

2 Working Paper

Noise and Vibration

SAPPHIRE TO WOOLGOOLGA
HIGHWAY UPGRADE
NOISE & VIBRATION IMPACT ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 00086
VERSION G

WILKINSON  MURRAY

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PREPARED FOR

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A C O U S T I C S A N D A I R

TABLE OF CONTENTS

	Page
1 INTRODUCTION	1
1.1 Background	1
1.2 Project Description	1
2 EXISTING AMBIENT NOISE ENVIRONMENT	4
2.1 Monitoring Locations	4
2.2 Monitoring & Analysis Procedures	12
3 CRITERIA FOR OPERATIONAL NOISE	13
3.1 Noise Criteria for Residences	13
3.2 Criteria for Construction / Blasting Noise & Vibration	15
3.2.1 General Guidelines	15
3.2.2 Sleep Disturbance	15
3.3 Vibration (Excluding Blasting)	16
3.3.1 Human Comfort	16
3.3.2 Building Damage	17
3.4 Blasting Assessment Criteria	17
3.4.1 Annoyance & Discomfort	17
3.4.2 Structural Damage	17
4 OPERATIONAL NOISE ASSESSMENT	19
4.1 Modelling Methodology	19
4.1.1 Modelling Procedures	19
4.1.2 Modelling Scenarios	20
4.2 Noise Catchment Areas	20
4.3 Traffic Modelling Parameters	21
4.4 Model Validation	31
4.5 Sensitivity Analysis	32
4.6 Predicted Noise Levels	32
4.7 Design of Noise Mitigation Measures	34
4.8 Summary of Operational Noise Mitigation Design	37
5 MAXIMUM NOISE LEVEL ASSESSMENT	40
5.1 Measurement of Maximum Noise Levels	40
6 REST AREA AT ARRAWARRA INTERCHANGE	46
6.1 Noise Criteria	48
6.2 Predicted Traffic Volumes	50
6.3 Noise Level Predictions	51

6.4	Assessment of traffic noise against Environmental Criteria for Road Traffic Noise	52
6.5	Summary of Rest Area Impacts	53
7	CONSTRUCTION NOISE & VIBRATION ASSESSMENT	54
7.1	General Description of Construction Methodology	54
7.1.1	Hours of Operation	54
7.1.2	Temporary Infrastructure	54
7.1.3	Batching Plant Sites	54
7.1.4	Construction Compounds	55
7.1.5	Stockpile Areas	55
7.1.6	On-site Materials Processing Areas	55
7.1.7	Casting Yards	56
7.2	Background Noise Levels	56
7.2.1	Description of Rating Background Level	56
7.2.2	Assessment Areas	56
7.2.3	Pacific Highway Upgrade section	56
7.2.4	Woolgoolga Bypass section	56
7.3	Construction Noise Criteria	57
7.3.1	General Guidelines	57
7.3.2	Criteria for Construction Road Traffic Noise	57
7.4	Assessment of Noise from Mobile Plant	58
7.4.1	Mobile Plant Source Noise Levels	58
7.4.2	Typical Activity Noise Levels	59
7.4.3	Noise to Residences	60
7.5	Assessment of Noise from Concrete Batching Plant	60
7.5.1	Noise to Residences	61
7.6	Assessment of Vibration	61
7.6.1	Vibration Criteria	61
7.6.2	Source Levels of Vibration	61
7.6.3	Vibration Levels at Residences	62
8	BLASTING VIBRATION & OVERPRESSURE ASSESSMENT	63
8.1	Prediction of Noise & Vibration Levels	63
8.2	Predicted MIC to meet Residential Overpressure & Vibration Criteria	64
9	CONCLUSION	67
APPENDIX A – Glossary of Terms		
APPENDIX B – Noise Catchment Areas		
APPENDIX C– Noise Contours		
APPENDIX D– Noise Measurement Results		

1 INTRODUCTION

1.1 Background

It is proposed to upgrade the Pacific Highway between Sapphire and Woolgoolga. The Proposal entails the provision of dual carriageways between the northern end of the existing dual carriageway at Sapphire to Arrawarra Creek, north of Woolgoolga, a distance of approximately 25km. A range of corridor and route options have previously been evaluated and a preferred route option has been selected. This report has been prepared to form part of the Environmental Assessment for the Proposal. It details the extent of potential noise and vibration impacts associated with the construction and operation of the proposed upgrade, including mitigation measures where relevant.

