ATTACHMENT 6

Addendum to Economic Assessment

of Amendment 3

10 September 2014

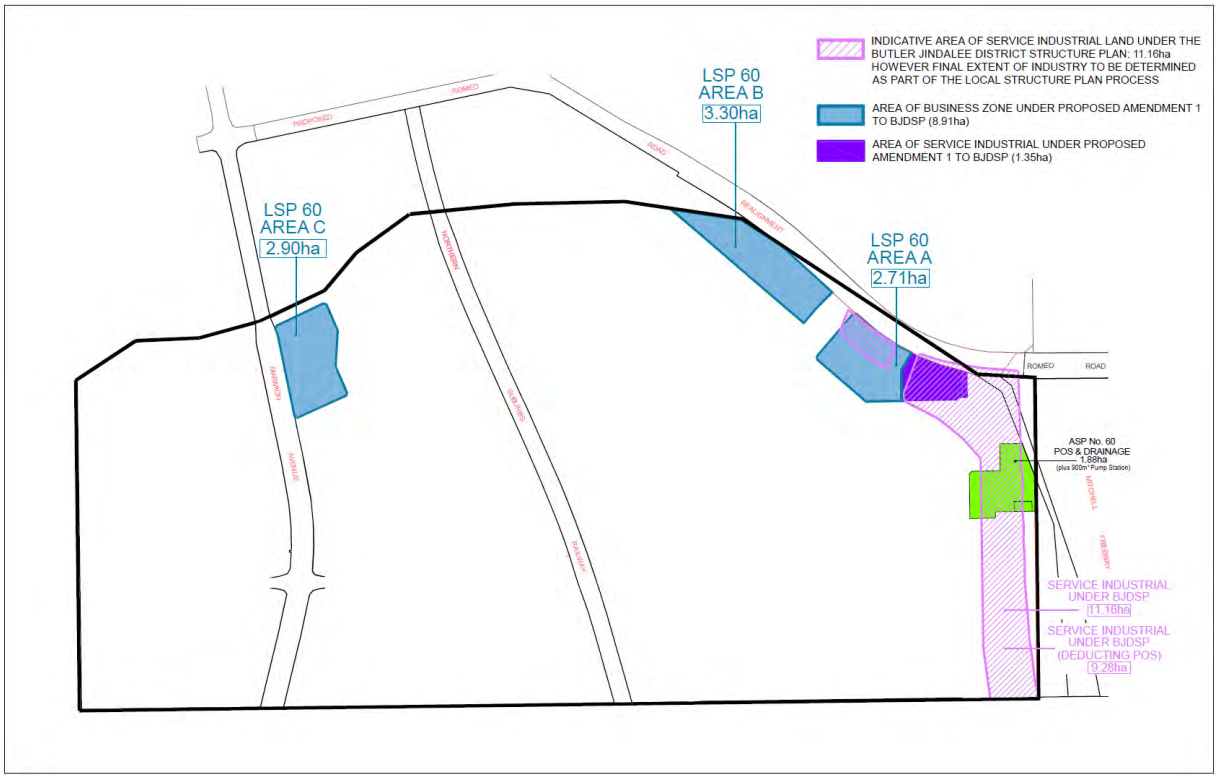
Mr. Alf Lay
Senior Project Manager - Trinity
LWP Property Group
34 Main Street
ELLENBROOK WA 6069

Dear Alf,

Addendum to Urbis' *Employment Assessment of Amendment 1 to the Butler Jindalee District Structure Plan* (July 2014)

On Thursday 4 September 2014, Gray & Lewis Land Use Planners instructed Urbis, on your behalf, to prepare an addendum to the above consultancy. We understand that the Department of Planning requires some Service Industrial to be retained on Lots 1001 and 1002, permitting uses convenient to local residents (such as mechanical repairers). The revised plan is shown below.

FIGURE 1 – PROPOSED AMENDMENT 1 DISTRICT STRUCTURE PLAN



Prepared by: Gray & Lewis Land Use Planners

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COMMENTARY

In terms of our methodology this does not have a large effect on the forecast employment or the employment self-sufficiency. We had allowed for an employment density of 102 sqm per person for the service industrial land use provided for under the original Butler-Jindalee District Structure Plan (BJDSP). In our report on Amendment 1 we applied an employment density of one person per 70 sqm. Based on the land use being focused on bulky good retail and serviced commercial users. Based on the revised land uses we have applied the employment density of one person per 102 sqm for the 1.35 ha of serviced industrial land and one person per 70 sqm for the 8.91 ha of business zone which would attract the bulky good retail and serviced commercial users.

EMPLOYMENT FIGURES

The revised employment forecasts are shown in the table below. The only change from our July report is that the employment use for Service Industry / Commercial / Bulky Goods / Showroom falls from 734 to 703 people.

Job Impacts Of Original BJDSP Compared With Amendment One

TABLE 1

	Jobs	
Employment Use	**Original BJ DSP**	**Amendment 1 BJDSP**
Service Industry / Commercial / Bulky Goods / Showroom	455	703
Retail	205	205
Primary Schools	100	70
High School	35	62
Child Care	44	44
Gymnasium	11	11
Commercial Office	100	100
Weekend Markets	5	5
Home-Based	371	352
Total Jobs	**1,327**	**1,552**
Net Difference		**225**

Source: PLUES, Urbis

EMPLOYMENT SELF SUFFICIENCY

Based on the job numbers quantified above, the revised proposed Development Concept according to Amendment 1 is expected to achieve an ESS ratio of 54%, compared with 55% in our July report. This is still in line with the City of Wanneroo's target of 60% ESS laid out in the Smart Growth Strategy.

Employment Self Sufficiency Comparisons Between BJDSP And Amendment 1

TABLE 2

	Original BJDSP	Amendment 1 BJDSP
Population	7,425	7,034
Population aged >15 years	80%	80%
Working age population	5,940	5,627
Labour force participation rate	64%	64%
Size of the labour force	3,802	3,601
- Full time	2,661	2,521
- Part time *	798	756
Size of FTE labour force	3,060	2,899
Lots 1001 & 1002 FTE job provision	**1,327**	**1,552**
ESS achieved by Lots 1001 & 1002	**43%**	**54%**

Source: WAPC, Urbis

Other than the above changes the revised land uses for Amendment 1 do not affect the contents of our July report.

We trust this letter meets your requirements. However please do not hesitate to contact the undersigned if there are any queries.

Yours sincerely,

David Cresp
Director – Economics and Market Research
(08) 9346 0503

ATTACHMENT 7

Local Water Management

LWP Property Group

Lot 3, Romeo Road Alkimos

Amendment 2 to Local Water Management Strategy

September 2014

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Appendices

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1. Introduction

1.1 Background

GHD Pty Ltd was commissioned by LWP Property Group Pty Ltd in 2006 to prepare a Local Water Management Strategy (LWMS) for Lot 3, Romeo Rd, Alkimos. The LWMS was submitted to the City of Wanneroo and the Department of Water and approved in 2007. An addendum to the LWMS was prepared by GHD and approved in December 2012. The addendum included updates to the surface water management strategy as well as indicative storage basin sizing and locations. This addendum supersedes the 2012 addendum as more updated information has been made available requiring changes to the surface water management plan.

Construction is significantly progressed throughout the Local Structure Plan (LSP) area. Further planning has resolved the proposed road and lot layouts in the remaining stages.

The purpose of this document is to present an up–to-date surface water management strategy and outline key changes to the water management strategy.

1.2 Amendments to the LWMS

Updates in the structure plan have resulted in the following revisions;

- **Catchment delineation**: the shape and number of catchments has been altered to include parts of the LSP that have undergone further planning since the 2007 LWMS and to reflect the minor changes in road and lot layout throughout the remainder of the site.
- **Basin locations and size**: the location and size of proposed detention basins have been altered according to the revised catchments for the site.

Furthermore, the following differences between the 2007 LWMS and this water management strategy are noted;

- **Modelling method**: PC Sump was used for stormwater modelling in the 2007 LWMS. However the Drains software was later employed by GHD to carry out detailed design work for the site, therefore a Drains ILSAX model was used for stormwater modelling presented in this surface water strategy.
- **Catchment parameters**: a runoff coefficient of 0.9 was adopted for stormwater modelling in the 2007 LWMS. This water management strategy adopts a runoff coefficient of 0.8 in accordance with part WD5.06 of *Stormwater Drainage Design, Development Design Specification WD5* (City of Wanneroo 2003).
- **Basin dimensions**: The basin side slope adopted in the 2007 LWMS was 1 in 6. This has been revised to 1 in 8, in accordance with part WD5.30 of *Stormwater Drainage Design, Development Design Specification WD5* (City of Wanneroo 2003).

2. Surface Water Management

To address stormwater and flood management the principles of the minor/major system of drainage will be employed. The minor/major drainage system is defined as a system of underground pipes, swale and kerbs which are designed to carry runoff generated by minor average recurrence interval (ARI) storms (5 year ARI) and a system of roads, drainage reserves, basins and open space designed to convey the major events (greater than the 5 year ARI).

The City of Wanneroo requires the stormwater management strategy to retain the 100 year ARI event within the LSP area. These objectives can be achieved through using the minor/major system incorporating the principles of water sensitive urban design (WSUD) and best management practices (BMPs).

2.1 Stormwater Management Network

The stormwater management network will comprise of the following components:

- The minor system will include an underground piped drainage network designed to carry the 5 year ARI storm event generated within the road reserves. Lot drainage will be contained on site by use of soak wells.
- As this site is located on generally free draining sands and is well above the existing water table, water sensitive design principles will include consideration to discharging water into the ground at the high end of the catchments by use of in line soakwells, open bottomed drainage pits and discharge to infiltration basins in the public open space (POS) area using current best management practices. Infiltration basins located in POS areas will be designed to accommodate the 10-year ARI storm event with a water depth less than 900 mm and the 100-year ARI storm event with a water depth less than 1200 mm, in accordance with part WD5.30 of *Stormwater Drainage Design, Development Design Specification WD5* (City of Wanneroo 2003). In locations where space for drainage infrastructure may be limited, consideration will be given to the use of underground storage / infiltration systems to cater for the 1-year ARI storm event.
- The major system will include the design of overland flow paths to carry the 100-year ARI storm event using the road system to direct flows to infiltration basins.

2.2 Stormwater Quantity

The sizing of infiltration basins located in POS areas is based upon modelling performed using Drains. Stormwater quantity was modelled for both the 10-year ARI and 100-year ARI flood.

Post-development catchment boundaries were defined by delineating post-development topographic watersheds. The post development loss model for the road and road reserve area of 20% was adopted (runoff coefficient of 0.8). All lot drainage will be contained on site by the use of soakwells.

As the site is predominantly free draining sand, a permeability of 1 m/day was adopted to assess the performance of the infiltration systems. This value is indicative of an un-maintained basin with a 100 mm clogged layer. This value has been verified by calibration against constructed and monitored basins in similar soil types. Infiltration rate should be refined at the UWMP stage using site specific geotechnical data.

