Appendix 6

Transportation Noise Assessment

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Transportation Noise Assessment

East of Beach Central Precinct
Lot 6 Taronga Place, Eglinton

Reference: 18074545-01

Prepared for:
Urban Quarter

Report: 18074545-01

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1 INTRODUCTION

This report has been prepared to support the proposed amendment to the Alkimos Eglinton District Structure Plan. The amendment proposes the modification of the central precinct from service commercial (as it is currently shown in the AEDSP) to urban. Given the site is bound by a railway reserve to support the future Yanchep Railway and a primary regional reserve to support the Mitchell Freeway, an assessment of the noise impacts on residential development has been undertaken. The level of detail is similar to that of a local structure plan to provide greater certainty for the proposed use.

The results of the assessment are compared against the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* and recommendations are provided on noise mitigation requirements under this policy. Further refinement of this work will be undertaken as part of a future local structure planning for the Central Precinct. The purpose of this work is to demonstrate that transport noise impacts can be managed in accordance with policy should residential development be progressed within this landholding.

For a general locality map, refer to *Figure 1-1* and an indicative subdivision layout for the purpose of the assessment is shown in *Figure 1-2*.

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

Figure 1-1 Project Locality

Figure 1-2 Subdivision Layout

2 CRITERIA

The criteria relevant to this assessment is the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as the Policy) produced by the Western Australian Planning Commission (WAPC). The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals; and
- Facilitate the strategic co-location of freight handling facilities.

The Policy's outdoor noise criteria are shown below in *Table 2-1*. These criteria apply at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

Note: The 5 dB difference between the target and limit is referred to as the margin.

In the application of these outdoor noise criteria to new noise sensitive developments, the objectives of this Policy is to achieve -

- acceptable indoor noise levels in noise-sensitive areas (e.g. bedrooms and living rooms of houses); and
- a 'reasonable' degree of acoustic amenity in at least one outdoor living area on each residential lot.

If a noise sensitive development takes place in an area where outdoor noise levels will meet the *target*, no further measures are required under this policy.

In areas where the *target* is exceeded, but noise levels are likely to be within the 5 dB margin (i.e. less than the *limit*), mitigation measures should be implemented by the developer with a view to achieving the *target* levels in at least one outdoor living area on each residential lot. Where indoor spaces are planned to be facing any outdoor area in the *margin*, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces.

In areas where the *limit* is exceeded (i.e. above $L_{Aeq(Day)}$ of 60dB(A) or $L_{Aeq(Night)}$ of 55dB(A)), a detailed noise assessment is to be undertaken. Customised noise mitigation measures should be implemented with a view to achieving the *target* in at least one outdoor living area on each residential lot, or if this is not practicable, within the *margin*. Where indoor spaces are planned to be facing outdoor areas that are above the *target*, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces.

3 METHODOLOGY

As this is a green-field site in that neither the railway nor the freeway have been constructed, measurements of the existing noise levels are not required. Therefore this assessment is based only on computer modelling.

The computer programme *SoundPLAN 8.0* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms for the road traffic noise and the Nordic Rail Prediction Method (Kilde Rep. 130) algorithm for rail noise. These algorithms have been modified to reflect local conditions and include:

- 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.

- The Nordic Rail Prediction Method (Kilde Rep. 130) algorithm is for generic train types in Europe and requires modification to align with measured noise levels of passenger trains operating in the Perth region.

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

Various input data are included in the modelling such as ground topography, road and railway design, traffic volumes and speeds and rail movements and speeds. These model inputs are discussed below.

3.1.1 Ground Topography

Topographical data was provided by Cossill & Webley.

Buildings have also 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 have a height of 4.0 metres.

3.1.2 Road Traffic Data

Traffic data includes:

- Road Surface – The future road surface is assumed to be open graded asphalt. The noise relationship between the various road surfaces is provided in *Table 3-1*. As a guide, 14 mm chip seal would be the noisiest surface and open-graded asphalt the quietest.

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	-1.0 dB	-2.5 dB

- Vehicle Speed – The future posted speed is assumed to be 100km/h.