Noise and vibration impacts have been assessed in accordance with the NSW Government's *Environmental Criteria for Road Traffic Noise (ECRTN)* and the *RTA Environmental Noise Management Manual (ENNM)*. In addition, the Department of Environment & Climate Change (DECC) *Environmental Noise Control Manual (ENCM)* has been employed in the assessment of construction noise impacts.

1.2 Project Description

The Proposal commences from approximately 8km north of Coffs Harbour at Sapphire, extending for approximately 25 km to the vicinity of Arrawarra Beach Road north of Woolgoolga. The Proposal can be further broken down into the southern "upgrade" section (from Sapphire to south Woolgoolga) and the northern "bypass" section (Woolgoolga bypass).

From Sapphire to south Woolgoolga, the Proposal entails the duplication of the existing highway to a dual carriageway, controlled access highway (Figure 1-1). This section of the Proposal includes an access road for local traffic alongside or near the highway. The Proposal ties into the existing dual carriageway highway at Korora, with a left-in/left-out intersection at Campbell Close on the western side and a right-in/left-out intersection with the eastern local access road (the existing highway) opposite Campbell Close. North of Campbell Close, access to and from the highway would be restricted to grade-separated interchanges.

The Woolgoolga bypass section of the Proposal is also a dual carriageway standard upgrade, with the existing highway becoming the local access road. The bypass would deviate from the existing highway just north of Graham Drive, and rejoin the existing highway at the grade-separated interchange at Arrawarra. Two interchanges, one at south Woolgoolga and another at Arrawarra, would provide access to the bypass (Figure 1-2).

