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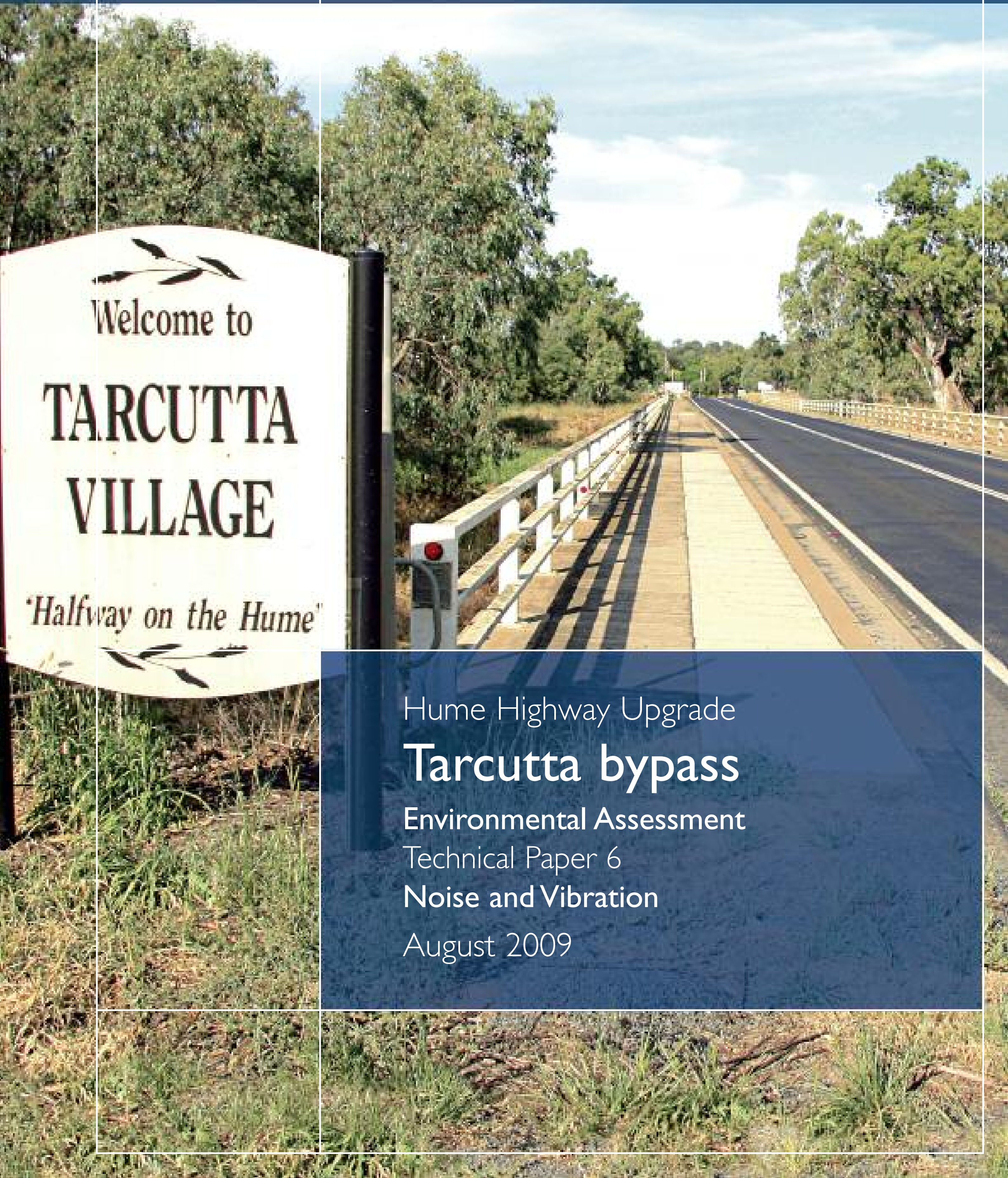
RTA



Hume Highway Upgrade

Tarcutta bypass

Environmental Assessment

Technical Paper 6

Noise and Vibration

August 2009

TARCUTTA BYPASS ENVIRONMENTAL ASSESSMENT

NOISE ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 07277-TE
VERSION H

WILKINSON MURRAY

TARCUTTA BYPASS ENVIRONMENTAL ASSESSMENT

NOISE ASSESSMENT

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JULY 2009

PREPARED FOR

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1 INTRODUCTION

As part of the Hume Highway upgrade a bypass is proposed for the town of Tarcutta. Currently the Hume Highway traverses the centre of the town. Traffic flow is reduced in speed and number of lanes, and properties in the town are exposed to high levels of noise.

A range of corridor and route options have been evaluated and a preferred route option has been selected. As such, an Environmental Assessment (EA) under Part 3A of the Environmental Planning & Assessment Act is currently being prepared. Wilkinson Murray Pty Ltd has been contracted by the Roads and Traffic Authority (RTA) to conduct a noise assessment as part of the EA.

The noise assessment will incorporated the following main stages:

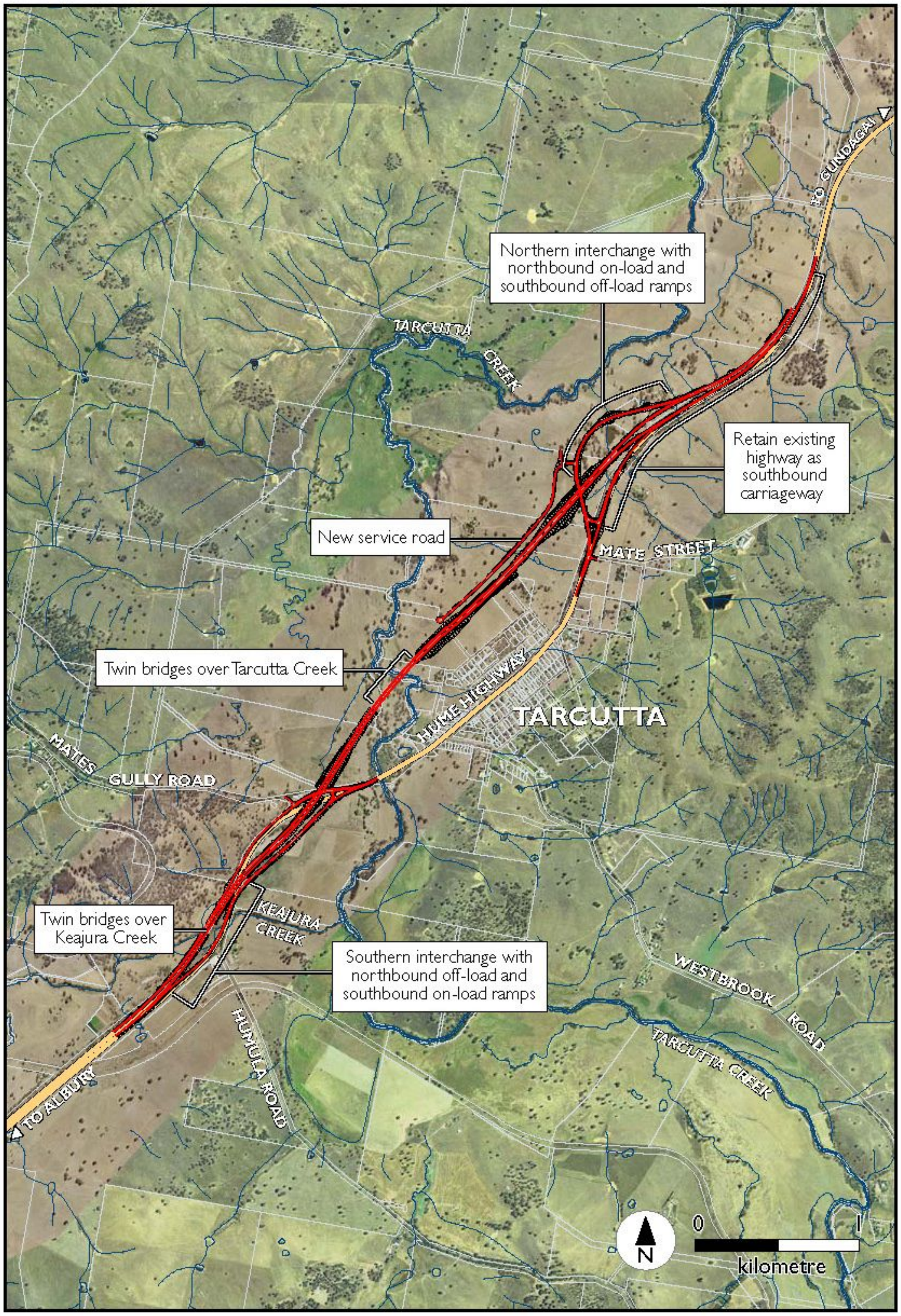
Stage 1 Identify noise sensitive receivers and establishing noise catchment areas;
Stage 2 Measure existing noise levels;
Stage 3 Validation of traffic noise model for existing conditions;
Stage 4 Determine operational traffic and construction noise criteria for the project;
Stage 5 Detailed traffic noise modelling methodology;
Stage 6 Calculation and assessment of noise for future scenarios without mitigation;
Stage 7 Review of traffic noise mitigation options;
Stage 8 Assessment of maximum noise levels; and
Stage 9 Assessment of construction noise and vibration.

Prior to the completion of the environmental assessment, the Tarcutta Bypass Alliance has been appointed by the RTA. Noise assessment and mitigation strategies have been discussed with the Alliance during the EA process. This has allowed development of feasible and reasonable noise mitigation strategies acceptable to the constructor of the bypass.

2 DESCRIPTION OF THE PROJECT

The proposed bypass is approximately 7km long and passes west of Tarcutta. The corridor is shown on Figure 2-1. Access to the bypass will be provided both north and south of the town. Servicing the needs of heavy vehicle traffic is important to Tarcutta, and this is expected to continue after the opening of the bypass.

Figure 2-1 Proposed Bypass



Proposed bypass | Existing highway | Cadastral | Drainage

3 DIRECTOR-GENERAL'S REQUIREMENTS

The Director-General's Requirements for the project, as they concern noise, are:

- *Construction noise and vibration, including construction traffic noise and blasting impacts;*
- *Operational road traffic noise impacts including consideration of local meteorological conditions (as relevant); and*
- *The assessment must take into account the following guidelines as relevant: Environmental Criteria for Road Traffic Noise (EPA, 1999); Environmental Noise Management Manual (RTA, 2001); Draft Noise Control Guidelines, Construction Sites (formerly published as Chapter 171 of the EPA's Environmental Noise Control Manual; Assessing Vibration: A Technical Guideline (DEC,2006); and Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).*

4 NOISE SENSITIVE RECEIVERS

Tarcutta contains approximately 120 noise sensitive receivers. Receivers were generally identified from overhead imagery, aided by information on specific residences from a site visit.

All identified noise sensitive receivers were included in the noise model. Commercial premises, other than the Tarcutta Hotel, were not considered noise sensitive and have not been included. The receivers in each zone are:

- Zone 1 – West of Bypass and Hume Highway
    - 4 rural residences.
- Zone 2 – Between Bypass and Hume Highway
    - Approximately 25 residences in Tarcutta.
    - Tarcutta Hotel;
    - St Marks Anglican Church and Church Hall;
    - Tarcutta Memorial Hall; and
    - Tarcutta Cemetery.
- Zone 3 - East of Hume Highway.
    - Approximately 89 residences in Tarcutta;
    - Tarcutta Public School;
    - Tarcutta Hospital Buildings;
    - St Frances Xavier Church;
    - The Truck Drivers Memorial Park; and
    - Approximately 5 rural residences.

Receivers are numbered as follows:

- Zone 1: Receivers west of Bypass – Numbers 1, 2, 3 and 4;
- Zone 2: Receivers between bypass and existing highway – Numbers 50 (Tarcutta Inn), 51 (Hotel), 52,53,53,54,55,56, 57, 58, 59, 60, 61 (St Marks Hall), 62 (St Marks Church), 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73 (Tarcutta Memorial Hall), 74 (Tarcutta Cemetery), 75 (Tarcutta Cemetery), 76, 77 and 78;
- Zone 3: Receivers east of existing highway – Numbers 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154 (St Francis Xavier Church), 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165 , 166, 167, 168, 170, 171, 172, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183 (Hospital), 184 (Tarcutta Hospital), 185 (Tarcutta Hospital), 186, 187 (Tarcutta Public School), 188, 189, 190, 191, 191, 192, 193, 194 (Truckers Memorial), 200, 201, 202, 203, 204 and 206 (Tarcutta House).

