Traffic Noise Assessment

Chianti Private Estate
Stage 1,
Woodvale

Prepared For

Cardno

June 2010

LLOYD GEORGE Acoustics

Reference: 10041539-03

Report: 10041539-03

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Approved for Issue:	Terry George 
Position:	Project Director
Date:	13 June 2010

CONTENTS

APPENDICES

1 INTRODUCTION

Chianti Private Estate is a proposed residential subdivision at Lots 27, 28 & 801 Wanneroo Road in Woodvale, as shown on the following page. On the eastern side of the subdivision is Wanneroo Road, which currently carries around 40,000 vehicles per day.

Stage 1 of the subdivision is the subject of this report, which is the southern most part of the land, containing 33 residential lots, including 3 group housing sites. The report has been limited to Stage 1 as the full design of this part has been completed, including the finished lot levels. For the northern stages, the noise impact will be similar as the design levels are likely to be similar.

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

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:

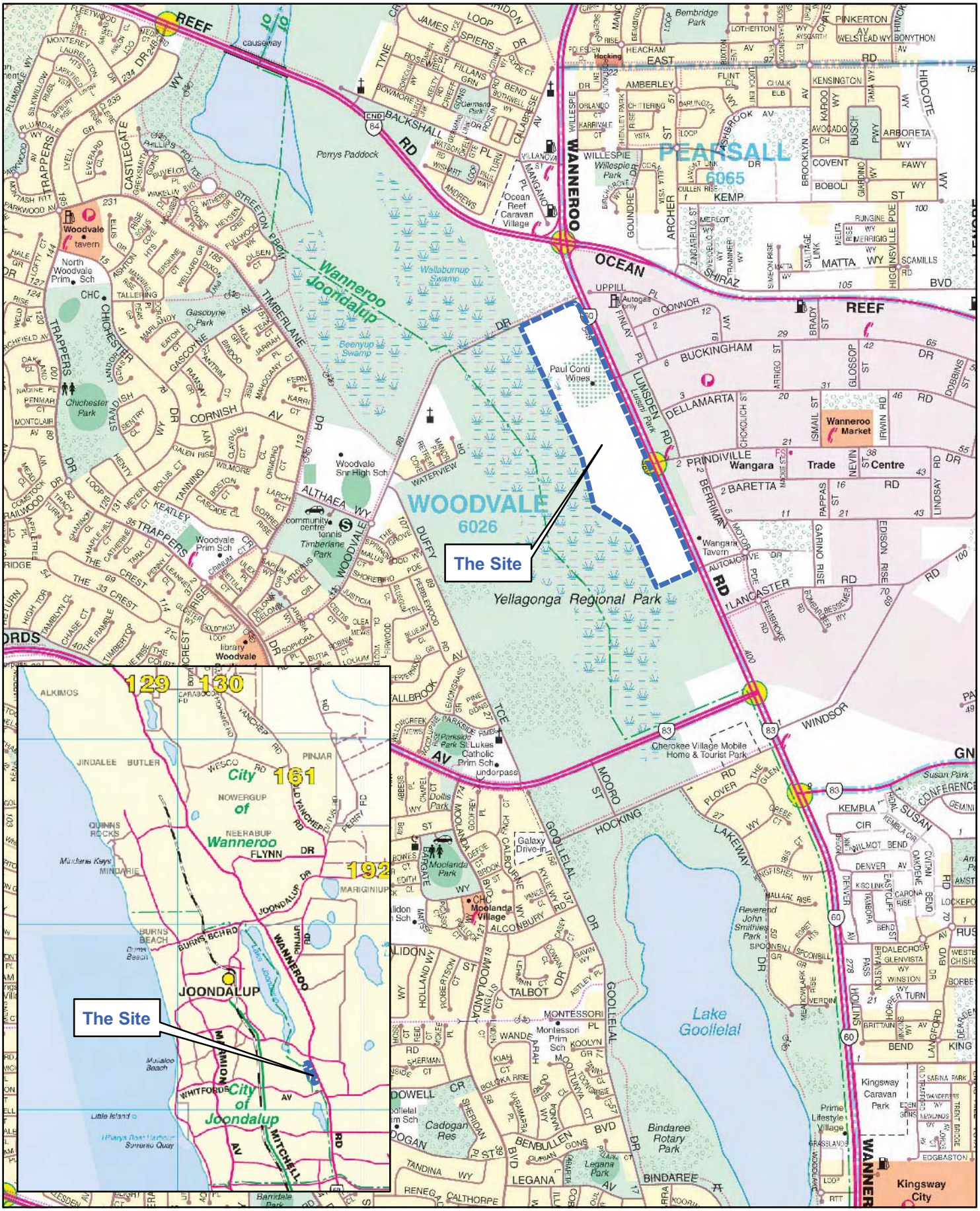
- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; 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 applying 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 $L_{Aeq(\mathbf{Day})}$	60 dB $L_{Aeq(\mathbf{Day})}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

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



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

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PROJECT **Woodvale - Wetlands Revegetation Management Plan**

DRAWING TITLE **FIGURE 1 : Locality Plan**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

Project Number **V7016**

Original **A4**

Drawing Number **SK01**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09

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 (eg 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

Noise measurements and modelling have been undertaken in accordance with the requirements of the Policy as described below in *Sections 3.1 and 3.2*.

3.1 Site Measurements

Noise monitoring was undertaken at an existing residence; being 533 Wanneroo Road in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$); and
- Calibrate the noise model for existing conditions.

The instrument used was an ARL Type 316 noise data logger (pictured below in *Figure 3.1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

Figure 3.1 – Automatic Noise Data Logger

The measurement location is shown in *Figure 3.2*.

The noise logger was set-up to obtain at least 3 full weekdays, between 11 May to 18 May 2010.