Figure 1-1 Southern Section

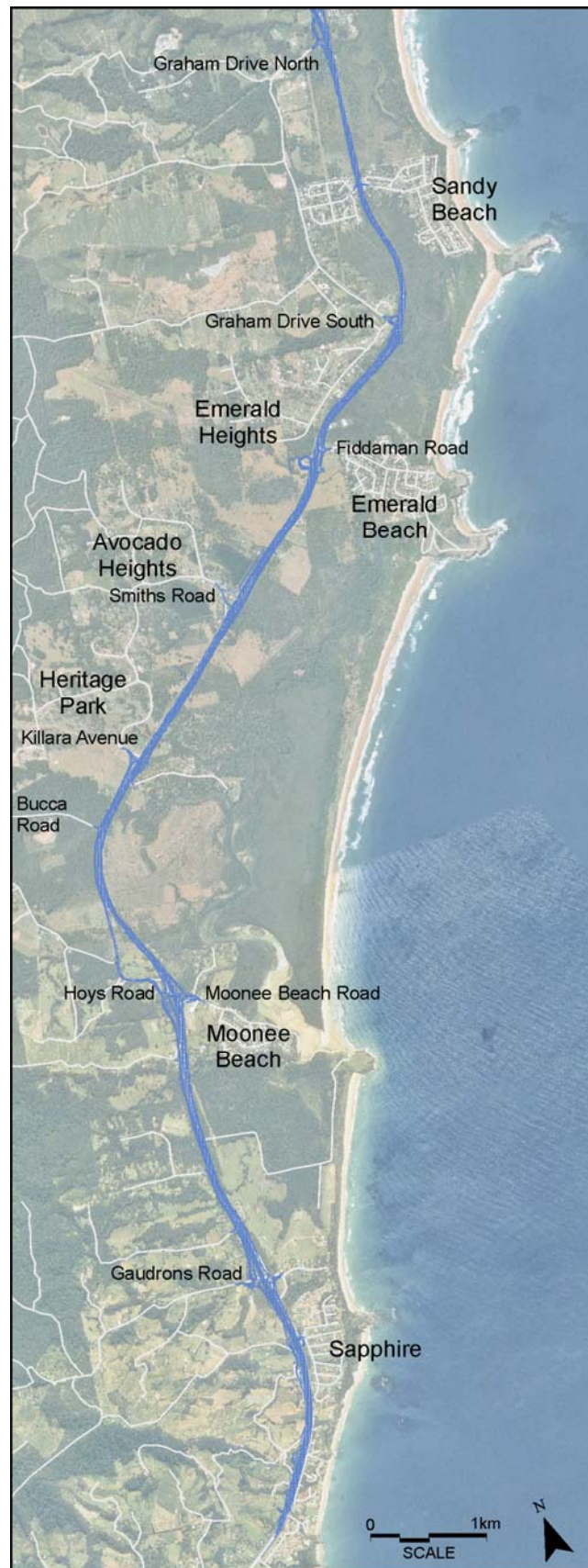


Figure 1-2 Woolgoolga Bypass Section



2 EXISTING AMBIENT NOISE ENVIRONMENT

2.1 Monitoring Locations

To define the existing noise environment in potentially affected areas, ambient noise surveys were undertaken between 19/20 May 2005 and 30/31 May 2005, and between 30/31 May 2005 and 8 June 2005. 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. The sites are listed in Table 2-1 and shown in Figure 2-1 to Figure 2-5.

The sites represent locations which may potentially experience noise impacts due to operational or construction noise (or both) associated with the project, and are designed to allow validation of the predictive model as well as derivation of relevant noise criteria.

Table 2-1 Noise Measurement Sites

Site	Location	Shown on Figure
1	2/786 Pacific Highway	2-1
2	817 Pacific Highway, Korora	2-1
3	8 Alpin Place, Sapphire Beach	2-2
4	18 Woodhouse Road, Moonee Beach	2-3
5	20 Hoys Road, Moonee Beach	2-3
6	26 Tiki Road, Moonee Beach	2-4
7	9 Smiths Road, Emerald Beach	2-4
8	9 Bream Close, Emerald Beach	2-5
9	53 Emerald Heights Drive, Emerald Beach	2-5
10	5 Pine Crescent, Sandy Beach	2-6
11	6 Wattle Place, Sandy Beach	2-6
12	11 Hearn Lake Road, Woolgoolga	2-7
13	5 Ryan Crescent, Woolgoolga	2-8
14	Go Bananas Motel, 53 Clarence Street	2-8
15	127 Woolgoolga Creek Road, Woolgoolga	2-8
16	18 Gresham Drive, Woolgoolga	2-8
17	2921 Pacific Highway, Woolgoolga	2-9

