. Where low-noise pavement surfaces (e.g. open graded asphaltic concrete) are recommended for noise mitigation purposes, a correction of -2.0 dB has been assumed.

19.5 Road traffic noise assessment

Noise levels have been predicted at over 400 individual residences and other receiver locations along the proposed route.

The noise level predictions were made independently for daytime (7am - 10pm) and night-time (10pm - 7am) for three cases:

- 'Future-Existing', i.e. predicted 2011 (proposed opening date) traffic flows on the *existing* road alignment
- '2011', i.e. predicted 2011 traffic flows on the proposed dual carriageway alignment
- '2021', i.e. predicted 2021 traffic flows (10 years after opening) on the proposed dual carriageway alignment.

Noise mitigation is recommended if either:

- the predicted '2021' noise level *exceeds* the relevant criterion (see Table 19–1) *and* the noise level increase is greater than 2 dB (Redevelopment) or 0.5 dB (New)

or

- the noise level is *Acute* (i.e. > 65 dBL_{Aeq,15hr} daytime, > 60 dBL_{Aeq,9hr} night-time) (even if the increase is <2 dB).

19.5.1 Analysis of 'feasible and reasonable' noise mitigation

Practice Note IV (PN-IV) of the ENMM provides a detailed procedure for '*selecting and designing "feasible and reasonable" treatment options for road traffic noise*' that is aimed at providing a consistent approach to the evaluation, selection and design of appropriate noise control options. In particular, PN-IV Part (a) provides a detailed cost/benefit analysis of noise barrier options, including the level of noise reduction achieved, the number of residences protected and the typical installed cost of noise barriers.

A detailed cost effectiveness analysis of noise mitigation options has been carried out in accordance with PN-IV of the ENMM. The analysis demonstrates that it is necessary to provide noise mitigation in the form of architectural treatment to buildings and quieter road surfaces in conjunction with both architectural treatment and noise barriers.

Overall, the PN-IV analysis results in the following potential noise mitigation measures:

- Architectural treatment is recommended for approximately 90 residences.
- Low-noise road surfacing is recommended adjacent to catchments A15, A28, A37, B06, B07, B08, B09, B17 and B28 (at Catchments B17 and B28, architectural treatment may be preferred over the provision of a low-noise road surface, see Section 19.5.2 below).
- Noise barriers of 6.0 m height are recommended adjacent to Catchment B07 (Johns River).
- Noise barriers of 3.0 m height are recommended adjacent to Catchment A28 (Kew).

These mitigation options are discussed further below.

19.5.2 Noise mitigation options

The noise mitigation options have been presented in the community consultation process.

The RTA does not consider it practical to provide short sections of low-noise road surfacing, as it is difficult to adequately maintain. It recommends that architectural treatments to residences be provided in preference to low-noise road surfacing at some locations. Similarly, it is not considered reasonable to provide a 6.0 m noise barrier near Johns River since it is likely to be visually obtrusive for both the community and road users. It is therefore proposed to provide a 4.5 m noise barrier (consisting of a 1.0 m high noise barrier on a 3.5 m high earth bund) at this location.

Urban design considerations have resulted in a proposed 3.0 m high earth bund on the western side of the highway south of Kew. This would provide additional noise mitigation.

A summary of the preferred mitigation options is given in Table 19–7.

In addition to the low noise road surfacing and noise barriers, architectural treatment would be required at approximately 90 residences. The form of the architectural treatment is to be agreed with the individual residents, and may include improved glazing and door constructions, installation of acoustic seals, upgrading of building facades and roof constructions, installation of insulation materials, and sealing under-floor spaces. The reduction in noise level that would be achieved by these treatments would depend on the structure type and condition of the existing building, but could be an improvement of 10-15 dB(A) indoors.

Table 19–7 Summary of preferred noise mitigation measures

Location	Description	Approximate station	Approximate length
Johns River	Low noise pavement	2400 – 3950 (NB+SB)	1550 m
Johns River	3.5 m noise mound	2570 – 3300 (SB)	730 m
Johns River	1.0 m noise wall	2570 – 2960 (SB)	400 m
Kew	Low noise pavement	15000 – 16600 (NB+SB)	1600 m
Kew	3.0 m noise wall	15370 – 15800 (NB)	470 m
Kew	3.0 m visual mound	15080 – 15520 (SB)	440 m
Kew	3.0 m noise mound	15820 – 16150 (NB)	330 m
Hérons Creek	Low noise pavement	20340 – 21450 (NB+SB)	1110 m
Hérons Creek Public School	3.0 m noise wall	21660 – 21980 (NB)	320 m

Note: NB = northbound carriageway, SB = southbound carriageway

Noise predictions have been carried out incorporating the noise mitigation measures shown in Table 19–7. Point receiver results and full noise level contour plots are shown in Appendices C and D of Working Paper No. 3. Figures 19-1A, 19-1B, 19-2A, 19-2B, 19-3A and 19-3B show the predicted noise levels at date of opening (2011) and 10 years after opening (2021) at key locations in Johns River, Kew and Herons Creek.