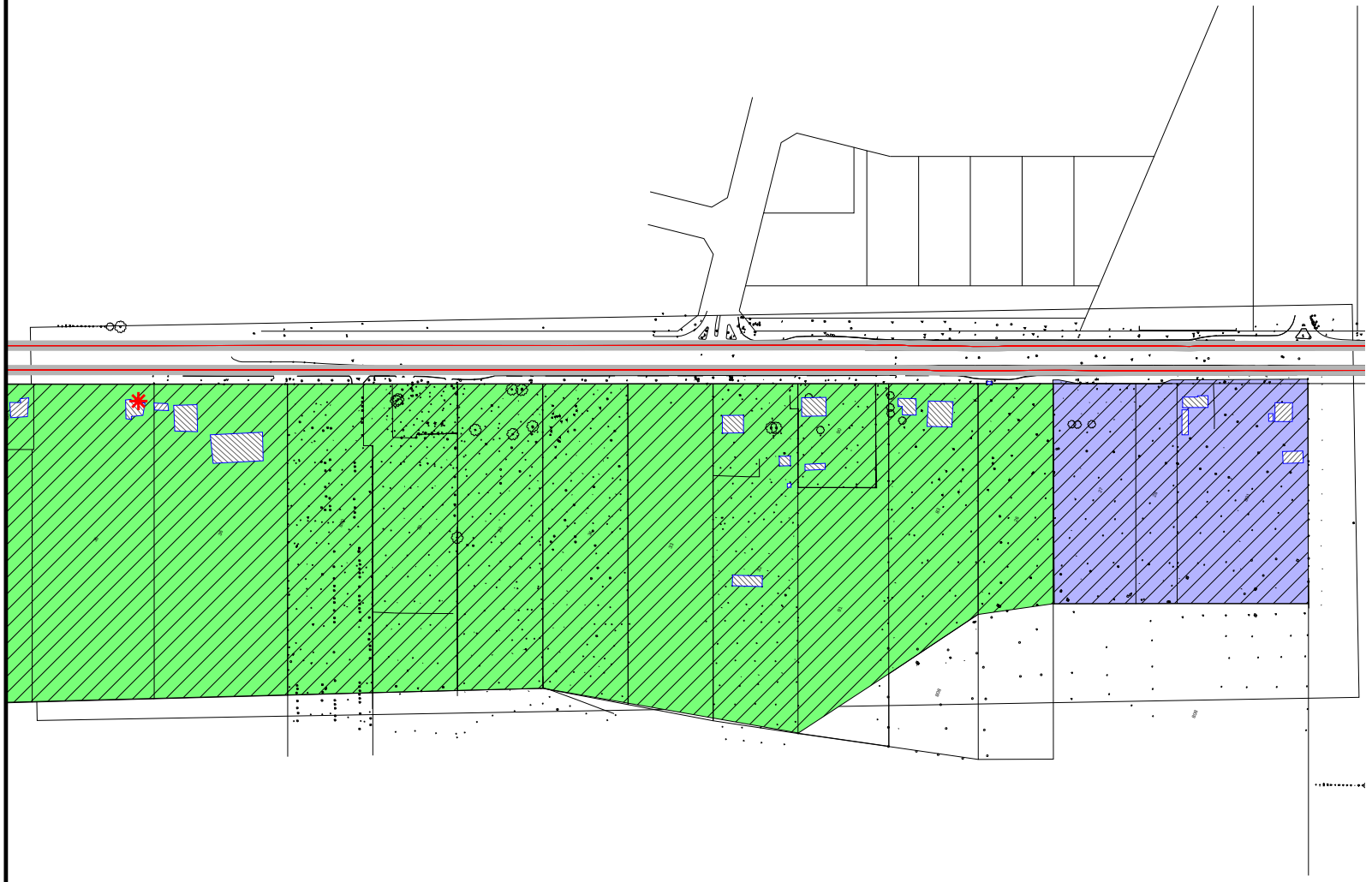
Sound pressure levels were measured in accordance with Australian Standard 2702-1984: *Acoustics - Method For Measurement of Road Traffic Noise*, with the logger positioned at one metre from the façade of interest. The logger was placed at least one metre from any corner of the building and the microphone height was 1.4 metres above ground floor level.

From the hourly measurements, the $L_{A10,18\ hour}$, $L_{Aeq,24\ hour}$, $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$ values were determined for each complete measurement day. These results were averaged and the mean level reported.

Woodvale Subdivision (Chianti Private Estate) - Watson Property Group Northern Aspects Ltd

Logger Location and Stage 1 Location

Figure 3.2



Signs and symbols

- Road Centre
- Road Surface
- Building
- Noise Logger
- Stage 1
- Remaining Stages

13 June 2010

Length Scale 1:5000

0 25 50 100 150 200 m

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3.2 Noise Modelling

The computer programme *SoundPLAN 7.0* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

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

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

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

3.2.1 Ground Topography, Road Design & Cadastral Data

The existing topographical data was provided by Cardno and are in 0.25 metre intervals, covering the area of concern. The design drawings were also provided which show the proposed finished lot levels for Stage 1 – refer *Appendix A*.

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 3.5 metres, representing a single storey residence.

3.2.2 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown below in *Table 3.1*.

Table 3.1 – Noise Relationship Between Different Road Surfaces

Road Surfaces						
Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.0 dB	-2.5 dB

The existing road surface is dense graded asphalt and it is assumed this will remain so in the future.

- Vehicle Speed – The existing posted speed is 70km/hr and is assumed to remain unchanged into the future.

- Traffic Volumes – Existing traffic counts were obtained from MRWA and are shown below in *Table 3.2*, being December 2008 counts. The forecast 2031 volume was also obtained as ranging between 34,000 to 42,000. To remain conservative and allow for some future growth, the upper limit has been used in the model.

Table 3.2 – Traffic Volumes Used in the Modelling

Parameter	Scenario	
	Existing	**Future**
24 Hour Volume	35,728	42,000
% Heavy	5.1	5.1

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.25 (25%) within the road reserve, 0.5 (50%) throughout the subdivision, except for the public open space, which was set to 1.00 (100%). Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.2.4 Parameter Conversion

The CoRTN algorithms used in the *SoundPlan* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The WAPC draft 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).

In this instance, the relationship between parameters that has been measured by the noise logger has been assumed to remain the same in the future.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised below in *Table 4.1* and shown graphically in *Figure 4.1*.

Table 4.1 – Measured Average Noise Levels – 533 Wanneroo Road

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
12 May 2010	62.9	59.8	61.2	53.5
13 May 2010	65.3	62.1	63.6	55.1
14 May 2010	64.4	61.0	62.4	54.5
17 May 2010	63.2	60.2	61.6	54.0
Weekday Average	**63.9**	**60.8**	**62.2**	**54.2**

The average differences between the $L_{A10,18hour}$ & $L_{Aeq(Day)}$ is 1.7 dB and between the $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 8.0 dB. As such, it is the daytime parameter that will dictate compliance since satisfying the $L_{Aeq(Day)}$ criteria will automatically result in satisfying the $L_{Aeq(Night)}$.

4.2 Noise Modelling

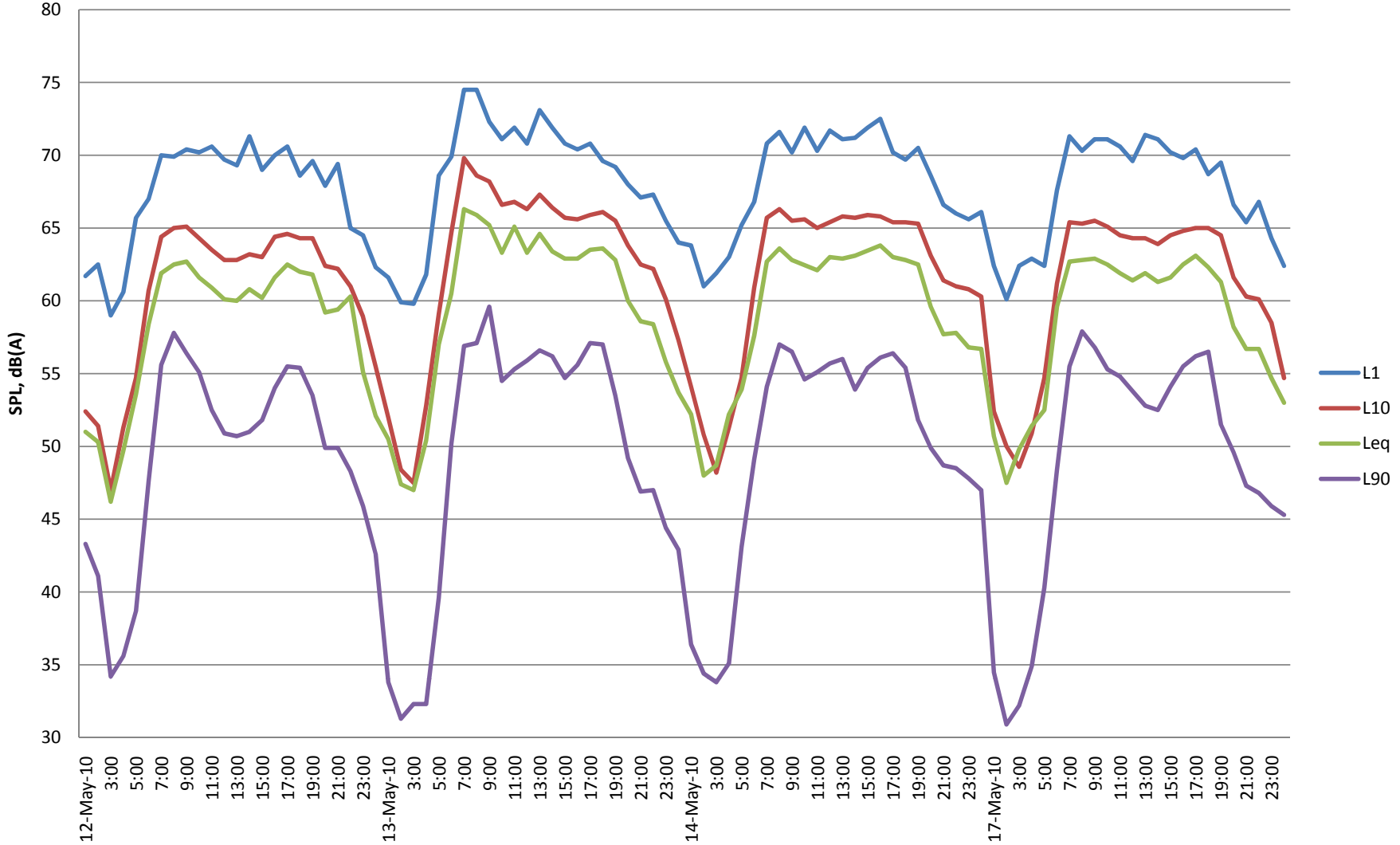
Three scenarios were initially considered being:

1. No noise walls;
2. With walls that satisfy a noise level of no more than 60 dB $L_{Aeq(Day)}$ (the *limit*) at all proposed residences; and
3. With walls that satisfy a noise level of no more than 63 dB $L_{Aeq(Day)}$ at all proposed residences.

The third scenario was considered as the WAPC Policy provides a deemed to satisfy construction for houses within such a noise level (referred to as Package B as described in *Appendix B* of this report). In this area, Western Power provide a restriction that wall heights cannot be more than 2.0 metres above road level so that with such a wall height restriction, it may not be practicable to achieve the *limit* or *target*. It should be noted that in some areas of Stage 1, the lot levels are lower than road level, so the wall height may be higher than 2.0 metres, relative to the lot level.

Noise contour plots for these three scenarios are shown on *Figures 4.2 to 4.4*.

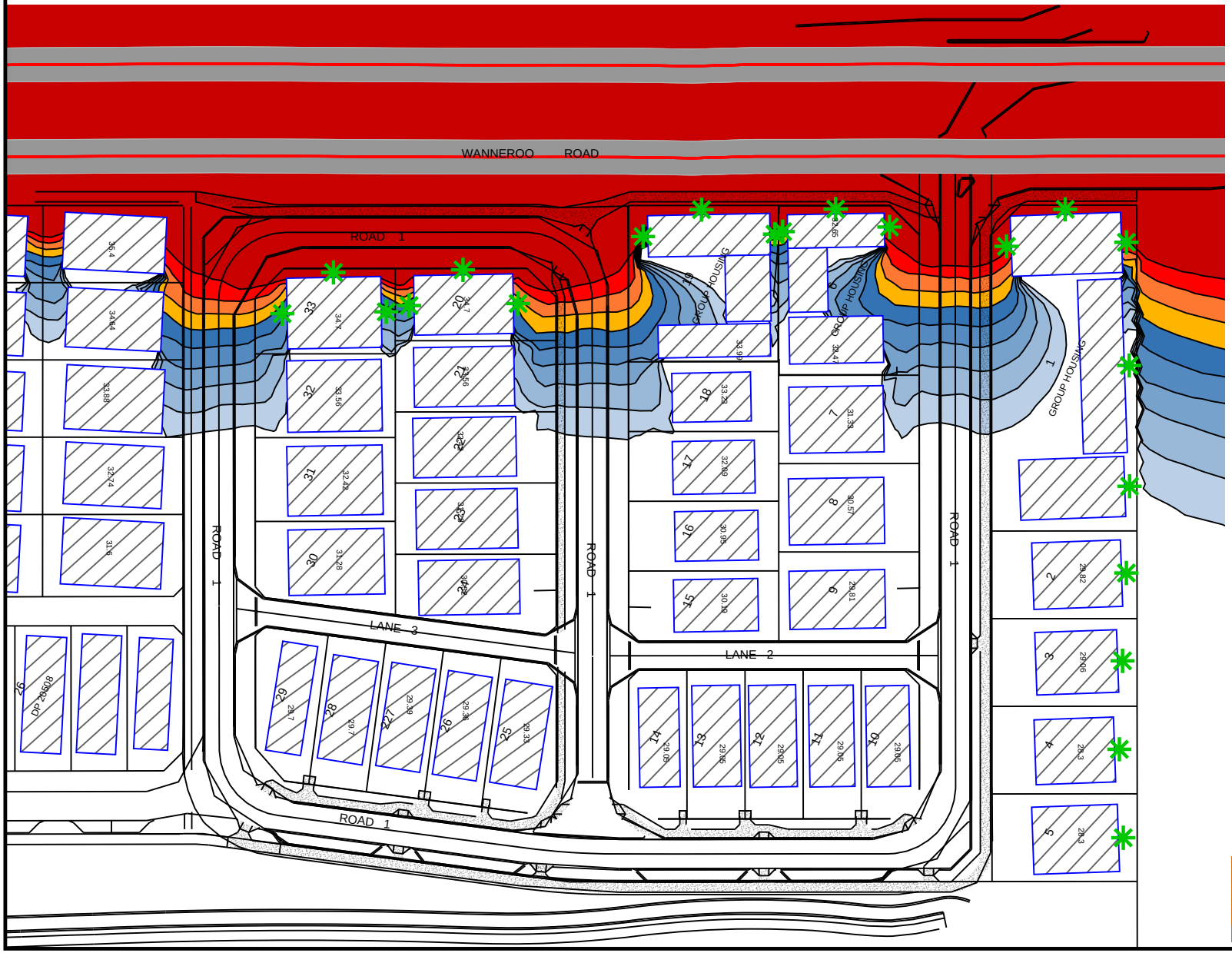
Figure 4.1 - Noise Data Logging 533 Wanneroo Road



Woodvale Subdivision (Stage 1) - Watson Property Group Northern Aspects Ltd

LAeq,Day Noise Level Contours - With No Walls

Figure 4.2



LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Road Centre
- Road Surface
- Building
- Point receiver