- The future traffic volumes were provided by GTA Consultants and are assumed to be 72,110 vehicles per day with 12% heavy vehicles. The 18-hour traffic volumes, required for the CoRTN calculations, are assumed to be 94% of the daily volumes.

- The CoRTN algorithms used in the SoundPLAN modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The Policy however uses $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles). The SoundPLAN model converts these parameters based on the findings from the technical paper Converting the UK Traffic Noise Index $L_{A10,18h}$ to EU Noise Indices for Noise Mapping; TRL Limited. The results are also compared against the measured data for consistency.

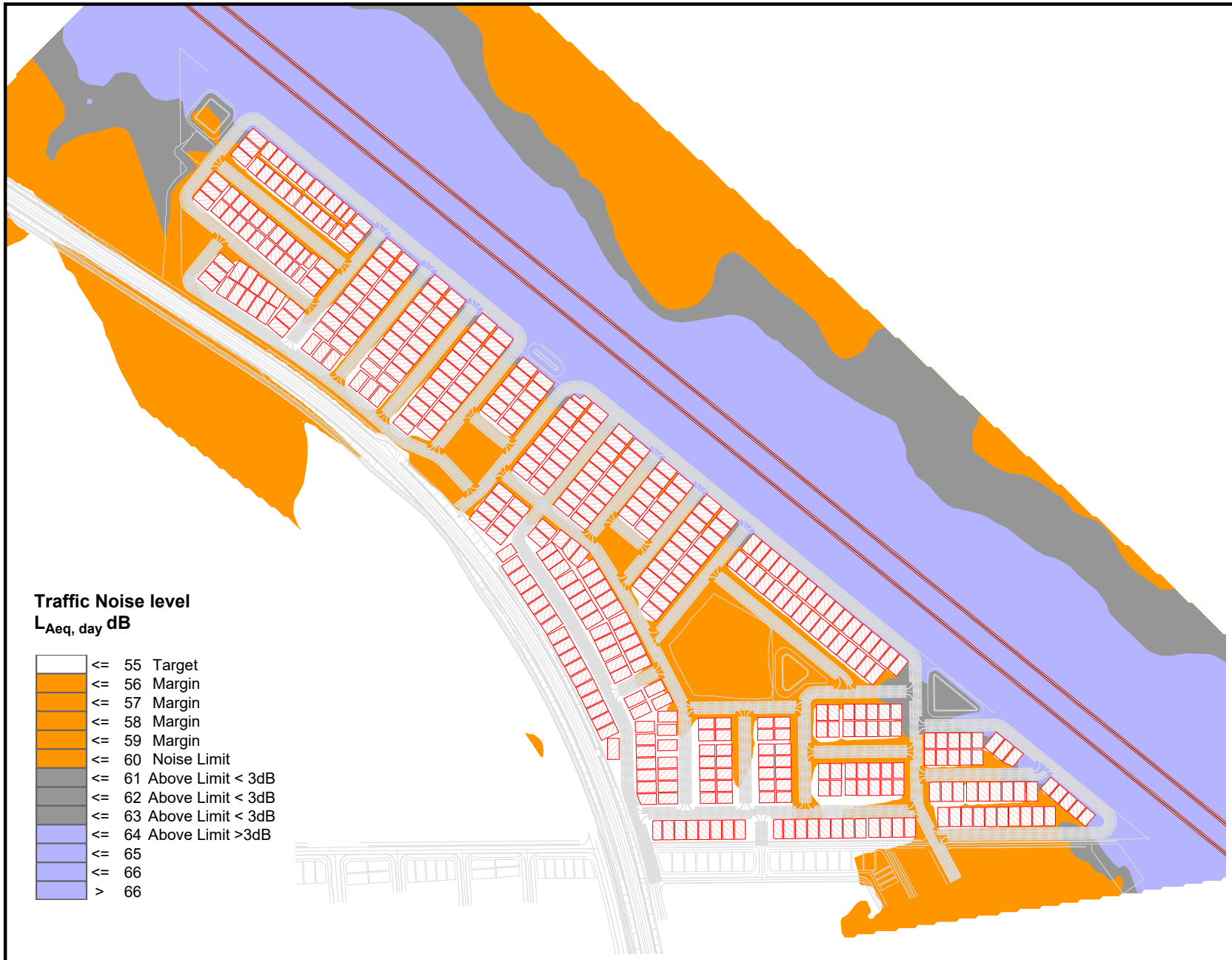
3.1.3 Railway Data

- The railway data was provided by the PTA and assumes 75 train movements in each direction using 6-car sets. Train speed adjacent to the proposed development is assumed to be 130 km/h.