Estimated storage requirements are summarised in Table 1. The infiltration basins have been designed to accommodate the 10-year ARI storm event with a water depth less than 900 mm

and the 100-year ARI storm event with a water depth less than 1200 mm, with 300 mm freeboard and 1 in 8 side slopes. All basins were assumed to be square, which provides the most conservative infiltration rates per fixed catchment volume.

The locations of infiltration basins are shown on Figure 1. These infiltration basins will be landscaped, and are subject to further detailed design.

Table 1 Preliminary drainage calculations

Catchment	Effective impervious area (ha)	Base area (m^2)	10-year TWL area (m^2)	10-year volume (m^3)	100-year TWL area (m^2)	100-year volume (m^3)
1	4.59	1406	2530	1547	3161	2603
2	6.80	2256	3636	2332	4449	3953
3	11.20	4225	5954	3837	7036	6603
4	6.38	2025	3341	2179	4122	3732
5	8.40	2970	4486	2877	5408	4912
6	3.06	700	1634	982	2074	1573
8	3.50	992	1962	1155	2490	1927
9	3.67	1056	2052	1226	2607	2051
10	1.78	324	1009	551	1348	910
11	5.73	1806	3076	1954	3807	3294

Note: TWL: Top Water Level

3. Implementation plan

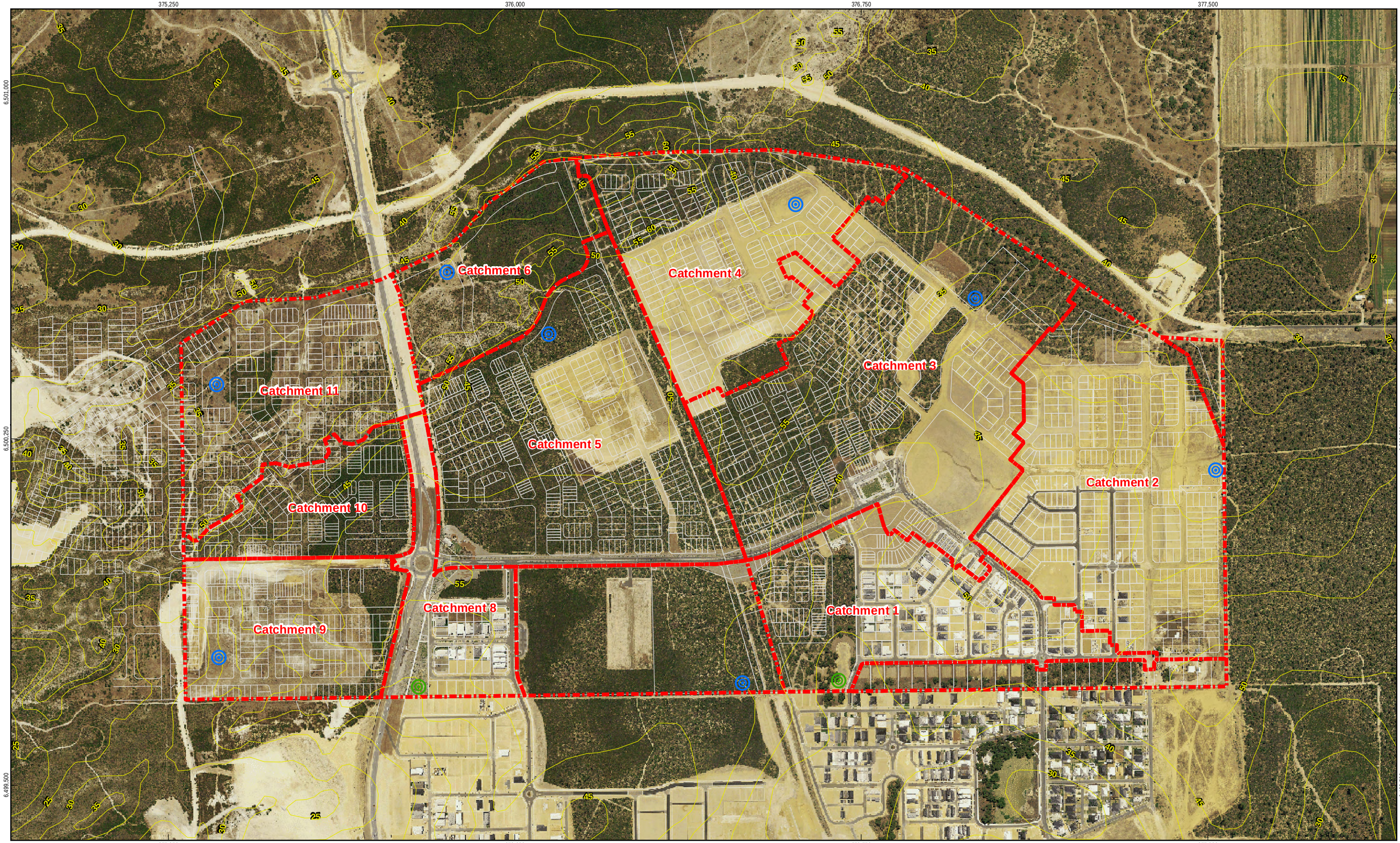
3.1 Monitoring

In this highly permeable site, stormwater in the development will be treated and infiltrated through the use of soakwells and infiltration basins. Due to the low risk of impact on groundwater level and quality, no groundwater monitoring program is proposed, apart from the existing DoW monitoring already being undertaken.

Appendices

Appendix A - Figures

Figure 1 Stormwater management concept plan



1:7,500 (at A3)

0 37.5 75 150 225 300 375 Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 50

N

LEGEND

Drainage Basin

- Existing / Built
- Proposed
- 5m Contours
- Site Layout
- Catchment

LWP Property Group
Lot 3 Romeo Road, Alkimos

Job Number	61-17935
Revision	1
Date	22 Sep 2014

Stormwater Drainage

Figure 1

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Data source: LWP Property Group and Gray & Lewis: Drainage Basin - 20140915, Catchment - 20120723, Site Layout - 20140817; Landgate: 5m Contours - 20121204, Metro North 2012 Mosaic. Created by: lyoong, mczekaj, aedwards

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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ATTACHMENT 8

Transportation Noise Assessment (Freeway)

Transportation Noise Assessment

Freeway Cell Stage 4
Lot 1001 Marmion Avenue, Alkimos
Proposed Residential Subdivision
Road Noise Assessment

Prepared For

LWP
bringing communities to life

October 2013

Reference: 9101393-01E

LLOYD GEORGE
Acoustics

Report: 9101393-01E

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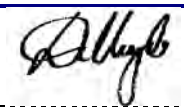
Approved for Issue:	Daniel Lloyd 
Position:	Project Director
Verified	Terry George 
Date:	23 October 2013

CONTENTS

APPENDICES

1 INTRODUCTION

This report has been prepared to assess road noise to the proposed Freeway Cell Phase 4 subdivision at Lot 1001 Marmion Avenue, Alkimos. As this proposed subdivision is located adjacent to the proposed Mitchell Freeway extension and Romeo Road (see *Figure 1.1*), an assessment of future transportation noise levels is required to determine the expected noise impact and the extent of noise control that would be required to achieve compliance with relevant criteria.

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

Figure 1.1 Proposed Sub-division Layout

2 CRITERIA

In Western Australia, transportation noise is assessed against the *State Planning Policy 5.4: Road And Rail Transport Noise And Freight Considerations In Land Use* (SPP 5.4). This policy provides a framework for the consideration and management of the impacts of transport noise and freight operations when dealing with:

- New noise-sensitive development in the vicinity of existing or future major transport corridors or freight handling facilities;
- New major road or rail infrastructure projects, including major redevelopments, in the vicinity of existing or future noise-sensitive land uses; and
- The location of freight handling facilities.

The noise criteria, shown in *Table 2.1*, were developed after consideration of road and rail transport noise criteria in Australia and overseas; and after a series of case studies to assess whether the levels were practicable.

Table 2.1 – External Noise Level Impact Criteria

Period	Noise "Target"	Noise "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 $L_{Aeq\ (Night)}$

In applying these outdoor noise criteria to new noise-sensitive developments, the objectives of this policy are to achieve –

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

For new noise-sensitive development proposals, the assessment position is 1m from the most exposed, habitable facade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.

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

In areas where the noise *Target* is likely to be exceeded, but noise levels are likely to be within the 5 dB margin, it is expected that mitigation measures would 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 that lies within the margin, noise mitigation measures should be implemented to achieve 'acceptable indoor noise levels' in those spaces.

In areas where the outdoor noise *Limit* is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB or $L_{Aeq(Night)}$ of 55 dB), it is expected that a Detailed Noise Assessment would be undertaken by the developer to identify customised noise mitigation measures 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. Where indoor spaces are planned to be facing outdoor areas that are above the noise *Limit*, mitigation measures should be implemented to achieve 'acceptable indoor noise levels' in those spaces, as specified below.

For residential buildings, 'acceptable indoor noise levels' are $L_{Aeq(Day)}$ of 40dB in living and work areas and $L_{Aeq(Night)}$ of 35dB in bedrooms[1]. For all other noise-sensitive buildings, 'acceptable indoor noise levels' under the policy comprise noise levels that meet the Recommended Design Sound Levels under Table 1 of Australian Standard AS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

The guidelines suggest a range of noise mitigation measures to meet the noise criteria. These include—

- using distance to separate noise-sensitive land uses from noise sources;
- construction of noise attenuation barriers such as earth mounds and noise walls;
- building design, such as locating outdoor living areas and indoor habitable rooms away from noise sources;
- building construction techniques, such as upgraded glazing, ceiling insulation and sealing of air gaps. Note that where upgraded glazing is required, the benefit is only realised when windows are kept closed and, as such, mechanical ventilation should also be considered in these circumstances;

The guidelines also provide detail on the range of noise mitigation measures and their potential for noise reduction. It is expected that noise management and mitigation strategies would be identified and implemented through a noise management plan, having regard to the guidelines, and would be—

- effective in reducing noise;
- practical and appropriate for the situation; and
- compatible with other relevant planning policies.

Where the *target* noise levels cannot be achieved, the policy states that: -

If the measures outlined previously cannot practicably achieve the target noise levels for new noise-sensitive developments, this should be notified on the certificate of title. Notifications on certificates of title and/or advice to prospective purchasers advising of the potential for noise impacts from major road and rail corridors can be effective in warning people who are sensitive to the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need to reduce the impact of noise

[1] For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. The policy encourages effective "quiet house" design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise.

through sensitive design and construction of buildings and the location of outdoor living areas. The notification is to ensure that prospective purchasers are advised of—

- *the potential for transport noise impacts; and*
- *the potential for quiet house design requirements to minimise noise intrusion through house layout and noise insulation (see the guidelines).*

Notification should be provided to prospective purchasers and be required as a condition of subdivision (including strata subdivision) for the purposes of noise-sensitive development as well as planning approval involving noise-sensitive development, where noise levels are forecast or estimated to exceed the target outdoor noise criteria, regardless of proposed noise attenuation measures. The requirement for notification as a condition of subdivision and the land area over which the notification requirement applies, should be identified in the noise management plan in accordance with the guidelines. An example of a standard form of wording for notifications is presented in the guidelines.

