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Transportation Noise Assessment

Vivente Estate, Hammond Park

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Prepared for:
Gold Estates C/- Richard Noble

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1 INTRODUCTION

It is proposed to subdivide land in the vicinity of Barfield Road, Frankland Avenue and Rowley Road in Hammond Park, referred to as Vivente Estate, with some of the subdivision having already commenced – refer *Figure 1-1*. An acoustic assessment for this subdivision was undertaken originally in 2014, with the most recent update completed in 2015 (*Noise Management Plan, Vivente @ Hammond Park*; Reference: 14113024-02a, 19 August 2015). Lloyd George Acoustics has also been working with Qube Property on the development of Apsley Estate, located immediately south of the Vivente subdivision, on the opposite side of Rowley Road. The Apsley work also commenced in 2014, however the main report was updated more recently in 2017, with Addendums to this report in 2019 and 2020. With the Apsley work being undertaken more recently, this current Vivente report has been updated to align with the traffic volumes and model calibration of the Apsley project. The proposed subdivision is shown on *Figure 1-2*.

Figure 1-1 Proposed Subdivision Locality

Figure 1-2 Proposed Subdivision

Appendix B contains a description of some of the terminology used throughout this report.

2 CRITERIA

The criteria relevant to this assessment is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1 Noise Targets for Noise-Sensitive Land-Use

Outdoor Noise Target		Indoor Noise Target	
55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonable drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken.

In the application of the noise targets, the objective is to achieve:

- indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and childcare centres, the design of outdoor areas should take into consideration the noise target.

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

3 METHODOLOGY

Noise modelling has been undertaken in accordance with the requirements of the Policy and associated Guidelines that accompany the Policy.

The computer programme *SoundPLAN 7.3* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered. Note that corrections are applied to the exhaust of –8.0 dB (based on Transportation Noise Reference Book, Paul Nelson, 1987) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;
- An adjustment of –1.7 dB has been applied to the predicted levels based on the findings of An Evaluation of the U.K. DoE Traffic Noise Prediction; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group 1982.

Predictions are made at heights of 1.4 metres above ground floor level and at 1.0 metre from an assumed building façade (resulting in a + 2.5 dB correction due to reflected noise).

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed on the following page.

3.1 Ground Topography, Road Design & Cadastral Data

Lloyd George Acoustics was previously involved in modelling the proposed Rowley Road upgrade in 2005, with the (then) Department of Planning and Infrastructure. The noise model included the existing surrounding topography, which was originally supplied by Maunsell (now AECOM). The ground contours were at 1-metre intervals. Where possible this ground contour information has been supplemented by additional survey data supplied by landowners. Civil Group provided the finished lot levels for the subdivision on 1 September 2020 so that these have been cut into the topography.

The road design information from the original noise model has been revised based on the latest information provided by the Department of Planning in 2014. The road design relates to both the proposed Rowley and Hammond Roads. The noise modelling also includes the existing Kwinana Freeway, and the interchange with Rowley Road, at the eastern extent.

Proposed buildings as part of this development have been included as these can provide barrier attenuation when located between a source and receiver, in much the same way as a hill or wall provides noise shielding. All buildings are assumed to be single storey at a height of 3.5 metres above lot level.

3.2 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown below in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Road Surfaces						
Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The road surfaces assumed in the previous Vivente modelling are described below.

It is assumed that Hammond Road and the ramps connecting Hammond and Rowley Roads will be constructed using dense graded asphalt.

Kwinana Freeway is and will remain open graded asphalt.

Rowley Road is also modelled as open graded asphalt. SPP 5.4 encourages a shared approach to noise mitigation. In this case, the developer will be providing a noise wall and dwellings will incorporate architectural treatments with lot notifications. It is therefore considered reasonable that the road provider incorporates the quietest available road surface (open graded asphalt), given the developer's commitment to noise mitigation and that the land was zoned Urban in the MRS and Development Zone in the TPS, prior to decisions made in respect to the designation of Rowley Road as a freight route.

- Vehicle Speed

  It is assumed that the future posted speed through this section of the Rowley Road upgrade will be 80km/hr.

  Existing and future posted speeds for the Kwinana Freeway were assumed to be 100 km/hr and 80 km/hr for the ramps.