Predicted night-time noise levels are around 2 dB less than daytime noise levels due to lower traffic volumes. However, since the night-time criteria are 5 dB lower than the daytime criteria, it is the night-time noise levels that are critical, and that determine the noise mitigation requirements.

The noise criteria are predicted to be exceeded at many of the residential properties adjacent to the Proposal during both the daytime and night-time. However, existing noise levels at these properties are often already relatively high, and the *increase* in noise level is likely to be small, particularly at properties adjacent to the ‘redevelopment’ sections of the route.

For properties adjacent to new sections of the route (e.g. Stewarts River Road near Johns River, and the Glen Haven residential area east of Kew), noise level increases would be higher, while properties adjacent to the existing route in Johns River and Kew are likely to experience significant reductions in noise level.

It is notable that the large cuttings at the Kew bypass would provide significant reductions to noise.

The noise level at the Camden Haven High School is predicted to be well below the relevant criterion, while at Herons Creek Public School the noise level already significantly exceeds the 55 dB_{L_{Aeq,15hr}} (external) criterion. The noise level is not expected to change significantly at this school with the proposed highway redevelopment.

19.5.3 Maximum noise levels

Existing maximum noise levels adjacent to the highway are due to individual truck movements, particularly during the night-time period when there is a high proportion of truck movements relative to other vehicles.

Due to the high number of vehicles during the night-time, the emergence of maximum levels (L_{max}) over the ambient night-time noise ($L_{eq,1hr}$) is not likely to be greater than 15 dB(A), except for receivers very close to the road. The $L_{eq,9hr}$ (night-time) target noise levels are therefore likely to reasonably account for sleep disturbance impacts.

There are no major road gradients on the proposed alignment nor are there any controls such as traffic signals. As a consequence, the use of noisy engine braking is likely to be limited.

