Failford Road to Tritton Road

Review of environmental factors - Appendix C

Noise and vibration assessment

May 2008

Project No: 05166/1588

Noise and Vibration Impact Assessment
Pacific Highway Upgrade
Failford Road to Tritton Road Section

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1.0 - INTRODUCTION

This report provides the results and findings of a noise and vibration impact assessment of the proposed construction and operation of the proposed upgrade of the Pacific Highway between Failford Road, Failford and Tritton Road, Possum Brush, NSW.

This report presents the results of the assessment as an input to a Review of Environmental Factors (REF). The following section gives a brief outline of the proposed development, with emphasis solely on factors relevant to acoustics. A more detailed project description is contained in the REF.

2.0 – ROUTE DESCRIPTION

The proposed upgrade of the Pacific Highway would involve widening the existing road to create a new northbound carriageway from just south of Failford Road to just south of Tritton Road at Possum Brush. The proposal would also involve the construction of an interchange and parallel service roads utilising part of the existing northbound carriageway.

The proposed works would be located along a 3.3km section of road approximately 17km south of the city of Taree. The location of the proposed works is shown in **Figure 1**.

The proposal site is located within a rural environment. Along this section of the existing road there are a number of rural properties located on both sides of the highway over the full length of the proposal.

The new carriageway would be constructed directly alongside and to the east of the existing southbound lane. From an acoustic point of view the existing northbound lane would go from carrying approximately 50% of the traffic flow to carrying only those vehicles using the new interchange. The noise source representing northbound traffic would, effectively, be relocated to the east. There are currently five residences on the eastern side of, and in close proximity to the road. Of these two are either to be acquired or have already been acquired by the RTA.

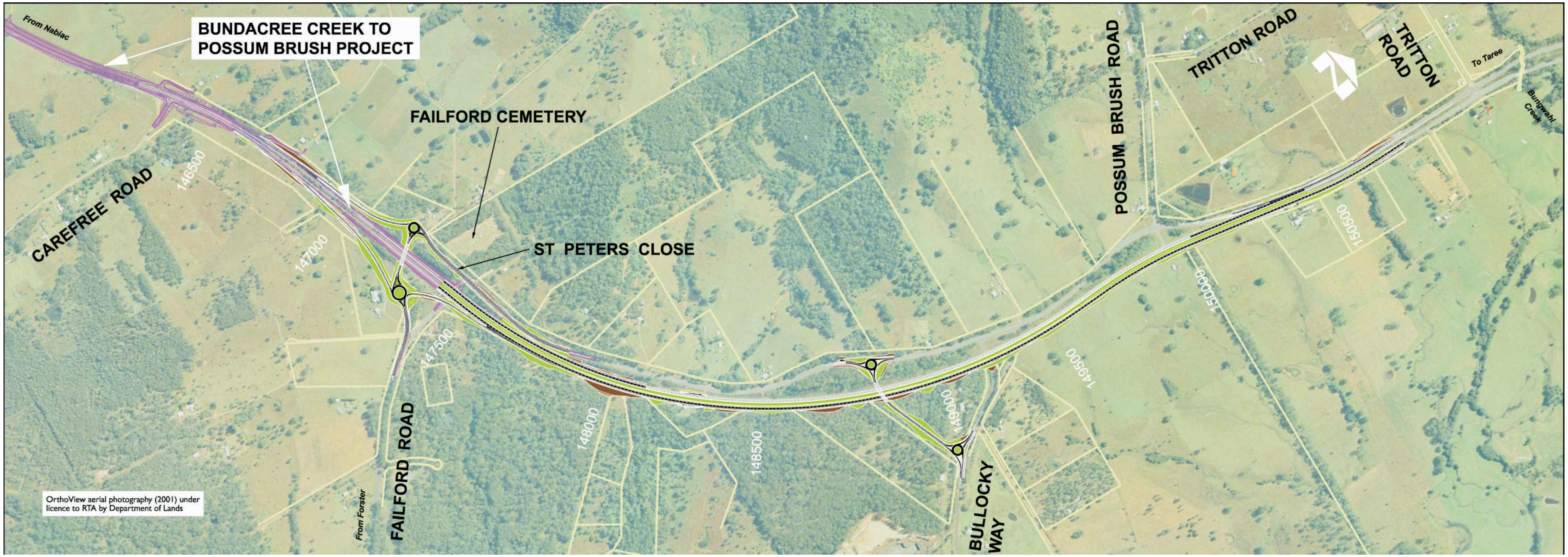

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FIGURE 1

Site Location Plan

3.0 - ROAD TRAFFIC NOISE INDICES

Road traffic noise is the sum of all noise produced by vehicles in a traffic stream. Road traffic noise levels vary throughout the daytime and night-time depending on the prevailing traffic volume, type and speed of vehicles. Because of these time-related variations in traffic noise, a variety of noise descriptors are used. The main descriptors are a measure of the amount of acoustic energy from the traffic stream over the daytime and night-time periods. The most commonly used descriptors when measuring or assessing traffic noise are the L_{A10} and the L_{Aeq} noise indices, definitions of which appear below.

L_{A10} – The A-Weighted sound pressure level, corresponding to the noise level exceeded for 10% of a particular time period. With respect to traffic noise, the $L_{A10,\ (18\ hour)}$ index is used widely throughout Australia. This index is the arithmetic average of the 18, $L_{A10,\ (1\ hour)}$ noise levels occurring between 6.00 a.m. and midnight.

L_{Aeq} – The A-Weighted, energy-averaged sound pressure level over the measurement period. This is the steady noise level, which contains the same amount of acoustic energy as all the varying noise levels observed during a particular time period. When assessing road traffic noise in NSW, the measurement period is commonly 15 hours (7.00 a.m. to 10.00 p.m.), and 9 hours (10.00 p.m. to 7.00 a.m.), in which case it is specifically referred to as the $L_{Aeq\ (15hour)}$ or the $L_{Aeq\ (9hour)}$ level.

A hypothetical time signal is shown, in **Figure 2** to illustrate various noise level percentiles. Unlike the L_{A10} index, the L_{Aeq} is sensitive to infrequent high level events, such as heavy vehicle movements etc.

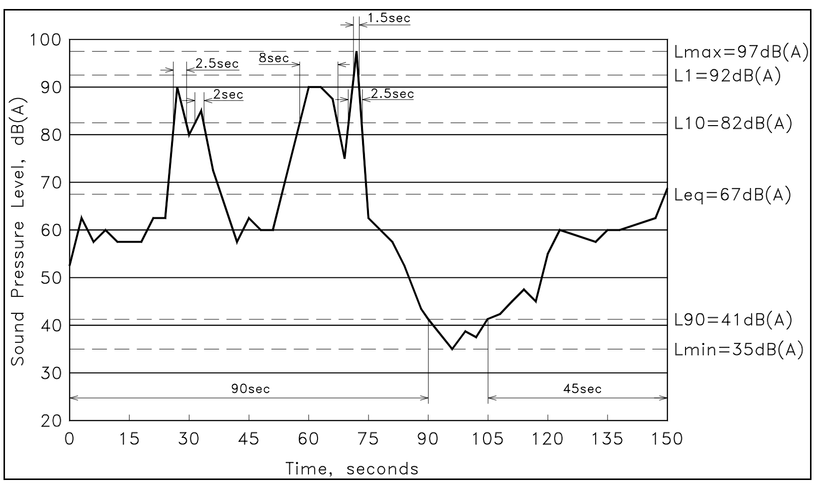


***Figure 2**. Hypothetical time signal to illustrate Ln percentiles*

Historically in Australia the $L_{A10,\ (18hour)}$ index has been used to assess traffic noise. This index is the arithmetic average of the 18, $L_{A10,\ (1hour)}$ noise levels occurring between 6.00 am and midnight. The department of Environment and Conservation (DEC, formally EPA) conducted an extensive review of the various noise indices used throughout Australia and the rest of the world in 1998 - 1999. This review considered the relationship between noise and annoyance, noise prediction requirements and the reproducibility of measurements required for compliance certification.