The SPP 5.4 applies a performance-based approach to the management and mitigation of transport noise. It states: -

It is recognised that in a number of instances it may not be reasonable and practicable to meet the noise target criteria. Where transport noise is above the target level, measures are expected to be implemented that best balance reasonable and practicable considerations, such as noise benefit, cost, feasibility, community preferences, amenity impacts, safety, security and conflict with other planning and transport policies. In these cases the community should also be consulted to assist in identifying best overall solutions. The guidelines assist in outlining ways in which some reasonable and practicable limitations can be addressed in a manner that also minimises transport noise.

It is further acknowledged that there may also be situations in which the noise limit cannot practicably be achieved, especially in the case of major redevelopment of existing transport infrastructure. Similarly, it may not be practicable to achieve acceptable indoor noise levels if the new development is located very close to the transport corridor. In these situations the primary focus should be on achieving the lowest level of noise, with other reasonable and practicable considerations being secondary to this objective.

3 NOISE PREDICTION METHODOLOGY

To assess the transportation noise levels to the proposed development, the computer programme *SoundPLAN 7.0* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms. The algorithms have, however, been modified to reflect local conditions as follows:

- 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.

In determining any requirements for noise barriers between the transport corridor and receiver, the predictions are made at a height of 1.4 metres above ground floor level and at 1.0 metre from an assumed building facade (resulting in a + 2.5 dB correction due to reflected noise). Noise to upper floors is also predicted, however, is only used to determine the extent of double (or multiple) storey dwellings that are above the *Target* and the facade treatments required to ensure acceptable internal noise levels.

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc and are discussed below.

Other input data included in the modelling includes ground topography, road design and traffic volumes.

3.1.1 Ground Topography, Road Design & Cadastral Data

Topographical data was based on that provided by Gray and Lewis Land Use Planners. The contours are in 1.0 metre intervals and cover the noise sensitive premises of concern.

Buildings and property fences (1.8m high) have also been included as these can provide barrier attenuation when located between a source and receiver, much the same as a hill. All single storey buildings are assumed to have a height of 3.5 m and double storey 7.0 m.

3.1.2 Road Traffic data:

- Road Surface –

  The freeway road surface is assumed to be open graded asphalt and Romeo Road is assumed to be dense graded asphalt. 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	-1.0 dB	-2.5 dB

- Vehicle Speed –Posted speeds are expected to be 80 km/h on Romeo Road and 100 km/h on the Freeway.

- Traffic Volumes –

  Future traffic volume data used in the modelling is shown below in *Table 3.2*. The volumes were obtained from Bruce Aulabaugh Traffic Engineering and Transport Planning.

Table 3.2 – 2031 Traffic Volumes Used in Modelling

Road Sector	Traffic Volume per Day	% Heavy Vehicles
Romeo Road	24,500	5%
Mitchell Freeway	52,000	5%
Mitchell Freeway Off Ramp to Romeo Road	7,000	5%

3.1.3 Ground Attenuation

The ground attenuation has been assumed to be 0.25 (25%) within the road reserve, 0.75 (75%) throughout the subdivision. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.1.4 Parameter Conversion

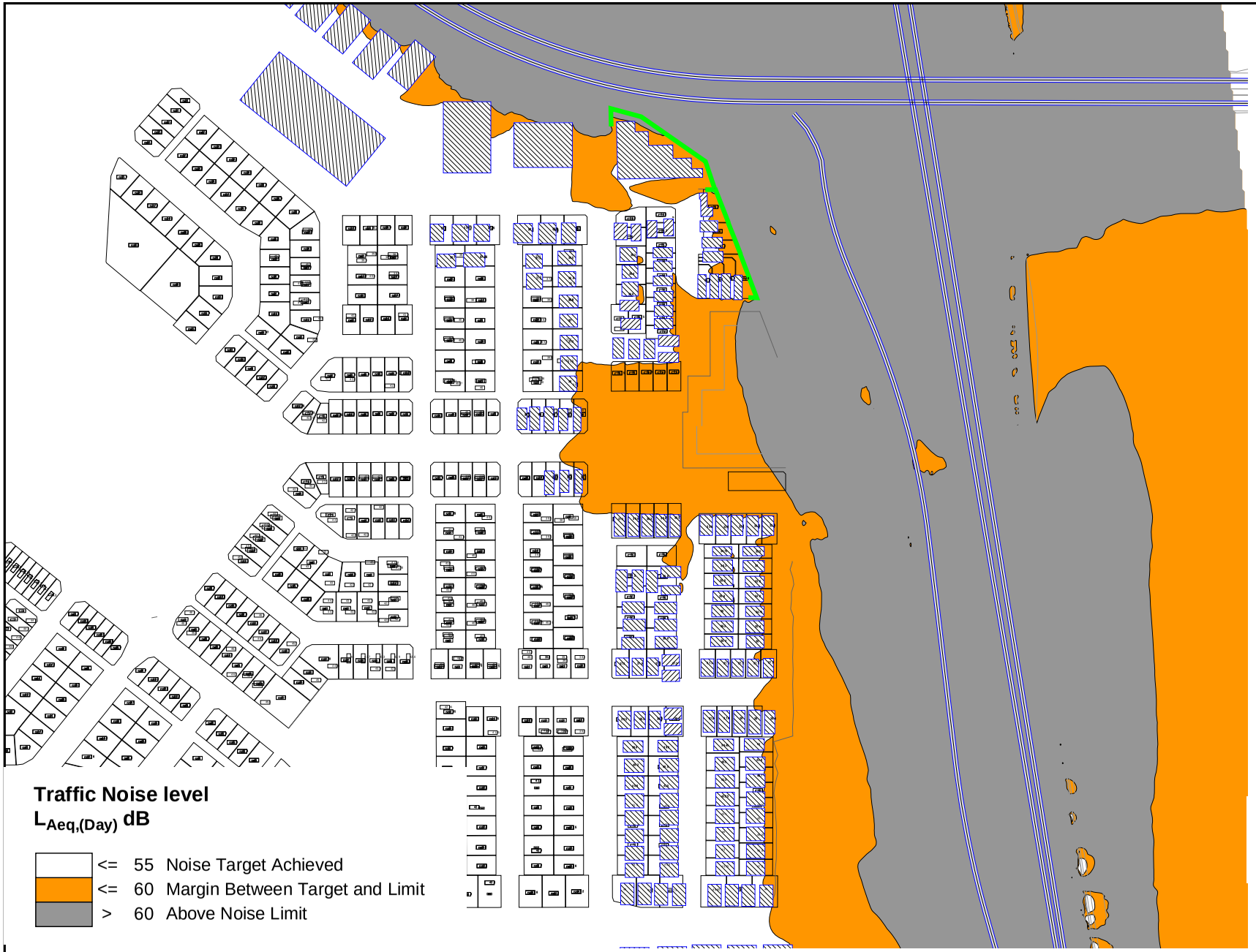
The CoRTN algorithms used in the SoundPlan modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The SPP 5.4 policy however uses $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles). It has generally been found that the $L_{A10\ (18\ hour)}$ to $L_{Aeq\ (Day)}$ noise level is -2.2 dB.

4 RESULTS

The results of the noise assessment are provided in *Figures 4.1 and 4.2.*

From previous acoustic studies undertaken by Lloyd George Acoustics in Alkimos, it has been determined that it is the daytime noise levels that will dictate compliance with the SPP 5.4 for road noise. Therefore only the daytime noise level contours are provided.

Figure 4.1



Trinity Estate - Lot 1001 Marmion Avenue, Alkimos
Predicted $L_{Aeq,(Day)}$ Noise Levels at Ground Floor Level

Lloyd George Acoustics
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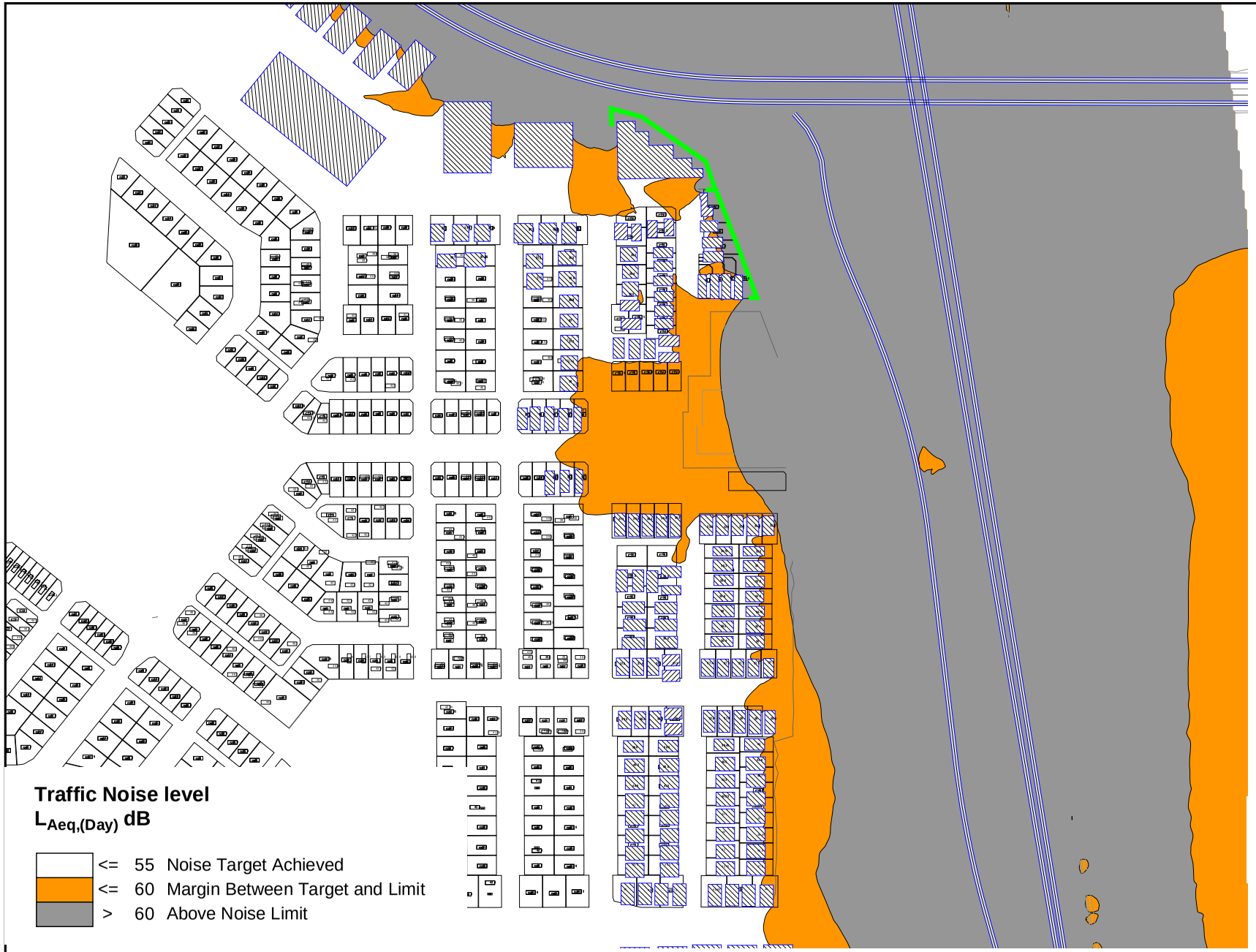
Figure 4.2