Figure 2-1 Monitoring Sites 1 and 2



Figure 2-2 Monitoring Site 3

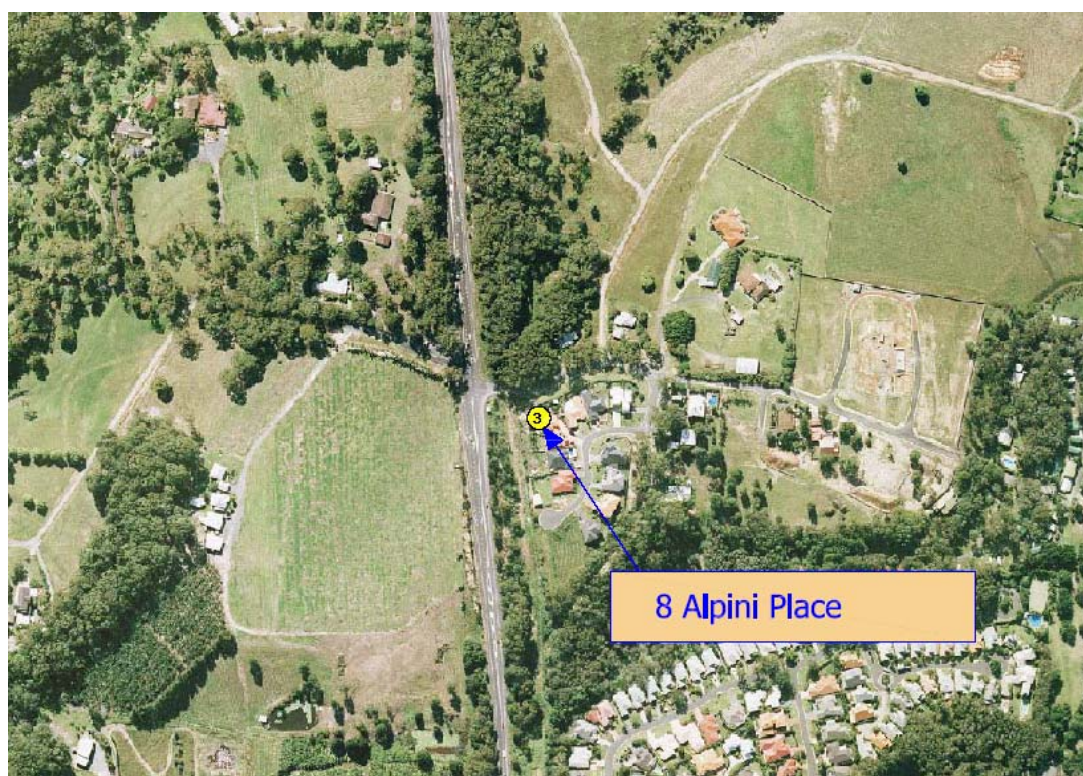


Figure 2-3 Monitoring Sites 4 and 5



Figure 2-4 Monitoring Sites 6 and 7



Figure 2-5 Monitoring Sites 8 and 9

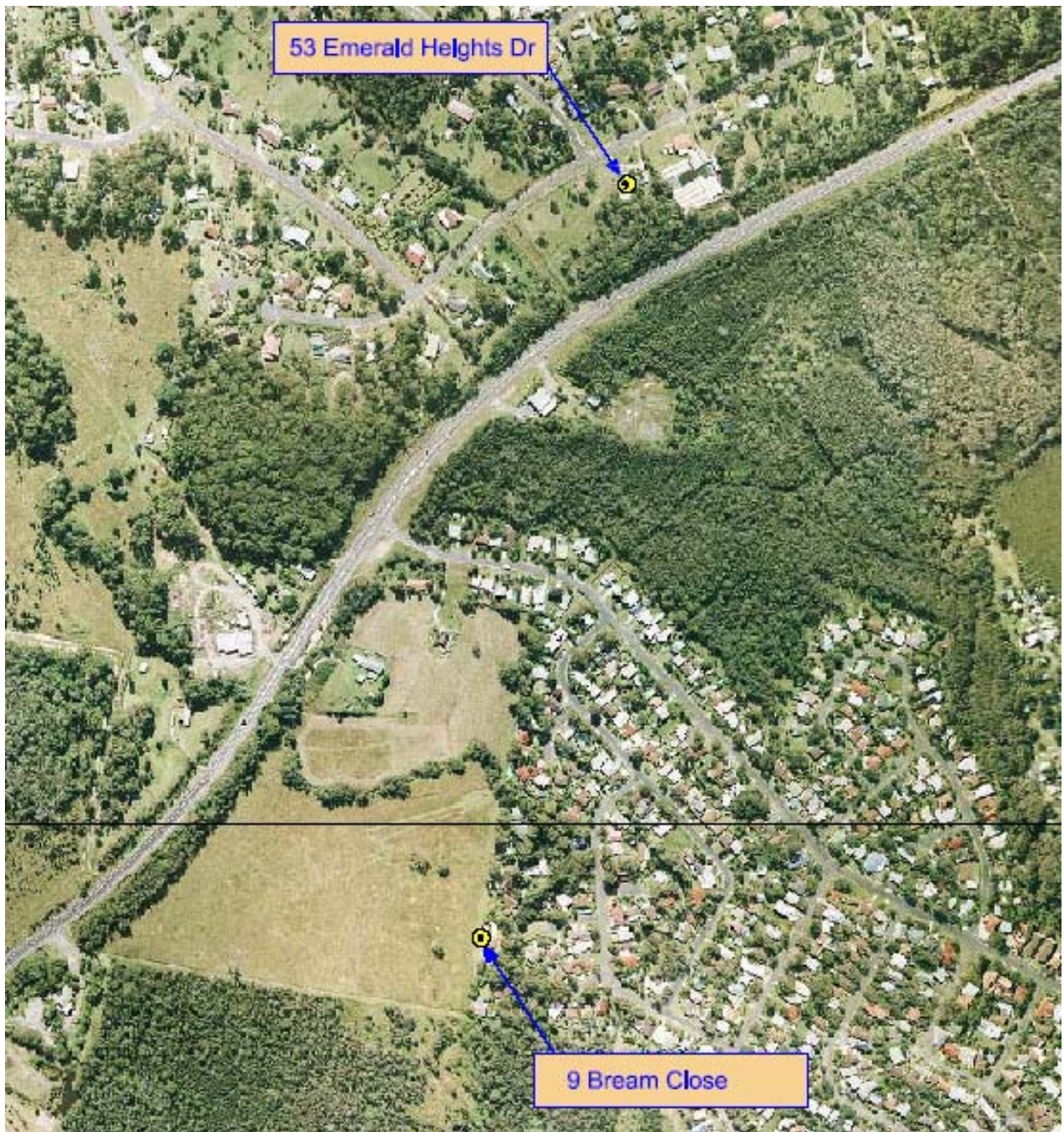


Figure 2-6 Monitoring Sites 10, 11



Figure 2-7 Monitoring Site 12

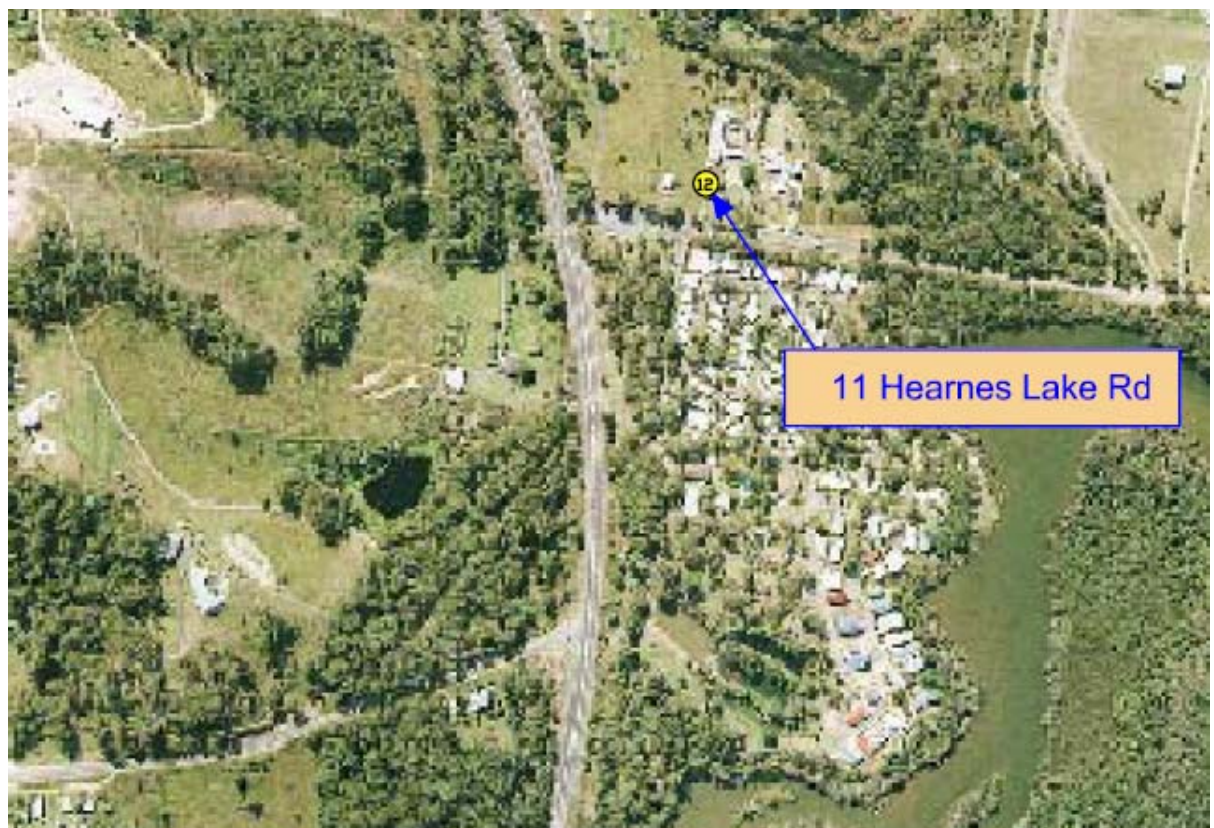


Figure 2-8 Monitoring Sites 13, 14, 15, 16



Figure 2-9 Monitoring Site 17



2.2 Monitoring & Analysis Procedures

The unattended noise monitoring equipment used for these measurements consisted of an Environmental Noise Logger set to A-Weighted, Fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later analysis. The equipment calibration was checked before and after the survey and no significant drift occurred.