As a consequence of this study, the DEC and the RTA agreed to jointly adopt the LAeq as the preferred base index.

The current policy of the DEC provides guidance for the assessment of road traffic noise in terms of $L_{Aeq\ (15hour)}$ and $L_{Aeq\ (9hour)}$ levels. These are the energy-averaged levels that occur in the 15 hour period between 7.00 am to 10.00 pm and the 9 hour period between 10.00 pm and 7.00 am respectively. Predictions are based on Annual Averaged Daily Traffic (AADT) flows.

The DEC requires the typical maximum traffic noise levels to be quoted, although this is not a direct part of the assessment procedure, and no criteria are set within the guidelines.

4.0 - AMBIENT NOISE ENVIRONMENT

The existing ambient noise levels were monitored at two representative locations along the study corridor in September 2005. Noise levels were recorded at 15 minute statistical intervals using Acoustic Research Laboratories EL-215 Environmental Noise Loggers. Recordings were done in accordance with relevant EPA guidelines and AS 1055-1997 “Acoustics – Description and Measurement of Environmental Noise”. All of the noise loggers used comply with the requirements of AS1259.2-1990. “Acoustics – Sound Level Meters”, and all have current NATA calibration certification. Calibration of the loggers was performed as part of the instruments uploading and downloading procedure, with all calibration results being within the allowable ± 0.5 dB(A) range.

The loggers were programmed to continuously register environmental noise levels over the 15 minute intervals, with internal software calculating and storing Ln percentile noise levels for each sampling period.

The logging locations are presented below and shown in **Figure 3**.

- Location 1 – No. 14841 Pacific Highway, and
- Location 2 – No. 14991 Pacific Highway.

The logger at Location 1 was in the free field in front of the residence, uphill from the road, with a partial view of the road. The logger at Location 2 was also in the free field, attached to the front fence of the residence, with full line of sight of the road. As a result of this a 2.5dB façade correction was added to all measured Leq levels.

Results of Ambient Noise Measurements Year 2005

The $L_{eq(15\ hour)}$ and $L_{eq(9\ hour)}$ road traffic noise indices were calculated for each day for each monitoring location. The results of the unattended noise monitoring are presented graphically in **Appendix A,** and the results are summarised below in **Table 1**. The results shown include the façade correction indicated above.

TABLE 1
AMBIENT NOISE LEVELS dB(A)

Location	$L_{Aeq(15\ hour)}$	$L_{Aeq(9\ hour)}$	Range L_{max}	Avge L_{max}
1 – No. 14841 Pacific Hwy	56.6	54.8	57 - 85	67
2 – No. 14991 Pacific Hwy	58.9	57.9	62 - 89	74

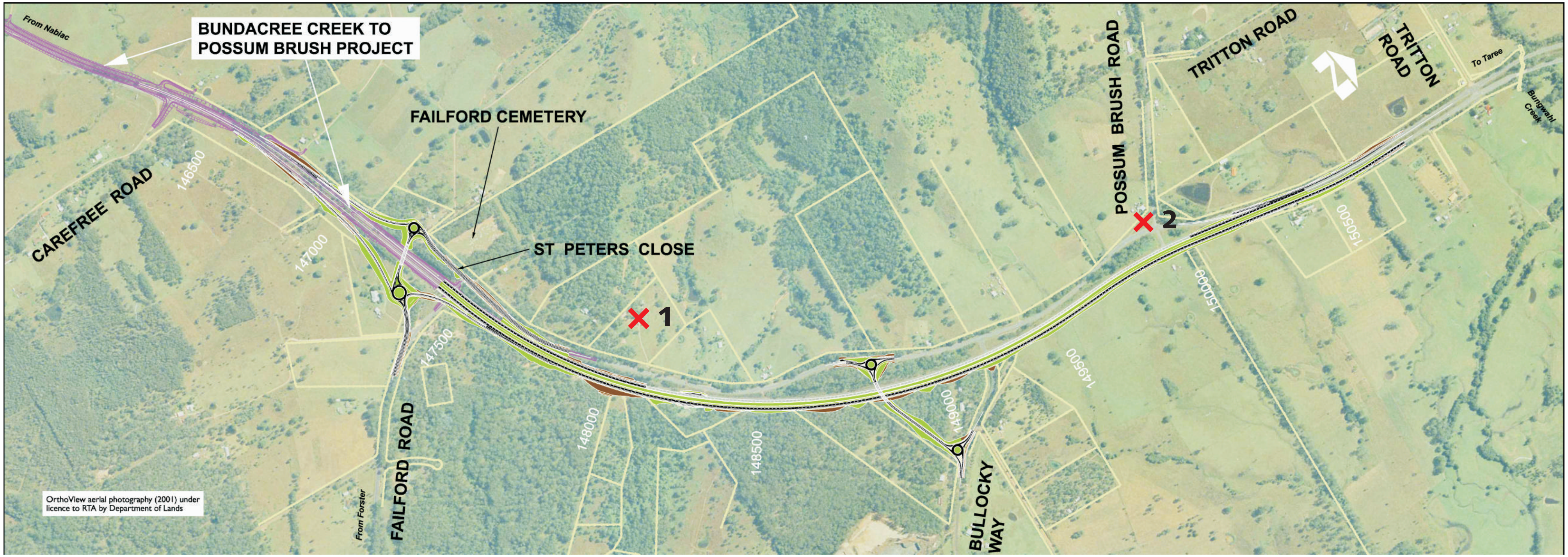
The data from the loggers showed a relatively uniform L_{eq} noise level over each 24 hour period of the monitoring. This is considered typical of locations near the Pacific Highway where the traffic mix alters between night and day. That is, during the night traffic volumes decrease but relative and actual numbers of heavy vehicles increase resulting in a similar overall L_{eq} noise level.

Construction noise criteria are calculated based on background (L_{90}) noise levels. Measured background noise levels for each monitored location are shown below in **Table 2**. As construction activities would be limited to day time hours, only this period is shown.

TABLE 2
BACKGROUND NOISE LEVELS dB(A) L_{90}

Location	L_{90} (Day)*
1 – No. 14841 Pacific Hwy	40
2 – No. 14991 Pacific Hwy	43

* 7.00 a.m. to 6.00 p.m. Monday to Saturday – 8.00 a.m. to 6.00 p.m. Sunday and Public Holidays.