Traffic Noise level
$L_{Aeq,(Day)}$ dB

	<=	55	Noise Target Achieved
	<=	60	Margin Between Target and Limit
	>	60	Above Noise Limit

Signs and symbols

- Buildings
- Emission line
- 1.8m Property Fence

N

Length Scale

0 25 50 100 150 200 m

Trinity Estate - Lot 1001 Marmion Avenue, Alkimos
Predicted $L_{Aeq,(Day)}$ Noise Levels at Ground Floor Level

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

5 ASSESSMENT

The objectives of the SPP 5.4 criteria 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 *Limit* is achieved or noise levels are within the margin (between the *Limit* and *Target*), further controls are necessary. From *Figure 4.1 and 4.2*, the following can be summarised:

Ground Floor Level

- The future road noise levels are predicted to be within the margin between the *Target* and *Limit* criteria at all the lots facing the proposed Mitchell Freeway; and
- The group housing located on the northeast corner of the site predicted to be within the margin between the *Target* and *Limit* criteria.

Upper Floor Level

- The future road noise levels are predicted to be within the margin between the *Target* and *Limit* criteria at all the lots facing the proposed Mitchell Freeway;
- The group housing located on the northeast corner of the site, together with the lots immediately to the southeast of the group housing are predicted to exceed the *Limit* criteria: and
- The group housing located on the northeast corner of the site is predicted to exceed the *Limit* criteria by more than 3 dB requiring specialist acoustic treatment

As the noise levels exceed the SPP 5.4 *Target* criteria, noise mitigation needs to be considered. As this is a 'greenfield' site, in that neither the road nor the development has been built, SPP 5.4 requires the *Target* to be achieved and any practicable noise mitigation to be cost shared between the transport infrastructure provider and the developer.

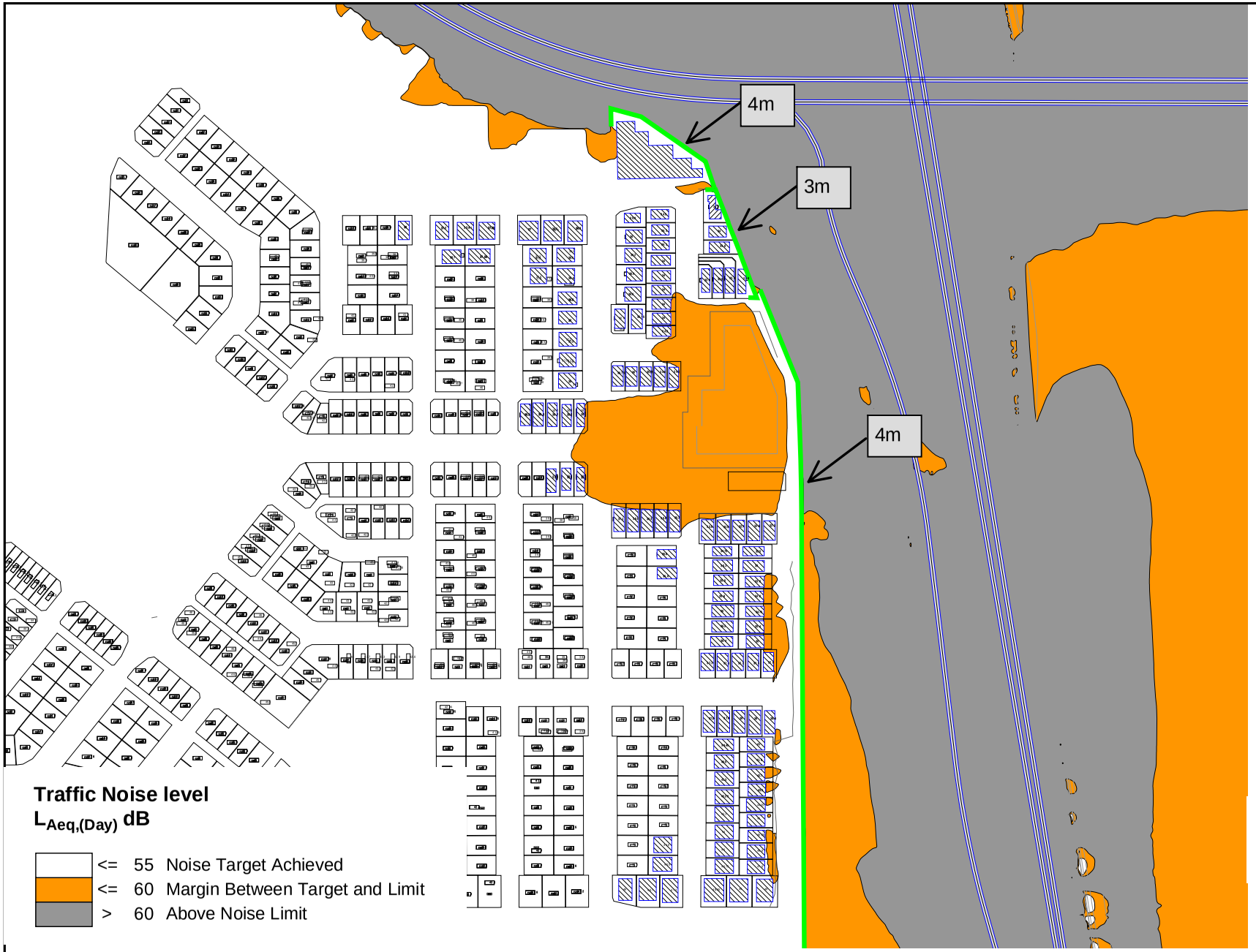
The mitigation options that are appropriate for this assessment are noise barriers and treatments to the facade of properties exceeding the *Target* criteria.

6 RECOMMENDATIONS

At ground floor level it has been shown that for lots facing the proposed Mitchell Freeway, the noise level is predicted to be above the SPP 5.4 *Target* criteria but below the *Limit* criteria.

As the Freeway is proposed to go over Romeo Road, the elevated Freeway section is much higher than the development ground levels. This significantly reduced the effectiveness of any barriers and even with some barriers up to 4.0m high, which are generally considered the highest practicable barrier, a number of lots are still predicted to be above the *Target* criteria. This is illustrated in *Figure 6.1.* It is likely that the most effective location for a noise barrier is close to the Freeway as it approaches the Romeo Road bridge, however, the assessment of this is outside of the scope of this report.

Figure 6.1



Trinity Estate - Lot 1001 Marmion Avenue, Alkimos
Predicted $L_{Aeq,(Day)}$ Noise Levels at Ground Floor Level With Noise Barrier

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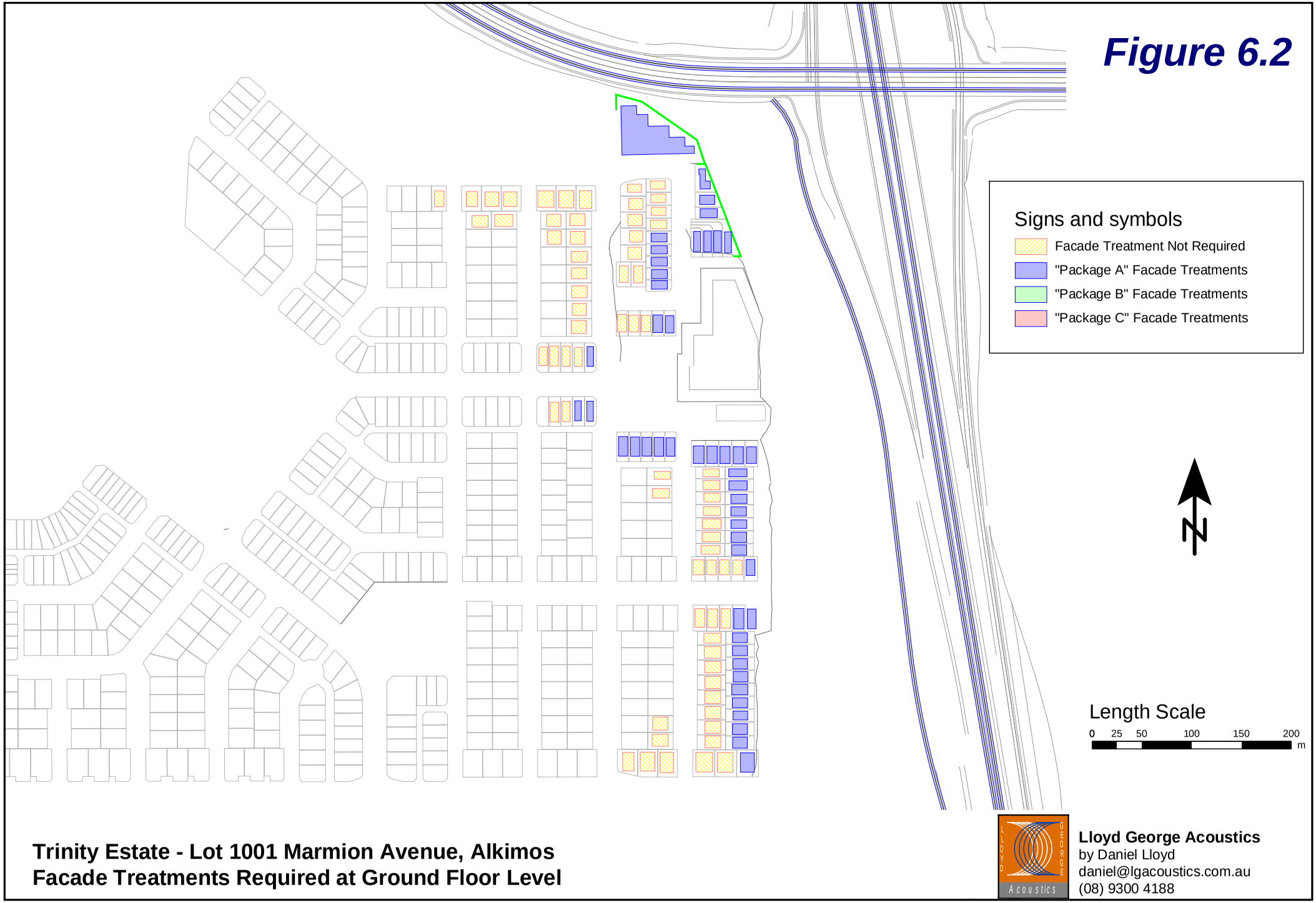
Should a noise barrier not be considered as practicable, it is considered acceptable under SPP 5.4, to provide building facade treatments and ensure that the building design incorporates a noise protected external entertaining area. The SPP 5.4 provides two 'deemed to comply" building facade packages which are detailed in *Appendix A*. For ground floor the "Package A" would be considered as acceptable. The facade treatment requirements are illustrated in *Figures 6.2.*