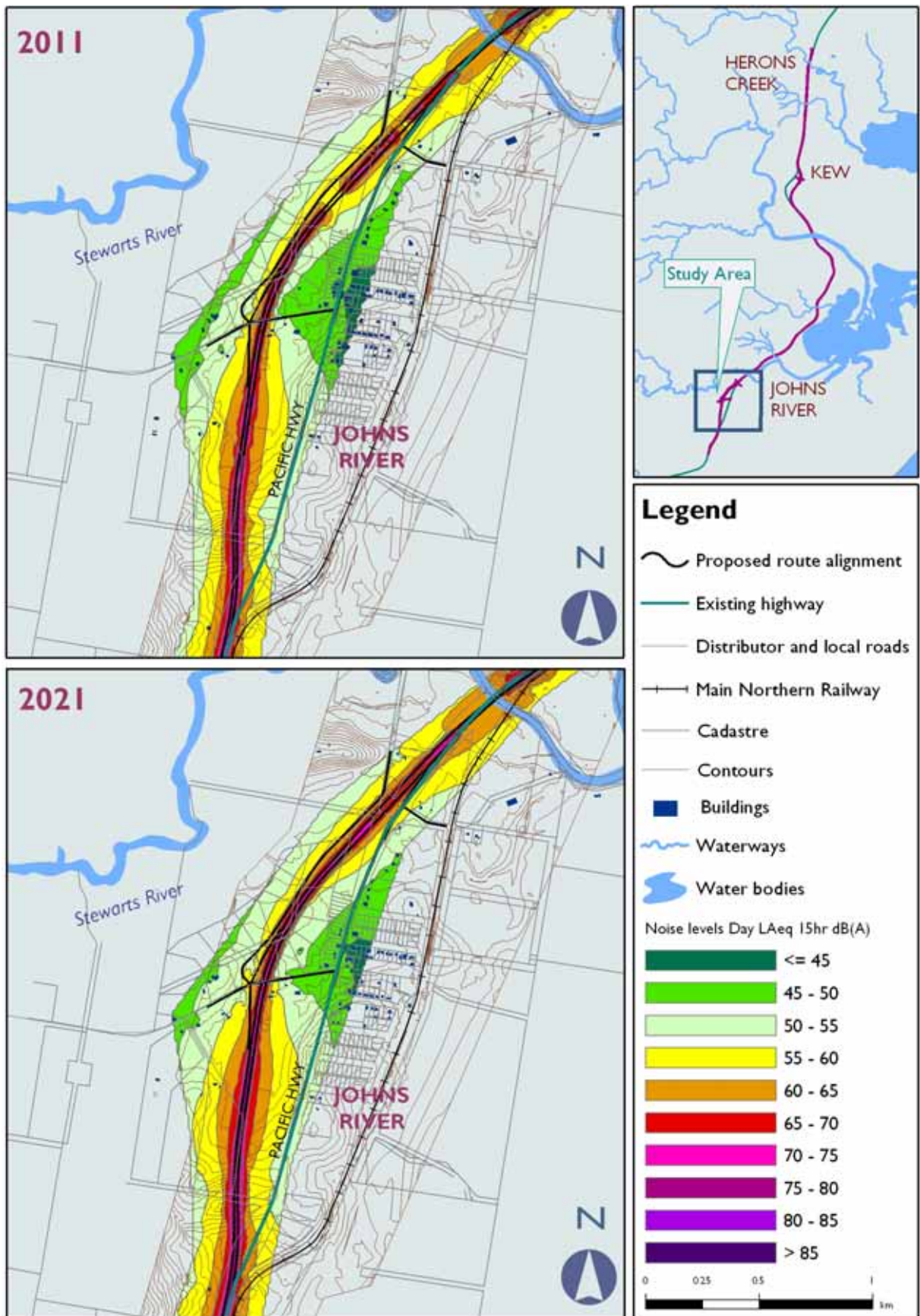


Figure 19-1A Predicted 2011 and 2021 daytime $L_{Aeq,15hr}$ noise levels, Johns River

