MARSHALL DAY Acoustics

PAKENHAM EAST PRECINCT STRUCTURE PLAN
ENVIRONMENTAL NOISE ASSESSMENT

Rp 001 20171138 | 11 January 2018

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Project:	**PAKENHAM EAST PRECINCT STRUCTURE PLAN**
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1.0 INTRODUCTION

The Cardinia Shire Council (CSC) and Victorian Planning Authority (VPA) are preparing a Precinct Structure Plan (PSP) for the Pakenham East area.

The PSP area includes approximately 650 hectares of land located approximately 3 km east of the Pakenham CBD.

Marshall Day Acoustics Pty Ltd (MDA) has been commissioned to undertake a noise assessment for the land within the PSP to consider potential noise impact associated with the intersecting Princes Highway and adjacent Princes Freeway to determine the location of the 63 dB $L_{A10(18hr)}$ noise contour and consider the following:

- Identification of the zone within which noise mitigation will be necessary
- The zone within which the noise barriers may be required
- The type of noise wall barrier to achieve compliance.

This report provides details of relevant noise assessment criteria, measurement surveys and predicted noise levels.

A glossary of acoustic terminology is provided in Appendix A.

2.0 SITE DESCRIPTION

The existing land uses within the PSP area are primarily agriculture (cattle and dairy) with rural residential dwellings and ancillary uses.

The PSP area is intersected by the Princes Highway, with proposed sensitive land uses to the north and south.

The overall site is generally bounded by the following:

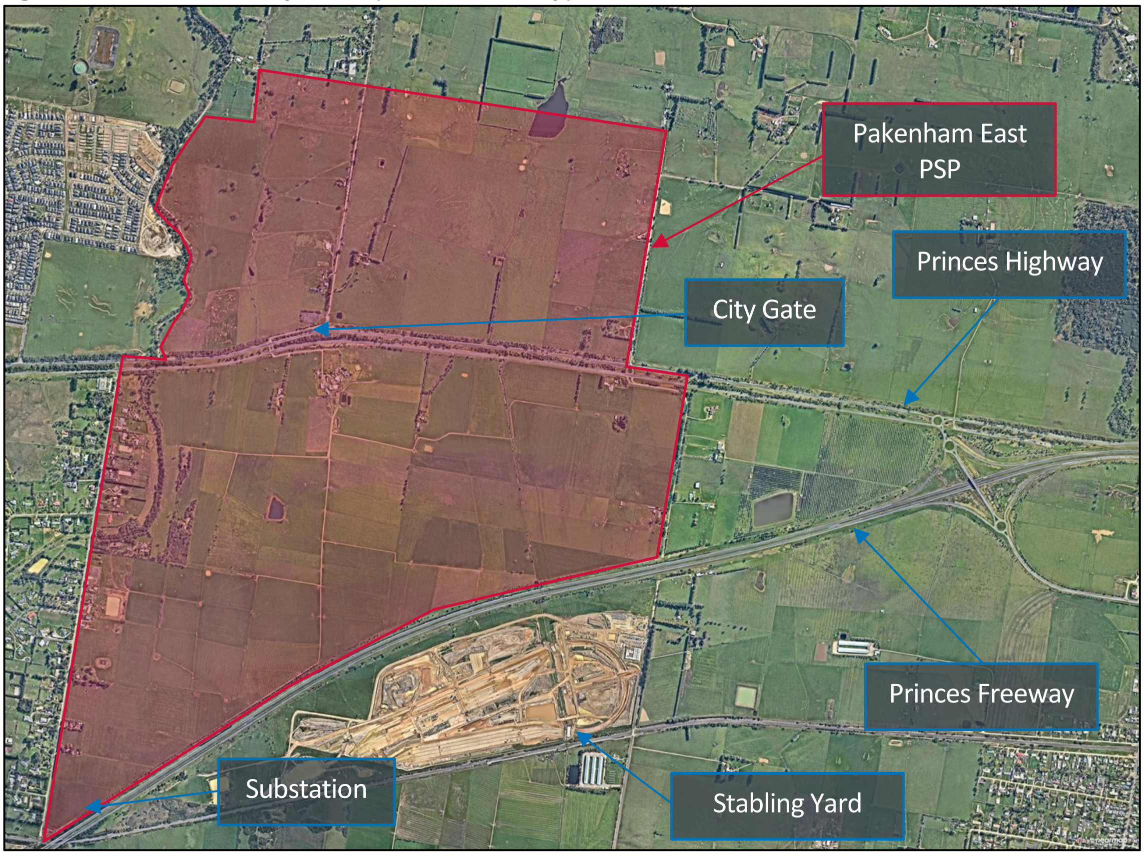
- An electricity transmission easement to the north
- Mount Ararat Road to the east
- The Pakenham Bypass (Princes Freeway) to the south, with the Pakenham Railway Line beyond
- Ryan Road and existing low-density residential development to the west, with Pakenham golf club and the Pakenham CBD beyond