At upper floor level, it has been shown that the noise level is predicted to be above the SPP 5.4 *Limit* criteria by more than 3 dB at the group housing and within 3 dB of the *Limit* criteria at the lots to southeast of the group housing. For the lots within 3 dB of the *Limit* criteria the SPP 5.4 'deemed to comply' "Package B" would be appropriate. For the group housing these packages would not be considered as acceptable. Therefore Lloyd George Acoustics have developed a "Package C" and this is detailed in *Appendix A.* The facade treatment requirements are illustrated in *Figures 6.3.*

Figure 6.2



Trinity Estate - Lot 1001 Marmion Avenue, Alkimos
Facade Treatments Required at Ground Floor Level

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Figure 6.3

Trinity Estate - Lot 1001 Marmion Avenue, Alkimos
Facade Treatments Required at Upper Floor Level

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APPENDIX A

Treatment Required to Building Facades

Package A: House Facade in Areas Where Noise Levels Exceed the Noise "Target" but are Within the "Margin".

Area type	Orientation	Noise Control Measures
Indoors		
Bedrooms	Facing road/rail corridor	6mm (minimum) laminated glazing Fixed, casement or awning windows with seals No external doors Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning[2]
	Side-on to corridor	6mm (minimum) laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[3]	Facing corridor	6mm (minimum) laminated glazing Fixed, casement or awning windows with seals 35mm (minimum) solid core external doors with acoustic seals[4] Sliding doors must be fitted with acoustic seals Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning
	Side-on to corridor	6mm (minimum) laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[5]	Facing corridor	Minimum 2.0m high solid fence (e.g. Hardifence, pinelap, or Colorbond) Picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

[2] See section on Mechanical ventilation/airconditioning for further details and requirements.

[3] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Code of Australia as a "habitable room". The Building Code of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Code of Australia describes these utility spaces as "non-habitable rooms".

[4] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[5] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

Where outdoor noise levels are above the *Target*, the property will require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing the noise control, the following need to be observed:

- evaporative airconditioning systems would require air relief grilles to meet the requirements for Packages A and B to allow windows to be closed;
- refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements;
- air inlets need to be positioned facing away from the transport corridor where practicable;
- ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notifications on certificates of title and/or advice to prospective purchasers advising of the potential for noise impacts from road and rail corridors can be effective in warning people of the potential impacts of transport noise.

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 12A of the Town Planning and Development Act and section 70A of the Transfer of Land Act. An example of a suitable notice is given below.

Notice: This property is situated in the vicinity of a transport corridor, and is currently affected, or may in the future be affected, by transport noise. Further information about transport noise, including development restrictions and noise insulation requirements for noise-affected property, are available on request from the relevant local government offices.

Package B: Noise within 3dB above the "limit"

The following noise insulation package is designed to meet the indoor noise standards for residential developments in areas where transport noise levels exceed the noise "limit" but by no more than 3dB (See Table 1 in the Policy).

Area type	Orientation	Package B measures
Indoors		
Bedrooms	Facing road/rail corridor	10mm (minimum) laminated glazing Fixed, casement or awning windows with seals No external doors Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning[6]
	Side-on to corridor	10mm (minimum) laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[7]	Facing corridor	10mm (minimum) laminated glazing Fixed, casement or awning windows with seals 40mm (solid core external doors with acoustic seals[8] Sliding doors must be fitted with acoustic seals Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning
	Side-on to corridor	6mm (minimum) laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[9]	Facing corridor	Minimum 2.4m solid fence (e.g. brick, limestone or Hardifence) Colorbond and picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

[6] See section on Mechanical ventilation/airconditioning for further details and requirements.

[7] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Code of Australia as a "habitable room". The Building Code of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Code of Australia describes these utility spaces as "non-habitable rooms".

[8] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[9] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

Mechanical ventilation/airconditioning

Where outdoor noise levels are above the "target", both Packages A and B require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing Packages A and B, the following need to be observed:

- evaporative airconditioning systems will not meet the requirements for Packages A and B because windows need to remain open;
- refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements;
- air inlets 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/or advice to prospective purchasers advising of the potential for noise impacts from road and rail corridors can be effective in warning people of the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need and opportunities to reduce the impact of noise through sensitive design and construction of buildings and the location and/or screening of outdoor living areas.

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 12A of the Town Planning and Development Act and section 70A of the Transfer of Land Act. An example of a suitable notice is given below.

Notice: This property is situated in the vicinity of a transport corridor, and is currently affected, or may in the future be affected, by transport noise. Further information about transport noise, including development restrictions and noise insulation requirements for noise-affected property, are available on request from the relevant local government offices.

Package C: Noise more than 3dB above the "limit"

Area type	Orientation	Package B measures
Indoors		
Bedrooms	Facing road/rail corridor	10.5mm Pilkington Optilam Phon laminated glazing Casement or awning windows No external doors Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning (see 4.5.3)
	Side-on to corridor	10.5mm Pilkington Optilam Phon laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[10]	Facing corridor	10.5mm Pilkington Optilam Phon Casement or awning windows 40mm (minimum) solid core external doors with acoustic seals[11] Sliding doors not permitted Closed eaves No vents to outside walls/eaves Mechanical ventilation/airconditioning
	Side-on to corridor	10mm laminated glazing Closed eaves Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[12]	Facing corridor	Minimum 3.0m solid fence (e.g. brick, limestone or Hardifence) Colorbond and picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

[10] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Guide of Australia as a "habitable room". The Building Guide of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Guide of Australia describes these utility spaces as "non-habitable rooms".

[11] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[12] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

Mechanical ventilation/airconditioning

Where outdoor noise levels are above the "target", Package C requires mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing Package C, the following need to be observed:

- evaporative airconditioning systems will not meet the requirements for Package C because windows need to remain open;
- refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements;
- air inlets 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/or advice to prospective purchasers advising of the potential for noise impacts from road and rail corridors can be effective in warning people of the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need and opportunities to reduce the impact of noise through sensitive design and construction of buildings and the location and/or screening of outdoor living areas.

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 12A of the Town Planning and Development Act and section 70A of the Transfer of Land Act. An example of a suitable notice is given below.

Notice: This property is situated in the vicinity of a transport corridor, and is currently affected, or may in the future be affected, by transport noise. Further information about transport noise, including development restrictions and noise insulation requirements for noise-affected property, are 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 $L_{A10,18hour}$.

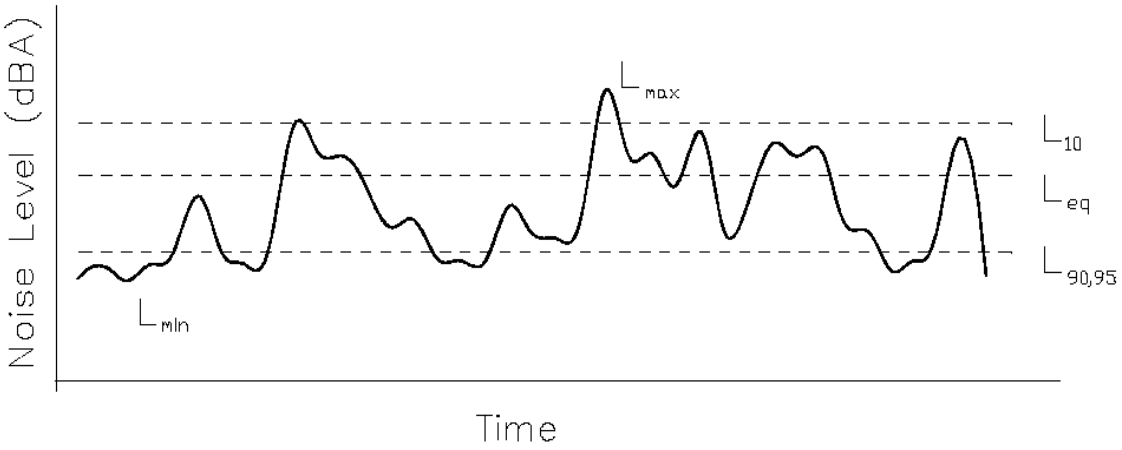
Satisfactory Design Sound Level

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

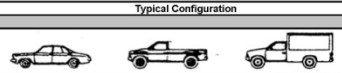
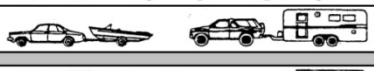
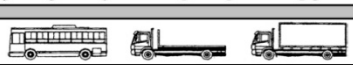
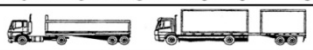
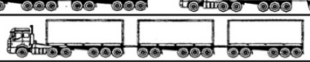
The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class

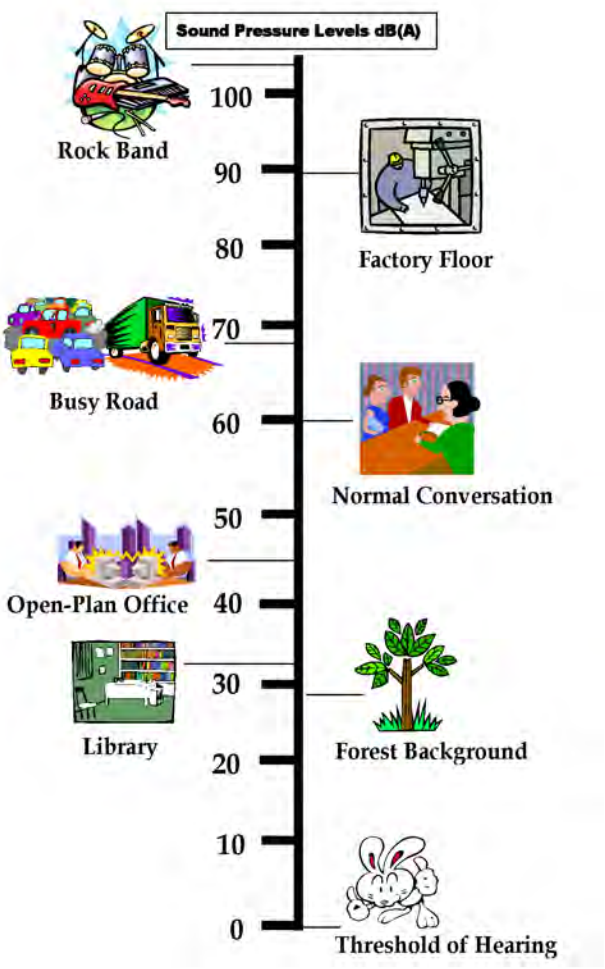
AUSTROADS Vehicle Classification System

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	
Medium 5.5m to 14.5m	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			
	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



ATTACHMENT 9

Transportation Noise Assessment (Railway)

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Transportation Noise Assessment

Trinity Estate, Alkimos - Railway Noise

Reference: 9101393-05

Prepared for:
LWP Property Group

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Date:	5 August 2013

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Appendices

1 INTRODUCTION

This report has been prepared to assess the impact of railway noise to the Trinity Estate. The noise from the railway has been predicted to the proposed residential lots located on both the east and west side of the railway, and compares the results against the relevant transportation criteria for Western Australia. This report supersedes previous assessments of railway noise to this development and incorporates the following variables:

- Finalised lot levels for the development;
- Latest railway alignment design provided by PTA; and
- Train speed of 100 km/h, which is considered reasonable when taking into consideration the proposed railway stations in the vicinity of the development.