5 TRAFFIC NOISE CRITERIA

5.1 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 of the bypass section would be classified as a "*new freeway or arterial road corridor*". Where the project follows the existing Hume Highway the project would be a *"redevelopment of existing freeway/arterial road*". For this project it is only at the north where there are residences exposed to the section considered a redevelopment. The criteria set out in Table 5-1 would therefore apply.

Table 5-1 *Environmental Criteria for Road Traffic Noise* criteria for operational traffic noise - residences

Type of Development	Noise Level Criterion: Day (7.00am-10.00pm)	Noise Level Criterion: Night (10.00pm-7.00am)	Where Criteria are already Exceeded
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. 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.

In applying Table 5-1, 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 ENMM 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 5-1 are already exceeded, Practice Note (iv) of the ENMM provides further discussion of situations where provision of additional controls would be considered "feasible and reasonable". In particular, for "new" road "redevelopments" 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 5-1.

RTA's Environmental Direction Number 24 "Noise assessment for acute levels of noise – redevelopment of existing roads" confirms the following:

"Application of all feasible and reasonable noise mitigation to aim to achieve the ECRTN noise criteria where, following a road redevelopment:

- *There is predicted to be a noticeable increase in road traffic noise, or*
- *Road traffic noise levels are predicted to be acute."*

The RTA has a Noise Abatement Program for existing roads where the RTA targets locations or lengths of existing roadways where road traffic noise levels are very high and are considered excessive for noise sensitive land uses. Noise affected sites are not currently given priority for noise treatment unless road traffic noise levels are at least 65dBA $L_{Aeq,15hr}$ or 60dBA $L_{Aeq,9hr}$. These noise levels are termed acute noise levels.

A further point should be noted in applying this RTA policy. The ECRTN 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.

5.2 Noise Criteria for Schools

The ECRTN has two criteria for schools: internal levels and playgrounds

- Internal: $L_{Aeq,\ 1h}$ 45dB(A) during school hours
- Playgrounds: $L_{Aeq,15hr}$ 55dBA.

For the external noise level, the discussion from the previous section with respect to "reasonable and feasible" mitigation is also relevant. That is, for redevelopments where all noise mitigation measures have been exhausted the proposal should not increase the existing noise by more than 2dBA.

5.3 Noise Criteria for Places of Worship

For places of worship, only an internal noise is considered in the ECRTN. The criterion is that the $L_{Aeq,1hr}$ should not exceed 40dBA during times when the place of worship would be in use.

5.4 Noise Criteria for Hospitals

For hospital wards only an internal noise is considered in the ECRTN. The criterion is that the $L_{Aeq,1hr}$ should not exceed 35dBA at any time.

5.5 Noise Criteria for Recreation Areas

For passive recreation areas (for example the Truck Drivers Memorial Park) the criterion is $L_{Aeq,15hr}$ 55dBA.

For active recreation areas the criterion is $L_{Aeq,15hr}$ 60dBA.

5.6 Noise Criteria for Cemeteries

There are no specific criteria for cemeteries. Typically the criterion for passive recreation is used.

For passive recreation areas the criterion is $L_{Aeq,15hr}$ 55dBA.

5.7 Noise Criteria for the Memorial Hall

Appropriate criteria for the Memorial Hall depend on its use. Typically, the criterion for such a hall would be similar to that for places of worship: that the $L_{Aeq,1hr}$ should not exceed 40dBA during times of use.

6 NOISE MONITORING

6.1 Purpose

There are two reasons why noise monitoring was conducted, namely:

- provide background noise levels to set appropriate criteria for construction noise assessment; and
- allow validation of the computational noise model used to determine existing traffic noise levels at residences in Tarcutta.

6.2 Locations

Noise monitoring was done at eight locations:

A. North east of Tarcutta on the western side of the Hume Highway;

B. North east of Tarcutta on the western side of the proposed bypass;

C. Myrtle St, Tarcutta;

D. Sydney St, Tarcutta;

E. Tarcutta Inn;

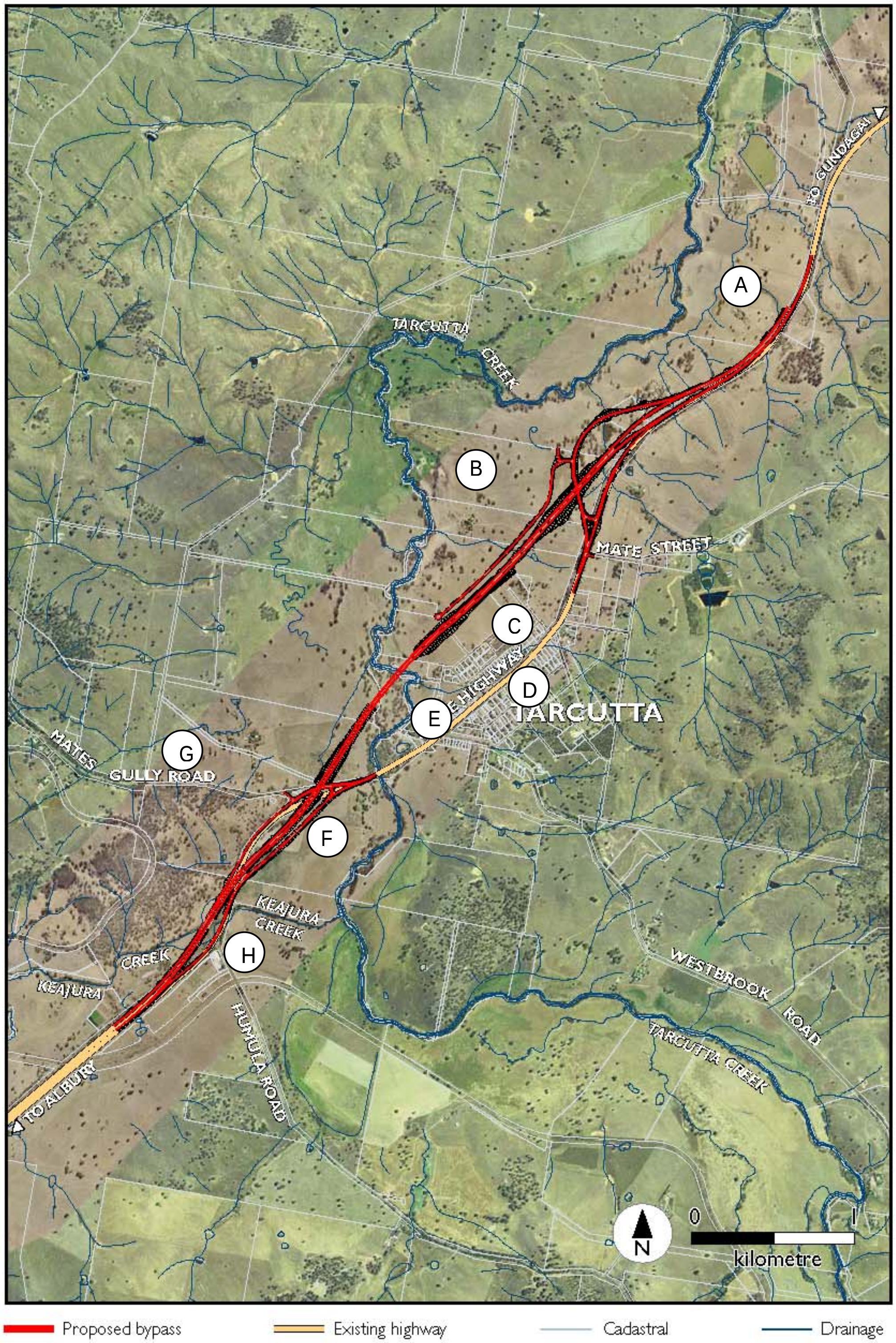
F. South west of Tarcutta on the eastern side of the Hume Highway;

G. Mates Gully Road; and

H. Tarcutta House, Hume Highway.

The locations are shown on Figure 6-1 All eight monitoring sites were suitable to establish background noise levels so that appropriate construction noise criteria can be established. However, Locations B, C and G were too far from the existing highway to establish noise levels from the existing highway and were not used to validate the computational noise model.

Figure 6-1 Noise Monitoring Locations



6.3 Noise Monitoring Procedure

The noise monitoring equipment used for these measurements consisted of environmental noise loggers 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 detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

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 pass-by 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.

Noise monitoring was carried out from 5 November to 28 November 2008. The batteries of the equipment were replaced on the 18th of November. Taking the whole period into consideration, at least 7 days of valid data was collected at G of the H locations as required by RTA procedures.

The logger at Location E, Tarcutta Inn, malfunctioned and was replaced. Five days of valid data were collected at this location. RTA procedures do allow periods shorter than seven days if the measured levels are considered to represent the traffic noise exposure at the location. As the traffic flow was consistent during the counting period, this was period was considered sufficient to give valid measurements.

The logger at Location F was interfered with by cattle, probably towards the end of logging period. Results from traffic noise at the beginning of the logging period were used for the validation, even though this was before the traffic counters were placed. As the traffic flow was consistent during the counting period, this was considered valid.

The result charts are reproduced in full in Appendix D. Appropriate exclusions of data were made for meteorology and obvious extraneous noise.

6.4 Measured Background Noise Levels

The long term background noise levels, in terms of Rating Background Level (RBL), are given in Table 6-1. The RBLs are based on the measured 15 minute L_{A90} levels according to procedures in the NSW Industrial Noise Policy (INP) The time periods are as defined in the INP – daytime is 0700 to 1800, evening is 1800 to 2200, and night time is 2200 to 0700. The INP discusses such occurrences, recommending that unless there is a specific cause for evening and night time levels to be higher than daytime, the lowest RBL measured throughout the 24 hour period should be used. In this case the traffic counts in Tarcutta showed a marked increase in heavy vehicle traffic during evening hours. As this is presumable the reason for the higher evening RBLs, the RBLs as measured will be used to set construction noise criteria.

Table 6-1 Rating Background Noise Levels (based on measured L_{A90})

Location	Rating Background Level, dBA		
	Daytime	Evening	Night time
A	37	37	36
B	38	41	35
C	35	41	37
D	43	47	42
E	44	47	41
F	40	44	40
G	40	41	38
H	42	44	38

6.5 Measured Traffic L_{Aeq} Levels

The measured L_{Aeq} levels over the periods used for assessing traffic noise (daytime 0700 to 2200, and night time 2200 to 0700) are given in Table 6-2. As noted earlier Locations 2, 3 and 7 are so distant from the highway that the L_{Aeq} is not dominated by traffic noise. Other sources such as animals and agricultural noise significantly affect the L_{Aeq} at those locations.

Table 6-2 Measured L_{Aeq}

Location	$L_{Aeq,period}$, dBA	
	Daytime	**Night Time**
A	55	56
D	61	63
E	57	57
F	61	60
H	56	58

6.6 Traffic Count

Traffic noise is described in two time periods, namely:

- daytime (0700 to 2200); and
- night time (2200 to 0700).

As the intention of monitoring traffic noise was partly to validate the noise model, simultaneous traffic counts were conducted at two locations in Tarcutta. The traffic count data was used to predict noise over the monitoring period. The average count over the monitoring period is given in Table 6-3. The count was quite consistent between counters and over the days of the monitoring period. The daily counts (as were used in the noise model) varied less than 5% from the values shown in Table 6-3, except for Saturday and Sunday nights.

Table 6-3 Traffic Count – Average of monitored days

	15hr Daytime (7.00am to 10.00pm)				9hr Night Time (10.00pm to 7.00am)			
	Northbound (vehicles per hour)		Southbound (vehicles per hour)		Northbound (vehicles per hour)		Southbound (vehicles per hour)	
	Total vehicles (light + heavy)	% heavy vehicles	Total vehicles (light + heavy)	% heavy vehicles	Total vehicles (light + heavy)	% heavy vehicles	Total vehicles (light + heavy)	% heavy vehicles
Average of both counters	128	32	128	32	91	80	91	80

7 NOISE MODELLING

7.1 Modelling Assumptions

Noise levels from the existing road alignment were calculated using procedures based on the CoRTN prediction algorithms. The standard CoRTN prediction procedures were modified in the following ways.