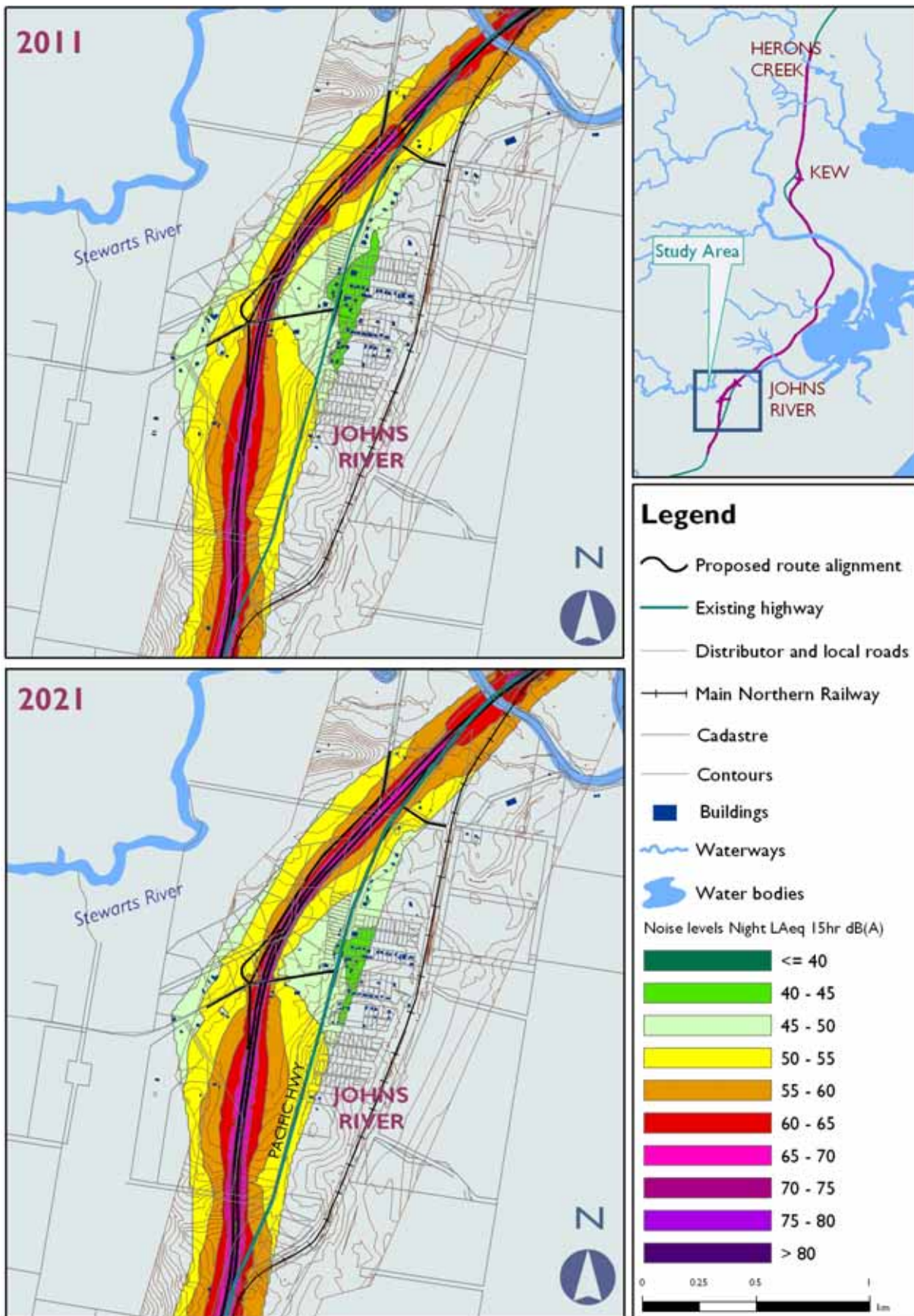


Figure 19-1B Predicted 2011 and 2021 night-time L_{Aeq,9hr} noise levels, Johns River