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LEGEND:

✕ Noise logger

FIGURE 3

Noise Logger Locations

SPECTRUM ACOUSTICS

KG4044_FIG3.CDR

JULY 2006

5.0 - NOISE AND VIBRATION CRITERIA

Operational Noise – Road Traffic

Noise emissions from vehicles travelling on public roads in NSW are assessed according to conditions outlined in the EPA's "Environmental Criteria for Road Traffic Noise" (ECRTN). This document provides a framework that guides the consideration and management of traffic noise issues associated with new building developments near existing or new roads, and new or upgraded road developments adjacent to new or planned building developments. It also provides guidance for the setting of environmental noise criteria applicable to the various situations.

Under the definitions in the ECRTN, the Pacific Highway is classed as an arterial road. The criteria applicable to the proposed works are for "redevelopment of existing freeway/arterial road", where "a redeveloped freeway, arterial or sub arterial road is a road corridor in which it is proposed to increase traffic carrying capacity, change the traffic mix or change the road alignment through design or engineering changes".

The recommended criteria for such works are set at 60 dB(A) $L_{Aeq(15\ hour)}$ (i.e. day) and 55 $L_{Aeq(9\ hour)}$ (night). The ECRTN also contains the proviso that where noise criteria are already exceeded, in all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. The ECRTN also suggests that, where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria.

In this context, "feasibility" refers to engineering practicality, while "reasonableness" is to be judged by taking account of:

- Noise mitigation benefits and costs;
- Community views and aesthetic impacts;
- Existing and future noise levels at affected land uses; and
- The benefits of the proposed development.

For all road developments, the criteria should apply on the basis of the traffic volumes immediately after the road opens and on volumes projected for 10 years time.

For proposed "new roads" and road "redevelopments" the RTA Environmental Noise Management Manual (ENMM) states that the RTA believes it is generally not "reasonable" to take action to reduce predicted noise levels to the target noise levels if the noise levels with the proposal, ten years after project opening, are predicted to be:

- Within 2 dB(A) of "future existing" noise levels (the noise levels from existing sources of road traffic noise predicted for the time of project opening); and

- No more than 2 dB(A) above the target noise levels set out in columns 2 and 3 of Table 1 in the ECRTN.

This approach is based on the insignificance of the changes in noise levels involved and the insignificant exceedances of the target noise levels.

It applies only if it can be demonstrated that all "feasible and reasonable" traffic management and other road design opportunities for reducing traffic noise have been exhausted.

For the proposed "redevelopments" of roads where existing noise levels already exceed the ECRTN target noise levels, and all "feasible and reasonable" traffic management and noise reducing design opportunities have been incorporated into the road design, the RTA believes it is generally not "reasonable" to apply additional treatments such as noise barriers/mounds, quieter pavement surfaces and architectural treatment of private dwellings if the predicted design year noise levels:

- Do not exceed the ECRTN allowances (in column 4 of Table 1 in the ECRTN) over the "future existing" noise levels (the noise levels from existing sources of road traffic noise predicted for the time of project opening); *and*

- Would not be acute (i.e. the noise levels are predicted to be less than 65 dB(A) $L_{eq(15\ hour)}$ (day) and 60 dB(A) $L_{eq(9\ hour)}$ (night)).

If either of these two "exceptions" applies, no further investigation of noise controls is required.

Vibration – Construction and Operational

Various authorities have set maximum limits on allowable ground and building vibration in different situations. The DEC has limits for vibration in buildings set out in their "*Environmental Noise Control*

Manual" (ENCM). These limits are directed at personal comfort for continuous and intermittent vibrations. **Table 3** shows the multiplying factors applicable in offices and workshops, taken from Chapter 174 of the Manual, "Noise Control Guideline – Vibration in Buildings".

Vibration associated with passing heavy vehicles, or construction machinery, is considered to be intermittent in nature.

Page 174-4 of the Manual contains a set of curves for various situations which are referred to in Table 3. As shown by the curve labelled 20, applicable for intermittent vibration for residential locations through the day, the maximum allowable acceleration at the lower limits between 4 Hz to 8 Hz is 0.1 m/sec^2. This equates to a maximum allowable z-axis velocity of 2.8 mm/sec.

TABLE 3
EPA VIBRATION CRITERIA – Z-AXIS ACCELERATION LEVELS MULTIPLYING FACTORS

Area, Time	Continuous Vibration	Intermittent or Impulsive
Office – Day	4	128
Office – Night	4	128
Workshops – Day	8	128
Workshops – Night	8	128
Residential – Day	2	60
Residential – Night	1.4	20

There are a number of Standards designed for the assessment of damage to building structures. One that is most frequently referred to is German Standard DIN 4150: Part 3-1986 *Structural Vibration in Buildings – Effects on Structures*.

DIN 4150 presents a series of "safe limit" values below which no damage due to vibration has been observed. Damage is specifically defined as including minor superficial cracking, the enlargement of existing cracks in cement render and the separation of partitions from load bearing walls.

A summary of the relevant sections from DIN 4150 is shown below in **Table 4**.

TABLE 4 STRUCTURAL DAMAGE SAFETY LIMITS FOR BUILDING VIBRATION					
Group	Type of Source	Vibration Velocity in mm/s			
		At Foundations		Plane of Floor of Uppermost Story	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Freqs
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in 1, or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

A more recent standard than DIN 4150 for assessing building damage is British Standard BS 7385: Part 2 – 1993 *Evaluation and Measurement of Vibration in Building part 2*. This standard was developed following a full review of available data, including other international standards, publications, and a review of UK data. The standard concludes by providing guidance for threshold values corresponding to the minimum risk of cosmetic damage from vibration.

A summary of the relevant sections from BS 7385 is shown below in **Table 5**.

TABLE 5 TRANSIENT VIBRATION LEVELS FOR COSMETIC DAMAGE			
Line	Type of Building	Peak Particle Velocity	
		4 Hz to 15 Hz	Greater than 15 Hz
1	Reinforced or framed structures. Industrial or heavy commercial buildings	50 mm/s	50 mm/s
2	Un-reinforced or light framed commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard specifically notes:

- Historic buildings should not to be assumed to be more sensitive to vibration (unless structurally unsound); and

- Structures below ground are known to sustain higher levels of vibration and are very resistant to damage, unless in poor condition.

Construction Noise

Noise emanating from construction sites in NSW is subject to conditions detailed in the ENCM. Section 171 of the ENCM specifies construction noise limits at the worst affected receivers as follows:

Level Restrictions

(i) *Construction period of 4 weeks and under*;

The L_{10} level measured 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 20 dB(A).

(ii) *Construction period greater than 4 weeks and not exceeding 26 weeks*;

The L_{10} level measured 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 10 dB(A).

Time Restrictions

Construction activities are usually restricted to the following times:

- Monday to Friday – 7.00 a.m. to 6.00 p.m.
- Saturday – 7.00 a.m. to 1.00 p.m. if audible on residential premises, otherwise 8.00 a.m. to 1.00 p.m.
- No construction work to take place on Sundays or Public Holidays.

The authorities can approve works outside these hours, if it can be demonstrated that the construction activities would have negligible impacts on nearby residential dwellings. Permits are also granted where issues of safety require out of hours operations, or where construction work would result in major traffic disturbances.