The logger determines L_{A1} , L_{A10} , L_{A90} and L_{Aeq} levels of the existing noise Environment. The L_{A1} , L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample time respectively. The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. The L_{A90} level is normally taken as the background noise level. The L_{Aeq} level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise Environment with its fluctuating sound levels. Whilst the L_{A10} has in the past been used as a descriptor for traffic noise, the L_{Aeq} is now the standard descriptor for traffic noise.

To describe background noise levels, the measure currently recommended in NSW is the Rating Background Level (RBL) as defined in the NSW Department of Environment & Climate Change (DECC) *NSW Industrial Noise Policy (INP)*. A glossary of terms is provided in Appendix A.

Meteorological data for the relevant periods was obtained from the nearest weather station at Coffs Harbour. Periods in which it was raining, or when wind speeds exceeded 5m/s at microphone height, were excluded from analysis, in accordance with principles agreed by the NSW DECC.

A second correction to the data was performed to exclude sources of extraneous noise. These sources are not always identifiable; however those 15 minute periods in which the L_{Aeq} level is significantly higher than the L_{A10} level and corresponds to a high maximum level are unlikely to be “normal” traffic noise and have therefore been excluded from statistical analysis of logger data.

The results of the noise survey are shown in graphical form in Appendix D. The results are summarised and discussed in detail in Sections 5 and Section 7 for construction and operational noise respectively.

3 CRITERIA FOR OPERATIONAL NOISE

3.1 Noise Criteria for Residences

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

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 Noise Management Manual describes the circumstances under which each of these applies. Applying this practice note to the Proposal, in general terms the area to the north (the bypass section) would be classified as a "new freeway or arterial road corridor" and the southern section to the south of the bypass a "redevelopment of existing freeway/arterial road". The criteria set out in Table 3-1 would therefore apply.

Table 3-1 *Environmental Criteria for Road Traffic Noise* criteria for operational traffic noise - residences

Type of Development	Noise Level Criterion		Where Criteria are already Exceeded
	Day (7.00am-10.00pm)	Night (10.00pm-7.00am)	
New freeway or arterial road corridor	$L_{Aeq,15hr}$ 55dBA	$L_{Aeq,9hr}$ 50dBA	The new road should be designed as not to increase existing noise levels by more than 0.5dB.
Redevelopment of existing freeway/arterial road	$L_{Aeq,15hr}$ 60dBA	$L_{Aeq,9hr}$ 55dBA	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2dB. <i>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 ...</i>

In applying Table 3-1, the noise level criterion applies to the predicted noise level at a time 10 years after opening of the project (design year), which in this case is year 2021. The "existing" noise levels are described in the Environmental Noise Management Manual as "future existing" levels – that is, noise levels due to traffic on existing roads as predicted at a time immediately before opening of the project.

Where the “base” criteria in Table 3-1 are already exceeded, Practice Note (iv) of the Environmental Noise Management Manual provides further discussion of situations where provision of additional controls would be considered “feasible and reasonable”. In particular, for “new freeways or arterial roads” it is generally *not* considered reasonable to take action to reduce noise levels to the target noise levels if the noise levels with the proposal, ten years after project opening, are predicted to be:

- Within 2dBA of “future existing” noise levels; *and*
- No more than 2dBA above the target noise levels set out in the Table 3-1.

For road “redevelopments” it is generally *not* considered reasonable to apply additional treatments (after opportunities for noise control have been incorporated into the road design) if predicted design year noise levels:

- Do not exceed the Environmental Criteria for Road Traffic Noise allowance of 2dBA over “future existing” noise levels, *and*
- Will not be “acute” (i.e. do not exceed 65dBA $L_{Aeq,15h}$ and 60dBA $L_{Aeq,9h}$).

A further point should be noted in applying this RTA policy. The Environmental Criteria for Road Traffic Noise indicates (technical note ix) that if the existing noise level is below the criterion but within 2dB of the criterion, then the 2dB allowance may also be applied. Hence, the exclusion above is also taken to apply to cases where an existing noise level below the “base” criterion is predicted to increase by 2dBA or less.