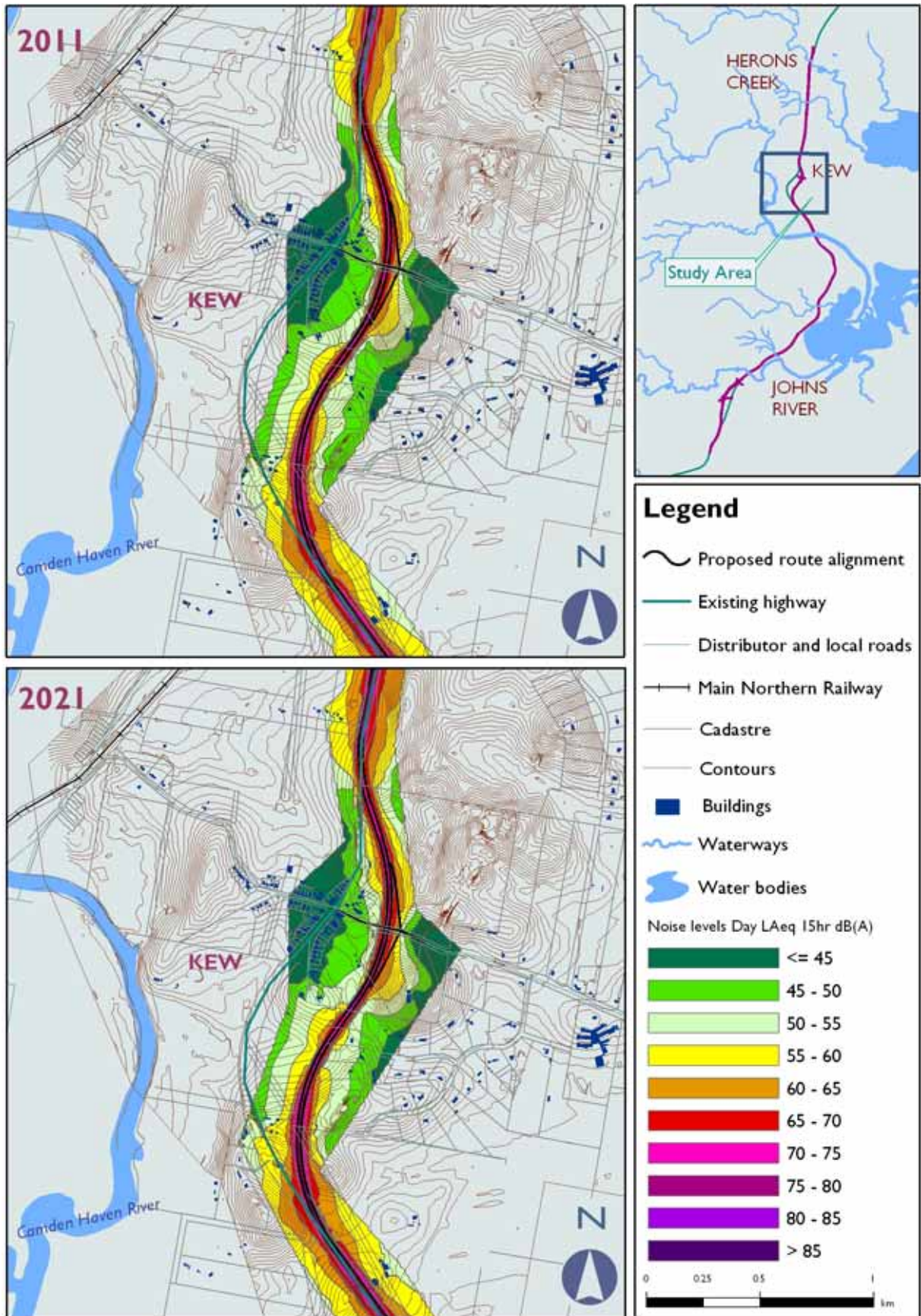


Figure 19-2A Predicted 2011 and 2021 daytime $L_{Aeq,15hr}$ noise levels, Kew

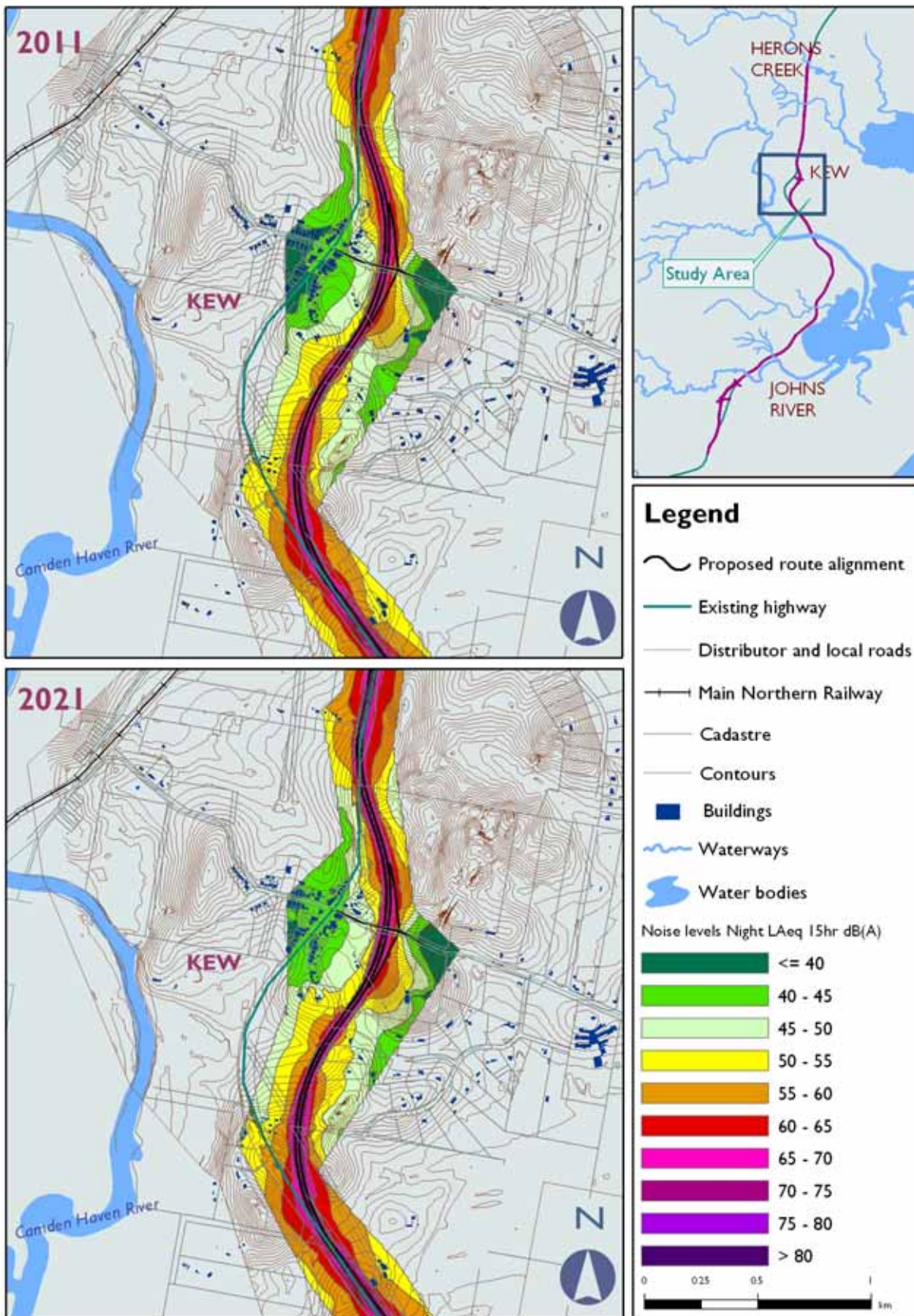