Where works outside of the detailed hours are necessary the ENMM details minimum roadworks requirements and consultation and procedural requirements to be adhered to in order to minimise potential impacts.

Construction of the entire road upgrade would take longer than 26 weeks to complete. Works would be carried out in stages, however, with noise impacts in effect "moving" with the work. That is, individual houses, or groups of houses, would only experience elevated noise levels for that period of time when construction work is passing in their vicinity.

This does not apply to the construction of overpasses which is confined to specific locations.

The aims and objectives of the construction noise criteria are to limit annoyance and to maintain the amenity of residents. It is in accordance to these objectives to impose a criterion at a residence that is applicable to that period of time when elevated noise levels are experienced.

Based on the background noise levels shown in **Table 2** of this report, construction noise criteria for the various monitored locations are shown below in **Table 6** for durations of less than 4 and between 4 and 26 weeks and greater than 26 weeks.

TABLE 6
CONSTRUCTION NOISE CRITERIA dB(A) L_{10}

Location	4 wks L_{10}	4 – 26 wks L_{10}	> 26 wks L_{10}
1 – No. 14841 Pacific Hwy	60	50	45
2 – No. 14991 Pacific Hwy	63	53	48

6.0 - ROAD TRAFFIC NOISE AND VIBRATION ASSESSMENT

Procedure

To predict the future changes in traffic noise along the Pacific Highway detailed modelling of the existing and proposed road configuration was carried out using RTA Technologies Environmental Noise Model (ENM) version 3.1. This model is accepted by EPA and RTA.

The model was set up using a series of point noise sources representing the continuous traffic flow on the Pacific Highway. The noise source was calibrated until modelled received noise levels were equivalent to the measured L_{eq} (15hr) and L_{eq} (9hr) noise levels at the two measurement locations.

The ENM noise prediction programme was then utilised in point calculation mode to determine existing and future noise levels at each potentially affected receiver. The modelling was based on variations in road alignment and configuration as per diagrams supplied by the RTA for road design.

As described previously the new carriageway would be constructed to the east of the existing southbound lanes and the current northbound lanes would act as access roads for local traffic and for traffic using the interchanges. The result would be to move the noise source representing northbound traffic to the east and, consequently away from the majority of residential receivers.

Traffic volumes used in the modelling were taken from data supplied by RTA from a traffic study undertaken for the project. The traffic study provided vehicle counts for the Pacific Highway as well as for the Failford Road/Pacific Highway intersection and Bullocky Way/Pacific Highway intersection.

The traffic study also provided details of projected traffic growth to the years 2010, 2020 and 2030. The study contained details of forecast traffic flows at the intersections detailed above. AADT figures for the Pacific Highway at Tritton Road are shown below in **Table 7**.

TABLE 7
PROJECTED AADT FOR PACIFIC HIGHWAY AT TRITTON ROAD

Year	AADT
2005	11550
2010	13889
2020	18566

Future Existing Predictions (2010)

In some cases of road construction the opening of works can take place several years after initial noise logging (and hence determination of criteria) was carried out. In these situations noise levels at sites affected by existing road traffic noise will often increase because of an increase in traffic flow between the time of the original monitoring and the opening date.

To address this situation the ENMM details the concept of the “future existing” noise level. This is the noise level from existing sources of road traffic predicted for the time of project opening.

It is envisaged that works on the current project would commence in 2010. Predicted road traffic flows for 2010 have been used to determine future existing noise levels at the time of road opening using the ENM model. Without any other variations that may affect the acoustic environment the predicted increase in traffic flow would lead to an increase in received noise of approximately 0.8 dB(A) by the year 2010.

Predicted Noise Levels 2020 Traffic Flow

Predicted traffic flows for 2020 have been used to determine traffic noise levels for that time using ENM and assuming no construction or variations to the road network have taken place. Without any other variations that may affect the acoustic environment the predicted increase in traffic flow would lead to an increase in received noise in 2020 of approximately 1.3 dB(A) over those of the year 2010.

Post Construction Noise Levels

Post construction noise levels were calculated using ENM based on predicted traffic flows for 2020 and the post construction road alignment.

Construction Noise Assessment

Detailed design of the proposed works would be undertaken prior to the completion of final construction contracts. The successful tenderer would be responsible for determining construction methods. This assessment is, therefore based on the general type of construction activity likely to occur. The construction of the project would involve several phases, an initial earthworks and drainage phase, the construction of overpasses phase, and a pavement laying and landscaping phase.

The earthworks and drainage phase is expected to have the longest duration and also generate the highest construction noise levels. This phase would involve the use of a variety of earth moving machinery undertaking various operations to create the base for the additional carriageway.

The construction of overpasses would likely involve the use of plant such as concrete trucks and pumps, pneumatic and hydraulic hammers, mobile cranes etc.

Surface preparation of the road base would involve compaction with vibratory rollers and final laying of paving. This process would be shorter than the earthworks phase and the machinery would generally produce lower noise emissions.

Typical noise levels of construction plant items were sourced from data in the ENMM and from the Spectrum Acoustics technical database. Sound pressure levels for these at a distance of 7m are listed below in **Table 8**.

TABLE 8 SOUND PRESSURE LEVELS (at 7m)– CONSTRUCTION PLANT ITEMS	
Item	SPL dB(A)
Bulldozer	85
Excavator	80
Water Tanker	84
Grader	84
Concrete Pump	84
Paver	85
Vibrating Roller	82
Backhoe	83
Concrete Vibrator	87
Front End Loader	86
Dump Truck	83
Batching Plant agitator trucks	89
Compressor	80
Generator	86
Concrete Truck	85
Mobile Crane	85
Pneumatic Hammer	88
Concrete Vibrator	80
Concrete Pump	82

The sound pressure levels shown in Table 8 are maximum levels produced when the machinery is operating under full load. The construction noise criteria are set for noise levels determined as $L_{10\ 15\ minute}$. During a full 15 minute period the machinery items to be used on site would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels whilst carrying out activities not requiring full power.

In addition to this, mobile machinery would likely move about during the 15 minutes, variously altering the directivity of the noise source with respect to individual receivers.

The logistics of typical road construction work would mean that all of the plant items shown in Table 8 could not operate at the same time. To give a conservative (i.e. worst case) estimate of typical construction noise various configurations of machinery were considered.

Construction Vibration

Typical vibration levels of construction plant items listed below in **Table 9**. These levels have been used to determine potential impacts at nearby receivers.

TABLE 9 TYPICAL VIBRATION LEVELS – CONSTRUCTION EQUIPMENT	
Item	Peak Particle Velocity at 10m (mm/sec)*
Piling	12-30
15 tonne compactor	7-8
7 tonne compactor	5-7
Roller	5-6
Dozer	2.5-4
Backhoe	1
Loader breaking kerbs	6-8

*Source: RTA Environmental Noise Management Manual

7.0 - RESULTS

Road Traffic Noise

A comparison of noise levels for before and after road works is shown in **Table 10**. The location numbers referred to in Table 10 are as per those in the copy of the property ownership plan shown here as **Figure 4**. The results in Table 10 show the predicted future existing traffic noise level at 2010 and the modelled noise level 10 years after the completion of works in 2020 for each location.