- Traffic Volumes

Traffic volume data was requested from MRWA as part of the Qube Apsley study and these were obtained from Clare Yu (Traffic Modelling Analyst) on 18 April 2017 (Ref: 40486). The information obtained included a 2016 calibration plot (showing the difference between observed counts and modelled counts). No existing count was shown on Rowley Road so this was obtained through the MRWA Reporting Centre. This data is used to assess the accuracy of the MRWA traffic model, with the differences between the observed and modelled then applied to the forecast volumes. The differences between the two are shown in *Table 3-2* and *Table 3-3*.

Table 3-2 2016 Traffic Volume Calibration – Kwinana Freeway

Road	MRWA Model		MRWA Observed		Difference	
	Northbound	Southbound	Northbound	Southbound	Northbound	Southbound
South of Rowley Road	39,200	41,200	47,500	49,700	-8,300	-8,500
Through Interchange	37,400	39,600	44,100	43,800	-6,700	-4,200
Off Ramp	4,100	-	2,300	-	+1,800	-
On Ramp	1,700	-	3,400	-	-1,700	-

Table 3-3 2016 Traffic Volume Calibration – Rowley Road

Section	MRWA Model		MRWA Observed		Difference	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
West of Kwinana Freeway	5,800	3,300	3,865	4,143	+1,935	-843

In the above tables, a positive value indicates the model is over-predicting and a negative value the model is under-predicting.

Generally the model appears to be under-predicting. The determined differences have been applied to the 2031 volumes provided as shown in *Table 3-4* and *Table 3-5*. Also shown in brackets are the percentage heavy vehicles.

Table 3-4 2031 Traffic Volume Calibration – Kwinana Freeway

Road	MRWA Model		Difference		2031 Calibrated	
	Northbound	Southbound	Northbound	Southbound	Northbound	Southbound
South of Rowley Road	65,400	63,000	-8,300	-8,500	73,700 (9%)	71,500 (9%)
Through Interchange	62,700	60,900	-6,700	-4,200	69,400 (10%)	65,100 (10%)
Off Ramp	2,700		+1,800	-	900 (3%)	-
On Ramp	10,300		-1,700	-	12,000 (21%)	-

Table 3-5 2031 Traffic Volume Calibration – Rowley Road

Section	MRWA Model		Difference		2031 Calibrated	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
West of Kwinana Freeway	14,500	12,100	+1,935	-843	12,565 (19%)	12,943 (22%)
West of Frankland Avenue[1]	5,300	6,200	+1,935	-843	3,365 (35%)	7,043 (30%)

1. The same difference has been applied to this section of road.

The CoRTN algorithms calculate an $L_{A10,\ 18hour}$ noise level and therefore require the input of 18-hour traffic volumes. The 18-hour traffic volumes (6:00am to midnight) were assumed to be 90% of the 24-hour volumes for Rowley Road and 94% for the Kwinana Freeway.

3.3 Ground Attenuation

Ground absorption values vary from 0 to 1, with 0 representing hard, reflective surfaces such as water or bitumen and 1 representing absorptive surfaces such as grass. The ground attenuation has been assumed to be 0.2 (20%) within the road reserve, and 0.6 (60%) elsewhere across the study area, except for public open space, which was set to 1.00 (100%).

3.4 Parameter Conversion

The CoRTN algorithms used in the *SoundPLAN* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. However, the WAPC Policy uses the parameters $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ (refer *Table 2.1*). Therefore an adjustment needs to be made to the predicted $L_{A10,18hour}$ noise level to enable the noise modelling results to be compared to the allowable $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ traffic noise criteria. The relationship between these parameters varies depending on the composition of traffic on the road (the volumes during each time period and the percentage of heavy vehicles).

For this assessment, the parameter conversion for Rowley Road was based on the results of actual noise measurements taken along Great Northern Highway between Reid/Roe Highway and West Swan Road, deemed to be a road similar in composition to the future Rowley Road. Note that the existing Rowley Road traffic is not considered representative of that in the future and therefore site noise measurements were not undertaken. An extract from the Great Northern Highway study is shown below, showing the $L_{Aeq(Day)}$ level is likely to be 2.8 dB less than the $L_{A10,18hour}$ value and the $L_{Aeq(Night)}$ level is likely to be 8.2 dB less than the $L_{A10,18hour}$ value. This results in the $L_{Aeq(Night)}$ being 5.4 dB less than the $L_{Aeq(Day)}$, so that the day parameter is slightly more critical, but only marginally.