The development layout used in this assessment is provided in *Figure 1.1*.

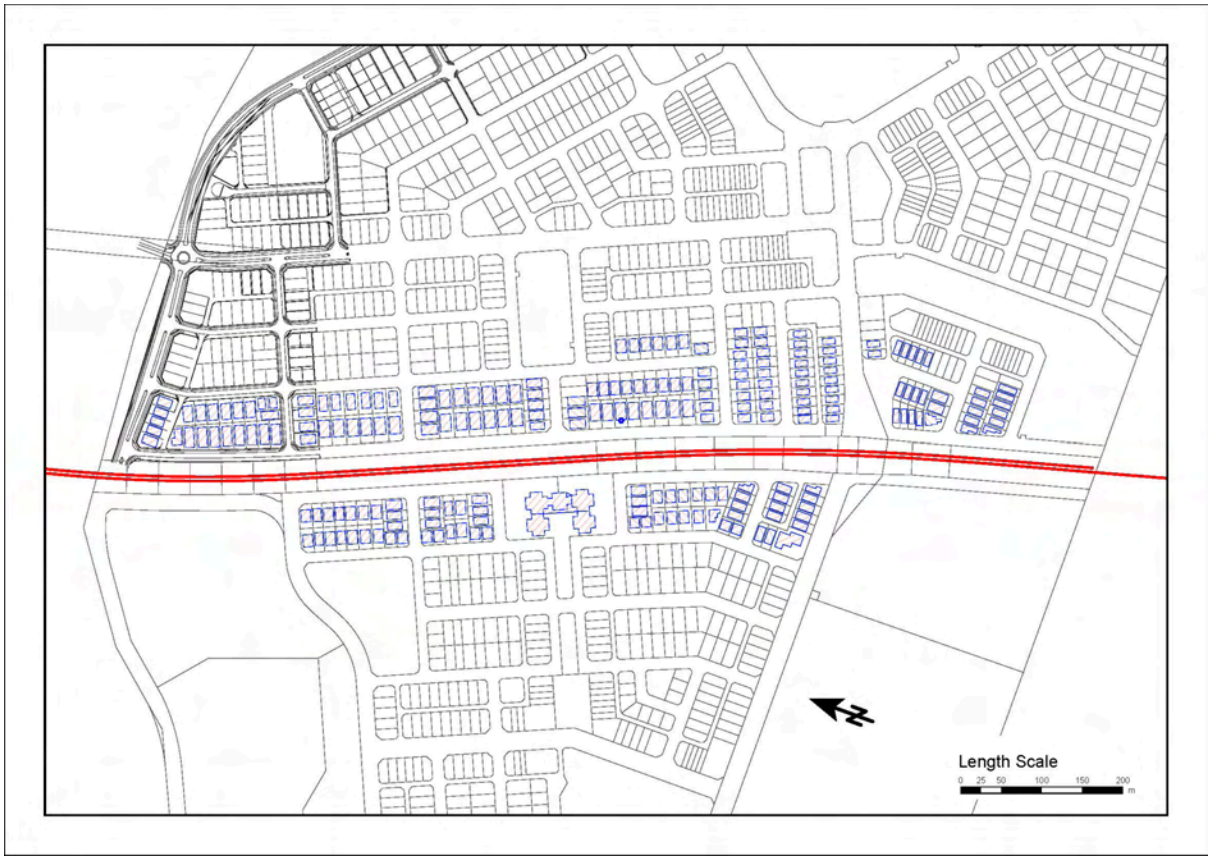

Figure 1-1 Proposed Subdivision Layout

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

2 CRITERIA

In Western Australia, transportation noise is assessed against the *State Planning Policy 5.4: Road And Rail Transport Noise And Freight Considerations In Land Use* (the Policy). The Policy provides a framework for the consideration and management of the impacts of transport noise and freight operations when dealing with:

- New noise-sensitive development in the vicinity of existing or future major transport corridors or freight handling facilities;
- New major road or rail infrastructure projects, including major redevelopments, in the vicinity of existing or future noise-sensitive land uses; and
- The location of freight handling facilities.

The noise criteria, shown in *Table 2.1,* were developed after consideration of road and rail transport noise criteria in Australia and overseas; and after a series of case studies to assess whether the levels were practicable.

Table 2-1 Outdoor Noise Criteria

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

The 5dB difference between the outdoor noise *target* and the outdoor noise *limit*, as prescribed in Table 1, represents an acceptable margin for compliance. In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin. In relation to greenfield sites, however, there is an expectation that the design of the proposal will be consistent with the *target* ultimately being achieved.

In applying these outdoor noise criteria to new noise-sensitive developments, the objectives of the Policy are to achieve –

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

For new noise-sensitive development proposals, the assessment position is 1m from the most exposed, habitable facade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.

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

In areas where the noise *target* is likely to be exceeded, but noise levels are likely to be within the 5 dB margin, it is expected that mitigation measures would 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 that lies within the margin, noise mitigation measures should be implemented to achieve 'acceptable indoor noise levels' in those spaces.

In areas where the outdoor noise *limit* is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB or $L_{Aeq(Night)}$ of 55 dB), it is expected that a Detailed Noise Assessment would be undertaken by the developer to identify customised noise mitigation measures **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.** Where indoor spaces are planned to be facing outdoor areas that are above the noise *limit*, mitigation measures should be implemented to achieve 'acceptable indoor noise levels' in those spaces, as specified below.

For residential buildings, 'acceptable indoor noise levels' are $L_{Aeq(Day)}$ of 40dB in living and work areas and $L_{Aeq(Night)}$ of 35dB in bedrooms[1]. For all other noise-sensitive buildings, 'acceptable indoor noise levels' under the policy comprise noise levels that meet the Recommended Design Sound Levels under Table 1 of Australian Standard AS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

The guidelines suggest a range of noise mitigation measures to meet the noise criteria. These include—

- using distance to separate noise-sensitive land uses from noise sources;
- construction of noise attenuation barriers such as earth mounds and noise walls;
- building design, such as locating outdoor living areas and indoor habitable rooms away from noise sources;
- building construction techniques, such as upgraded glazing, ceiling insulation and sealing of air gaps. Note that where upgraded glazing is required, the benefit is only realised when windows are kept closed and, as such, mechanical ventilation should also be considered in these circumstances;

Where the *target* noise levels cannot be achieved, the policy states that: -

If the measures outlined previously cannot practicably achieve the *target* noise levels for new noise-sensitive developments, this should be notified on the certificate of title. Notifications on certificates of title and/or advice to prospective purchasers advising of the potential for noise impacts from major road and rail corridors can be effective in warning people who are sensitive to the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need to reduce the impact of noise through sensitive design and construction of buildings and the location of outdoor living areas. The notification is to ensure that prospective purchasers are advised of—

- *the potential for transport noise impacts; and*
- *the potential for quiet house design requirements to minimise noise intrusion through house layout and noise insulation (see the guidelines).*

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

[1] For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. The policy encourages effective "quiet house" design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise.

outdoor noise criteria, regardless of proposed noise attenuation measures. The requirement for notification as a condition of subdivision and the land area over which the notification requirement applies, should be identified in the noise management plan in accordance with the guidelines. An example of a standard form of wording for notifications is presented in the guidelines.

The Policy applies a performance-based approach to the management and mitigation of transport noise. It states: -

It is recognised that in a number of instances it may not be reasonable and practicable to meet the noise *target* criteria. Where transport noise is above the *target* level, measures are expected to be implemented that best balance reasonable and practicable considerations, such as noise benefit, cost, feasibility, community preferences, amenity impacts, safety, security and conflict with other planning and transport policies. In these cases the community should also be consulted to assist in identifying best overall solutions. The guidelines assist in outlining ways in which some reasonable and practicable limitations can be addressed in a manner that also minimises transport noise.

It is further acknowledged that there may also be situations in which the noise *limit* cannot practicably be achieved, especially in the case of major redevelopment of existing transport infrastructure. Similarly, it may not be practicable to achieve acceptable indoor noise levels if the new development is located very close to the transport corridor. In these situations the primary focus should be on achieving the lowest level of noise, with other reasonable and practicable considerations being secondary to this objective.

3 NOISE PREDICTION METHODOLOGY

To assess the transportation noise levels to the proposed development, the computer programme *SoundPLAN 7.1* was utilised incorporating the Nordic Rail Prediction Method (Kilde Rep. 130) algorithm. The algorithm has been modified to reflect local conditions as follows:

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. The sound pressure levels used in the modelling are shown in *Table 3.1*.

Table 3-1 Sound Pressure Levels Used in the Noise Model

Description	dB(A) at One-Third Octave Frequencies (Hz)									Overall dB(A)
	31.5	63	125	250	500	1K	2K	4K	8K	
Train speed of 100 km/hr at a distance of 15m	27	48	56	59	70	76	76	74	66	84
	32	51	58	62	70	76	77	71	61	
	39	50	58	66	75	77	75	69	55	

The predictions are made at a height of 1.4 metres above ground floor level for single storey dwellings and 4.4 metres for two-storey dwellings and at 1.0 metre from an assumed building facade (resulting in a + 2.5 dB correction due to reflected noise). Noise to upper floors is only predicted to determine the extent of facade treatments required to ensure acceptable internal noise levels.

Other input data included in the modelling includes ground topography, rail design and train configurations and movements.

Ground Topography, Rail Design & Cadastral Data

Topographical data was based on that provided by Gray and Lewis Land Use Planners. The contours are in 1.0 metre intervals and cover the noise sensitive premises of concern.