Figure 19-2B Predicted 2011 and 2021 night-time $L_{Aeq,9hr}$ noise levels, Kew

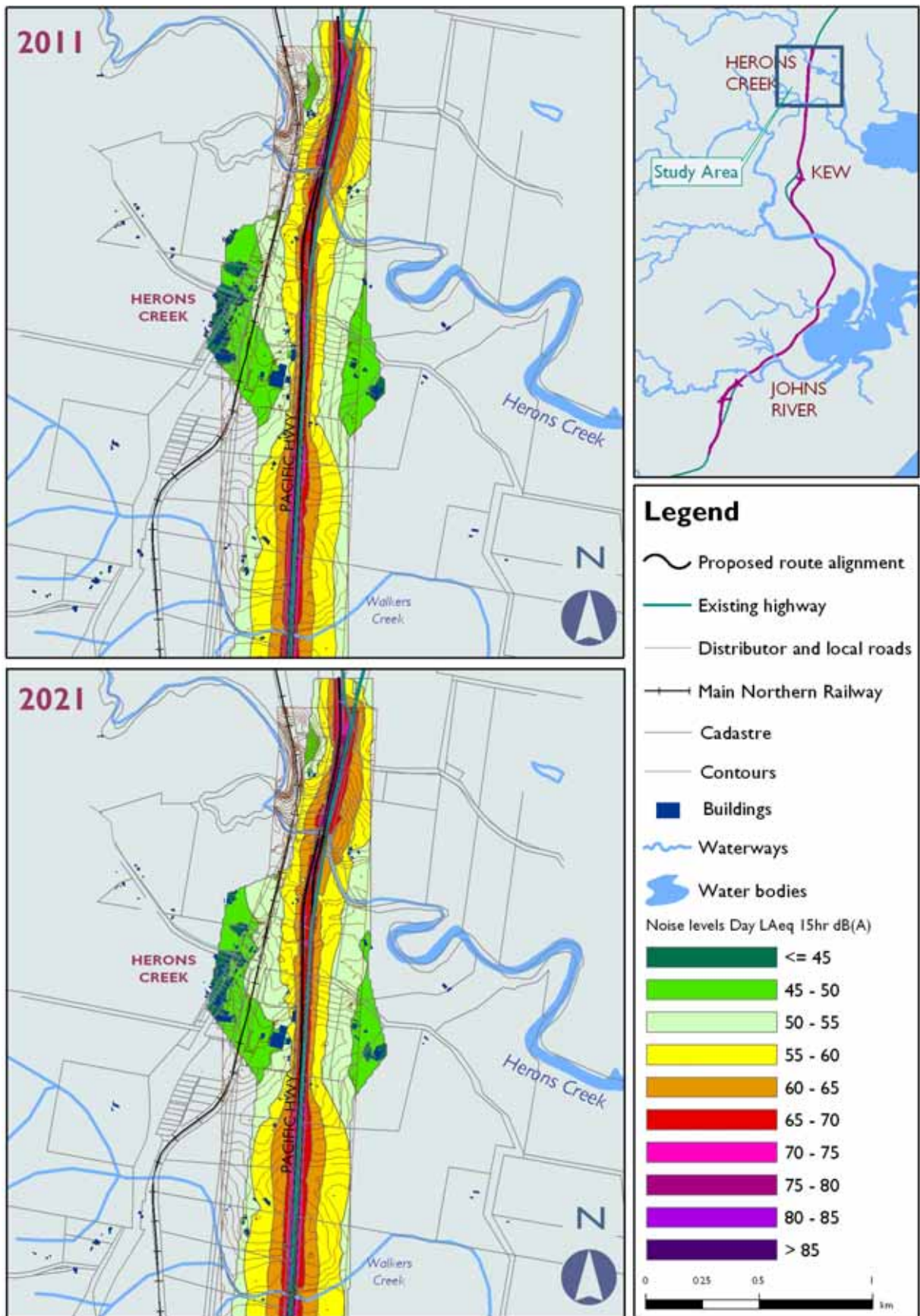


Figure 19-3A Predicted 2011 and 2021 daytime $L_{Aeq,15hr}$ noise levels, Herons Creek