TABLE 10 PREDICTED INCREASE IN NOISE LEVELS				
Location	$L_{Aeq(15 hr)}$ Future Existing	$L_{Aeq(9 hr)}$ Future Existing	$L_{Aeq(15 hr)}$ Predicted	$L_{Aeq(9 hr)}$ Predicted
1 – 1 St Peters Close	To be acquired by RTA			
2 – 3 St. Peters Close	55.6	53.8	56.1	54.3
3 – Cemetery	n/a	n/a	n/a	n/a
4 – 21 St. Peters Close	57.1	55.3	56.7	54.9
5 – 41 St. Peters Close	58.2	56.4	58.3	56.5
6 – 14841 Pacific Highway (logger location)	57.4	55.6	56.6	54.8
7 – 14861 Pacific Hwy	56.8	55.0	57.1	55.3
8 – 14863 Pacific Hwy	62.9	61.1	59.7	57.9
9 – 14913 pacific Hwy	64.4	62.6	60.3	58.5
10 – 14945 Pacific Hwy	61.9	60.1	62.5	60.7
11 – 14947 Pacific Hwy	No residence			
12 – 14991 Pacific Hwy (logger location)	59.7	57.9	55.6	53.8
13 – 4 Possum Brush Road	No residence			
14 – 4 Possum Brush Road	59.4	57.6	59.8	58.0
15 – Lot 24 Pacific Hwy	No residence			
16 – Lot 23 Pacific Hwy				
17 – Lot 15 Pacific Hwy				
18 – Lot 14 Pacific Hwy				
19 – 249 Bullocky Way	62.5	60.7	65.7	63.9

TABLE 10 (continued)
PREDICTED INCREASE IN NOISE LEVELS

Location	$L_{Aeq(15 hr)}$ Future Existing	$L_{Aeq(9 hr)}$ Future Existing	$L_{Aeq(15 hr)}$ Predicted	$L_{Aeq(9 hr)}$ Predicted
20 – 235 Bullocky Way	56.2	54.4	56.3	54.5
21 – 107 Bullocky Way	No residence near highway			
22 – 14826 Pacific Hwy	To be acquired by RTA			
23 – Address unknown	No residence			
24 - Lot 8 Tipton Place	No residence			
25 – 408 Failford Road	No residence near highway			
26 – 545 Failford Road	Owned by RTA			
27 – 543 Failford Road	No residence near highway			
28 – 531 Failford Road	No residence			
29 – 3 Greys Road	56.7	54.9	57.9	56.1
30 – 38 Possum Brush Road	No residence near highway			
31 – 234 Bullocky Way	No residence near highway			
32 Shady Valley Pet Motel	59.9	58.1	62.6	60.8
45 Highland Estate	53.0	51.2	53.5	51.7
47 Highland Estate	54.1	52.3	54.7	52.9
48 Highland Estate	53.0	51.2	53.5	51.7

Construction

Construction noise levels have been predicted at a number of representative distances from the centre of road works. The noise levels from the various phases of construction activities have been determined.

For the initial earthworks phase of construction up to four plant items (eg a roller, dozer, grader and water cart) were considered to be working in close proximity. Such a configuration of machinery would result in sound pressure levels of about 93 dB(A) at 7m (i.e. a combined sound power level of 118 dB(A)). The results of the calculations of noise from earthworks are shown below in **Table 11**.

Due to of the relatively short distance between the noise sources and the potentially most affected receivers (i.e. <500m), the influence of variable meteorological conditions was not considered in the modelling. The calculations also do not take into account the variable screening effects of topography or intervening structures (eg sheds etc) between the noise sources and the receiver. Such effects are more likely to influence received noise levels as the distance to receivers increases.

Due to the rural nature of the area and the majority of works being undertaken to the east of the existing road (where there are fewer houses) the majority of receivers would be greater than 50m from the construction site.

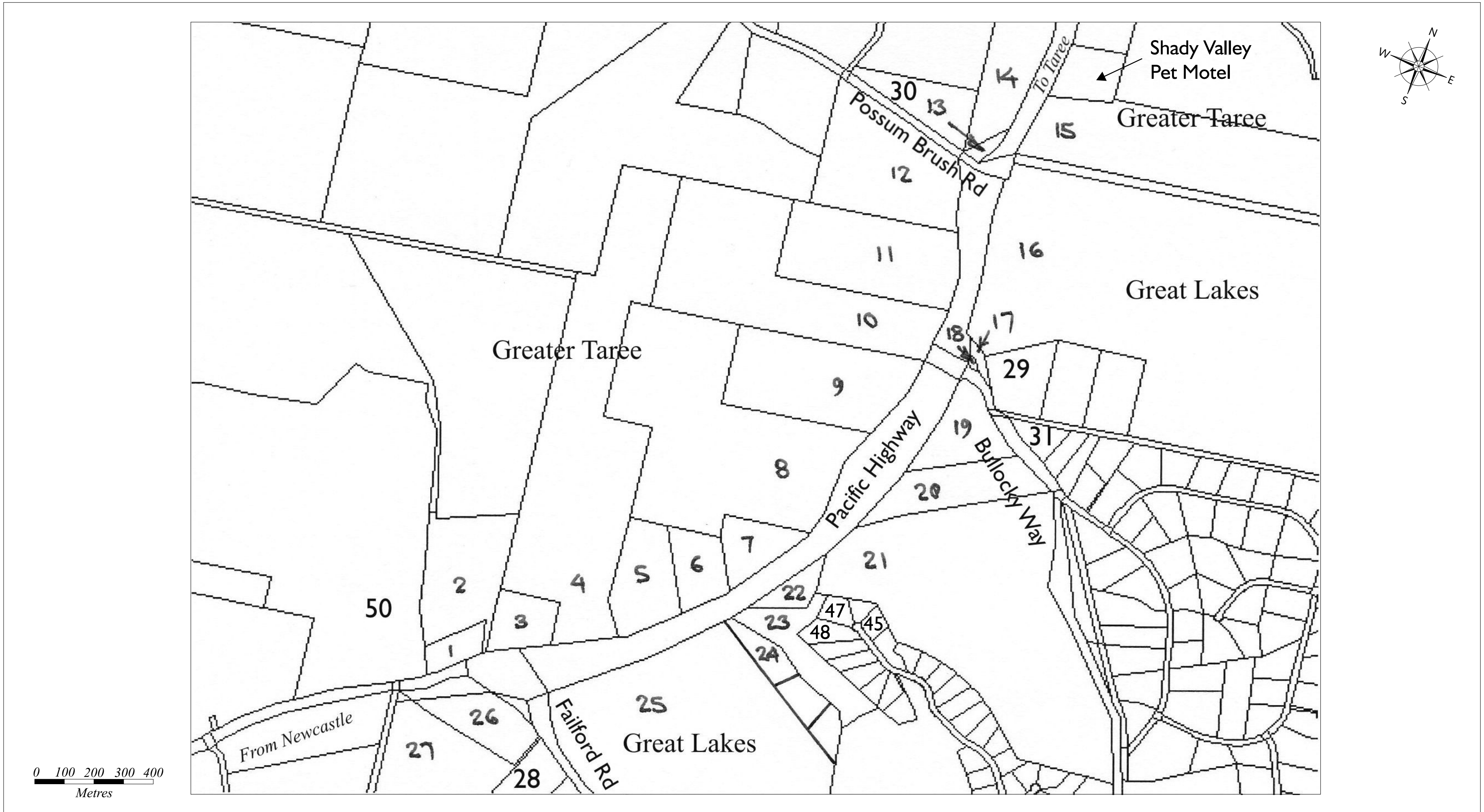


FIGURE 4

Property Ownership Plan

TABLE 11 TYPICAL CONSTRUCTION NOISE (EARTHWORKS PHASE)	
Distance from Centre of Works	Predicted Noise dB(A) L_{10}
50m	76
100m	70
200m	64
400m	58
800m	52

On the whole noise from paving activities would be significantly lower than those for the general earthworks. In addition to this the paving works moves along the route at a faster rate and typically would impact on individual receivers for up to 2 weeks only. Based on the noise levels listed in Table 8 the predicted paving noise levels are shown in **Table 12**.