18 May 2010

Length Scale 1:1200

0 5 10 20 30 40 m

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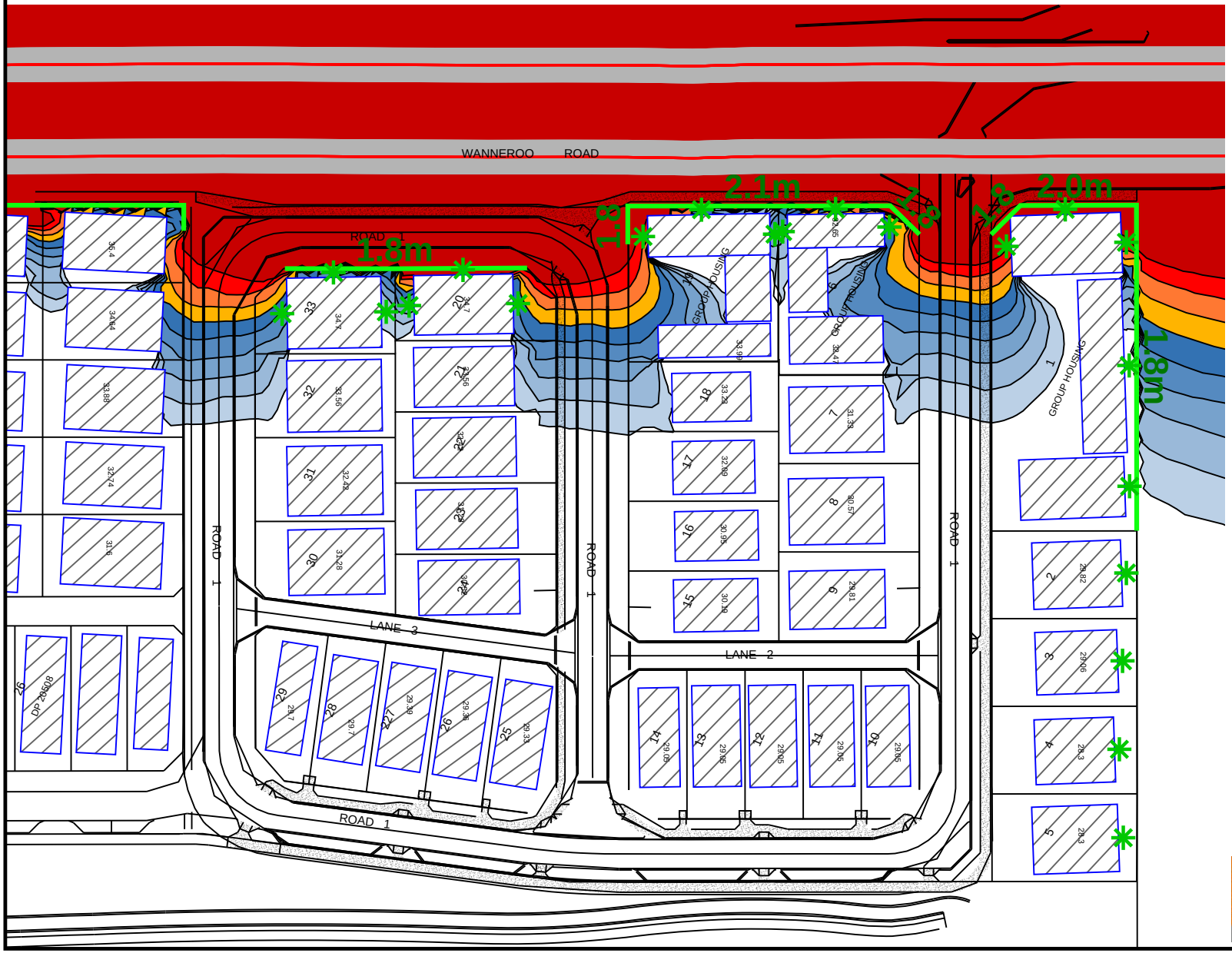
Woodvale Subdivision (Stage 1) - Watson Property Group Northern Aspects Ltd

LAeq,Day Noise Level Contours - With Walls to Achieve Limit of 60 dB LAeq(Day)

Figure 4.3



Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

N

Signs and symbols

- Road Centre
- Road Surface
- Building
- Point receiver
- Wall

19 May 2010

Length Scale 1:1200

0 5 10 20 30 40 m

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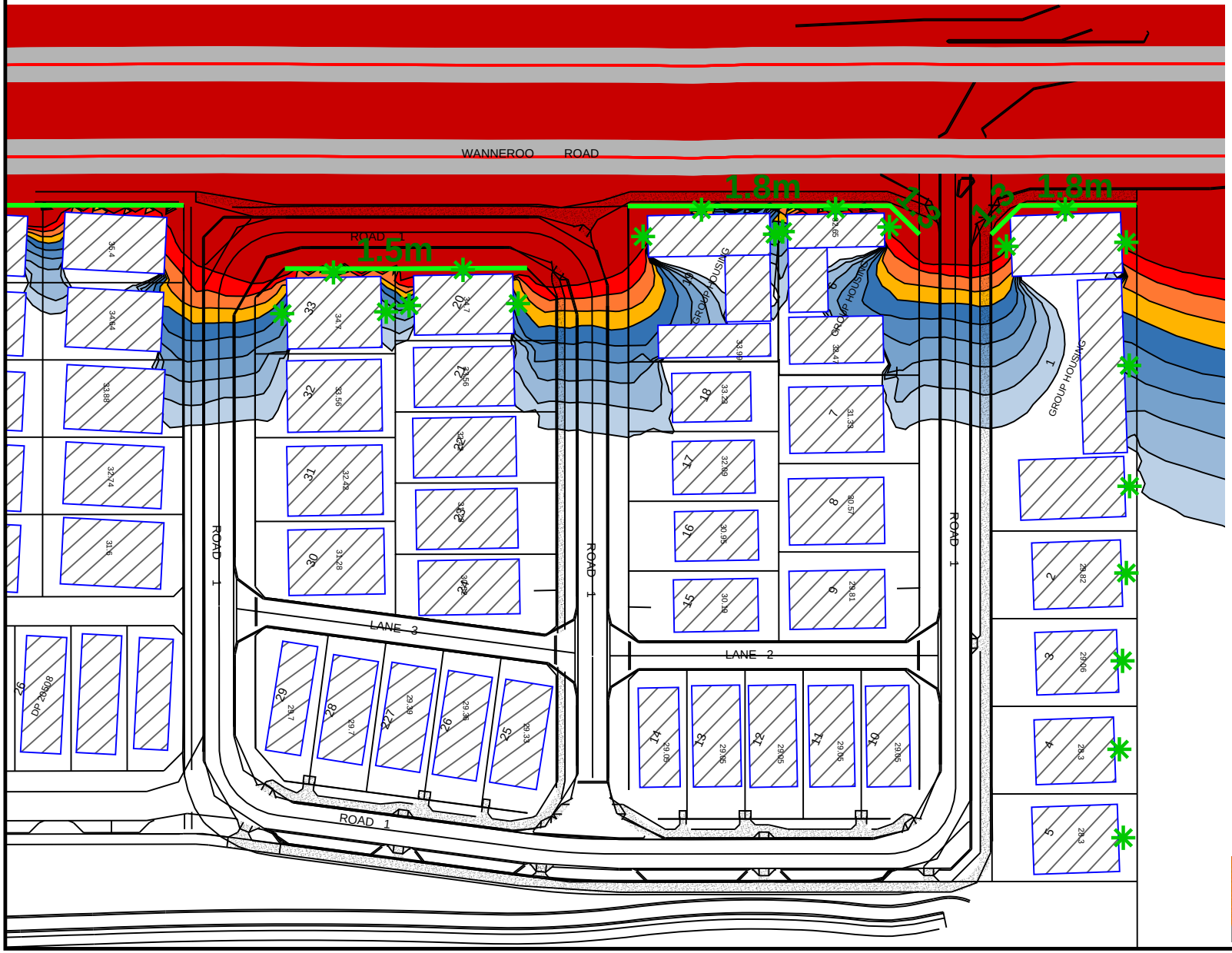
Woodvale Subdivision (Stage 1) - Watson Property Group Northern Aspects Ltd

LAeq,Day Noise Level Contours - With Walls to Achieve Limit of 63 dB LAeq(Day)

Figure 4.4



Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

N

Signs and symbols

- Road Centre
- Road Surface
- Building
- Point receiver
- Wall

19 May 2010

Length Scale 1:1200

0 5 10 20 30 40 m

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5 ASSESSMENT

The objectives of the criteria are for noise at all houses to be no more than the *limit* and preferably no more than the *target*. Noise levels above the *limit* are generally considered unacceptable for residential use. 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.