3.2 Criteria for Construction / Blasting Noise & Vibration

3.2.1 General Guidelines

Guidelines for assessment of construction noise are specified in the Department of Environment and Climate Change (DECC) Environmental Noise Control Manual (*ENCM*) Chapter 171. These are currently under revision, but these revisions are not expected to substantially alter their application in this project. The guidelines are:

- For periods of 4 weeks or less, the L_{A10} level should not exceed the background (L_{A90}) level by more than 20dBA; and
- For periods greater than 4 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 DECC would expect that the L_{A10} level should not exceed the background (L_{A90}) level by more than 5dBA.

It is accepted that for determining noise criteria, the L_{A90} background noise level should be quantified by the Rating Background Level (RBL) value.

In addition, the DECC specifies the following time restrictions for construction activities:

- Monday to Friday 7.00am to 6.00pm
- Saturday 8.00am to 1.00pm (if noise is audible at residential premises)

No construction work is to take place on Sundays or Public Holidays.

There are cases where it is impossible or impractical to restrict road construction activities to within the above hours. For example activities involving road closures, diversions or traffic disruption are also most appropriately conducted outside normal working hours. In these cases, in the absence of specific criteria supplied by the DECC, the criteria for out-of-hours operations are also assumed to be the RBL background level plus 5dBA. (Of course, the RBL will be significantly lower at night.)

The DECC also recommends generally that all possible steps should be taken to reduce noise levels of construction site equipment so as to minimise the impact of construction noise.

3.2.2 Sleep Disturbance

In addition to the above criteria, where any work is conducted during the night-time period 10.00pm-7.00am, the DECC recommends that to protect against sleep disturbance, the L_{A1} noise levels should not exceed the background level by more than 15dBA at any residence. In practice, the L_{A1} level can be represented by the maximum noise level. 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.

3.3 Vibration (Excluding Blasting)

Impacts from vibration can be considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits is achieved, it will follow that compliance will be achieved with the building damage objectives.

3.3.1 Human Comfort

The DECC's *Assessing Vibration: A Technical Guideline* provides acceptable values for continuous and impulsive vibration in the range 1-80Hz. Both preferred and maximum vibration limits are defined for various locations and are shown in Table 3-2.

Table 3-2 Preferred and Maximum Peak Particle Velocity (PPV) values for Continuous and Impulsive Vibration

Location	Assessment period ⁽¹⁾	Preferred values	Maximum Values
Continuous vibration			
Critical areas ⁽²⁾	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices, schools, educational institutions and places of worship	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2
Continuous vibration			
Critical areas ⁽²⁾	Day or night time	0.14	0.28
Residences	Daytime	8.6	17.0
	Night time	2.8	5.6
Offices, schools, educational institutions and places of worship	Day or night time	18.0	36.0
Workshops	Day or night time	18.0	36.0
Note: 1) Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am. 2) Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.			

These limits relate to a long-term (16 hours for daytime), continuous exposure to vibration sources. Where vibration is intermittent, a vibration dose is calculated and acceptable values are shown in Table 3-3.

Table 3-3 Acceptable Vibration Dose Values for Intermittent Vibration ($\text{m/s}^{1.75}$)

Location	Daytime ⁽¹⁾		Night time ⁽¹⁾	
	Preferred value	Maximum Values	Preferred value	Maximum Value
Critical areas ⁽²⁾	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: 1) Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am.

2) Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.

3.3.2 Building Damage

In regard to potential building damage, the German Standard DIN4150 suggests a limit of 10mm/s PPV within any building and the British Standard BS7385: Part 2 - 1993 sets a limit within buildings which depends upon the vibration frequency, but is as low as 7.5mm/s PPV (at 4.5Hz). For the likely frequency content of vibration resulting from this Proposal, a limit of approximately 10 mm/s PPV would apply.

3.4 Blasting Assessment Criteria

3.4.1 Annoyance & Discomfort

For assessment of annoyance due to blasting, the DECC (and most similar authorities in Australia) has adopted guidelines produced by the Australian and New Zealand Environment and Conservation Council (ANZECC). The fundamental criteria are that at any residence or other sensitive location:

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

3.4.2 Structural Damage

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 and above, 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* contains an appendix specifying recommended levels for peak particle vibration velocity to protect typical buildings from damage. These are:

- “Structures that may be particularly susceptible to ground vibration” – 5mm/sec
- “Houses and low-rise residential buildings; commercial buildings not included below” – 10mm/sec
- “Commercial and industrial buildings or structures of reinforced concrete or steel construction” – 25mm/sec