Location	$L_{A10,18hour} - L_{Aeq,16hour}$	$L_{A10,18hour} - L_{Aeq,8hour}$	$L_{Aeq,16hour} - L_{Aeq,8hour}$
Lennard Road to Padbury Avenue			
706 GNH	3.1	9.1	6.0
758 GNH	2.6	8.2	5.6
822 GNH	3.3	9.2	5.9
899 GNH	1.9	7.3	5.4
Average	**2.7**	**8.5**	**5.7**
Padbury Avenue to Maisie Street			
934 GNH	2.9	8.1	5.2
998 GNH	2.5	8.1	5.5
1011 GNH	2.7	8.0	5.5
Average	**2.7**	**8.2**	**5.4**
Maisie Street to Haddrill Road			
1085 GNH	3.0	7.7	4.7
Average	**3.0**	**7.7**	**4.7**
Haddrill Road to West Swan Road			
1118 GNH	3.2	8.8	5.4
1247 GNH	2.7	7.2	4.5
Average	**3.0**	**8.0**	**5.0**

Figure 3-1 Extract from Great Northern Highway Study

As part of the Qube Apsley study, data from the Satterley land to the east, ATP Consulting Engineers undertook noise measurements on their site (*Road & Railway Noise Assessment, Mandogalup East Local Structure Plan, Mandogalup*; ATP140414-R-TNIA-04, November 2016). An extract from this report is shown below, resulting in the $L_{Aeq(Day)}$ being 1 dB less than the $L_{A10,18hour}$ and the $L_{Aeq(Night)}$ being 7 dB less than the $L_{Aeq(Day)}$. Hence, the $L_{Aeq(Day)}$ will again be the critical parameter to determine compliance.

Date	$L_{A10(18\text{-}hour)}$* dB(A)	$L_{Aeq(16\text{-}hour)}$* dB(A)	$L_{Aeq(8\text{-}hour)}$* dB(A)
8 July 2013 (Monday)	63	62	56
9 July 2013 (Tuesday)	64	63	55
10 July 2013 (Wednesday)	63	62	55
11 July 2013 (Thursday)	63	62	54
12 July 2013 (Friday)	63	61	55
Average	**63**	**62**	**55**

**Free-field*

Figure 3-2 Extract from ATP Report (Kwinana Freeway)

The measured differences have been applied to each road, with only the $L_{Aeq(Day)}$ parameter reported throughout, given this is expected to be more critical for compliance.

4 RESULTS

The results of the noise modelling for the ultimate scenario are provided in *Figure 4-1*. This modelling incorporates:

- Forecast 2031 traffic volumes, assuming the Rowley Road extension would have been constructed prior to this year;
- A continuous 3-metre high noise wall on the southern boundary of Vivente Estate;
- Open graded asphalt road surface to Rowley Road and Kwinana Freeway and dense graded asphalt road surface to Hammond Road and all on/off ramps.

The modelling provided in *Figure 4-1* indicates noise levels to some dwellings will be above the outdoor noise target and therefore architectural packages to these dwellings and notifications on title are to be incorporated.