Buildings and property fences (1.8m high) have also been included as these can provide barrier attenuation when located between a source and receiver, much the same as a hill. All single storey buildings are assumed to have a height of 4.0 m and double storey 7.0 m.

Train Movements

The train configuration and numbers of movements used in the noise prediction modelling are presented below in *Tables 3.2 and 3.3.*

Table 3-2 Variables Used in the Noise Prediction Model

Description of Variable		Value
Type of noise source		Line source
Train length	3 Car Set	75 metres
	4 Car Set	100 metres
	6 Car Set	150 metres
Height of noise source above railhead		0.8 metres
Train Speeds		130 km/h

Table 3-3 Rail Movements Per Hour Assumed in Noise Model

Train Description	Train Movements per Hour	
	Day	Night
Northbound		
3 Car Sets	3.9	0.5
4 Car Sets	0.4	0.4
6 Car Sets	1.5	0.25
Southbound		
3 Car Sets	4.0	0.5
4 Car Sets	0.2	0.4
6 Car Sets	1.6	0.25

4 RESULTS

The results of the noise assessment assuming a train speed of 100 km/h are provided in *Figure 4.1*. The train speed assumed in this assessment takes into consideration the location of proposed train stations close to the proposed development.

From previous acoustic studies undertaken by Lloyd George Acoustics in Alkimos, it has been determined that it is the daytime noise levels that will dictate compliance with the Policy for rail noise. Therefore only the daytime noise level contours are provided.

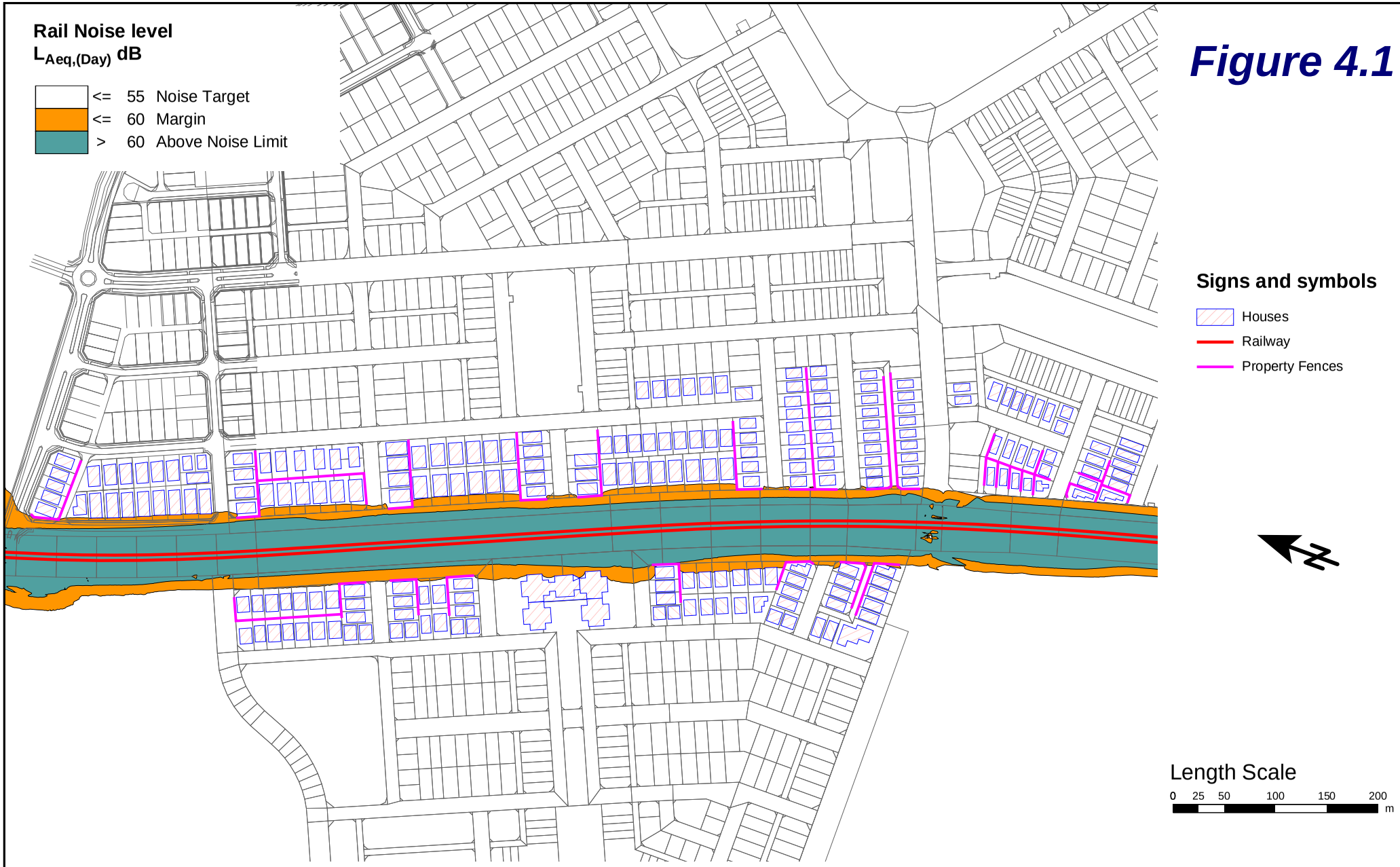

Figure 4.1

Trinity Estate - Lot 1001 Marmion Avenue, Alkimos

Predicted Rail Noise Levels at Ground Floor - No Noise Mitigation

$L_{Aeq,(Day)}$ Noise Level Contours - Train Speed 100 km/h

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5 ASSESSMENT

The objectives of the Policy criteria are for noise at all houses to be no more than the *limit* and preferably no more than the *target*. However, for a greenfield site such as this, there is an expectation that the design of the proposal and railway will be consistent with the *target* ultimately being achieved and that this burden should be shared between the developer and the railway provider. Where the *target* is achieved, no further controls are required; where the *limit* is achieved or noise levels are within the margin (between the *limit* and *target*), further controls are necessary. From *Figure 4.1*, the following can be summarised:

Ground Floor Level

- The future rail noise levels would exceed the *target* criteria at a some of the lots directly adjacent to the Northern Suburbs Railway reserve; and
- The future rail noise levels would comply with the *Limit* criteria at all lots.

As the noise levels exceed the Policy *target* criteria, noise mitigation needs to be considered. The mitigation options relevant to this project are:

- Increased setbacks;
- Noise Barrier along the boundary of the railway reserve; and
- Treatment to the facade of properties exceeding the Target criteria.

Increased Setbacks

Increasing the setbacks from a railway can result in reduced noise levels at residential premises. From previous assessments of the Trinity Estate, it is our understanding that the subdivision has been designed to ensure setbacks are at the maximised while maintaining the viability of the subdivision in terms of lot yield. It is therefore assumed that this noise control option has been addressed in the design.

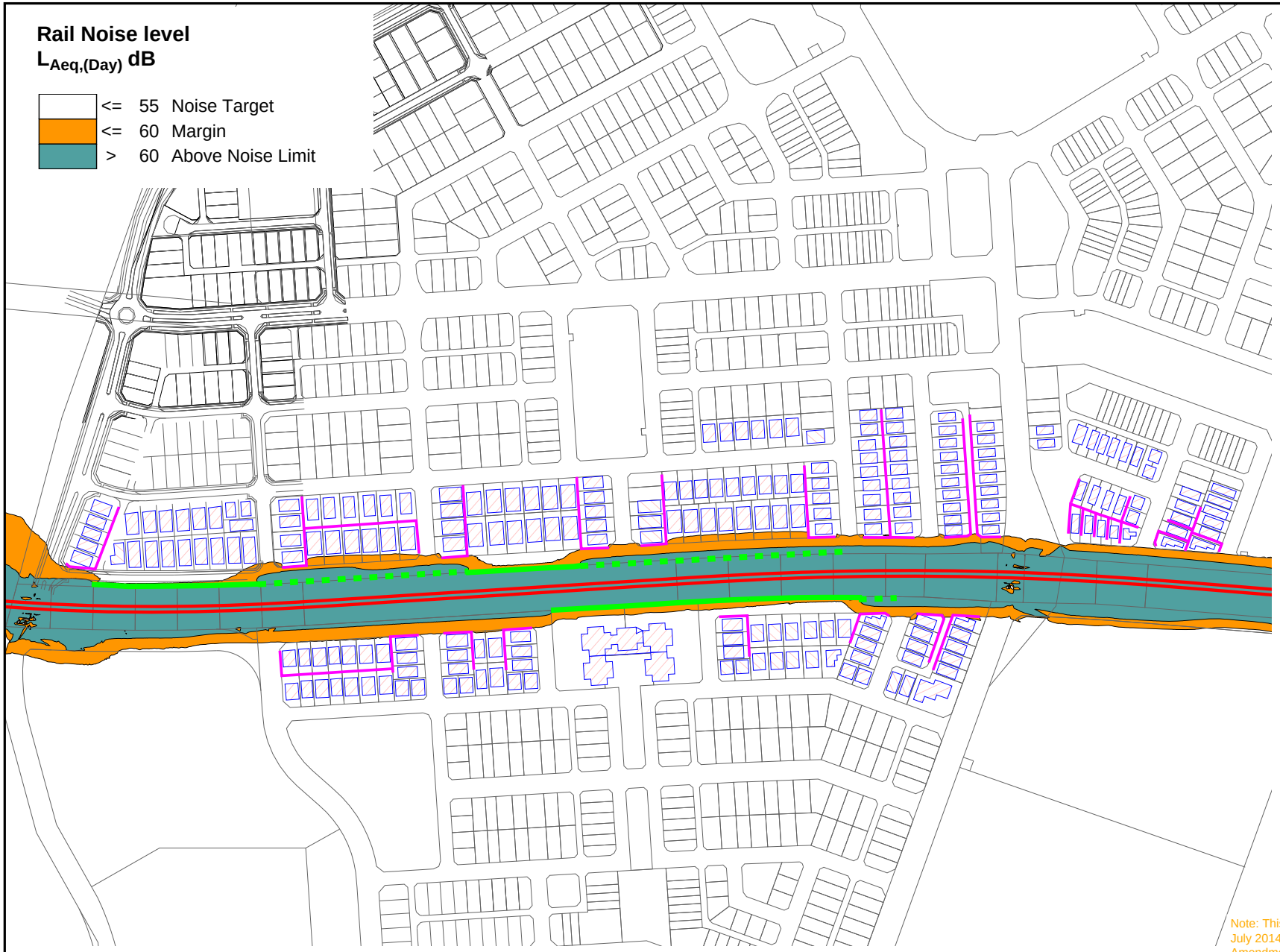
Noise Barrier

Noise barriers located on the railway reserve boundary would be an effective way of achieving the *target* criteria at all receivers on ground floor level, as required under Policy. The predicted noise levels assuming noise barriers designed to achieve the *target* at all receivers are provided in *Figure 5.1.* In addition, the predicted noise levels for upper floors assuming these noise barriers are provided in *Figure 5.2.* This figure shows that at upper floors, the *target* criteria would be exceeded at most lots adjacent to the railway and facade protection would also be required should two-storey houses be built. It should be noted that while the noise to both ground and upper floors requires consideration under the Policy, it is generally accepted that noise barriers are designed to achieve the criteria at ground floor only. In addition to the noise barriers shown, the design requires property fences that are facing the railway (corner blocks) and within the orange contour to be 2.1m high.