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CoRTN algorithms using the well-validated approximation $L_{Aeq,1hr} = L_{A10,1hr} - 3$.

- Noise source heights were set at 0.5m for cars, 1.5m for heavy vehicle engines and 3.6m for heavy vehicle exhausts, representing typical values for Australian vehicles. Noise from a heavy vehicle exhaust was assessed as 8dBA lower than the noise from the engine. The combined noise from heavy vehicle exhaust and engine gives the sound level as defined in CoRTN. The acoustical energy for the various sources is then derived from speed, road surface and traffic volume.

- Small negative corrections for "Australian conditions", derived from documented validation of the CoRTN algorithms, have been included, both for calculations with and without façade correction.

- Where there are no barriers present, ground was taken to be 50% soft. With barriers hard ground is assumed as required under the CoRTN procedures.

7.2 Model Inputs

The inputs and assumptions for the noise model were as follows.

Road Alignment and Topography

Details of the surrounding topography were provided digitally by the RTA. The existing highway alignment was digitised by combining aerial photography with the topography.

Traffic Speed

The traffic count showed that the 85th percentile speed at the traffic counters was generally faster than the sign posted speed at the location of the counters.

The modelled speed for the existing highway outside Tarcutta has the sign posted speed of 100km/h. The traffic counters indicated that speed in Tarcutta was typically 65 to 75km/h at all times and for all vehicles. The model reflected these speeds taking into account the location of the counters and the traffic direction.

Road Surface Correction

Surface corrections for various surfaces are given in Table 7-1.

All corrections are for traffic with 40% heavy vehicles. In this project the existing Hume Highway was assumed to be chipseal.

Table 7-1 Road Surface Corrections

Road Surface Type	Vehicle Speed km/h		
	60	80	100/110
Chipseal	+1.5	+2.5	+3.0
Dense Graded Asphaltic Concrete(DGAC)	-1	0	0
Low Noise Pavement* Open Graded Asphaltic Concrete(OGAC)	-3	-3	-3
Portland Cement Concrete (PCC)	+.5	+2.0	+2.5

* There are alternative low noise pavements that could be considered in the detailed design stage of the project.

Receiver Heights

Receiver heights calculated at logger microphone heights:

- 1.5m for all locations

Façade Reflections

For validation of the noise model the predicted noise levels did not include correction for façade reflection as the noise loggers were placed in free field conditions. For prediction of operational noise to residences, a 2.5dBA correction was added to the noise results.

8 RESULTS OF MODELLING VALIDATION

8.1 Predicted and Measured Noise Levels

The results of traffic noise measurement and prediction for the monitoring period for which traffic count and noise measurement coincide are given in Table 8-1. Note that measured levels are usually rounded to integer levels. They are shown to one decimal place here to minimise rounding effects.

Table 8-1 Results for Whole Monitoring Period

Location	Measured and Predicted Traffic Noise Levels					
	Daytime $L_{Aeq,15hr}$			Night time $L_{Aeq,9hr}$		
	Measured	Calculate	Difference	Measured	Calculate	Difference
A	55.0	56.5	-1.5	56.0	57.5	-1.5
D	60.7	60.6	0.1	62.8	61.6	1.2
E	57.3	57.0	0.3	57.0	58.0	-1
F	60.5	58.5	2	59.5	59.3	0.2
H	56.0	58.0	-2	57.6	58.7	-1.1

8.2 Discussion

8.2.1 Locations Close to the highway

At Locations A, D, E, F and H the predicted noise levels are within 2dBA of the measured noise levels. This indicates valid noise predictions.

8.2.2 Locations far from the highway

At B, C, and G the ambient L_{Aeq} noise levels were affected by noise other than traffic noise and therefore were not considered as part of the validation of the noise model.

9 PREDICTED TRAFFIC VOLUMES

The draft traffic report from Parsons Brinckerhoff, *SH2 Hume Highway Town Bypass Traffic Study Tarcutta, Holbrook and Woomargama*, May2009, discusses traffic volumes for the Hume Highway and the bypass. Updated traffic volumes were received on 2 July 2009 which allowed consideration of a "high diversion" scenario.

For noise assessment the volumes required are the Hume Highway just before opening (this gives the *Future Existing* predicted noise level), and the Hume Highway and Bypass at 10 years after opening.

For the noise to residences, the 15 hour (7.00am to 10.00pm) and 9hour (10.00pm to 7.00am) traffic volumes are used. These were determined from classified traffic counts in Tarcutta.

For non-residential receivers the traffic volumes at the busiest hour of use is used. Analysis of the hourly flow shows that the highest volume of heavy vehicles occurs during the evening hours (this is still part of the daytime period). The typical one hour flow during the daytime (when schools are in use) is similar to the average flow through the day. For the $L_{Aeq,1hr}$ analysis at non-residential receivers, the level will be similar to the $L_{Aeq,15hr}$ for the whole day.

Table 9-1 Traffic volumes for Residential Receivers

	Do Nothing-Hume Highway		**With Bypass – Hume Highway**		**With Bypass - Bypass**	
			2012			
Total per day	5952		2154		3799	
15 hour	4642	35%	1682	35%	2963	34%
9 hour	1306	75%	472	74%	836	76%
			2022			
Total per day	7845		2839		5006	
15 hour	6120	34%	2217	35%	3906	34%
9 hour	1725	75%	622	75%	1100	76%

10 PREDICTED NOISE LEVELS – OPERATIONAL NOISE

10.1 Procedures for Assessment

10.1.1 Groups of Receivers

Isolated rural properties will be considered independently, as they would be little affected by noise mitigations proposed for the village.

Residences where acute noise levels are predicted will be discussed individually.

Receivers are numbered as follows:

- Zone 1: Receivers west of Bypass – Numbers 1, 2, 3 and 4;
- Zone 2: Receivers between bypass and existing highway – Numbers 50 (Tarcutta Inn), 51 (Hotel), 52,53,53,54,55,56, 57, 58, 59, 60, 61 (St Marks Hall), 62 (St Marks Church), 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73 (Tarcutta Memorial Hall), 74 (Tarcutta Cemetery), 75 (Tarcutta Cemetery), 76, 77 and 78;
- Zone 3: Receivers east of existing highway – Numbers 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154 (St Francis Xavier Church), 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165 , 166, 167, 168, 170, 171, 172, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183 (Hospital), 184 (Tarcutta Hospital), 185 (Tarcutta Hospital), 186, 187 (Tarcutta Public School), 188, 189, 190, 191, 191, 192, 193, 194 (Truckers Memorial), 200, 201, 202, 203, 204 and 206 (Tarcutta House).

Finally, the impact at non-residential receivers will be considered.

10.1.2 Daytime and Night time Comparison

The noise criterion for night time is 5dBA lower than the daytime criterion. However, because of the daily profile of traffic flow through Tarcutta, the night time noise is only 1dBA quieter than the daytime noise. Hence the assessment of noise impact and design of any noise mitigation will be determined by night time noise. The following discussion for residential noise impact will therefore focus on night time noise impacts. For comparison purposes both daytime and night time noise contours are presented in Appendix C.

10.2 Residences in Tarcutta Township

Typically a bypass would remove most through traffic from a town, leaving noise from the existing highway much reduced or insignificant.

The traffic report for the EA, summarised for noise analysis in Section 9, predicts that many heavy vehicles will continue to use the Hume Highway through the town. If the predictions are borne out the traffic noise from the existing highway will reduce approximately 3dBA throughout the town. As will be shown later, this would mean the noise from the Hume Highway alone would still be above the noise criterion for the new road at many residences in Tarcutta. As the guidelines require consideration of combined noise (that is from the existing Highway and the bypass), then reasonable and feasible noise controls need to be considered for nearly the whole of Tarcutta. It is clear that reduction of traffic noise to below the criterion for new roads (from the ECRTN) for the whole of Tarcutta would not be considered reasonable and feasible.

For this report:

- Noise from the new bypass will be assessed according to base ECRTN noise criteria for new roads at all residences;
- The objective for noise to residences currently impacted by the existing highway will be to have reduced noise levels, and in all cases to be below acute levels;
- Appropriate noise mitigation would be considered according to the guidelines in the ENMM.

Most of the residences are east of the Hume Highway and will experience a reduction in noise levels as traffic moves from the Highway onto the bypass.

As discussed earlier the assessment at these residences will be based on the noise from the bypass only, with the goal being to provide noise levels from the bypass less than the ECRTN base noise levels at all residences.

Because the road is a bypass, the initial application of the policy is to consider all noise against the "New Road" criterion (except at Receiver 4 and Receiver 204 at the northern extent of the project). Considering the Hume Highway alone, in 2022 the noise would exceed the base criterion at:

- approximately 110 residences if the bypass were not built, and
- approximately 86 residences if the bypass were built.

The combined noise from bypass and existing highway would exceed the base criterion at approximately 110 residences in 2022 if the bypass were built. The combined noise will be discussed in the consideration of reasonable and feasible mitigation. The results in this section are concerned with noise from the bypass alone.

Table 10-1 shows the number of residences in Tarcutta where the base ECRTN noise level is exceeded by the bypass. The table does not include the isolated residences or non-residential receivers. As can be seen in predictions for individual residences in Appendix B, the exceedances are generally less then 4dBA. As changing pavement type from concrete to a low noise pavement (eg. open graded ashphaltic Concrete (OGAC)) lowers noise predictions by up to 5dBA (difference between concrete road and OGAC), this was considered a reasonable means of noise mitigation for analysis (reasons for not considering noise barriers at this stage are discussed in Section 11). Calculated noise contours were used to constrain the length of low noise pavement: that is the pavement was not extended past a point where it would not benefit residential receivers. Note that the theoretical maximum change of 5dBA would only be achieved if the entire length of the project were changed to low noise pavement. Contributions from other segments of the project diminish the effectiveness of low noise pavement.

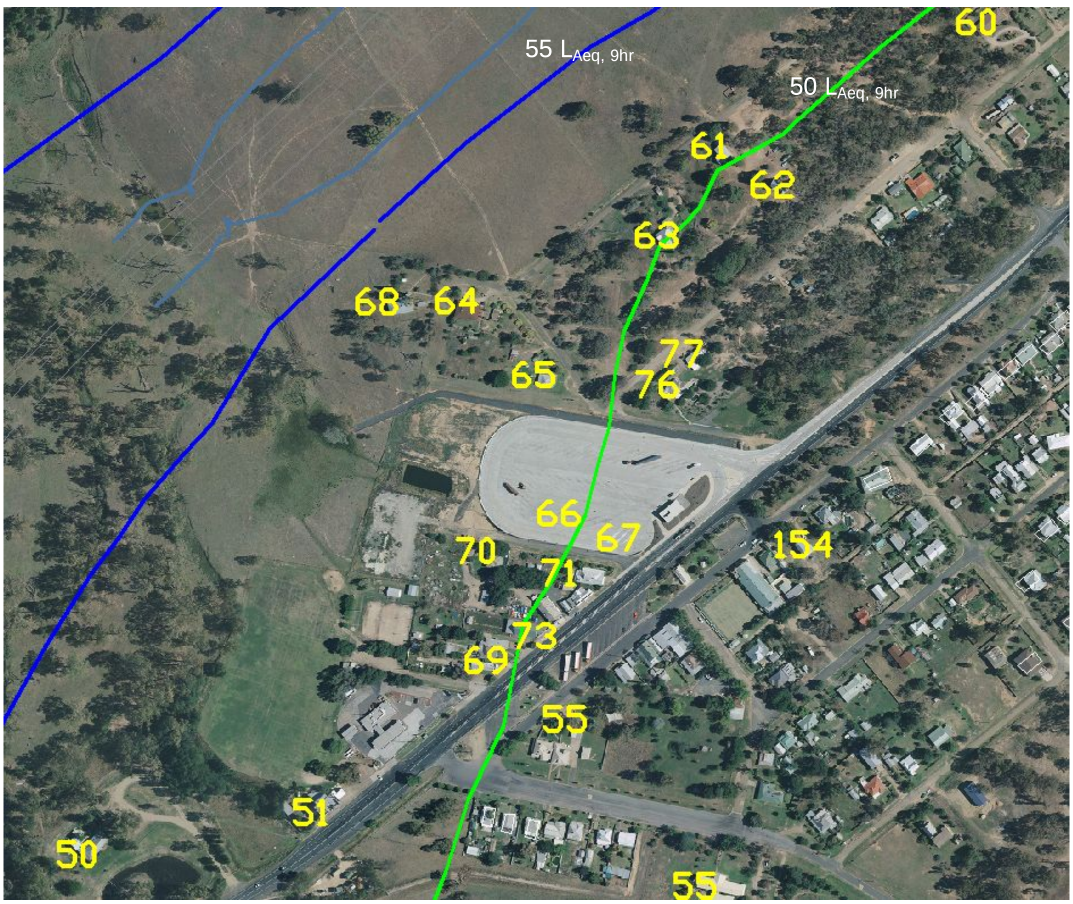
Table 10-1 shows numbers of houses where predicted noise would exceed the criterion if low noise pavement was used.