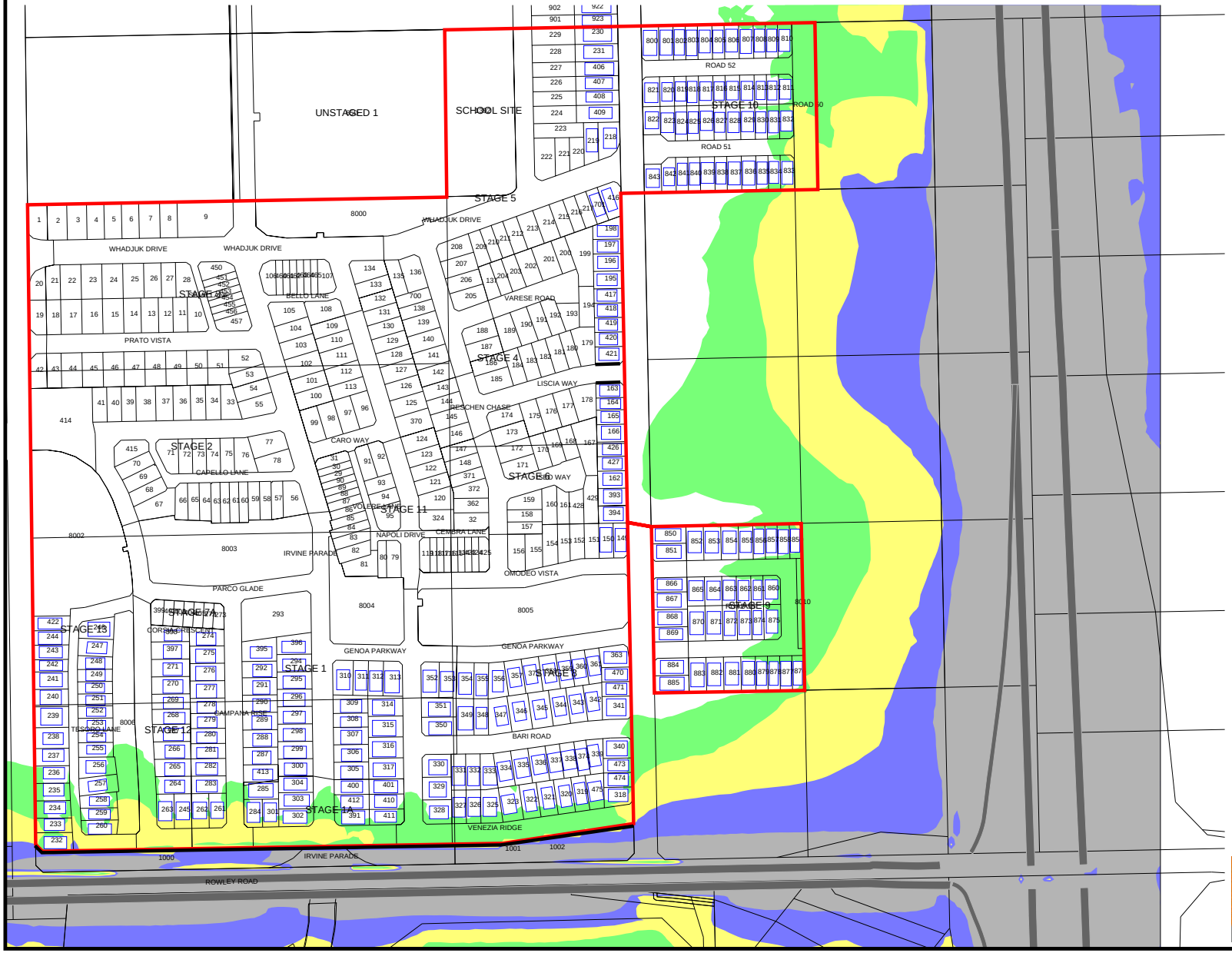
As discussed in *Section 3.1*, an interim access to the subdivision will be permitted at the road labelled Road 25 in *Figure 1-1*. This means there will be a period of time where the proposed noise wall will not be continuous. Based on the same assumptions above, *Figure 4-2* provides the noise level contours, allowing for a gap in the noise wall.

Figure 4-1

Vivente Subdivision: Ultimate Scenario

LAeq(Day) Noise Level Contours - Future

Includes 3m High Noise Wall Along Rowley Road



Noise levels $L_{Aeq(day)}$ dB

<= 55		
<= 56		Exposure A
<= 57		
<= 58		
<= 59		Exposure B
<= 60		
<= 61		
<= 62		
<= 63		Exposure C
<= 64		
<= 65		
<= 66		
> 66		Exposure D+