Facade Treatments

From *Figures 5.1* and *5.2*, it can be seen that assuming the proposed barrier design, all lots directly adjacent to the railway would be below the Policy *target* at ground floor level, however, are either within the margin between the *target* and the *limit* or above the *limit* at upper floor levels. Therefore no facade treatment would be required for single storey houses and the 'deemed to satisfy' facade Package A or B as detailed in *Figure 5.2* would be required for two-storey houses. The 'deemed to satisfy' facade packages are provided in *Appendix A*.

Figure 5.1



Note: This Figure was amended by Gray & Lewis on 30 July 2014 as per a request by the City of Wanneroo (for Amendment 2)

Trinity Estate - Lot 1001 Marmion Avenue, Alkimos

Predicted Rail Noise Levels at Ground Floor - 2m High Noise Barriers

$L_{Aeq,(Day)}$ Noise Level Contours - Train Speed 100 km/h

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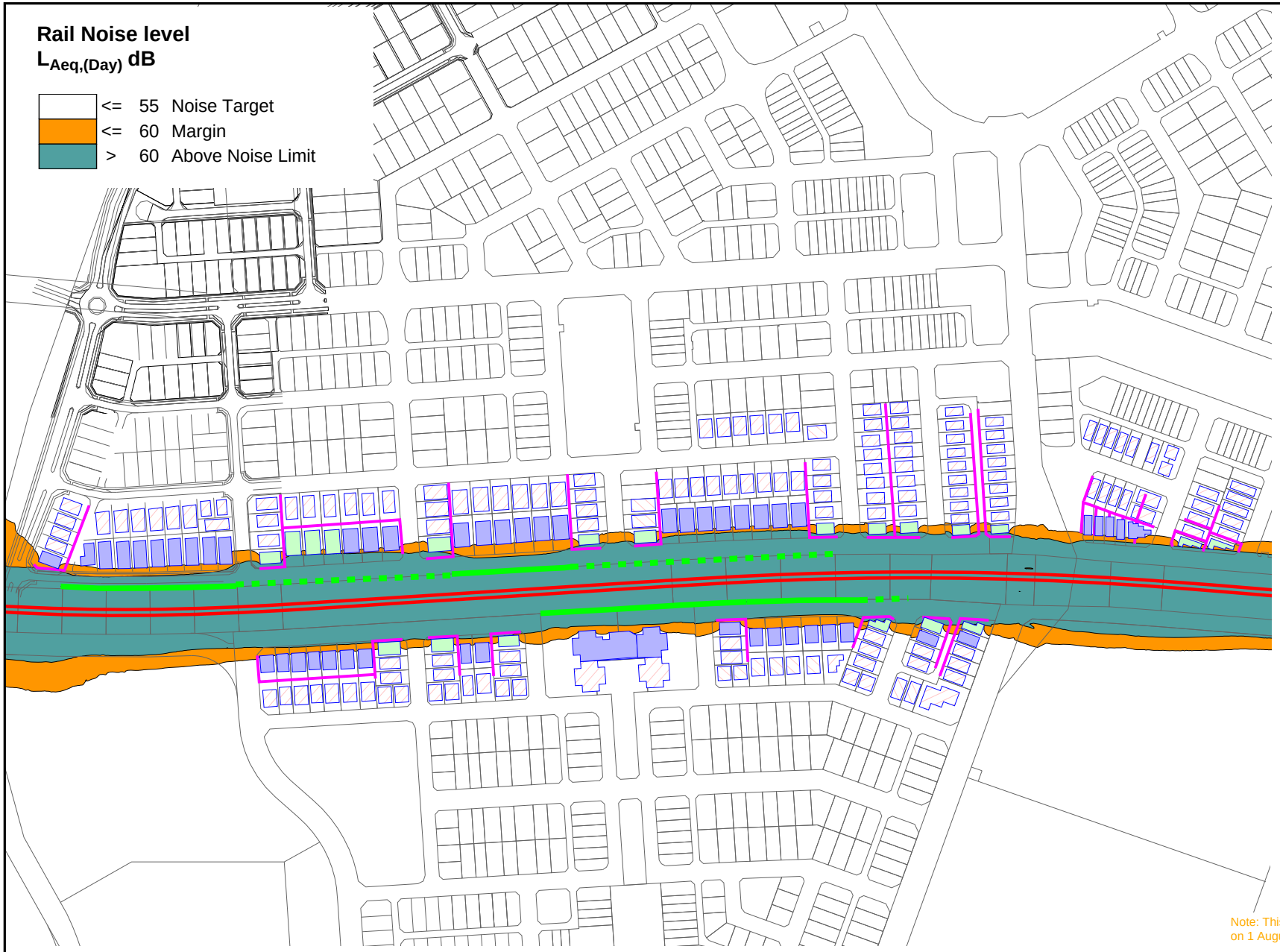
Figure 5.2



Note: This Figure was amended by Gray & Lewis on 1 August 2014.

Trinity Estate - Lot 1001 Marmion Avenue, Alkimos

Predicted Rail Noise Levels at Upper Floor - 2m High Noise Barriers

$L_{Aeq,(Day)}$ Noise Level Contours - Train Speed 100 km/h

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6 GROUND-BORNE VIBRATION

As indicated by the Department of Environment and Conservation, the Public Transport Authority's "*Noise Vibration and Light Management Plan for the Northern Suburbs Railway – Clarkson Station to Romeo Road*" does require vibration reduction measures to be considered where houses are within 30m of the track and train speed are expected to exceed 100km/h. It is our understanding that the PTA would consider the use of ballast matting in these circumstances, as vibration isolation to residential premises is not generally a practicable solution. While train speeds are not expected to exceed 100 km/h, it is suggested that the Developer contact the PTA to ensure they are aware that the development would be close to 30m of their track

7 CONCLUSION

The results of this assessment shows that for lots adjacent to the railway, the noise level is predicted to be above the Policy *target* criteria. As such, it is a requirement for noise control to be considered with an aim to achieve the *target* criteria at ground floor level for all houses if practicable. From this assessment it has been determined that a series of 2.0 metre high noise barriers can achieve this requirement. Should two-storey houses be considered, facade protection would be required for some lots.

Appendix A

DEEMED TO SATIFY CONSTRUCTION STANDARDS

Package A: Noise levels within the *margin*

The following noise insulation package is designed to meet the indoor noise standards for residential developments in areas where noise levels exceed the noise *target* but are within the *limit*.

Area type	Orientation	Package A measures
Indoors		
Bedrooms	Facing road/rail corridor	• 6mm (minimum) laminated glazing • Fixed, casement or awning windows with seals • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning[2]
	Side-on to corridor	• 6mm (minimum) laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[3]	Facing corridor	• 6mm (minimum) laminated glazing • Fixed, casement or awning windows with seals • 35mm (minimum) solid core external doors with acoustic seals[4] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6mm (minimum) laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements

[2] See section on Mechanical ventilation/airconditioning for further details and requirements.
[3] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Code of Australia as a "habitable room". The Building Code of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Code of Australia describes these utility spaces as "non-habitable rooms".
[4] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

Mechanical ventilation/airconditioning

Where outdoor noise levels are above the "target", both Packages A and B require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing Packages A and B, the following need to be observed:

- evaporative airconditioning systems will not meet the requirements for Packages A and B because windows need to remain open;
- refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements;
- air inlets 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/or advice to prospective purchasers advising of the potential for noise impacts from road and rail corridors can be effective in warning people of the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need and opportunities to reduce the impact of noise through sensitive design and construction of buildings and the location and/or screening of outdoor living areas.

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 12A of the Town Planning and Development Act and section 70A of the Transfer of Land Act. An example of a suitable notice is given below.

Notice: This property is situated in the vicinity of a transport corridor, and is currently affected, or may in the future be affected, by transport noise. Further information about transport noise, including development restrictions and noise insulation requirements for noise-affected property, are available on request from the relevant local government offices.

Package B: Noise levels above the *limit* but within 3 dB

The following noise insulation package is designed to meet the indoor noise standards for residential developments in areas where noise levels exceed the *limit* by no more than 3 dB.

Area type	Orientation	Package B measures
Indoors		
Bedrooms	Facing road/rail corridor	• 10mm (minimum) laminated glazing • Fixed, casement or awning windows with seals • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning[5]
	Side-on to corridor	• 10mm (minimum) laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[6]	Facing corridor	• 10mm (minimum) laminated glazing • Fixed, casement or awning windows with seals • 40mm (minimum) solid core external doors with acoustic seals[7] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6mm (minimum) laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements

[5] See section on Mechanical ventilation/airconditioning for further details and requirements.
[6] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Code of Australia as a "habitable room". The Building Code of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Code of Australia describes these utility spaces as "non-habitable rooms".
[7] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

Mechanical ventilation/airconditioning

Where outdoor noise levels are above the "target", both Packages A and B require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing Packages A and B, the following need to be observed:

- evaporative airconditioning systems will not meet the requirements for Packages A and B because windows need to remain open;
- refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements;
- air inlets 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/or advice to prospective purchasers advising of the potential for noise impacts from road and rail corridors can be effective in warning people of the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need and opportunities to reduce the impact of noise through sensitive design and construction of buildings and the location and/or screening of outdoor living areas.

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 12A of the Town Planning and Development Act and section 70A of the Transfer of Land Act. An example of a suitable notice is given below.

Notice: This property is situated in the vicinity of a transport corridor, and is currently affected, or may in the future be affected, by transport noise. Further information about transport noise, including development restrictions and noise insulation requirements for noise-affected property, are 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 $L_{A10,18hour}$.

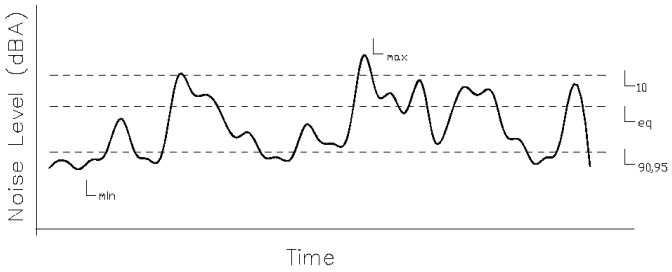
Satisfactory Design Sound Level

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 (motorbike) 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	
Medium 5.5m to 14.5m	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			
	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