4 RESULTS

The results of the assessment for road and rail noise are presented in *Figures 4-1 and 4-2*. Assessments undertaken for other developments in the area has shown that it is the daytime traffic noise that would be dominant in terms of compliance with the Policy, so only these results are shown.

Figure 4-1



Traffic Noise level
$L_{Aeq,\ day}$ dB

<= 55	Target
<= 56	Margin
<= 57	Margin
<= 58	Margin
<= 59	Margin
<= 60	Noise Limit
<= 61	Above Limit < 3dB
<= 62	Above Limit < 3dB
<= 63	Above Limit < 3dB
<= 64	Above Limit >3dB
<= 65	
<= 66	
> 66	

Signs and symbols

Buildings

Road

N

Length Scale

0 35 70 140 210 280 m

Proposed Residential Development - Lot 6 Taronga Place, Eglinton - Central Precinct

$L_{Aeq,Day}$ Noise Level Contours - RoadTraffic Noise - Ground Floor

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Figure 4-2

Traffic Noise level
$L_{Aeq,\ day}$ dB

<=	55	Target
<=	56	Margin
<=	57	Margin
<=	58	Margin
<=	59	Margin
<=	60	Noise Limit
<=	61	Above Limit < 3dB
<=	62	Above Limit < 3dB
<=	63	Above Limit < 3dB
<=	64	Above Limit >3dB
<=	65	
<=	66	
>	66	

Signs and symbols

Buildings

Emission line

N

Length Scale

0 35 70 140 210 280 m

Proposed Residential Development - Lot 6 Taronga Place, Eglinton - Central Precinct

$L_{Aeq,Day}$ Noise Level Contours - Railway Noise - Ground Floor

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5 ASSESSMENT

The objectives of the Policy are for noise at all houses to be no more than the *limit* and preferably no more than the *target*. Where the *target* is achieved, no further controls are required. Where the noise levels exceed the *target,* noise control is to be incorporated into the design.

From *Figures 4-1 and 4-2*, it can be seen that assuming no noise mitigation measures, there are a number of lots predicted to receive a future transportation noise level that will be above the *target* criteria. Therefore noise mitigation measures must be considered in the development design.