TABLE 12 TYPICAL CONSTRUCTION NOISE (PAVING PHASE)	
Distance from Centre of Works	Predicted Noise dB(A) L_{10}
50m	68
100m	62
200m	56
400m	50

The closest residences to the construction of the overpasses (that are not RTA owned or to be RTA owned) are approximately 250m away (at No. 3 St. Peters Close and No. 249 Bullocky Way). Based on the details in Table 8 a conservative sound power level of 117 dB(A) (or 92 dB(A) at 7m) was adopted for a scenario where a concrete truck, concrete pump, concrete vibrator, generator, compressor and pneumatic hammer were all operating, and producing maximum noise emissions, in close proximity. Results of calculations are shown below in **Table 13**.

TABLE 13 TYPICAL CONSTRUCTION NOISE (OVERPASS)	
Distance from Centre of Works	Predicted Noise dB(A) L_{10}
250m	61
300m	59
500m	55
1000m	49
1500m	45

The location(s) of any batching plants is yet to be determined and would depend on contractor's requirements. The main source of noise from a batching plant comes from agitator trucks at high revs whilst being loaded and preparing to depart. Noise from the batching plant itself is relatively insignificant.

The number of trucks using the batching plant at any time would vary depending on the capacity of the plant and the stage of operations etc. A scenario of 3 trucks using the batching plant at the one time has been assessed.

Predicted noise levels are shown in **Table 14**. These do not take into account any screening effects of the batching plant or buildings associated with it.

TABLE 14
TYPICAL CONSTRUCTION NOISE (BATCHING PLANT)

Distance from Centre of Works	Predicted Noise dB(A) L_{10}
100m	74
200m	68
500m	60
2000m	48

Construction Vibration

Typical vibration levels of construction plant items at a distance of 10 are listed Table 9.

As there are no residences within 10m of the construction area it can be seen from the above table that the only potential vibration impacts that may arise would be from piling activities.

The attenuation of vibration through the ground is dependant upon site specific factors relating to the strata between the vibration source and receivers. In obtaining an initial indication of likely vibration levels, it can be assumed that the vibration level is inversely proportional to distance. That is, at double the distance from the source the vibration level would be halved.

This indicates that, even at the maximum listed vibration level for piling of 30mm/sec at 10m, received vibration levels would likely be below the criterion at all distances greater than 35m from the piling activity.

It is recommended that, wherever piling is to be carried out within 50m of any residence, compliance monitoring studies be undertaken during the works.

Where there are heritage buildings or particularly vibration sensitive structures within 50m of piling works then it is recommended that a pre construction survey of the structured integrity of these be carried out.

Based on the typical vibration levels shown in Table 9 received vibration levels would be less than a peak particle velocity of 5 mm/s at distances of approximately 15m from a 15 tonne roller and less than 12m from a 7 tonne compactor.

Road works with the potential to create vibration are to be carried out in rural areas where residences are generally greater than 10m from the road. To ensure compliance with the criterion, it is recommended that where the construction machinery listed in Table 9 (or other potentially vibration inducing machinery or processes) is to be operated within 15m of an existing building vibration monitoring be undertaken during the first phases of the use of that machinery. It is further recommended that, prior to any construction work being carried out, a dilapidation survey be carried where the construction machinery listed above (or other potentially vibration inducing machinery or processes) is to be operated within 15m of an existing building.

Vibration from Road Traffic

Vibration arising from vehicular movements along road corridors can be divided into the following two broad sources:

- The roughness of the road surface;
- Potholes, bumps or other surface discontinuities.

The site-specific measurements of vibration resulting from existing vehicular movements would indicate that the potential for excessive vibration from the operation of the re-aligned roadway is negligible.

Conservative calculations to determine the vibration arising from a continuous stream of heavy vehicles to residential receivers (10 m from the traffic stream) result in mid-span levels of less than 0.1 mm/s, readily complying with the criteria for residential receivers.

The presence of potholes can result in vibration levels that approach or possibly exceed the criterion, depending upon local parameters. If required, a regular maintenance schedule program readily solves this potential aspect of vibration impact.

8.0 - ANALYSIS OF RESULTS

Road Traffic Noise

The analysis of traffic noise for the year 2020 (with road works completed) and 2010 (future existing) showed that;

- For residences 2, 20 45, 47 and 48 the received noise level for 2020 would be less than the applicable day and night criteria and no further assessment is necessary,

- For residence 29 the resultant noise would be above the night time criterion. The level would be within 2 dB(A) of future existing and no more than 2 dB(A) above the ECRTN target and, therefore, no further assessment is necessary,

- For residences 4, 5, 6, 7 8, 9, 12 and 14 the existing night time noise level already exceeds the ECRTN target level. The 2020 noise level would not exceed the 2 dB(A) allowance in the ECRTN and would not be acute and, therefore, no further investigation of noise controls is required (in many cases the noise level would decrease),

- For residence 10 the existing noise level already exceeds the day and night time ECRTN target level. The resultant received noise level would only be 0.6 dB(A) and, therefore, would not exceed the ECRTN allowances over future existing levels. As such, no further investigation of noise controls is required, and

- For residences 19 and 32 the 2020 noise level would be acute at night and would be greater than 2 dB(A) above the future existing noise level.

It is apparent that noise control options would need to be considered for residences 19 (249 Bullocky Way) and 32 (Shady Valley Pet Motel). The required traffic noise reduction would need to be in the vicinity of about 7dB(A) to achieve compliance with the criterion.

The options available for noise control include construction of an acoustic barrier, architectural modification to the residences or the use of relatively quiet road surfaces.

The ENMM details procedures for determining the reasonableness and feasibility of various noise control options for minimising potential impacts. The ENMM notes that if residences are grouped in numbers of three or less, architectural treatments are preferred over roadside barriers as it is likely that the cost per residence for barriers would be at least twice that for architectural treatments.

In instances where noise barriers are considered unacceptable, the subsequent options for noise control are to use quieter pavement surfaces, and/or architectural treatments to residences.

The effectiveness and costs of architectural modifications to residences depend on many factors. These include the age, type and state of repair of facades, (windows, doors, roofs etc.), the access, and heritage and cultural aspects of each residence.