N

Signs and symbols

- Road Lanes
- Building
- Subject Site
- 3m High Noise Wall

2 Sep 2020

Length Scale 1:5000

0 25 50 100 150 200 m

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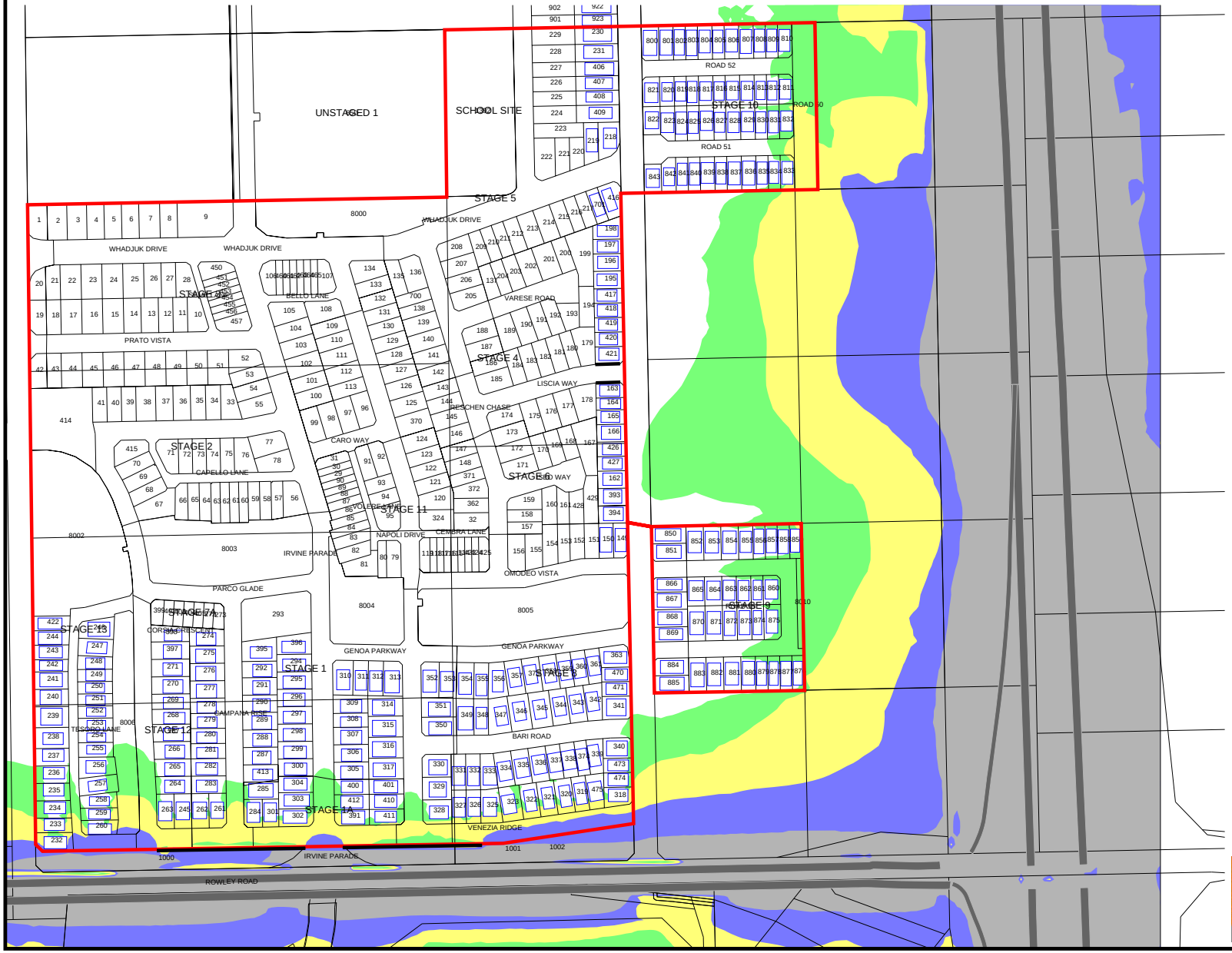
Figure 4-2

Vivente Subdivision: Ultimate Scenario

LAeq(Day) Noise Level Contours - Future

Includes 3m High Noise Wall Along Rowley Road



Noise levels $L_{Aeq(day)}$ dB

<=	55	
<=	56	Exposure A
<=	57	
<=	58	
<=	59	Exposure B
<=	60	
<=	61	
<=	62	
<=	63	Exposure C
<=	64	
<=	65	
<=	66	
>	66	Exposure D+

N

Signs and symbols

- Road Lanes
- Building
- Subject Site
- 3m High Noise Wall

2 Sep 2020

Length Scale 1:5000

0 25 50 100 150 200 m

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5 ASSESSMENT

The objectives of SPP 5.4 are to achieve:

- indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

Where the outdoor noise targets of *Table 2-1* are achieved, no further controls are necessary.