Table 10-1 Tarcutta Residences Exceeding Night Time Noise Criterion

Traffic Volume as Predicted	
Base design	Base design with Low Noise Pavement
10	2

The receivers where the night time criterion would be exceeded (with the base design and traffic volume as predicted) are: 50, 51, 63, 64, 65, 66, 67, 68, 69, 70 and 71 as shown on Figure 10-1.

Figure 10-1 Location of Town Receivers[1]



1 Receiver numbers in yellow.

Using low noise pavement, traffic noise is effectively mitigated to below the ECRTN criterion at all but two residences: these are Receiver 50 at the south west of the town, and the old school house at the end of Myrtle Street (Receiver 68). The location of these houses is indicated on Figure 10-2 in red.

Figure 10-2 Mitigations by Low Noise Pavement

10.3 Assessment at Isolated Rural Residences

The predicted noise levels at isolated residences are given in Table 10-2. The locations of most residences are shown on Figure 6-1 in the discussion of noise monitoring. The location of Receivers 102 and 204 is shown on Figure 10-3.

With the exception of Receiver 4 and Receiver 204 the isolated residences are considered to have the "New Road" criterion. Receiver 4 and 204 are adjacent to the existing highway and the road at this point is considered a "Redevelopment". For these two residences the predicted 2022 levels with the project are listed in the "Combined 2022", of Table 10-2.

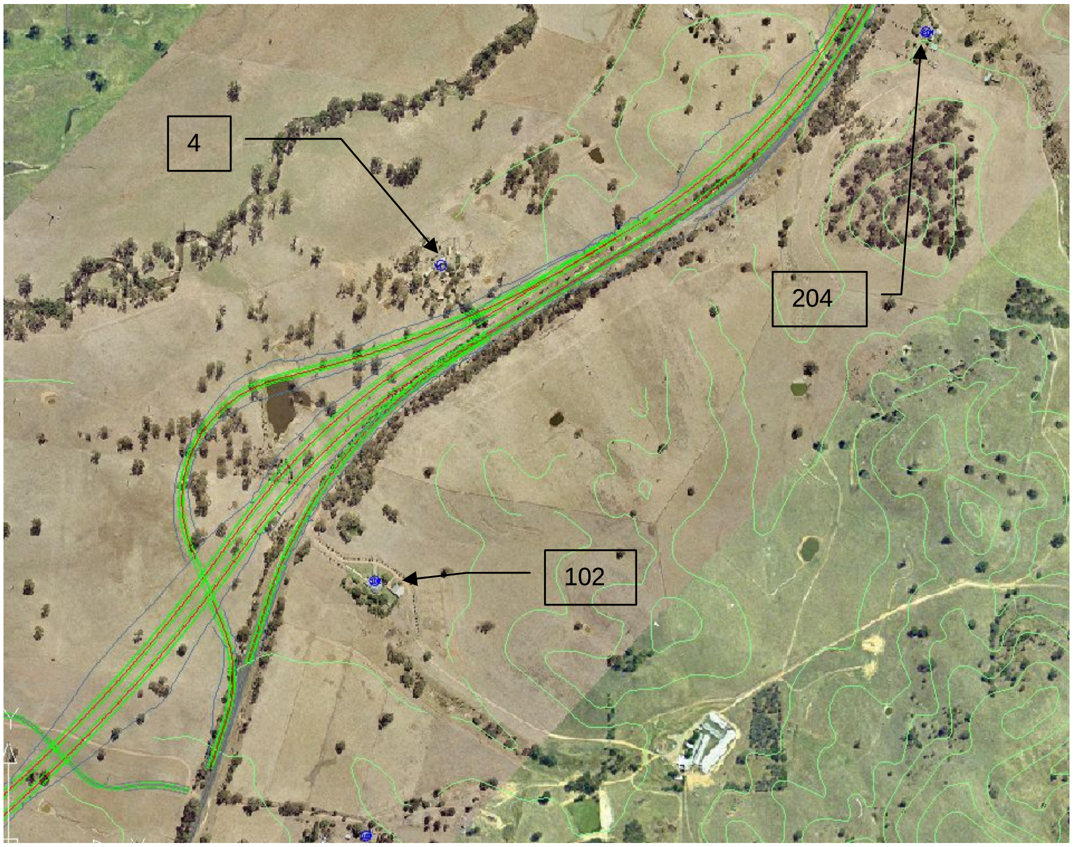
Table 10-2 Predicted Night Time Noise Levels, $L_{Aeq,9hr}$ at Isolated Residences (Worst Case Facade)

Receiver Number	Hume Highway 2012 (no bypass)	Hume Highway 2022 (no bypass)	Hume Highway 2022 (with bypass)	Bypass 2022	Combined 2022	Criterion $L_{Aeq,9hr}$
1	50	52	47	53	54	50
2	47	49	44	52	52	50
3	44	45	41	51	51	50
4	57	58	59	59	62	55
102	56	57	53	56	58	50
103	58	59	55	59	60	50
204	57	60	59	58	61	55
206	57	59	54	59	60	50

The Table 10-2 shows that noise from the bypass alone is predicted to exceed the base ECRTN criteria at all isolated residences. The most significant source of noise to the two houses north of the project (Receiver 4 and 204) is the existing Hume Highway alignment, and noise contribution from the bypass is not shown in the table. There is some increase in noise at these locations due to increased speed and changed pavement surface.

At road noise mitigations are not usually considered cost effective for isolated residences. Noise mitigation by architectural treatment to properties would be considered for these properties.

Figure 10-3 Location of Receivers 102 and 204



10.4 Acute Noise Levels

Noise levels (from the bypass and Hume Highway combined) above $L_{Aeq,9hr}$ 60dBA or $L_{Aeq,15hr}$ 65dBA are considered "acute" and would be considered for noise mitigation as part of the project, even if noise from the bypass complies with the allowance criterion.

After the bypass is operational, the following receivers are predicted to have acute noise levels in 2022: Receivers 51, 67 and 69 on the Hume Highway.

The location of these receivers is shown on Figure 10-4 in blue.

Figure 10-4 Location of Receivers with Acute Noise Levels

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10.5 Assessment of Reasonable and Feasible Mitigation

Noise from the new bypass will be assessed according to base ECRTN noise criteria for new roads at all residences;

In addition to the above analysis, the ENMM gives guidance as to whether it is reasonable and feasible to offer noise mitigation. For new roads it is generally not considered reasonable and feasible to offer mitigation if the combined noise levels of traffic noise are:

- Within 2dBA of "future existing" noise levels; and
- No more than 2dBA above the target noise levels.

If this test is applied to houses in Tarcutta, only three residences would be considered for mitigation: 50, 64 and 68. This outcome can be determined from the noise levels in Appendix B.

If these conditions were applied then the most likely outcome would be consideration of architectural treatments for the properties in question.

10.6 Noise Contours

Noise Contours are shown in Appendix C for the predicted daytime and night time noise. The contours show the predicted noise from the bypass only. No noise mitigation was included in the noise prediction.

10.7 Noise Levels to Non-Residential Receivers

Noise levels at non-residential receivers are given in Table 10-3.

For some receivers the criterion is based on internal noise. For most buildings, if the windows are open the internal noise level is approximately 10dBA less than the external noise level. Hence at buildings with predicted external noise levels more than 10dBA above the internal noise criterion, a possible exceedance is noted.

Table 10-3 Predicted Noise Levels at Non-Residential Receivers

Receiver Number	Receiver Name	External Noise Levels, $L_{Aeq,1hr}$ dBA			Comments
		Hume Highway 2012	Combined Traffic Noise 2022 (Hume Highway and Bypass)	Criterion	
61	St Marks Church Hall	52	51-52	40 (internal)	Possible exceedance
62	St Marks Church	54	51-52	40 (internal)	Possible exceedance
73	Tarcutta Memorial Hall	69	66	40 (internal)	Possible exceedance
74,75	Tarcutta Cemetery	52	53-58	55	Might exceed at closest point to bypass
154	St Francis Xavier Church	60	58	40 (internal)	Bypass would comply, but combined noise exceeds
183-185	Tarcutta Hospital	48	49	35 (internal)	Possible exceedance
187	Tarcutta Public School	53	52	45 (internal)	Complies
194	Truckers Memorial	61	59	55	Bypass would comply, but combined noise exceeds

11 BARRIER SENSITIVITY ANALYSIS

The *ENMM Practice Note iv* discusses a method for determining the effectiveness of noise barriers with the aim of determining the cost effectiveness of barriers as a noise mitigation option for new roads. The method is intended to assess the “reasonableness” of noise barriers and weighs the benefits, in terms of the noise reductions achieved and the number of people protected, against the total cost of the barrier.

The method states that the noise level to be assessed is a total noise level: that is the noise from the new road combined with noise from other roads in the area. As previously discussed, in the case of Tarcutta such an analysis will most likely fail due to the continuing use of the Hume Highway by a high proportion of Hume Highway traffic.

Further, the methodology states that barriers to be assessed should reduce the total noise level by at least 5dBA at the most affected residences in order to be considered cost effective.

Barriers up to six metres high were assessed along the eastern side of the carriageway. The height of the barrier was measured from the top of the cut where the road was in cut, and from the carriageway height when the road was on fill. The calculations showed that due to the topographic arrangement of Tarcutta with respect to the proposed carriageway, even barriers up to six metres in height would not reduce noise levels by 5dBA from the new highway. Also, noise from the existing highway remains significant as it is not changed by the barrier. Hence it was considered that the cost effectiveness analysis proposed by the ENMM was not appropriate for this project and no further analysis was carried out.

As discussed it was proposed for this project that noise mitigation of the bypass would be provided in order to reduce noise levels from the new road by itself to below the base levels of the ECRTN. The noise barrier may be effective for residences in Tarcutta itself, but would not be applicable to the isolated rural residences. The effectiveness of various height barriers is shown in Table 11-1. The table shows the number of houses exceeding $L_{Aeq,9hr}$ 50dBA for night time noise. The table shows that the barrier would only reduce the noise level to below the criterion at seven of the 10 houses where the criterion is exceeded. This includes barriers up to 6 metres in height. The table also shows the number of houses exceeding 48dBA. This is to take into account the possibility that the traffic flow could have been underestimated by 2dBA. In this case the table shows that the barrier would be effective at up to 17 housed but would still leave 6 houses above the criterion.

Table 11-1 Barrier Effectiveness

	Barrier Height, metres				
	0	3	4	5	6
Number of Houses Exceeding $L_{Aeq,9hr}$ 50dBA	10	5	5	5	3
Number of Houses Exceeding $L_{Aeq,9hr}$ 48dBA	23	11	8	6	6

12 METEOROLOGICAL EFFECTS

The Director General's requirements state that local meteorological conditions should be assessed for their impact on noise transmission from the bypass. Neither the ECRTN nor the ENMM discuss assessment of traffic noise under changing meteorological conditions. It has been suggested that the *NSW Industrial Noise Policy (INP)* of the DECC be used to make and ensure and qualitative assessment of meteorological effects.