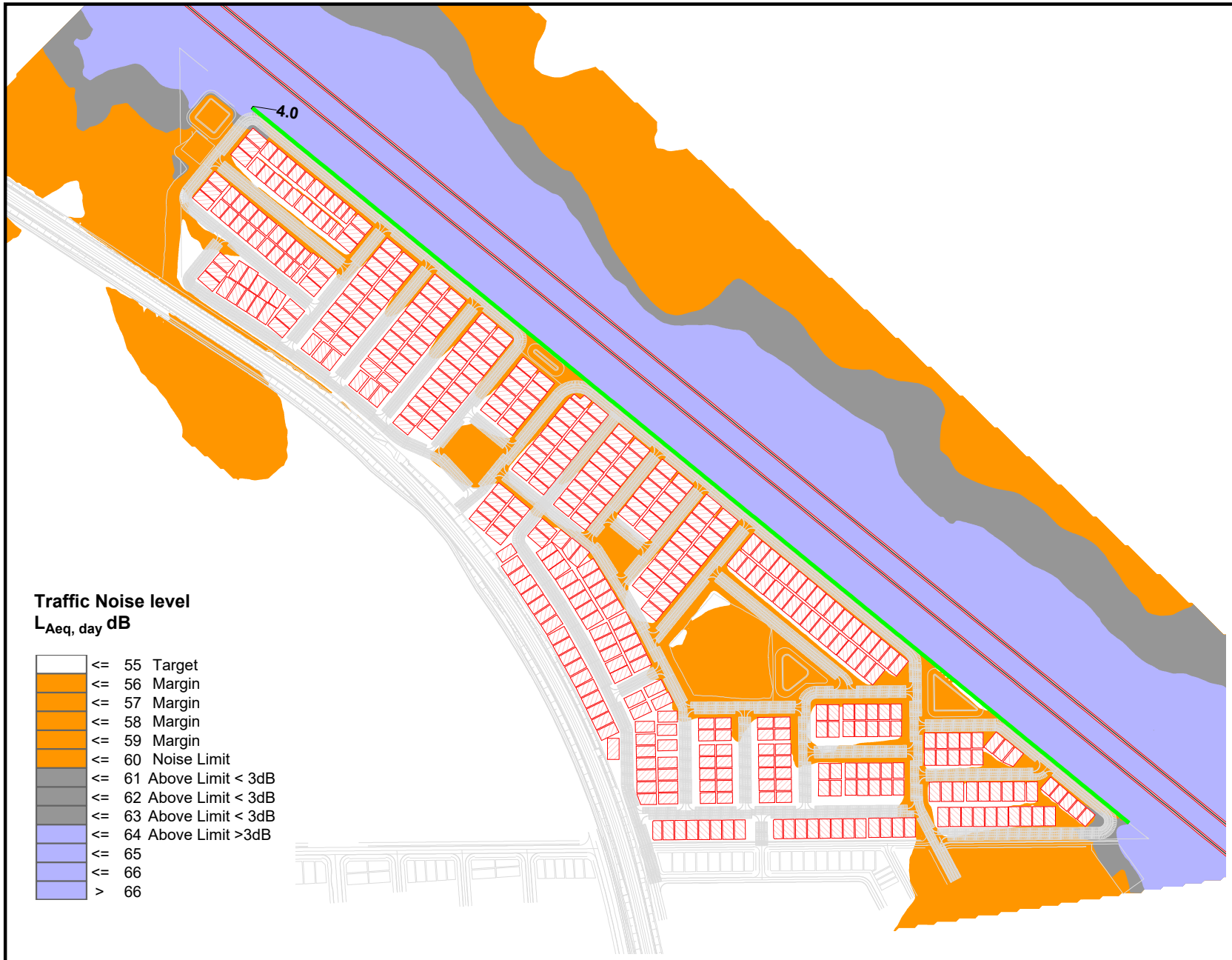
Where noise mitigation measure do not result in the traffic noise being reduced to below the *target* level, noise impacts would also need to be addressed using facade protection. The Policy provides "deemed to comply" facade packages (Package A, B and C) where traffic noise is above the *target* but not more than 5 dB above the *limit*. These facade packages are provided at *Appendix A.* Noise levels that are more than 5 dB above the *limit* would require specialist acoustic advice. In addition, the Policy also states that "Customised noise mitigation measures should be implemented with a view to achieving the noise *target* in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin.

To mitigate the traffic noise we recommend constructing noise barriers on the property boundary. This would result in future traffic noise levels at ground floor to be below the *limit* at all lots. The material used for the barrier would require a surface density of at least 15 kg/m^2 and be free of gaps.

The predicted noise levels at ground floor level, together with the location and height of the proposed noise barriers are provided in *Figures 5-1 and 5-2*. This barrier design would be considered preliminary only.

It can be seen from *Figures 5-1 and 5-2* that with the proposed barriers, the predicted traffic noise level is still above the *target* (within the margin) for the majority of the proposed subdivision, which is shown by the lots falling within the orange noise contour. Therefore, facade protection (Package A) and notification on property titles would also be required. The actual extent of these measures would depend upon a number of factors including the final lot levels, noise wall heights and the design of the freeway and railway.