To achieve the *limit*, moderate walls are required (up to 2.1 metres above lot level). To achieve the *target*, walls up to 3.8 metres high would be necessary. Walls of this height were considered impracticable given the Western Power height restrictions, however for the lots set-back by the local road (Lots 20 & 39), achieving the *target* may be practicable.

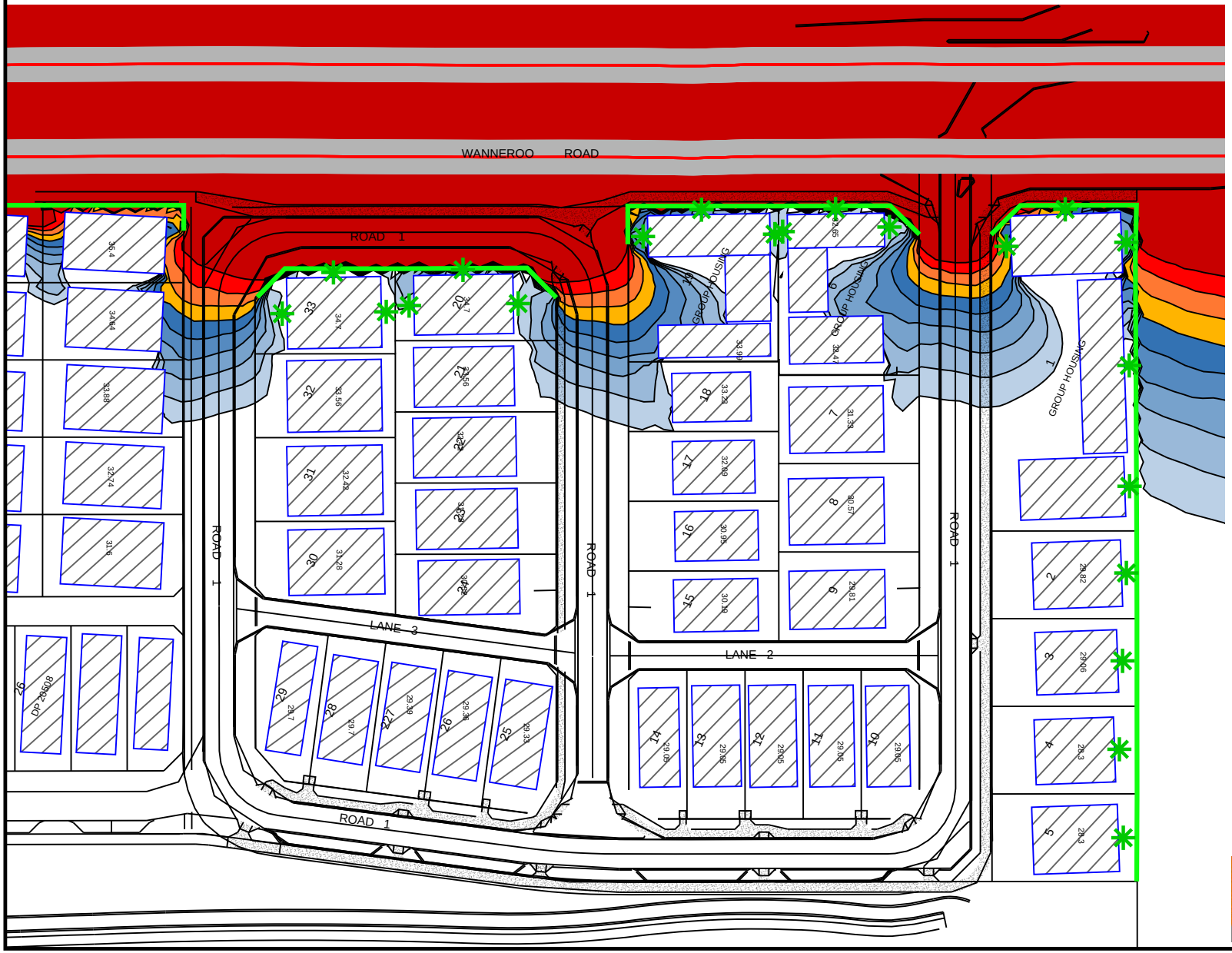
An alternative approach was taken whereby the design team would use the wall heights of *Figure 4.3* as the minimum required and then increase these as far as practicable taking into account the Western Power restriction and aesthetics. The proposed noise walls are shown in *Appendix A*, with the top of wall height incorporated into the noise model. The resultant noise levels are shown on *Figure 5.1* with *Figure 5.2* showing those lots that are still considered affected by noise.

Based on the proposed walls, the WAPC Policy can be satisfied by a combination of noise walls and Package A treatments – refer *Appendix B* for details. Note that noise walls must be solid, free of gaps and have a minimum surface mass of 12kg/m^2.