The INP discusses the effect of temperature inversions and wind. Both the temperature inversions and wind can enhance noise propagation from a source to receiver. The INP discusses procedures for this assessment. For the best confidence in the assessment it is required to have meteorological data for the area under consideration. In this case we have been unable to find meteorological data for Tarcutta. In such cases the default conditions of the INP can be applied. The default conditions are temperature inversions of 3 degrees per 100 metres in combination with a drainage wind of 2 metres per second from source to receiver where the receiver is below the noise source. In this case the receivers are typically above the height of the bypass, hence the drainage wind has not been considered.

The prediction of traffic noise under different meteorological conditions is not well understood. The CORTN algorithms used for prediction in this study do not include any methodology for different meteorological conditions. The following procedure was used to estimate the effect of these conditions:

Noise propagation from the bypass was predicted using the environmental noise model (ENM) from RTA Technology. A line source (to simulate the flow of traffic) representing the bypass was used and noise was predicted at all receivers under various meteorological conditions. We then have the noise at any receiver from the bypass under isothermal still conditions and under a temperature inversion of 3° per 100 metres. The difference in these two levels is typically 1 to 4 dBA, depending on the location of the receiver with respect to the highway. This difference was then added to the predicted traffic noise level calculated from the CoRTN algorithms. In this way the traffic noise level under various meteorological conditions was estimated.

The analysis shows that the temperature inversion increases noise level by up to 3dBA at any residence. This increase in noise level exists only for the time of the temperature inversion.

The INP suggests that temperature inversions most likely occur for the hour immediately before and after sunrise. So while there may be a significant increase in noise level during those periods, the effect over the entire 9 hour period of night time is an increase in $L_{Aeq,}$ 9 hour by only 1 dBA at most residences.

With respect to wind, there would be a similar increase in noise level at many residences if there were a continuous low velocity wind from the west. We have no meteorological data to suggest that this would be the case in Tarcutta.

13 MAXIMUM NOISE LEVEL EVENTS

13.1 Guidelines

For road upgrades the ECRTN and ENMM provide guidance as to the likelihood of sleep disturbance. The ECRTN points out the following:

- There are no universally accepted criteria governing the likelihood of sleep disturbance. In other words, at the current level of understanding, it is not possible to establish absolute noise level goals that would correlate to levels of sleep disturbance (for all or even a majority of people).

- The ECTRN suggests that :

  Maximum internal noise levels below 50dBA to 55dBA are unlikely to cause awakening reactions.

  One or two events per night, with maximum internal noise levels of 65dBA to 70dBA, are not likely to affect health and wellbeing significantly.

  At locations where road traffic is continuous rather than intermittent, the $L_{Aeq,9hour}$ target noise level should sufficiently account for sleep disturbance impacts.

  However, where the emergence of L_{Amax} noise levels over the L_{Aeq} noise level is greater than 15dBA, the $L_{Aeq,9hour}$ criteria may not sufficiently account for sleep disturbance impacts.

Thus, the ECRTN recommends that the assessment of sleep disturbance should include a consideration of the maximum noise level exceedances occurring during the night time period and the emergence of these exceedances above the ambient noise level.

The issue of sleep disturbance is addressed within the RTA's ENMM in a similar fashion.

- It is suggested that the assessment of sleep disturbance should include an examination of "maximum noise events": A "maximum noise event" is defined as any single event where the L_{Amax} noise level exceeds 65dBA and the L_{Amax} noise level exceeds the $L_{Aeq,1hour}$ noise level by more than 15dBA.

- "Maximum noise event" characteristics to be assessed at nearest residential receivers include their occurrence throughout the 10pm to 7am night time period and their magnitudes.

Due to the absence of definitive qualitative correlation between sleep disturbance and noise level, the ENMM suggests that the above nominated noise levels and guidelines should not be taken to be criteria, but should be taken into consideration when determining noise mitigation measures to address general road traffic noise.

The quoted noise levels are not intended as specific noise criteria for the purpose of implementing mitigation measures but to highlight the potential for awakening reactions and the consideration of this in the design of noise mitigation, where this is considered to be necessary to reduce overall noise levels.

13.2 Maximum Noise Level Assessment

A desktop assessment of the maximum noise events of heavy vehicles travelling along Hume Highway, Tarcutta at Receiver 51 was conducted.

Table 13-1 shows estimated maximum levels from the existing Hume Highway. The table shows that the levels exceed the threshold at residences in Tarcutta and rural residences. As the Hume Highway will continue to be used after the opening of the bypass, the analysis will change only by the number of vehicles using the highway. This means there still could be up to 100 events per hour with maximum noise levels above the threshold.

Table 13-2 shows the maximum noise levels for the bypass. In general, the maximum noise levels will be much less in Tarcutta township, but will increase for the rural residences.

Table 13-1 Maximum Noise Level Events – Hume Highway

Location	$L_{Aeq,1hour}$ Noise Level (dBA) – typical night time	Estimated L_{Amax} Noise Level (dBA)	Degree of L_{Amax} above the 65dBA Noise Threshold (dBA)	Level of L_{Amax} above the $L_{Aeq,1hour}$ Noise Level (dBA)	No of Vehicle Movements – 2012	No of Vehicle Movements – 2022 with bypass
Town on highway	63-68	75-90	10-25	12-22	200-220	90-100
Sydney Street	60-65	75-88	10-23	9-23	200-220	90-100
Rural (eg Receiver 103)	50-65	70-75	5-10	10-20	200-220	90-100

Table 13-2 Maximum Noise Level Events – Bypass

Location	$L_{Aeq,1hour}$ Noise Level (dBA) – typical night time from all sources	Estimated L_{Amax} Noise Level (dBA) – from bypass	Degree of L_{Amax} above the 65dBA Noise Threshold (dBA)	Level of L_{Amax} above the $L_{Aeq,1hour}$ Noise Level (dBA)	No of Vehicle Movements – 2022 with bypass
Town on highway	60-63	55	0	0	120-130
Sydney Street	55-58	50	0	0	120-130
Rural (eg Receiver 103)	45-60	55-70	10	10-20	120-130

13.3 Engine Brakes

During our noise monitoring, concern was expressed about noise from trucks braking as they enter town. If engine brake noise were managed, some improvement in amenity would result, and possibly fewer waking events at residents near the approaches to the town.

14 CONSTRUCTION NOISE

14.1 Construction Noise Criteria for Residences

Although the DGRs ask for the NSW DECC draft Construction Noise Guideline to be used, correspondence from the Department of Planning confirms that the DECC's *Environmental Noise Control Manual (ENCM)* should be used.
The construction noise objectives presented in the ENCM, Chapter 171 are as follows:

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

Although not clearly stated by the DECC, it is considered that for construction periods longer than 26 weeks, as is the case with the Tarcutta Bypass, the L_{A10} noise level should not exceed the background (L_{A10}) level by more than 5 dBA.

In addition, the DECC suggests the following time restriction for the construction activities where the noise is audible at residential premises:

- Monday to Friday 7.00 am - 6.00 pm
- Saturday 8.00 am - 1.00 pm
- No construction work is to take place on Sundays or public holidays.

However, if night time construction is required for the project, it recommended that the L_{A10} should not exceed the existing night background (L_{A10}) by more than 5 dBA.

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.

14.1.1 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.

14.2 Proposed Working Hours

The majority of construction activities would take place during the daytime period (6am to 7pm, Monday to Friday; and 7am to 4pm Saturday), with no work on Sunday or public holidays. However, certain activities would be required to take place during the evening and night periods due to:

- Technical considerations (such as the need to meet particular quality specifications for placement of concrete pavement).
- The climatic environment (cold winters and hot summers).
- An accelerated construction program.

14.2.1 Justification for working hours

Early 6am starts

DECC standard working hours commence at 7am. By commencing works for the project at 6am each weekday, an additional hour of work may be achieved for daytime activities.

The extra hour of work in the morning allows for a number of essential pre-start activities such as mechanical pre-start, minor maintenance and refuelling, equipment establishment and setup, and minor preparation works. These activities are generally of a quiet nature but would allow construction activities to commence at maximum efficiency immediately when sufficient daylight is available.

Concrete paving

The RTA has specifications for placement of concrete pavement that relate to temperature and rainfall. For jointed concrete base, the specifications prohibit the placement of concrete during rain or when the ambient air temperature is below 5˚C or above 32˚C. As hot weather affects the quality of concrete pavement, in this climate paving in the early evening and into the night is preferred as it takes advantage of night temperatures. For cold weather concreting, early morning paving is recommended, to take advantage of daytime solar radiation and heat generation to promote concrete strength.

It is highly likely that concrete paving would need to be carried out during summer. Due to the climatic conditions experienced in the region during summer months, where day time ambient temperatures often exceed the maximum temperature threshold of 32˚C, concrete paving would need to occur during the day, evening and night-time periods as indicated in Table 7-4.

Concrete saw cutting

The project would use plain concrete pavement (PCP), which is an unreinforced pavement. To manage cracking associated with drying shrinkage, saw cutters are used to cut the pavement (usually in 4.2 metre sections). The timing of concrete cutting is governed by the hydration rate of the pavement, and may require cutting at any time within 4 and 24 hours after paving, with a 'cutting window' as short as 30 minutes. As the timing of cutting is critical to the quality of the pavement and acceptance of the finished product, concrete saw cutting may be needed at any time, including outside normal construction hours. Concrete saw cutting is a construction activity that is transient in nature, and each 'saw cut' would be of a short duration.

As mentioned above, concrete paving is highly likely to be carried out during summer months. Following concrete paving, concrete saw cutting will take place within 4 and 24 hours, during the day, evening and night-time periods as indicated in

Concrete batch plant

A concrete batch plant is proposed as part of the project. In addition to normal daytime operation for concrete products (drainage structures etc), the concrete batch plant would need to operate in conjunction with concrete paving works during the evening and night-time periods.

The concrete batch plant would also supply concrete to a number of other project components (eg pre-cast beams and parapet barriers (see below)), for which concrete may need to be supplied out of normal working hours.

Although yet to be confirmed, there is likelihood that some bridge may be cast in situ, which would require the batch plant to provide concrete continuously for up to 24 hours. This may occur on three separate occasions.

To keep up with materials demand during these peak periods of concrete production, the batch plant would require materials deliveries outside of normal working hours. Due to the regional location of the project, the timing of deliveries may be determined by the pattern of supplier fleet movements (ie at night).

The number of deliveries would be dependent on the size of the batching plant and its storage capabilities; however, there is potential for up to three deliveries per night during peak periods.

The concrete batch plant would be operational for the entire construction period (approximately two years). Within that period, concrete batch plant deliveries may be undertaken during the evening and night-time periods during the following hours:

- 12am to 6am and 7pm to 12pm Monday to Friday; and
- At no time on Saturdays, Sundays or public holidays.

Pre-cast yard

A pre-cast yard is proposed for the project as the construction of bridge structures to traverse Tarcutta and Keajura creeks would require in the order of 250 pre-cast beams (or super-tees).

Heat accelerated curing of the pre-cast beams is required to accelerate their early strength gain. The curing process would need to occur during the day, evening and night-time periods, after the beams have been cast to enable removal of the shutters the following day. This method of pre-casting and curing would provide for the most efficient production of pre-cast beams for the project.

The pre-cast yard would be in operation for approximately one year. In this time, the 'noisy' operations would occur during daytime working hours. However, the boiler and a small laboratory would operate during the following evening and night time hours:

- 12am to 6am and 7pm to 12pm Monday to Friday;
- 12am to 7am Saturday; and
- At no time on Sundays or public holidays.

14.3 Project Specific Criteria

The criteria specific to this project are shown in Table 14-1, based on the measured RBLs. Logger charts in Appendix D indicate that the noise level between 6.00am and 7.00am is generally similar to the daytime RBL. Hence the criterion for L_{A10} construction in that period has been included with the daytime criterion. A sleep disturbance criterion for this period is shown.

Two sets of noise criteria have been determined: township and isolated residences. The township criteria are based on the background measurements in Myrtle Street. This would give a conservative assessment at residences closer to the Hume Highway. Note that the highest background level was recorded during evening hours, and daytime is quieter than night time. This follows from the diurnal pattern of heavy vehicles on the Hume Highway.