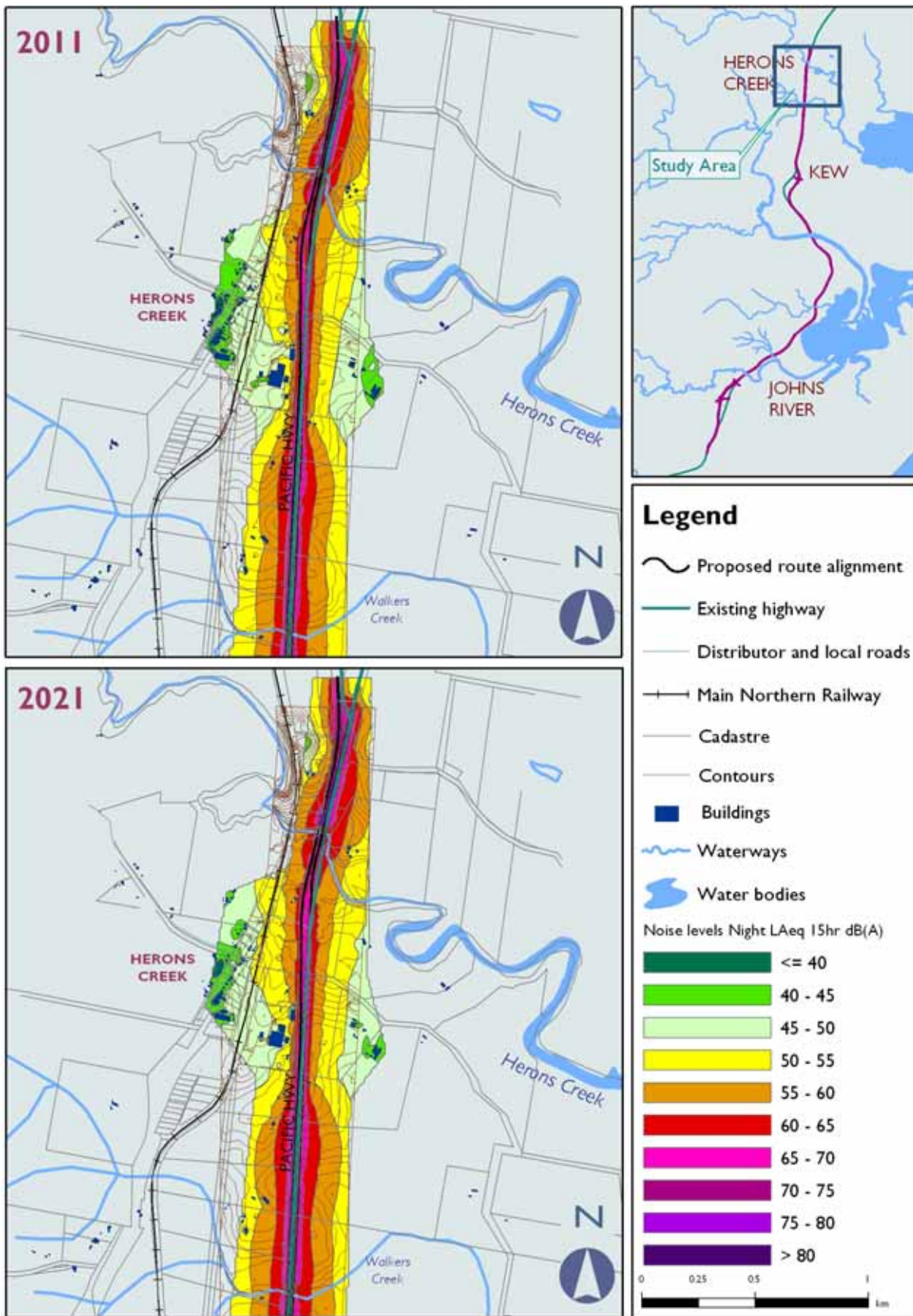


Figure 19-3B Predicted 2011 and 2021 night-time L_{Aeq,9hr} noise levels, Herons Creek

19.5.4 Noise monitoring program

The ENMM recommends that post-construction noise monitoring should be included as a part of the operation of the upgraded highway to monitor and review the effectiveness of the noise mitigation in relation to the design noise level targets.

It is recommended that a noise and traffic flow monitoring program is conducted 12 months after the road opening. This should include:

- measurement of traffic noise levels with normal operational traffic flows
- comparisons of the measured results with predicted noise levels
- verification that road traffic noise levels are in accordance with the Proposal design noise levels.