Figure 5.1

Woodvale Subdivision (Stage 1) - Watson Property Group Northern Aspects Ltd

LAeq,Day Noise Level Contours - With Proposed Walls



Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

N

Signs and symbols

- Road Centre
- Road Surface
- Building
- Point receiver
- Wall

13 June 2010

Length Scale 1:1200

0 5 10 20 30 40 m

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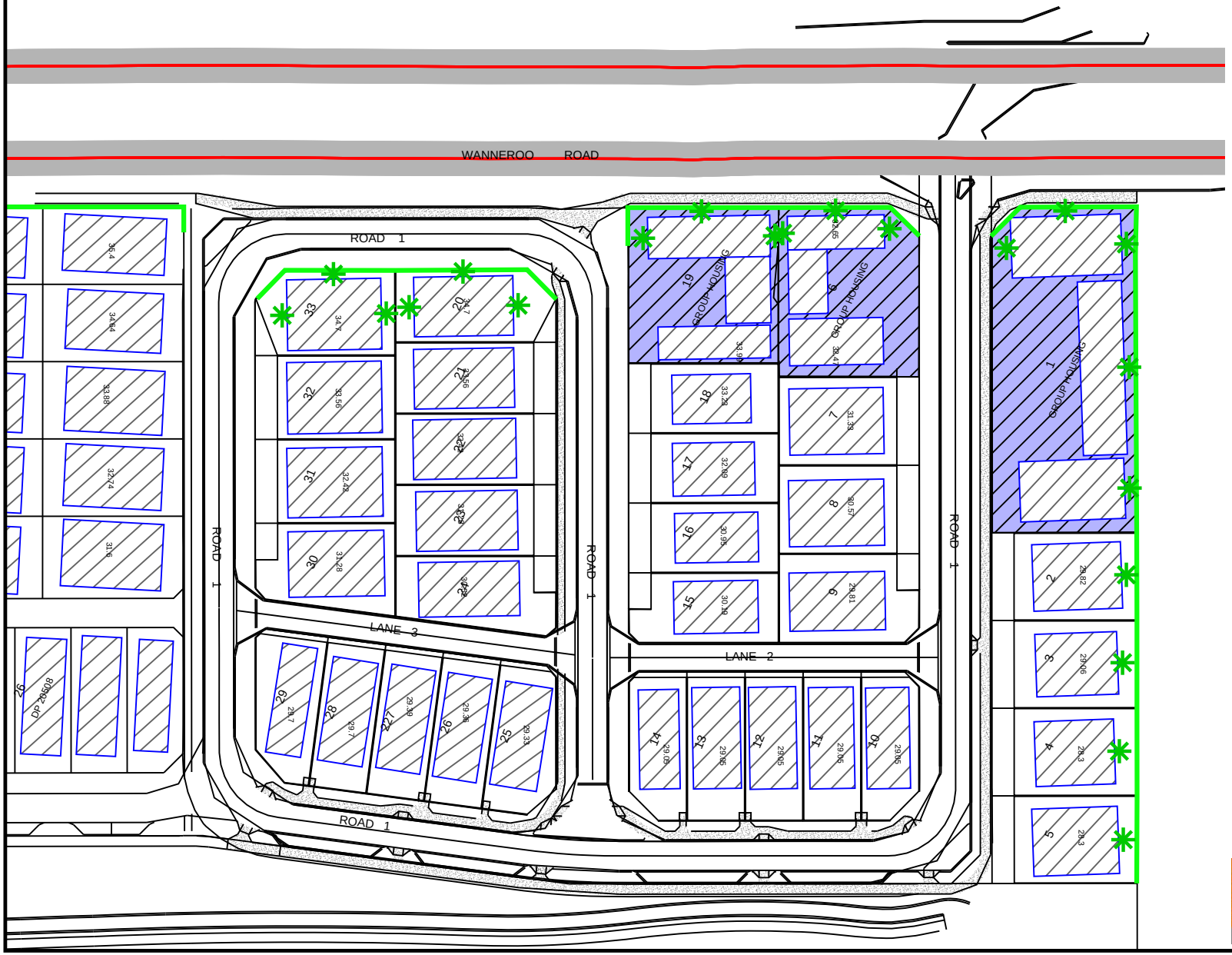
Figure 5.2

Woodvale Subdivision (Stage 1) - Watson Property Group Northern Aspects Ltd

Lots Above Target Requiring Package A Treatment - With Proposed Walls in Place



Signs and symbols

- Road Centre
- Road Surface
- Building
- Point receiver
- Wall
- Package A Treatment Req'

13 June 2010

Length Scale 1:1200

0 5 10 20 30 40 m

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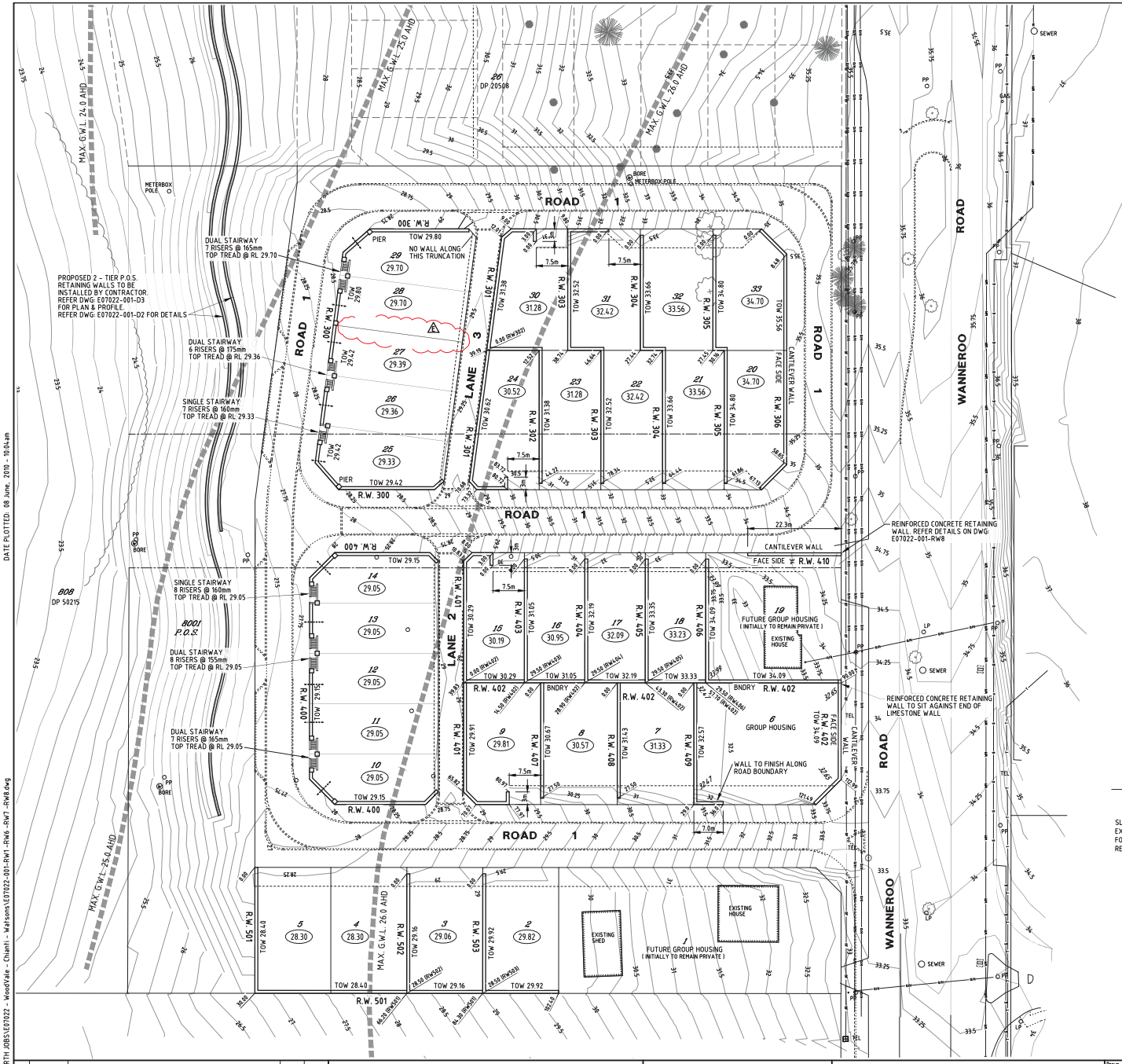
APPENDIX A