The isolated residences criteria are based on the minimum level measured at any of the rural properties. The demarcation of isolated residences and residences in the township are presented in

Table 14-1 L_{A10} Construction Noise Criteria

	L_{A10} Construction Noise criteria (dBA)			Sleep disturbance L_{A1}, dBA	
	Daytime (6.00am – 7.00pm)*	Evening (7.00pm to 10.00pm)	Night (10.00pm to 6.00am)	Early Morning (6.00am to 7.00am)	Night (10.00pm to 6.00am)
Isolated Residences	42	42	40	52	50
Township	40	46	42	50	50

* including DECC Early Morning (7.00am to 6.00am) and Early Evening (6.00pm to 7.00pm)

Figure 14-1 Northern side of Tarcutta showing the Isolated Residences

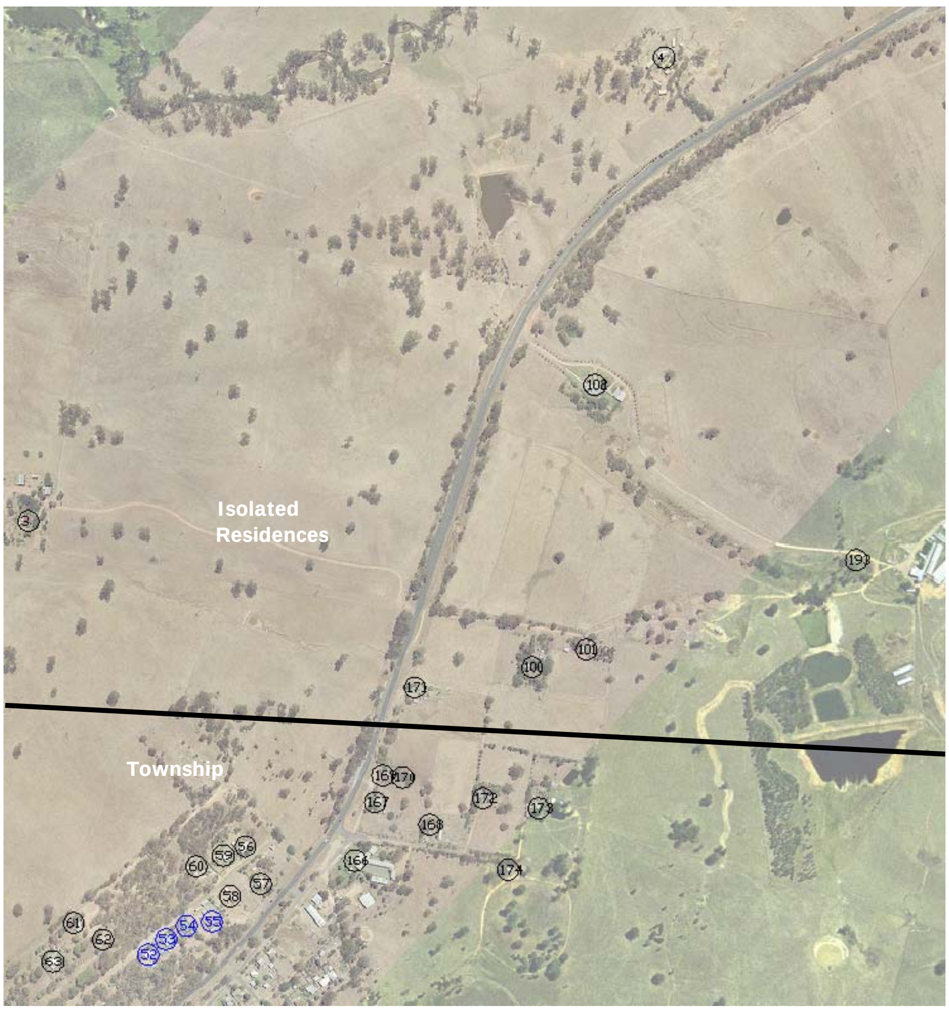
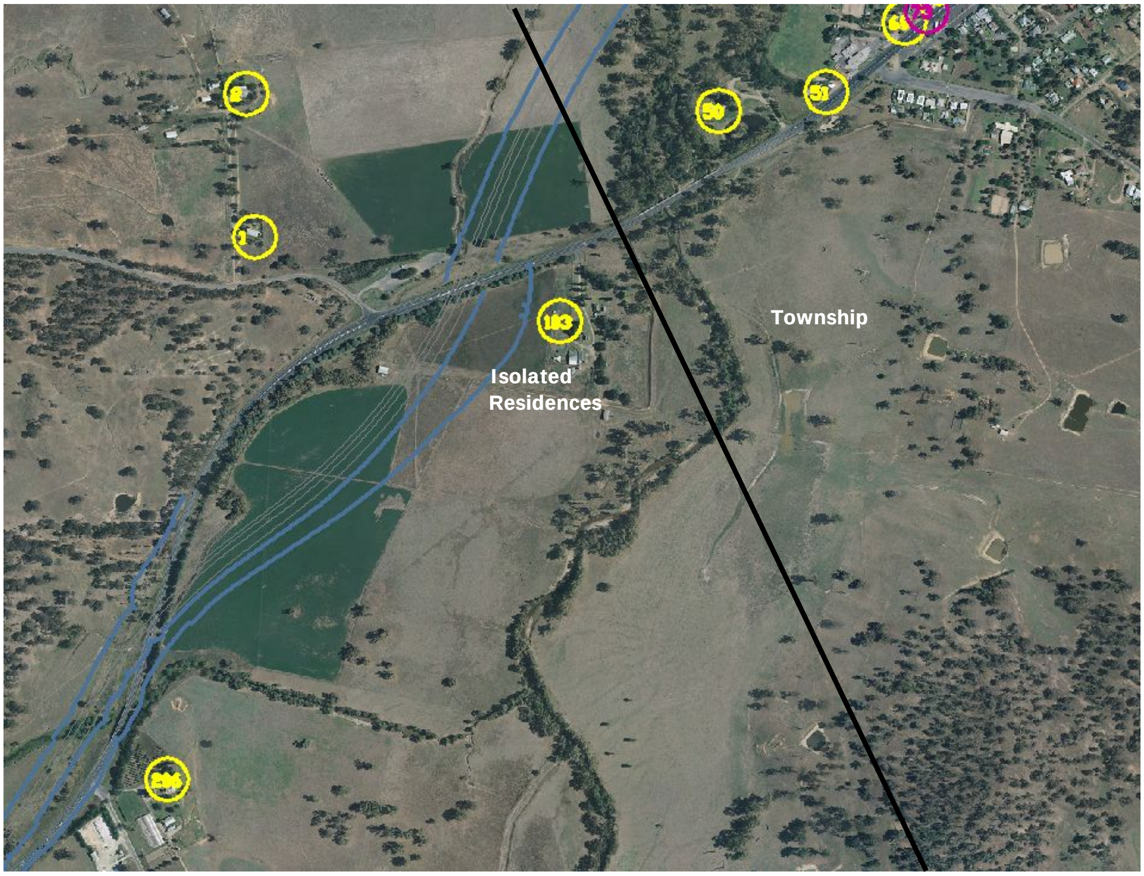


Figure 14-2 Southern side of Tarcutta showing the Isolated Residences



14.4 Work Program and Working Hours

Construction is expected to occur over two years with project opening planned for December 2011. The expected duration of the main construction activities is as follows:

- Early works – 2 months;
- Clearing – 5 months;
- Earthworks – 14 months;
- Bridgeworks – 14 months;
- Piling – 10 months; and
- Drainage works – 6 months.

Table 14-2 shows the typical activities that would be done during any period of the day or night. The table includes descriptions of necessary night works.

Table 14-2 Work Activities and Time

Day	Time	Activity
Monday to Friday	Daytime (6am – 7pm)	▪ Compound operation. ▪ Earthworks. ▪ Blasting (if required). ▪ Structures. ▪ Drainage. ▪ Ancillary/finishing works. ▪ Concrete paving. ▪ Asphalt paving. ▪ Concrete saw cutting. ▪ Concrete batch plant operation. ▪ Pre-cast yard operation. ▪ Deliveries.
Monday to Friday	Evening and Night (7pm – 6am)	▪ Concrete paving. ▪ Concrete saw cutting. ▪ Concrete batch plant deliveries. ▪ Concrete batch plant operation. ▪ Casting of bridge decks. ▪ Pre-cast yard. ▪ Maintenance activities.
Saturday	Daytime (7am – 4pm)	▪ Compound operation. ▪ Earthworks. ▪ Structures. ▪ Drainage. ▪ Ancillary/finishing works. ▪ Concrete paving. ▪ Asphalt paving. ▪ Concrete saw cutting. ▪ Concrete batch plant deliveries. ▪ Batch plant operation. ▪ Pre-cast yard operation.
Sunday and Public Holiday		No scheduled work

Variation to the above working hours and/or activities would be limited to:

- Works that do not cause construction noise to be audible at any sensitive receiver; or
- Delivery of materials required by the Police or other authorities for safety reasons; or

- Work required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or
- As a case-by-case or activity specific basis, which would be subject to consultation with the NSW Department of Planning, DECC and affected sensitive receivers, for example the continuous concrete pour of cast in situ bridge decks (a potential requirement).

14.5 Assessment of Noise from Mobile Plant

14.5.1 Mobile Plant Source Noise Levels

Sound levels of typical equipment are listed in Table 14-3. The Table gives both Sound Power Level (SWL) and Sound Pressure Levels (SPL) at 7 metres for the equipment. SWL is independent of measurement position. Verification of plant noise is typically done by measuring the SPL at 7m.

Table 14-3 Typical Construction Plant Sound Levels

Plant	L_{A10} Sound Power Level (dBA)	L_{A10} Sound Pressure Level at 7m (dBA)
Front End Loader	111	86
Grader	107	82
Smooth Drum Roller	107	82
Spoil, Materials or Concrete Truck	109	84
Tower Crane or Mobile Crane	105	80
Truck-mounted Shotcrete Pump	106	81
Excavator or Bobcat	107	82
Concrete Pump	105	80
Concrete Vibrator	103	78
Concrete Cutter	109	84
Large Bored Drilling Rig	112	87
Small Bored Drilling Rig	108	83
Powered Hand Tools	109	84
30t Excavator operating with hydraulic hammer	122	97
Rock Saw	116	91
Water Cart	110	85
Kerbing Machine	99	74
Chainsaw	106	81
Forklift	106	81
Mulcher	106	81
Articulated Dump Truck	113	88
Handheld Jackhammer	113	88
Air Compressor (Power Tools)	98	73
Asphalt Paving Plant	114	89

14.5.2 Typical Activity Noise Levels

Based on the above, noise level predictions have been conducted for each of the construction phases outlined in Section 7.1 above.

Table 14-4 Calculation of Total Sound Power Level (SWL)

Activity	Typical equipment used	Total L_{A10} sound power level (dBA)[1]
Milling and repaving	Road trucks, compactors, multi-tyred and vibratory rollers, asphalt paving plant, backhoe, profiler, sweeper, compressors, generators, truck and dog.	113
Site establishment	Excavators, chainsaws, mulching plant and chipper, cranes, generators.	111
Removal of vegetation	25-tonne excavator, mulcher, chainsaw, trucks, grader, combination backhoe FEL, bulldozer.	113
Earthworks	Road trucks, compactor, grader, steel, multi-tyred and vibratory rollers, concrete pour (including trucks and concrete vibrator), asphalt paving plant, backhoe, sweeper, compressors, generators, (excavator with hammer) scrapers, water carts.	114 (120)
Piling	Bored or driven piling rigs, pumps, generators.	115 (bored)–120 (driven)
Bridge works	Piling rigs, cranes, , hand tools, compressors, generators	115–120 (possible when piling)
Paving	Road trucks, compactor, (jackhammers), steel, multi-tyred and vibratory rollers, concrete pour (including trucks and concrete vibrator), asphalt paving plant, backhoe, (concrete saw), profiler, sweeper, compressors, generators.	113 (116)
Landscaping of exposed areas	Excavator/bobcat, powered hand tools, air compressor, spoil, material or concrete truck, jackhammer (for concrete embedded parts).	111

Note: The sound power levels in brackets are for the occasional use of rock breakers, jackhammers and concrete saws.