The most significant noise leakage path in most residences is through glazed areas. To reduce traffic noise ingress would usually require replacement of existing windows with thicker glass. In many instances this would also require replacement of window frames to ensure sufficient sound transmission loss is achieved. Final determination of glazing requirements is dependant upon many factors such as, area of glass, area of the room, orientation of the room with respect to the road etc. This would require individual assessment for each of the affected residences. It must be noted that, in some instances, further architectural modification may also be required to achieve the desired internal noise levels.

It must also be noted that architectural modifications are only capable of reducing internal noise levels, and have no effect at all on noise levels within the external areas of the residence.

The type of road surface can have a significant impact on traffic noise generated by pavement surface/tyre interactions. The degree of noise reduction depends upon such factors as the road surface's porosity, macrotexture, depth and wavelength, the percentage of heavy vehicle and vehicle speeds. The ENMM states that the noise level variation for an open graded asphaltic concrete road surface as compared to dense graded asphaltic concrete is up to a 4.5 dB(A) reduction. It is noted, however, that open graded asphalt has a limited life with respect to traffic noise reduction, due to the clogging of air voids over time. Accordingly, it is recommended that in planning noise control measures, the correction factor for the use of open graded asphalt should be no greater than –3 dB(A).

A noise reduction of 3 dB(A) would not achieve a sufficient attenuation of traffic noise to result in received levels being less than night time criterion and is unlikely to be a cost effective noise mitigation measure for this project.

It is, therefore, recommended that further investigation of the type and effectiveness of architectural modifications for residences 19 and 32 need be undertaken. Such assessment would require detailed analysis of the existing construction and internal layout of each residence.

Construction Noise

Construction noise levels have been shown to be at or above the 4 – 26 week construction noise criterion at a distance of greater than about 800m from the modelled earthworks scenario and greater than 400m from paving activities.

Noise from the construction of the overpass would exceed the >26 week construction noise criterion at distances of up to 1500m from the site. Similarly, noise from the batching plant would exceed the >26 week noise criterion at distances within about 2km of the site of operations under the assessed conditions.

Construction activities, therefore, would have the potential to cause some short-term impacts as works approach or recede from individual residence.

Due to the nature of construction work, noise exceedances would likely be sporadic in nature. That is, received noise levels would be dependant upon factors such as;

- The location and proximity to each other of various plant items
- What work is being undertaken at any given time and whether it involves all machinery operating at the maximum sound power levels assessed.

In addition, any impacts on individual residences would be likely to be short term only as the construction works move along the road corridor.

The following general recommendations are, therefore, detailed as being applicable to the site.

It is recommended that close liaison with the potentially affected receivers be initiated at the earliest opportunity. Once informed of the project description and aims, the community should be given progress updates at regular intervals or at particular milestones. A contact name and phone number of a responsible person should be given out so that complaints can be dealt with effectively and efficiently. All complaints or communication should be answered.

All personnel working on the job including contractors and their employees should be made aware of their obligations and responsibilities with regard to minimising noise emissions.

Contractors should familiarise themselves with methods of controlling noisy machines and alternative construction procedures. These are explained in AS2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites".

Activities that are known or have the potential to create excessive noise should, where possible, be scheduled to occur at times to cause least annoyance to the community. Carrying out such work during early morning should be avoided. This includes start up and idling etc. of heavy machinery prior to commencement of work.

If noisy activities must be carried out then a responsible person should inform people in potentially affected residences and also convey to the contractor any special needs of the public.

Regular and effective maintenance of all equipment including vehicles moving on and off the site should be conducted. Prompt attention must be given to repair of loose or rattling parts and broken equipment. All maintenance work should only be carried out by qualified persons.

Mechanical plant should be silenced using best available control technology. Noise suppression devices should be maintained to manufacturer's specifications. Internal combustion engines should be fitted with appropriate, well maintained, high efficiency mufflers.

When selecting contractors and/or equipment for the job, preference must be given to those with capacities best suited to the task at hand. That is the use of larger machines with excess capacity should be avoided unless these can be shown to be quieter than smaller capacity machines.

Machines that are used intermittently such as dozers, graders, rollers, some trucks etc should either be shut down in the intervening periods between work or throttled down to a minimum.

Consider alternatives to reverse alarms such as manually adjustable or ambient noise sensitive types ("smart" reversing alarms). Alternative site management strategies can be developed, in accordance with a site OH & S Plan, with the concurrence of the appropriate OH & S Officer.

Any portable equipment with the potential to create high levels of noise eg compressors, generators etc should only be selected for use if it incorporates effective noise control. This equipment should be located where practical so that natural ground barriers or site sheds etc are between it and the nearest potentially affected receivers.

Due to the distance between the noise source and the receivers, the linear nature of the proposed works, the location of receivers all around the site, and the relatively short duration of works in most instances the use of barriers or screens is not considered reasonable or feasible.

Noise from batching plants has the potential to exceed long term construction noise goals at a considerable distance from the plant. As discussed the results shown on Table 14 do not make allowance for screening effects of the plant or buildings etc.

The location and orientation of any batching plants should, therefore, be considered with noise emissions and receiver locations ain mind. Plants should be located as far from any residences as is practicable. The layout of the plant should be designed such that the engines of agitator trucks are oriented away from residences whilst they are being loaded and are they are producing maximum sound levels.

A detailed noise impact assessment of the final location and design of any batching plants should be undertaken prior to installation.

9.0 - REFERENCES

Environment Protection Authority (EPA), 1994. Environmental Noise Control Manual, Sydney.