Subdivision Design Drawings

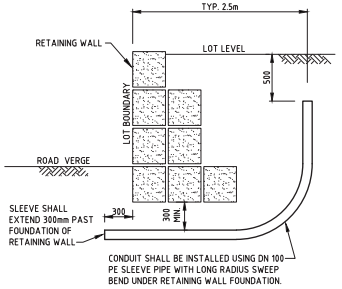


LEGEND

- PROPOSED RETAINING WALLS REFER WALL PROFILE DRAWING (ALL WALLS VIEWED FROM LOWER SIDE) (CHAINAGES SHOWN @ RELEVANT PTS.)
- BNDRY — CADASTRAL BOUNDARY SIDE OF WALL
- (45.25) — PROPOSED FINISHED LOT LEVELS
- R.W. 207 — PROPOSED RETAINING WALL IDENTIFICATION (2 = SHEET No. 07 = WALL No.)
- 29.26 — PROPOSED DESIGN SPOT LEVEL (ON ROAD CENTRELINE OR LOT CORNER)
- TOW 5.25 — TOP OF WALL LEVEL. (EXCL. CAPPING PIECE)
- PROPOSED LOCATION OF STAIRWAYS
- STAIRS 12 RISERS @ 160mm TOP TREAD @ RL 5.53 — NUMBER OF STEP RISERS - EACH BEING ? HIGH. FINAL LEVEL AT TOP OF STAIRWAY.
- EXISTING TREES - AS SURVEYED
- PP LP — EXISTING POWER / STAY POLES LIGHT POLES
- EXISTING DRAINAGE INLET PITS
- EXISTING DRAINAGE PIPES & JUNCTION PITS
- EXISTING SEWER PIPEWORK
- EXISTING WATER SUPPLY
- EXISTING HIGH PRESSURE GAS MAINS
- EXISTING TELSTRA CONDUIT
- EXISTING UNDERGROUND ELECTRICAL
- EXISTING AERIAL/OVERHEAD POWER
- PROPOSED KERBING / EDGE OF SEAL
- PROPOSED FINISHED LEVEL CONTOURS
- PROPOSED IRRIGATION CONDUIT LOCATIONS (SEE DETAIL BELOW)

NOTES

1. LEVEL DATUM - AUSTRALIAN HEIGHT DATUM.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH RETAINING WALL ELEVATIONS / PROFILES DRAWINGS & STAIRWAY DETAIL DRAWINGS. PIER LOCATIONS SHALL BE AS PER DWGs: E07022-001-RW3 & -RW4.
3. ANTI-GRAFFITI COATING (NON SACRIFICAL TYPE) TO BE APPLIED TO ALL WALLS EXPOSED TO ROAD FRONTAGE, P.O.S. OR SCHOOLS. CONFIRMATION THAT COATING HAS BEEN APPLIED TO RELEVANT WALLS AND CLEANING SPECIFICATION SHALL BE SUPPLIED TO THE PRINCIPAL.
4. THE CONTRACTOR SHALL INSTALL FENCING ON WALLS AS SPECIFIED ON FECING PLAN E07022-001-F1.
5. WALLS WITHOUT FEATURE FENCING - SHALL HAVE TEMPORARY SAFETY FENCING - ERECTED ON ALL FINISHED RETAINING WALLS GREATER THAN 1.0m IN HEIGHT.
6. THE CONTRACTOR SHALL ENSURE THAT THE NECESSARY CONDUITS FOR SERVICING THE LOT - ARE INSTALLED UNDER THE WALLS - PRIOR TO CONSTRUCTION. REFER APPLICABLE SERVICING PLANS. INDIVIDUAL LOT LANDSCAPE IRRIGATION CONDUIT TO BE INSTALLED AS PER DETAIL ON THIS DRAWING & LOCATED AS SHOWN.
7. PIER SIZES & WALL THICKNESSES SHOWN ARE NOT DRAWN TO SCALE.



TYP. LOT - VERGE IRRIGATION CONDUIT DETAIL

NOT TO SCALE

NOTES:

- THE CONTRACTOR SHALL INSTALL VERGE IRRIGATION CONDUIT TO ALL LOTS WHERE RETAINING WALLS RUN ALONG THE FRONT ROAD RESERVE. REFER TO LOCATIONS SHOWN ON PLAN.
- THE CONTRACTOR SHALL ALSO INSTALL - CONDUITS AND LONG BENDS FOR ALL OTHER SERVICES (ie. WATER, GAS, TELSTRA, POWER) UNDER RETAINING WALLS - AS REQUIRED. REFER APPLICABLE SERVICING PLANS. (SEPARATE TO THIS DETAIL)
- THE CONTRACTOR SHALL ALLOW FOR PROVISION OF DIGITAL / HARD COPY OF THE AS-CONSTRUCTED INFORMATION.
- ALL SERVICES SHALL BE PROPERLY CAPPED OFF 0.5m BELOW FINISHED GROUND LEVEL WITH MARKER TYPE: IRRIGATION (PE160 PN8) - GREEN TAPE
- IN THE EVENT THAT THE FOOTPATH IS ADJACENT OR AGAINST THE RETAINING WALL, THE IRRIGATION CONDUIT SHALL BE EXTENDED (300mm) BEYOND THE FOOTPATH / D.U.P AS APPROPRIATE.
- CONDUIT TO BE SEALED, FLAGGED AND INSTALLED WITH A DRAW WIRE

1:500 0 5m 10 15 20 25 30 35 40 45 50

W.A.P.C. 140038

Rev	Date	Description	Drawn	Appr.
E	8.06.10	RET.WALL @ LOTS 27/28 REMOVED @ CLIENT REQUEST	WSJ	NTT
D	4.06.10	POS WALLS ADDED. RW307 NOT THIS CONTRACT	WSJ	NTT
C	13.4.10	MAX. G.W.L. CONTOURS ADDED	WSJ	RPA
B	1.4.10	ISSUED FOR LOC.AUTH. APPROVAL	WSJ	RPA
A	19.03.10	ISSUED FOR INTERNAL REVIEW	WSJ	NTT

chianti
PRIVATE ESTATE - WOODVALE

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

		Date
Drawn	WSJ	19.03.10
Designed	WSJ	19.03.10
Checked	RPA	31.3.10
Reviewed	NTT	31.3.10
Approved	NTT	31.3.10

Client: WATSON PROPERTY GROUP
Project: CHIANTI PRIVATE ESTATE - STAGE 1 LOTS 27, 28 & 801, WANNEROO ROAD WOODVALE
Title: RETAINING WALLS LAYOUT PLAN