14.5.3 Noise to Residences

The noise level experienced at any residence along the route will depend upon many factors, such as distance to the construction site, shielding between the site and the residence, and the activity occurring at the construction site. The quietest activities, such as site preparation, would be up to 20dBA quieter than the noisiest activities if earthworks using rock breakers are used. Further, noise levels would be quieter whenever the construction takes place in cut compared with that undertaken on fill. The construction site is also long – more than 5km. As activities move along the corridor noise will change at any residence.

Table 14-5 shows the duration of noise impact that could be expected from the different construction activities.

Table 14-5 Predicted Duration of Noise Impact of Construction Activities

Activity	Expected Duration of Impact at any Residence
Removal of Corridor Vegetation, fencing	2-3 weeks
Bulk earthworks	3 to 6 months
Bridges	6-8 months
Paving	2-4 weeks

As the construction site moves, residences are typically not exposed to line of sight view of paving equipment for an extended period of time (i.e. more than a few days or a week). Noise impact is therefore restricted to a limited time period.

Daytime

Table 14-6 show the predicted noise levels of construction activities. For each residence the table shows the daytime criterion, and a range of noise levels to be expected from each activity. The table gives a maximum level based on construction at the nearest point to the residence. The "typical" level in the table is an estimated noise level that would be audible for a significant time. Owing to the length of the project there will be times when the construction is inaudible.

Daytime road work noise is predicted to satisfy the criterion at all township residences east of the Hume Highway, and these locations are not shown in the table. At most residences west of the Hume Highway an exceedance up to 5-10dBA is predicted for general roadworks during daytime hours. At the closest residence (Receiver 68) the exceedance is predicted to be up to 19dBA during roadworks, and 24dBA during piling for the bridge.

At isolated residences along the route the predicted exceedance is up to 23dBA for general roadworks. The highest exceedances are at Receiver 4 and Receiver 103 during earthworks at the closest point to the houses.

Piling

Noise from piling is predicted to exceed the criteria by up to 24dBA at residences in Myrtle Street. Theses residences would have a clear view to the bridge structure at the creek crossing. The next highest exceedance is predicted to be at Reciever 50 (Tarcutta Inn), where an exceedance of 17dBA is predicted.

As the extent and location of piling is yet to be determined, these results are indicative of the impact to be expected.

Evening

The predicted noise levels for evening work are shown in Table 14-7.

Night Time

The predicted noise levels for night time work are shown in Table 14-8. As work is proposed during to commence at 6.00am on weekdays, and the hour from 6.00am to 7.00am is considered as night time, the table shows noise levels from paving and earthworks and includes a predicted L_{A1} noise level for sleep disturbance assessment.

At residences in Tarcutta east of the Hume Highway the night time noise is predicted to meet the criteria.

At residences in Tarcutta west of the Hume Highway the predicted night time noise is 5-18dBA above the criteria. Again the closest residence (Receiver 68) will be the most impacted. This is the predicted exceedance during paving works. During necessary sawcutting works, the exceedance would be up o 19dBA at that receiver.

At rural residences the night time exceedance is predicted to be up to 24dBA at Receiver 4 and Receiver 103.

The sleep disturbance criteria are predicted to be exceeded at rural residences, and town residences west of the Hume Highway.

Table 14-6 Predicted construction Noise Levels - Daytime

Receiver	RBL	Criterion, L_{Aeq} dBA	Sound Levels, L_{A10} dBA									
			Site Preparation		Earthworks		Piling		Bridge Structure		Paving	
			Typical	Max	Typical	Max	Typical	Max	Typical	Max	Typical	Max
1	37	42	49	56	52	59	49	55	44	50	51	58
2	37	42	43	50	46	53	49	54	44	49	45	52
3	37	42	49	55	52	58	48	49	43	44	51	57
4	37	42	57	62	60	65	48	49	43	44	59	64
50	35	40	44	51	47	54	55	57	50	52	46	53
51	35	40	42	48	45	51	53	54	48	49	44	50
56	35	40	40	46	43	49	43	44	38	39	42	48
63	35	40	37	44	40	47	61	62	56	57	39	46
68	35	40	48	56	51	59	61	64	56	59	50	58
73	35	40	34	40	37	43	47	48	42	43	36	42
100	37	42	44	49	47	52	44	45	39	40	46	51
101	37	42	42	47	45	50	44	45	39	40	44	49
102	37	42	46	53	49	56	51	52	46	47	48	55
103	37	42	54	62	57	65	59	60	54	55	56	64
206	37	42	57	61	60	64	50	50	45	45	59	63

Table 14-7 Predicted Construction Noise Levels – Evening

Receiver	Noise Levels					
	RBL	Intrusiveness of Construction Noise, L_{A10} dBA				
		Criterion 7.00pm to 10.00pm	Noise Level, Paving		Noise Level, Sawcutting	
			Typical	Max	Typical	Max
1	42	47	51	58	54	61
2	42	47	45	52	48	55
3	42	47	51	57	54	60
4	42	47	59	64	62	67
50	46	51	46	53	49	56
51	46	51	44	50	47	53
56	46	51	42	48	45	51
63	46	51	39	46	42	49
68	46	51	50	58	53	61
73	46	51	36	42	39	45
100	42	47	46	51	49	54
101	42	47	44	49	47	52
102	42	47	48	55	51	58
103	42	47	56	64	59	67
206	42	47	59	63	62	66

Table 14-8 Predicted Construction Noise Levels – Night Time

Receiver	Sound Levels									
	RBL	Intrusiveness of Construction Noise, L_{A10} dBA					Sleep Disturbance Levels, L_{A1} dBA			
		Criterion 10.00pm to 7.00am	Noise Level, Paving		Noise Level, Sawcutting		Criterion 10.00pm to 6.00am	Criterion 6.00am to 7.00am	Noise Level, maximum event	
			Typical	Max	Typical	Max			Typical	Max
1	35	40	51	58	54	61	50	52	56	63
2	35	40	45	52	48	55	50	52	50	57
3	35	40	51	57	54	60	50	52	56	62
4	35	40	59	64	62	67	50	52	64	69
50	37	42	46	53	49	56	52	50	51	58
51	37	42	44	50	47	53	52	50	49	55
56	37	42	42	48	45	51	52	50	47	53
63	37	42	39	46	42	49	52	50	44	51
68	37	42	50	58	53	61	52	50	55	63
73	37	42	36	42	39	45	52	50	41	47
100	35	40	46	51	49	54	50	50	51	56
101	35	40	44	49	47	52	50	50	49	54
102	35	40	48	55	51	58	50	50	53	60
103	35	40	56	64	59	67	50	52	61	69
206	35	40	59	63	62	66	50	52	64	68

14.6 Assessment of Noise from Concrete Batching Plant

A batching plant is proposed at the north of the project between Receiver 3 (Cullinga) and the existing Hume Highway. The site is on the western side of the proposed Tarcutta Bypass alignment. A ridge would serve as a topographical barrier shielding noise from the batch plant, to some extent, to the Tarcutta township.

14.6.1 Source noise levels

Wilkinson Murray has previously measured noise levels of concrete batching plants. The typical sound power levels of batching plant are given in Table 14-9.

Table 14-9 Source Noise Levels of Concrete Batching Plant

Plant	L_{A10} Sound Power Level (dBA)	L_{A10} Sound Pressure Level at 7m (dBA)
Conveyor Drive	97	72
Front end loader	111	86
Concrete batching, including concrete truck	109	84
Trucks unloading into hopper	115	90
Cement Bulk Tanker unloading	109	84

The typical overall sound power level of the concrete batching plant during full production has been established at approximately $L_{A10,15min}$ 116dBA.

For the possibility of after hours deliveries, the estimated source level is $L_{A10,15min}$ 113 dBA – equivalent to one truck and one front end loader.

For sleep disturbance assessment a maximum level of L_{A1} 120 dBA is assumed.

Assuming a typical overall sound power level of $L_{A10,15min}$ 116dBA, L_{A10} noise levels have been predicted using the Environmental Noise Model (ENM). A temperature inversion of 3^{o}C/100m was included for the night time and evening periods.

14.6.2 Predicted Noise Levels

Table 14-10 summarises the daytime noise level predictions for the batching plant. Minor exceedances up to 3dBA are predicted at the closest residences.

Table 14-10 Predicted Daytime L_{A10} Levels of Batching Plant

Receiver	Daytime Noise Levels, L_{A10} dBA		
	Predicted Operational Noise Level	Objective	Exceedance
3	44	42	2
4	43	42	1
100 East of Batch	43	42	2
102 NE of Batch	45	42	3
171 East of Batch at north of township	43	42	2

Table 14-11 shows the predicted noise level for evening. Levels are given for operation, which includes batch plant operation and delivery, and delivery only. Maximum noise levels are also given for comparison with the sleep disturbance criterion.

Exceedances up to 3dBA are predicted at the closest residences during operation. Minor exceedances of 1 and 2dBA are predicted for deliveries only. a

Table 14-11 Predicted Evening Time Levels of Batching Plant

Receiver	Night Time Noise Levels, L_{A10} dBA					
	Predicted Operational Noise Level	Objective	Exceeds objective	Just Delivery	Objective	Exceeds objective
3	44	42	2	41	42	0
4	43	42	1	40	42	0
100 East of Batch	43	42	1	40	42	0
102 NE of Batch	45	42	3	42	42	0
171 East of Batch at north of township	43	42	1	40	42	0

Table 14-12 shows the predicted noise level for night time. Levels are given for operation, which includes batch plant operation and delivery, and delivery only. Maximum noise levels are also given for comparison with the sleep disturbance criterion.

Exceedances up to 5dBA are predicted at the closest residences during operation. Minor exceedances of 1 and 2dBA are predicted for deliveries only. No exceedance of the sleep disturbance criterion is predicted. The noise was compared to the lowest sleep disturbance criterion, so this applies both to the night time 10.00pm to 6.00am period, and the 6.00am to 7.00am period.

Table 14-12 Predicted Night Time Levels of Batching Plant – Night Time

Receiver	Night Time Noise Levels, L_{A10} dBA						Night Time Noise Levels, L_{A1} dBA (for sleep disturbance)		
	Predicted Operational Noise Level	Objective	Exceeds objective	Just Delivery	Objective	Exceeds objective	Predicted Level	Objective	Exceeds objective
3	44	40	4	41	40	1	48	50	0
4	43	40	3	40	40	0	47	50	0
100 East of Batch	43	40	3	40	40	0	47	50	0
102 NE of Batch	45	40	5	42	40	2	49	50	0
171 East of Batch at north of township	43	40	3	40	40	0	47	50	0

14.7 Assessment of Noise from Precast Yard

A precast yard is proposed on the western side of the highway near the northern extremity of the project.

The site is on the western side of the proposed Tarcutta Bypass alignment.

14.7.1 Source noise levels

The typical sound power levels of precast yards are given in Table 14-13.

Table 14-13 Source Noise Levels of Precast Yard

Plant	L_{A10} Sound Power Level (dBA)	L_{A10} Sound Pressure Level at 7m (dBA)
Boiler	90-100	65-75
Trucks – Concrete and delivery	109	84
Mobile Crane	105	80

From the noise levels in Table 14-13 the estimated site sound power levels are:

- Daytime - $L_{A10,15min}$ 113dBA;
- Evening - $L_{A10,15min}$ 100dBA; and
- Night Time – $L_{A10,15min}$ 100dBA; and
- Night Time – $L_{A1,15min}$ 100dBA (for sleep disturbance).

14.7.2 Predicted Noise Levels at Residences

The closest assessed residence to the proposed site is Receiver 204, approximately 300m southwest of the site. The next nearest is a residence approximately 850m northwest of the site that was not assessed previously as it is north of the project. For both residences the criteria for construction noise are L_{A10} 42dBA daytime and evening, and 40dBA night time. The night time sleep disturbance criterion is L_{A1} 50dBA.

Figure 14-3 Location of Precast Yard

Table 14-14 Predicted Noise Levels of Precast Yard

Location	Daytime L_{A10} Level (dBA)	Evening L_{A10} Sound Level (dBA)	Night Time L_{A10} Sound Level (dBA)	Night Time L_{A1} Sound Level (dBA)
204	54	42	42	42
House at 850m to northwest	46	34	34	34

At Receiver 204 the daytime noise level is predicted to exceed the criterion by up to 12dBA during times of maximum activity, and some noise impact is predicted during those times.