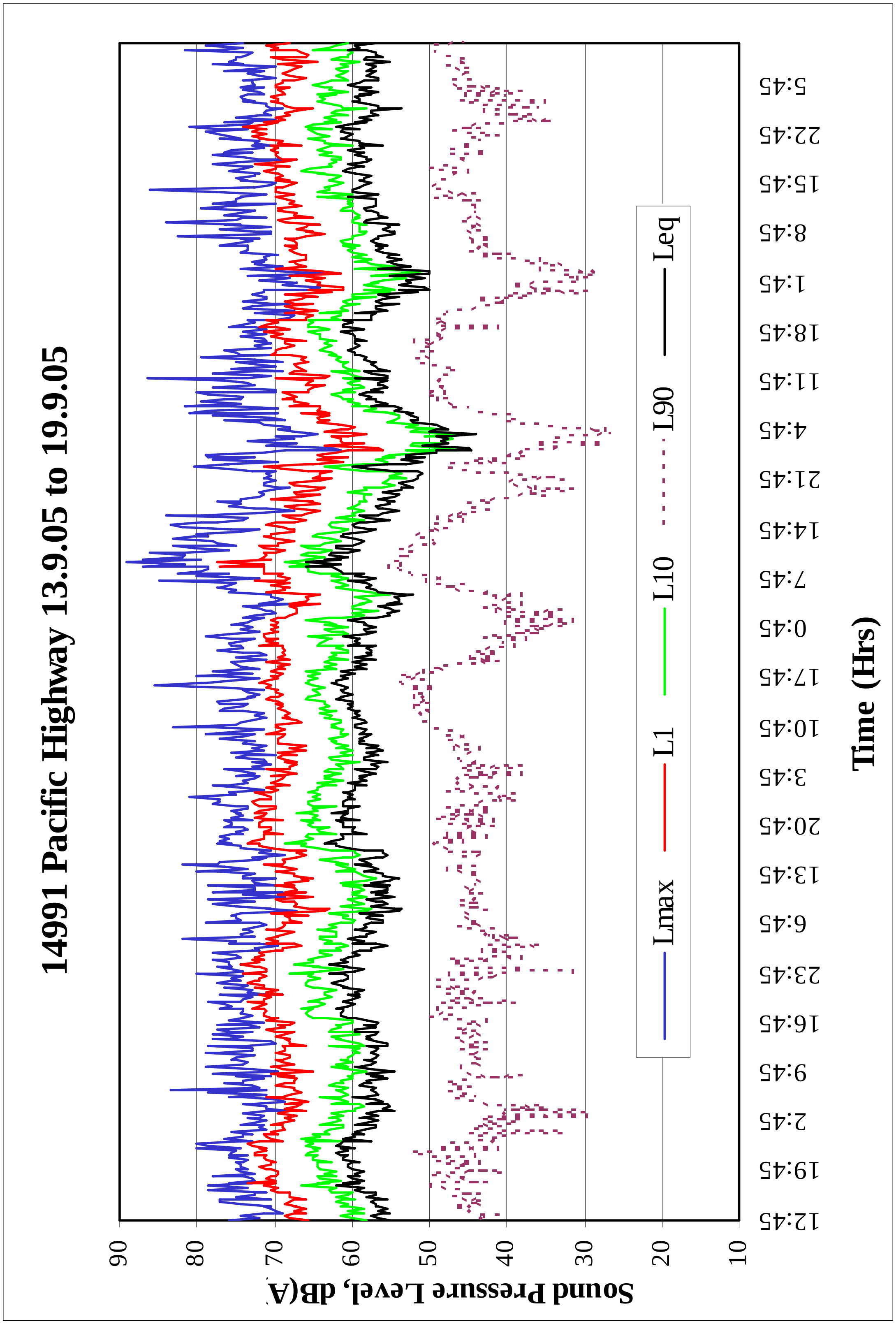
Environment Protection Authority (EPA), 1999. Environmental Criteria for Road Traffic Noise, Sydney

Environment Protection Authority (EPA), 2000. NSW Industrial Noise Policy, Sydney.

Roads and Traffic Authority (RTA) 2001 RTA Environmental Noise Management Manual, Sydney

APPENDIX I

NOISE LOGGER CHARTS


14991 Pacific Highway 13.9.05 to 19.9.05
Sound Pressure Level, dB(A
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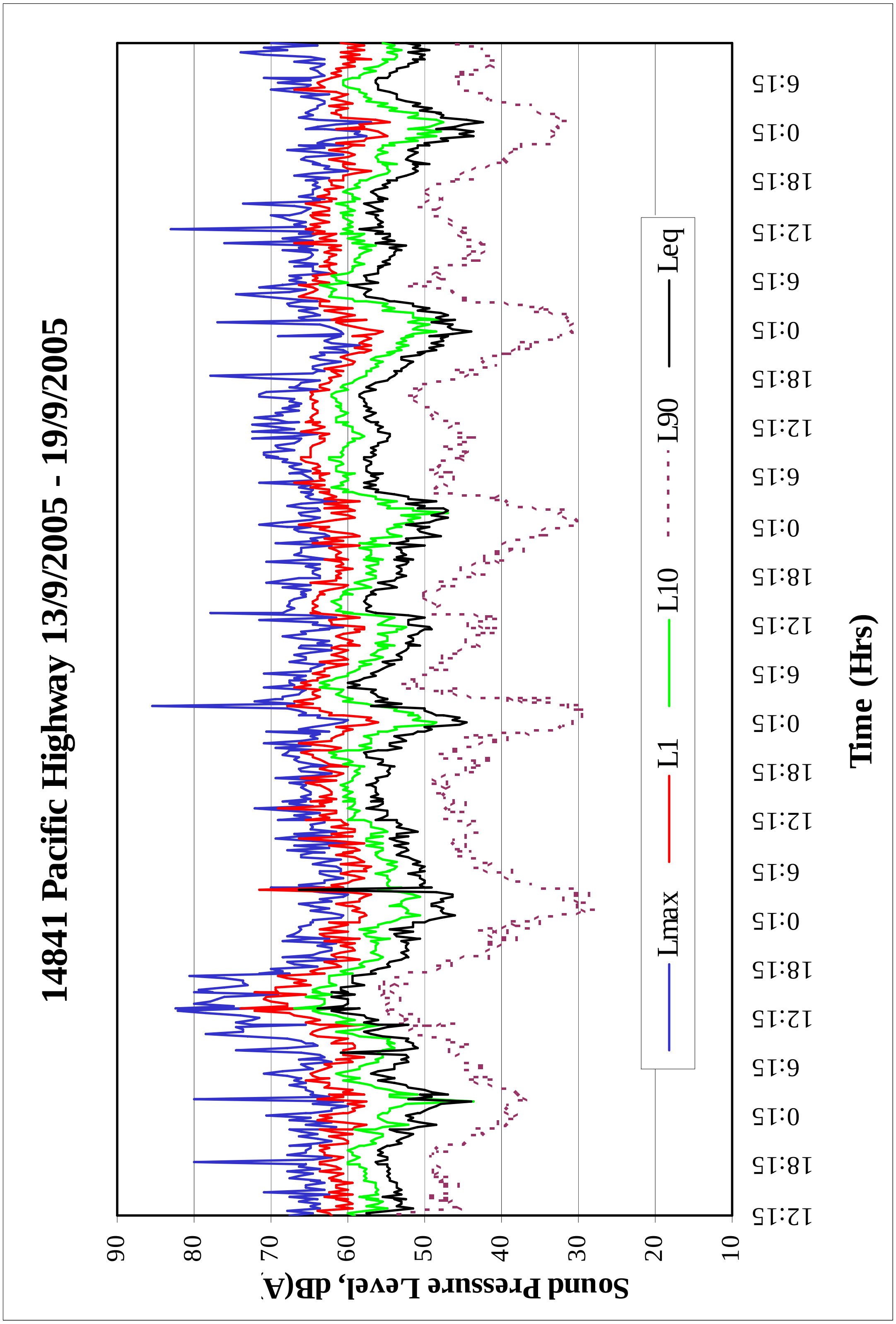
80
70
60
50
40
30
20
10
12:45
19:45
2:45
9:45
16:45
23:45
6:45
13:45
20:45
3:45
10:45
17:45
0:45
7:45
14:45
21:45
4:45
11:45
18:45
1:45
8:45
15:45
22:45
5:45
Time (Hrs)
Lmax
L1
L10
L90
Leq


14841 Pacific Highway 13/9/2005 - 19/9/2005
Sound Pressure Level, dB(A)
90
80
70
60
50
40
30
20
10
Time (Hrs)
12:15
18:15
0:15
6:15
12:15
18:15
0:15
6:15
12:15
18:15
0:15
6:15
12:15
18:15
0:15
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12:15
18:15
0:15
6:15
12:15
18:15
0:15
6:15
Lmax
L1
L10
L90
Leq

APPENDIX II

NOISE LOGGER PHOTOS

View of Pacific Highway from noise logger at 14991

View of noise logger at 14991 from direction of Pacific Highway

View of Pacific Highway from noise logger at 14841

View of noise logger at 14841 from direction of Pacific Highway