19.6 Construction noise and vibration assessment

Road construction involves several different phases, including earthworks, laying of pavement, structures and roadside furnishings. The duration of the earthworks is likely to exceed 26 weeks at some locations. The laying of pavement could exceed 4 weeks at particular locations. Bridge and embankment construction will include piling activities.

The actual level of construction noise impact would depend on the type of equipment, construction methodology chosen by the construction contractor and final location of the work sites and batching plants. Since each of these is subject to large variation, detailed noise and vibration predictions are unlikely to be representative of the final situation, and are not presented in this assessment.

However, practices to reduce construction noise exposure would be required, and may include:

- adhering to the operating time limits and conditions where possible
- agreeing work outside standard operating limits in advance with the community and the DEC
- locating of stationary plant (such as air-compressors and generators) as far away as possible from residential areas
- using natural screening by topography
- using site sheds and other temporary structures or screens
- installing operational noise barriers as early as possible to provide ongoing screening from construction activities, where possible
- choosing appropriate low-noise construction equipment and/or methods
- careful programming and management of construction activities.

Whilst the contractor would be able to achieve reductions in noise and vibration, some impact is likely to remain. A construction Noise and Vibration Management Plan would be adopted during construction stages incorporating a programme of noise monitoring at sensitive receivers, a community information programme and a complaints hotline.

Similarly, the levels of vibration generated from various construction activities would be site specific, and would be dependant on the ground type, the particular equipment used, and the proximity of the construction activity to the receiver location.

Construction activities associated with general road construction are not expected to generate perceptible levels of vibration at nearby residences due to the propagation distances.

To reduce the impact of piling noise, nearby residents should be consulted regarding the intended activities associated with the piling process. Mitigation measures to reduce the impact of percussive piling activities include:

- using a resilient pad (dolly) between pile and hammer head
- enclosing the hammer head in a temporary acoustic shroud.

Alternatively, rotary bored or vibro-piling may be used where it is consistent with the type of pile used and restrictions on soil disturbance.

Blasting may be required at cutting locations near to Kew, subject to geotechnical investigations. Many site factors would influence the transmission of vibration through the ground, such as the lithography and topography between the blast site and the receiver locations. Recommendations given in Australian Standard AS 2187.2 *Explosives – Storage, Transport and Use. Part 2: Use of Explosives* for reducing the effects of ground vibration and overpressure levels should be applied where necessary.

19.7 Conclusions and recommendations

A study has been carried out to assess the impact of noise and vibration on the surrounding community from the proposed alignment for the upgrading of the Pacific Highway from Moorland to Herons Creek.

Traffic noise criteria have been based on the EPA *Environmental Criteria for Road Traffic Noise*. Construction noise and vibration criteria have been based on EPA guidelines and Australian and New Zealand Standards.

Ambient noise surveys were conducted adjacent to the existing route, and the resulting noise levels were used to calibrate the noise prediction model.

The noise model demonstrates that noise mitigation is required for residences along much of the route. This should comprise noise barriers near Johns River, Kew and Herons Creek Public School, and low-noise road surfacing near Johns River, Kew and Herons Creek. Many residences near to the route will need to be provided with architectural acoustic treatment.

The level of construction noise and vibration depends on the construction methodology and construction equipment used on the site. However, construction noise and vibration is expected to have some impact on residences near to the upgrade route, and suitable mitigation would be required to reduce the impacts.

19.8 Implications for ESD

19.8.1 Precautionary principle

The route selection process sought to reduce noise impacts on sensitive receptors such as residences and businesses adjacent to the alignment. After the opening of the Proposal, traffic volumes would decrease on the existing highway in these locations, therefore reducing the associated noise impact. However the Proposal would increase noise levels at many residences as discussed in Section 0. Mitigation measures have been outlined to reduce the impacts on those properties likely to be affected.

19.8.2 Intergenerational equity

If the Proposal proceeds, there would be a reduction in noise levels for many residents, particularly in the townships of Johns River and Kew. Where noise level increases are predicted, extensive mitigation is proposed.

19.8.3 Conservation of biological diversity

Very little information is available on the effects of noise and vibration on flora and fauna. It is expected that noise levels that are acceptable to humans are unlikely to have a negative impact on these species.

19.8.4 Improved valuation and pricing of environmental resources

Noise mitigation measures are recommended to limit the noise impacts of the proposal. These measures would be incorporated into the construction, detailed design and operation of the proposed upgrade and, thus, place a value on preserving the acoustic environment.