Figure 5-1



Traffic Noise level
$L_{Aeq,\ day}$ dB

<=	55	Target
<=	56	Margin
<=	57	Margin
<=	58	Margin
<=	59	Margin
<=	60	Noise Limit
<=	61	Above Limit < 3dB
<=	62	Above Limit < 3dB
<=	63	Above Limit < 3dB
<=	64	Above Limit >3dB
<=	65	
<=	66	
>	66	

Signs and symbols

- Buildings
- Road
- Wall

N

Length Scale

0 35 70 140 210 280 m

Proposed Residential Development - Lot 6 Taronga Place, Eglinton - Central Precinct

$L_{Aeq,Day}$ Noise Level Contours - RoadTraffic Noise - Ground Floor - With Mitigation

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Figure 5-2

Traffic Noise level
$L_{Aeq,\ day}$ dB

<= 55	Target
<= 56	Margin
<= 57	Margin
<= 58	Margin
<= 59	Margin
<= 60	Noise Limit
<= 61	Above Limit < 3dB
<= 62	Above Limit < 3dB
<= 63	Above Limit < 3dB
<= 64	Above Limit >3dB
<= 65	
<= 66	
> 66	

Signs and symbols

- Buildings
- Emission line
- Wall

N

Length Scale

0 35 70 140 210 280 m

Proposed Residential Development - Lot 6 Taronga Place, Eglinton - Central Precinct

$L_{Aeq,Day}$ Noise Level Contours - Railway Noise - Ground Floor - With Mitigation

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6 CONCLUSION

The results of this assessment show that assuming no noise control measures, there are a number of lots predicted to receive a future transportation noise level that will be above the Policy *target* criteria. Therefore under the requirements of the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* the following noise mitigation measures would be required as detailed in *Section 5* of this assessment.

- Implement noise mitigation as shown in *Section 5*. Noise walls are to be solid, free of gaps and of a material having a minimum surface mass of 15kg/m^2;
- All affected lots are to have notifications on lot titles as per the Policy requirements – refer *Appendix A*.
- All affected lots are to provide one outdoor entertaining area where noise levels are below the *limit*.

Appendix A

Deemed to Comply Facade Packages

The packages and information provided on the following pages are taken from *Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise and freight Considerations in Land Use Planning*; December 2014.

Where outdoor noise levels are above the ***target*** level, excluding the effect of any boundary fences, the Guidelines propose acceptable treatment packages that may be implemented without requiring detailed review. The packages are also intended for residential development only. At higher noise levels or for other building usages, specialist acoustic advice will be needed.

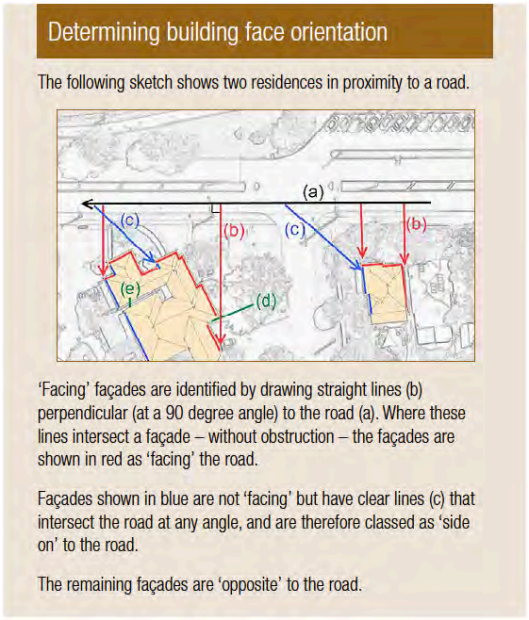
The acceptable treatment packages are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development in lieu of a detailed assessment.

Transition between each package should be made on the basis of the highest incident $L_{Aeq(Day)}$ or $L_{Aeq(Night)}$ value to the nearest whole number determined for the building development under assessment.

Any departures from the acceptable treatment specifications need to be supported by professional advice from a competent person that the proposal will achieve the requirements of the Policy.

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

- **Facing** the transport corridor: Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor: Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor: Neither 'side on' nor 'facing', as defined above.