With reference to the predicted noise levels in *Section 4*, it is evident the outdoor noise target will be exceeded. As such, the following is recommended:

- Road provider to incorporate open graded asphalt road surface to Rowley Road (or acoustic equivalent).
- Developer to construct a 3-metre high noise wall along the southern boundary of the estate. Noise wall is to be constructed of a material having a minimum surface mass of 15kg/m^2.
- Lots where noise levels are above 55 dB $L_{Aeq(Day)}$ (refer *Figure 4-1*) are to incorporate Quiet House A architectural treatments (refer *Appendix A*). Alternative constructions may be acceptable if supported by a report undertaken by a suitably qualified acoustical consultant, once the lots specific building plans are available.
- Lots where noise levels are above 55 dB $L_{Aeq(Day)}$ are to incorporate notifications on lot titles, with suggested wording as follows:
    - *Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise from Rowley Road. Quiet House design strategies at potential cost to the owner are required to achieve satisfactory internal noise levels.*
    - *Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise from Kwinana Freeway. Quiet House design strategies at potential cost to the owner are required to achieve satisfactory internal noise levels.*
    - *Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise from Rowley Road and Kwinana Freeway. Quiet House design strategies at potential cost to the owner are required to achieve satisfactory internal noise levels.*
- Refer *Figure 5-1* showing affected lots and notification requirements.
- Where a lot is noise affected and double storey construction is proposed, a specific assessment on that dwelling is required and to be undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants).

With the gap in the noise wall (refer *Figure 4-2*), allowing for interim access to the subdivision, there is potential for an increase in noise level, however those closest houses to the opening still remain within Package A. The two lots immediately behind the front row closest to the gap (300 & 305) may also be above the outdoor noise target under this scenario, whereas they did not for the continuous wall. The modelling with the gap in the wall is for 2031 traffic volumes on the upgraded Rowley Road and therefore may never occur in reality, as there is no timeframe for the Rowley Road upgrade. That is, the estate may be developed and sold and therefore the wall closed off, before Rowley Road is upgraded or traffic volumes reach those assumed in the modelling. As such, no architectural upgrades are recommended for dwellings on these lots, however the following notification is suggested:

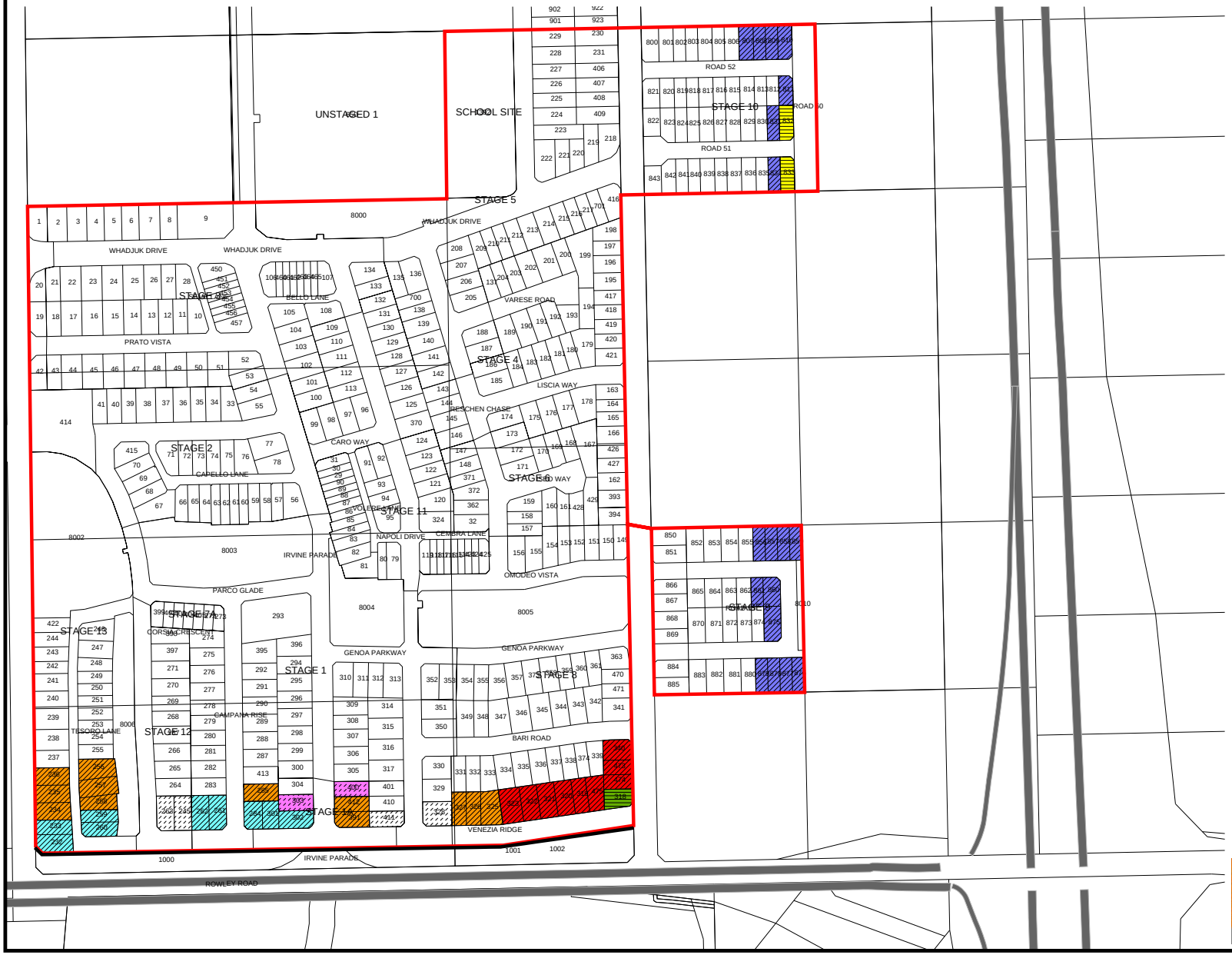
- *Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise from Rowley Road until such time that the interim access is removed and the estate wall closed off.*