Predicted evening noise complies with the criterion.

At Receiver 204 the night time noise level is predicted to 2dBA above the criterion. However it is noted that noise from the boiler could include low frequency components that would be audible at the residences. This characteristic of the noise would increase the noise impact at that residence. If possible the boiler should be located in a way that shields Receiver 204 from the noise, and the quietest boiler available should be selected. Predicted night time noise complies with the sleep disturbance criterion.

14.8 Mitigation of Construction Noise

Reduction of construction noise for night time road works is often impractical. For example if temporary screens are proposed a significant part of the shift might be used in setting up and taking down noise control, thereby extending the duration of the project. Best practice mitigation and management measures will be used to minimise construction noise and vibration at noise sensitive receivers and will be described in a construction noise management plan.

The plan would include procedures for:

- Where any work outside to meet the evening / night time criteria and exceedence against the criteria are predicted at a sensitive receiver;
- A notification and negotiation procedure will be developed for residences where noise impact cannot be mitigated to meet the criteria;
- An undertaking not be audible at any sensitive receiver unless a negotiated agreement (as defined under the Industrial Noise Policy (EPA, 2000)) is in place;
- A procedure for dealing with and responding to complaints; and
- Noise monitoring and auditing procedures will be developed to verify compliance with the predicted noise impacts.

In general, management of noise and vibration requires attention to the following:

- Construction hours.
- Noise and vibration monitoring where appropriate.
- Training and awareness.
- Communication.
- Incident and emergency response.
- Non-conformance, preventative and corrective action.

Where appropriate the specific noise mitigation measures could include:

- Mitigation of specific noise sources may be possible by using portable temporary screens.
- For extended periods of driven piling and use of rock breakers, respite periods might be considered.
- Maximising the offset distance between noisy plant items and sensitive receivers.
- Construction timetabling, in particular for works outside standard hours, to minimise noise impacts. This may include time and duration restrictions and respite periods.
- Avoiding using noisy plant simultaneously and/or close together, adjacent to sensitive receivers.
- Orienting equipment away from sensitive receivers.
- Carrying out loading and unloading away from sensitive receivers.
- Using dampened tips on rock breakers.
- Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks.
- Selecting plant and equipment based on noise emission levels.
- Using alternative construction methods.
- Providing alternative arrangements with affected residents such as temporary relocation.
- Selecting site access points and roads as far as possible away from sensitive receivers.
- Using spotters, closed circuit television monitors, “smart” reversing alarms, or “squawker” type reversing alarms in place of traditional reversing alarms.

Education and training of site staff is necessary for satisfactory implementation of noise mitigation measures. Education and training strategies should focus on:

- Site awareness training / environmental inductions that include a section on noise mitigation techniques / measures to be implemented throughout the project.
- Ensuring work occurs within approved hours.
- Locating noisy equipment away from sensitive receivers.
- Using noise screens for mobile plant and equipment.
- Ensuring plant and equipment is well maintained and not making excessive noise.
- Turning off machinery when not in use.

15 ASSESSMENT OF CONSTRUCTION VIBRATION

15.1 Vibration Criteria (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.

15.1.1 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 15-1.

Table 15-1 Preferred and Maximum Peak Particle Velocity (PPV) values for Continuous and Impulsive Vibration

Location	Assessment period (1)	Preferred values, mm/s	Maximum Values, mm/s
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
Impulsive 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 15-2.

Table 15-2 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

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.

15.1.2 Building Damage

In regard to potential building damage, German Standard DIN 4150-3 (Table 1 – reproduced here as Figure 15-1) shows guideline values for short term vibration for commercial buildings, houses and heritage buildings which are dependent on the frequency of vibration. The recommended vibration level for sensitive heritage buildings ranges from 3 to 10mm/s, and 5 to 20mm/s for dwellings.

Figure 15-1 Table 1 from DIN 4150-3

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Table 1: Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures

Line	Type of structure	Guideline values for velocity, v_i, in mm/s			
		Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz *)	at all frequencies
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 and/or occupancy	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

*) At frequencies above 100 Hz, the values given in this column may be used as minimum values.

15.2 Source Levels of Vibration

Table 15-3 provides some estimated vibration levels at a range of distances from the various construction activities.

Table 15-3 Typical Vibration Emission Levels from Construction Plant

Activity	PPV Vibration Level (mm/s) at Distance		
	10m	**20m**	**30m**
Concrete Sawing	0.5	0.3	0.2
4-Tonne Vibratory Roller (High)	2.0-2.4	0.4-1.2	0.2-0.8
Hydraulic Hammer (30t)	3	1.5	1.0

15.3 Vibration Levels at Residences

The closest residence to the route is the Tansley cottage at 77m from the bypass. This house is currently unoccupied but is a heritage structure. Vibration levels are predicted to be below 1.0mm/s in all frequencies, and no exceedance of the damage criterion is predicted.

The remaining residences are more than 100m from construction activity locations. Vibration from construction activities are predicted to be below the criteria for residential buildings at this distance.

15.4 Vibration at the Cemetery

The closest point from the edge of the construction site boundary to Tarcutta cemetery is 30m. There are no specific vibration criteria for cemeteries. To be conservative it is proposed to use the criterion for sensitive heritage buildings (ranges from 3 to 10mm/s).

Vibration levels at the cemetery are predicted to be below 3.0mm/s in all frequencies, as such it is concluded that it is unlikely that construction vibration could damage any gravestones.

16 BLASTING

16.1 Blasting Locations

Information from the Tarcutta Hume Alliance indicates that blasting may be undertaken at three locations. Geotechnical investigations at each of the three main cuttings are incomplete due to heritage constraints. The information available to date indicated that blasting is unlikely to be undertaken; however an assessment of overpressure and vibration from potential blasting was done for the three main cuts. The location of the cuts and nearest receivers are given in Table 16-1.

Table 16-1 Location of Potential Blasting and Nearest Receiver

Location	Chainage	Nearest Receiver Location	Distance to Receiver, m
Cut 1	41600 to ch.41750	204	370-480
Cut 2	42800 to ch.43500	102	240-760
Cut 3	43800 to ch.44500	68	110-670

16.2 Assessment Criteria

16.2.1 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.

16.2.2 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

16.3 Definition of "Scaled Distance"

Airblast overpressure and ground vibration levels from blasting are related to the "scaled distance" from the blast, which is defined as

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

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

16.4 Prediction of Overpressure

Peak overpressure levels are predicted as:

$$L = A - B \log(D/W^{1/3})$$

where B depends on the site characteristics and A depends on both site characteristics and blasting practice.

Wilkinson Murray have analysed blast monitoring from Prospect Quarry and Bayswater No 3 Mine. The "best fit" of that data has values of B = 22.4 and A = 158 in the above equation. However, to ensure that 95% of blasts are within a criterion, a value of A = 171 is required.

While mine blasts are typically much larger than those expected on the Tarcutta Bypass, experience suggests that the overpressure values would meet the criterion for 95% of blasts if best practice blasting procedures are adopted.

16.5 Prediction of Vibration Levels

The "scaled distance" from the a blast, which is defined as

Scaled distance = $D/W^{(1/2)}$ for ground vibration.

Peak particle velocity is predicted as

$$PPV = K \ (D/W^{1/2}) \ -a$$

where a depends on the ground characteristics and K depends on both site characteristics and blasting practice.

Australian Standard 2187.2 gives recommended values K and a for cases where site data are not available, the relevant values being:

Blasting to a free face, hard rock : K = 500, a = 1.6

Blasting to a free face, average rock: K = 1140, a = 1.6

16.6 Recommendations for Blasting

Table 16-2 shows the recommended Maximum Instantaneous Charge (MIC) for each cut based on the values for average rock. MIC is shown for estimated minimum and maximum distance from the cut to the residences.

Table 16-2 Recommended MIC to Achieve Criteria

Receiver	Distance to Cut, m		MIC to Meet Criteria from Nearest Point of Cut		MIC to Meet Criteria from Furthest Point of Cut	
	Minimum	Maximum	Vibration	Overpressure	Vibration	Overpressure
Cut 1						
204	370	480	370	88	480	193
Cut 2						
102	240	760	56	24	554	765
Cut 3						
68	110	670	12	2	430	524

17 CONCLUSION

Noise from the proposed Tarcutta Bypass has been assessed. Noise from both construction and operation of the bypass was considered.

17.1 Noise Monitoring

Noise monitoring was done at eight locations. The noise monitoring determined background noise and traffic noise.

17.2 Noise Modelling and Validation

Noise from both the existing highway and the bypass was modelled. The model was validated using predicted noise from the highway and comparing it to noise measured while traffic was counted. Good agreement was found.

17.3 Noise Criteria and Operational Noise Findings

The traffic report used as part of the noise model predicts that approximately 40% of traffic would continue to pass through Tarcutta instead of using the bypass. In this case the traffic noise from the existing highway remains significant.

As it was not considered reasonable and feasible to reduce noise from the existing highway, noise mitigation was investigated in order to reduce the noise level contribution of the bypass to the base criteria of the ECRTN. Low noise pavement was considered more effective than noise barriers in this regard.

Notwithstanding the analysis of barriers and low noise pavement, the RTA's ENMM gives guidance for selecting reasonable and feasible noise mitigation based on combined noise from new and existing roads. These guidelines would favour architectural treatments for individual residences rather than at road mitigations for the Tarcutta bypass.

The assumed traffic flow was based on the continuing use of Tarcutta by 40% of traffic. Consideration should be given to scenarios where more traffic uses the bypass. The noise from the bypass could be 2dBA higher than predicted if traffic flows change, in which case at-road noise mitigation might be considered reasonable and feasible.

17.4 Acute Noise Levels

Approximately 4 residences on the existing Hume Highway in Tarcutta would have acute noise levels after construction of the bypass. These residences would be considered for architectural treatment.

17.5 Summary of Reasonable and Feasible Mitigation of Operational Noise

Noise from the bypass would exceed the base criteria at 11 residences in Tarcutta.

The ENMM guidelines for selection of reasonable and feasible noise mitigation require consideration of the total noise at a receiver (that is the sum of noise from all roads) and the increase in noise that would result from a project.

Noise barriers or low noise pavement would only reduce noise from the bypass, and not from the existing Hume Highway.

Consideration of the ENMM guidelines for reasonable and feasible noise mitigation would result in only 7 residences considered for mitigation in Tarcutta. This is based on the road with standard pavement and traffic as given in the traffic report.

Isolated properties would be considered for architectural treatment against noise from the bypass.

Table 17-1 summarises 17 residences where acoustic architectural treatment would be considered for noise mitigation.

Table 17-1 Summary of Residences Considered for Architectural Treatment

Receiver Number in Appendix	Reason
1	Isolated Residence
2	Isolated Residence
3	Isolated Residence
4	Isolated Residence
102	Isolated Residence
103	Isolated Residence
204	Isolated Residence
206	Isolated Residence
50	Combined noise level exceeds guidelines
51	Combined noise level exceeds guidelines
63	Combined noise level exceeds guidelines
64	Combined noise level exceeds guidelines
65	Combined noise level exceeds guidelines
66	Combined noise level exceeds guidelines
68	Combined noise level exceeds guidelines
51	Acute from Hume Highway 2022
67	Acute from Hume Highway 2022
69	Acute from Hume Highway 2022

17.6 Construction Noise Assessment

Noise from construction is predicted to have some impacts, particularly during night time works.

The noise impact of proposed extended hours construction was discussed. It is proposed to commence work at 6.00am (except on Sundays). As the hour from 6.00am to 7.00am is normally considered night time, noise during this hour was assessed against sleep disturbance criteria.

Construction noise is predicted to exceed the criteria, particularly at isolated residences near the route of the project, and township residences west of the existing Hume Highway.

Noise from piling is predicted to exceed the construction noise criteria, particularly at residences closest to the proposed bridges.

Noise from the batch plant would exceed the noise criteria at residences at the northern part of Tarcutta. Exceedances up to 5dBA are predicted during night time operation.

Vibration from construction will meet all criteria for building damage and human comfort.

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