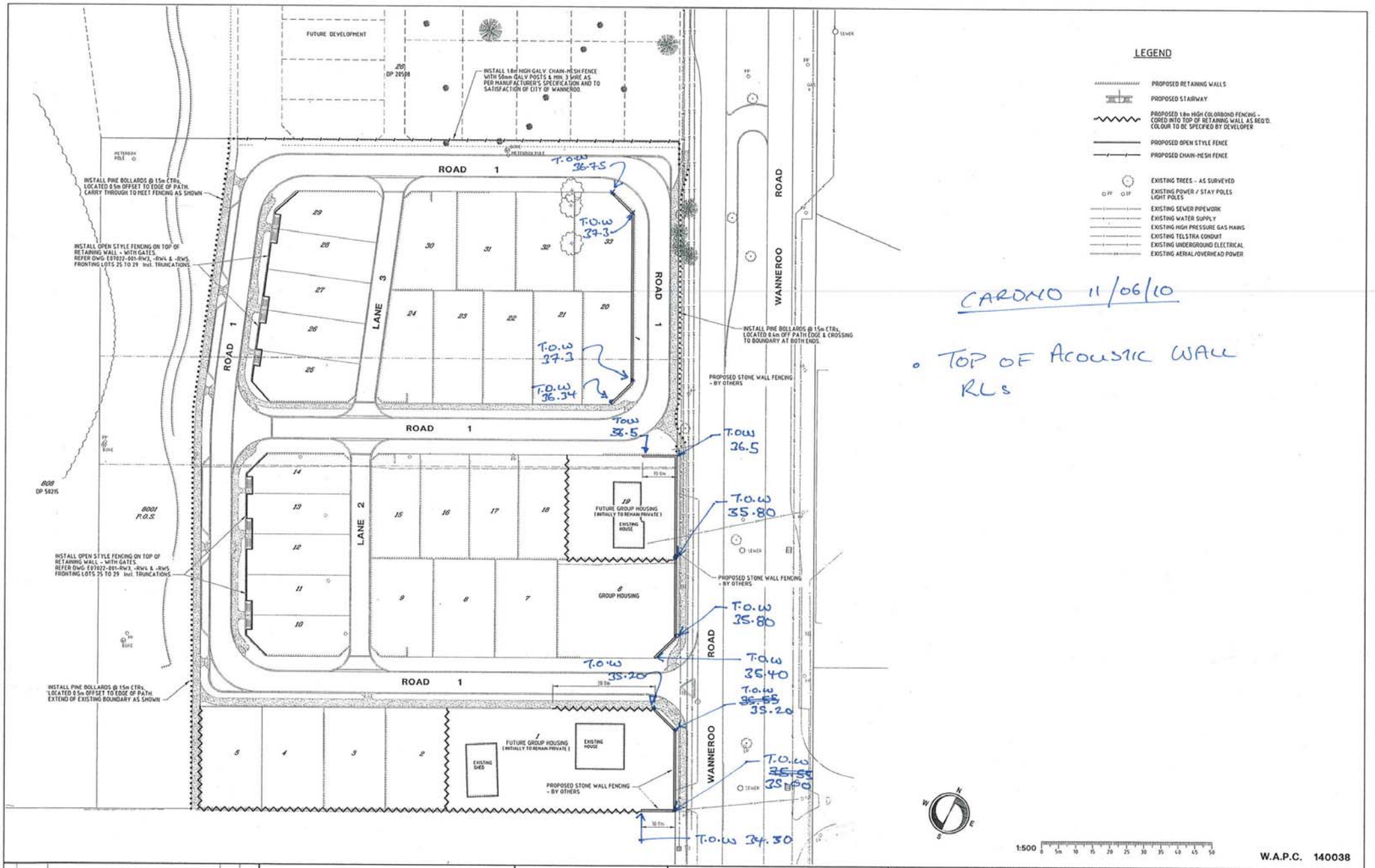
Status: PRELIMINARY ISSUE

Date	Datum	Scale	Size
19.03.10	A.H.D.	1 : 500	A1

Drawing Number: E07022-001-RW1 Revision: E

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

DATE PLOTTED: 08 June, 2010 - 10:04am
XREFs: XR-0A, XD-CONT
CAD FILE S:\Projects\AAA - PERTH JOBS\E07022 - Woodvale - Chianti - Watsons\E07022-001-RW1-RW6 -RW7 -RW8.dwg



Rev	Date	Description	Drawn	Appr
C	4.06.10	WALLS, FENCING & BOLLARDS EXTENDED	WSJ	NTT
B	14.10	ISSUED FOR LOC.AUTH. APPROVAL	WSJ	RPA
A	19.03.10	ISSUED FOR INTERNAL REVIEW	WSJ	NTT

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PRIVATE ESTATE - WOODVALE

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BUILDING DESIGN

		Date
Drawn	WSJ	19.03.10
Designed	WSJ	19.03.10
Checked	RPA	31.3.10
Reviewed	NTT	31.3.10
Approved	NTT	31.3.10

Client: WATSON PROPERTY GROUP
Project: CHIANTI PRIVATE ESTATE - STAGE 1
LOTS 27, 28 & 801, WANNEROO ROAD
WOODVALE
Title: FENCING LAYOUT PLAN

Status: PRELIMINARY ISSUE
Date: 19.03.10 | Datum: A.H.D. | Scale: 1:500 | Size: A1
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APPENDIX B

Deemed-to-Satisfy Construction Standards

Noise insulation – "Deemed to Comply" packages for residential development

The following "deemed-to-comply" Packages outline noise insulation measures that are designed to ensure that the indoor noise standards in the Policy are achieved for residential developments in areas where outdoor noise levels will exceed the *target* noise levels by up to 8 dB(A).

The deemed-to-comply specifications are intended to simplify compliance with the noise criteria, and the relevant Package should be required as a condition of development. However, this should not remove the option to pursue alternative measures or designs. Departures from the deemed-to-comply specifications need to be accompanied by acoustic certification from a competent person, to the effect that the development will achieve the requirements of the Policy.

Superior construction standards, such as those specified in the "deemed-to-comply" packages, are now becoming more prevalent in residential buildings; and do not significantly increase the cost of building. A similar standard of construction has been recommended by the Western Australian Planning Commission for new housing in areas forecast to be seriously affected by aircraft noise.[1] That recommendation followed a comprehensive assessment of the efficacy and costs of noise attenuation measures, taking into account the recent changes in industry building standards as well as changes to the *Building Code of Australia*.

Where transport noise levels are more than 8 dB above the noise *target*, i.e. 3 dB above the noise *limit*, or where noise-sensitive development other than residential is proposed, a Detailed Assessment should be prepared by a competent person. The report should specify the level of noise reduction required and the noise insulation measures needed to comply with the Policy. The approval may require that the construction drawings be checked for compliance with the Detailed Assessment, and that follow-up verification be carried out to certify compliance.

[1] Statement of Planning Policy No 5.1, *Land Use Planning in the Vicinity of Perth Airport* and the accompanying report on *Aircraft Noise Insulation for Residential Development in the Vicinity of Perth Airport,* February 2004.

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
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.

Package B: Noise within 3 dB 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 3 dB (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 (minimum) 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.

APPENDIX C

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 $L_{A10,18hour}$.

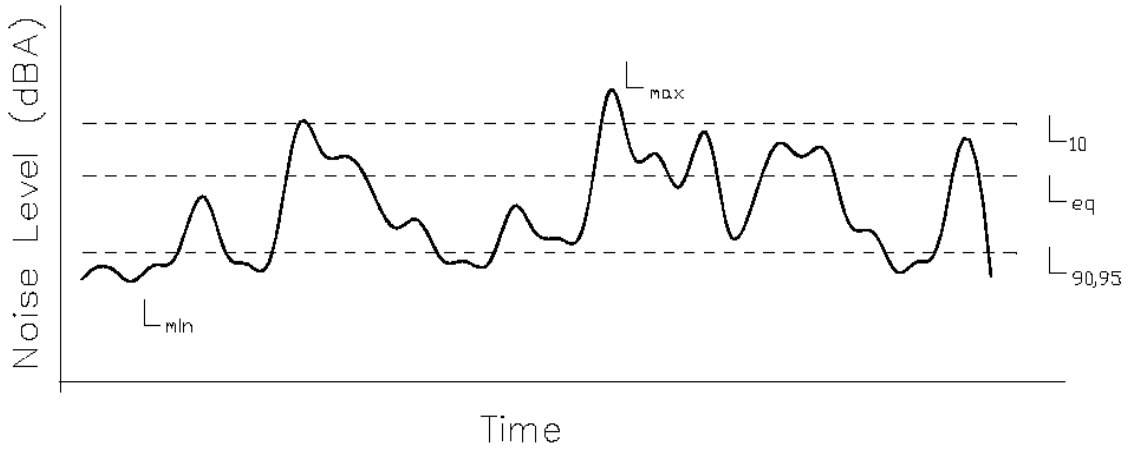
Satisfactory Design Sound Level

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)	Level 2 Axles and Axle Groups		Level 3 Vehicle Type	AUSTROADS Classification		
Type	Axles	Groups	Typical Description	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