Figure 5-1

Vivente Subdivision: Ultimate Scenario

LAeq(Day) Noise Level Contours - Future

Includes 3m High Noise Wall Along Rowley Road



Signs and symbols

- Road Lanes
- Subject Site
- 3m High Noise Wall
- Package A (Kwinana Fwy)
- Package A (Rowley Rd)
- Package A (Both Roads)
- Package B (Kwinana Fwy)
- Package B (Rowley Rd)
- Package B (Both Roads)
- Interim Notification
- Previously Sold

2 Sep 2020

Length Scale 1:5000

0 25 50 100 150 200 m

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Appendix A

Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

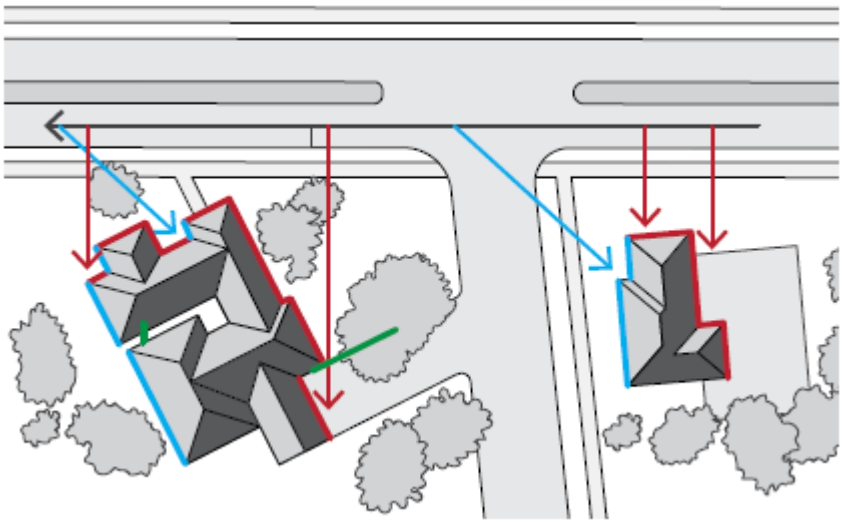
The quiet house packages are not the only solution to achieving acceptable internal transport noise levels. A suitably qualified acoustical engineer or consultant may also determine more tailored acoustic design requirements for buildings in a transport noise corridor by carrying out acoustic design in accordance with relevant industry standards. This includes the need to meet the relevant design targets specified in AS/NZS 2107:2016 for road traffic noise.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A – Affected by One Road

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): o Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): o Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: o 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; o Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: o Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or o Single leaf of 150mm brick masonry with 13mm cement render on each face; or o One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	