Package A

Area	Orientation to Road or Rail Corridor	Package A (up to 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	No requirements
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Side	• Windows and external door systems: As above.
	Opposite	No requirements
General	Any	• Walls (minimum $R_w + C_{tr}$ 45) – Two leaves of 90mm thick brick with minimum 50mm cavity • Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Boundary wall to be minimum 2m high; or • Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package B

Area	Orientation to Road or Rail Corridor	Package B (up to 63 dB $L_{Aeq(Day)}$ and 58 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 25) – 4mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Alternatively, 6mm thick glass (monolithic, toughened or laminated) in sliding frame.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Opposite	No requirements
General	Any	• Walls (minimum $R_w + C_{tr}$ 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 50mm thick insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Boundary wall to be minimum 2.4m high; or • Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package C

Area	Orientation to Road or Rail Corridor	Package C (up to 65 dB $L_{Aeq(Day)}$ and 60 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 20% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: • Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
General	Any	• Walls (minimum $R_w + C_{tr}$ 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 50mm thick insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum $R_w + C_{tr}$ 40) – Standard roof construction with 2 x 10mm plasterboard ceiling and minimum R3.0 insulation between ceiling joists. • Eaves to be closed using 6mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Mechanical Ventilation requirements

It is noted that natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the National Construction Code. Where the noise *limit* is likely to be exceeded, a mechanical ventilation system is usually required. Mechanical ventilation systems will need to comply with AS 1668.2 – *The use of mechanical ventilation and air-conditioning in buildings*.

In implementing the acceptable treatment packages, the following must be observed:

- Evaporative air conditioning systems will meet the requirements for Packages A and B provided attenuated air vents are provided in the ceiling space and designed so that windows do not need to be opened.
- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings (e.g. air inlets, vents) need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notification

Notifications on certificates of title and advice to prospective purchasers warning of the potential for noise impacts from major transport corridors help with managing expectations.

The area of land for which notification is required should be identified in the noise management plan and contain a description of major noise sources nearby (e.g. 24-hour freight rail).

Notification should be provided to prospective purchasers, and required as a condition of subdivision (including strata subdivision) for the purposes of noise sensitive development or planning approval involving noise sensitive development, where external noise levels are forecast or estimated to exceed the 'target' criteria as defined by the Policy.

In the case of subdivision and development, conditions of approval should include a requirement for registration of a notice on title, which is provided for under Section 165 of the Planning and Development Act 2005 and Section 70A of the Transfer of Land Act 1893. An example of a suitable notice is:

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. Transportation noise controls and Quiet House design strategies at potential cost to the owner may be required to achieve an acceptable level of noise reduction. Further information is available on request from the relevant local government offices.

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).

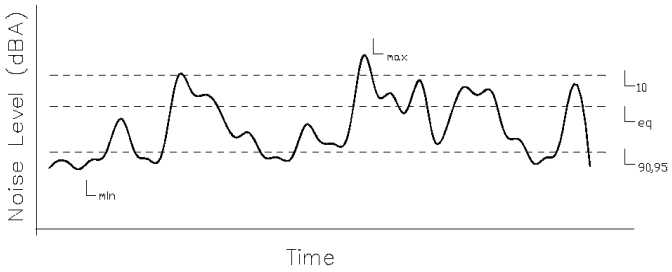
$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
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 $L_{A10,18hour}$.

Satisfactory Design Sound Level
The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level
The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class

AUSTROADS Vehicle Classification System

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups Axles	Groups	Level 3 Vehicle Type Typical Description	AUSTROADS Classification Class	Parameters	Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) ≤ 3.2m and axles = 2	
	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 d(1) > 2.1m, d(1) ≤ 3.2m, d(2) ≤ 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
Medium 5.5m to 14.5m	2	2	**Two Axle Truck or Bus**	3	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) ≤ 2.1m or d(1) + 2.1m or d(1) > 3.2m axles = 4 and groups = 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) ≤ 2.1m or d(1) + 2.1m or d(1) > 3.2m axles = 5 and groups = 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles = 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart. Groups: Number of axle groups. Axles: Number of axles (maximum axle spacing of 10.0m). d(1): Distance between first and second axle. d(2): Distance between second and third axle.

Typical Noise Levels