Quiet House Package A – Affected by Two Roads

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing Kwinana Freeway/Rowley Road	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): o Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): o Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On to Kwinana Freeway/Rowley Road	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
External Doors	Facing Kwinana Freeway/Rowley Road	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: o 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; o Glazed sliding door with 10mm glass and weather seals.
	Side On to Kwinana Freeway/Rowley Road	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
External Walls	All	• $R_w + C_{tr} \geq 45$: o Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or o Single leaf of 150mm brick masonry with 13mm cement render on each face; or o One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	

Quiet House Package B – Affected by One Road

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): o Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): o Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: o 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; o Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: o Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m^3). Resilient ties used where required to connect leaves. o Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). o Single leaf of 220mm brick masonry with 13mm cement render on each face. o 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. o Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	

Quiet House Package B – Affected by Two Roads

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing Kwinana Freeway/Rowley Road	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): o Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): o Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On to Kwinana Freeway/Rowley Road	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
External Doors	Facing Kwinana Freeway/Rowley Road	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: o 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; o Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On to Kwinana Freeway/Rowley Road	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: o Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m^3). Resilient ties used where required to connect leaves. o Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). o Single leaf of 220mm brick masonry with 13mm cement render on each face. o 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. o Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1
An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}
An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}
An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}
The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$
The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

Noise-sensitive land use and/or development
Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

About the Term 'Reasonable'

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

About the Term 'Practicable'

'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

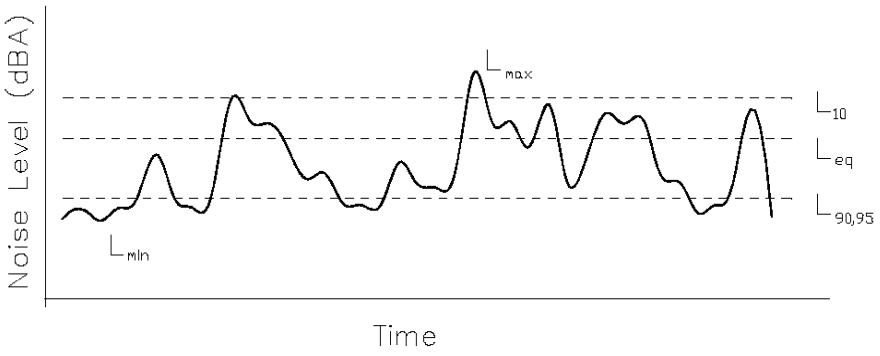
R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

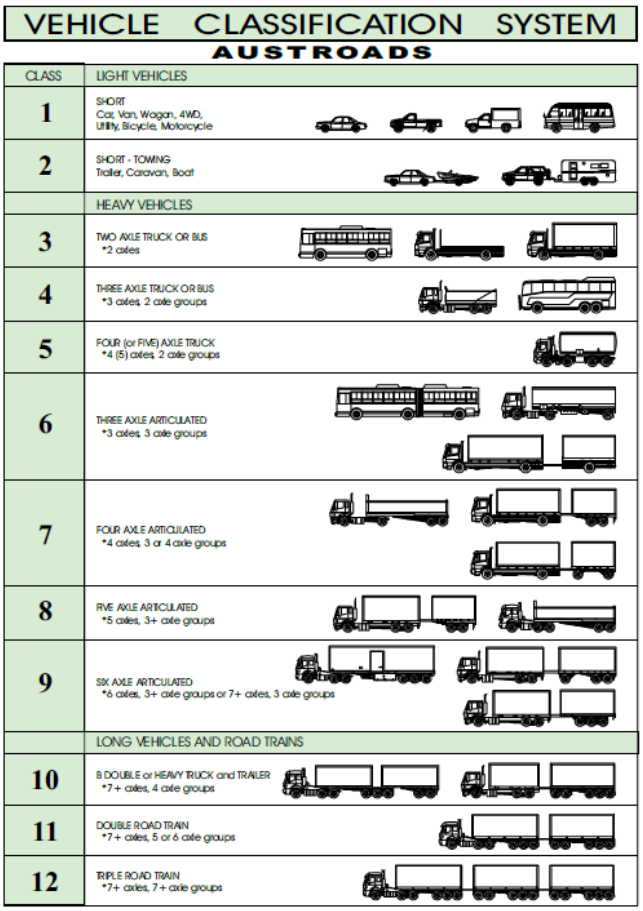
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

Chart of Noise Level Descriptors



Austroads Vehicle Class



Typical Noise Levels