There are a number of industrial facilities surrounding and within the PSP area extent. These include:

- An existing City Gate gas infrastructure located centrally to the PSP at 27 Dore Road
- A stabling yard currently under construction to the south of the site between the Princes Freeway and the Pakenham Railway Line
- A transformer substation located in the south-west corner of the PSP

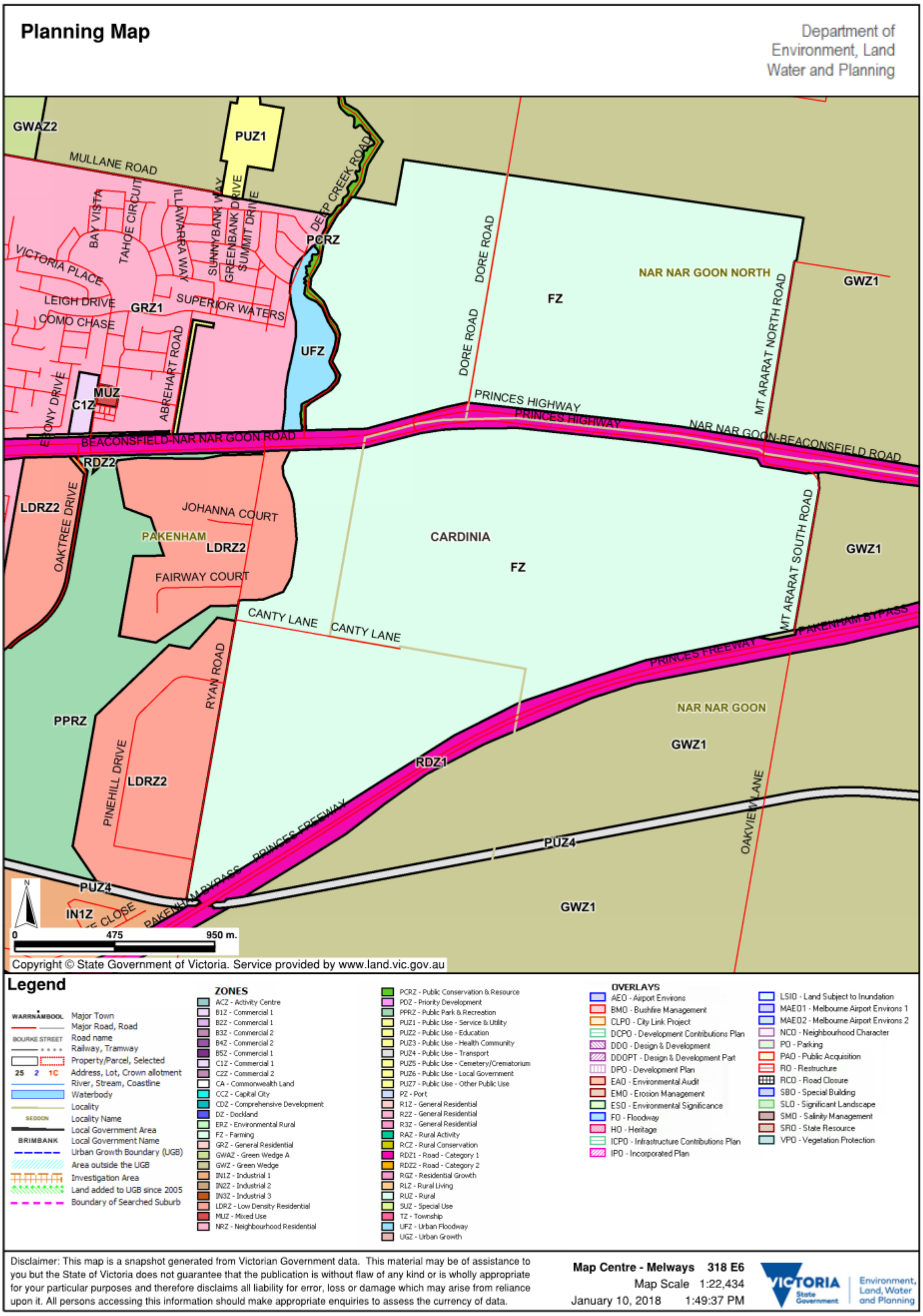
An aerial photograph of the PSP extent and the surrounding environment is provided in Figure 1.

Figure 1: Aerial view of subject site (Source: NearMap)



The land within the PSP is zoned Farming (FZ) with Road (RDZ1), Green Wedge (GWZ1), Low Density Residential (LDRZ2), Public Park and Recreation (PPRZ) and Urban Floodway (UFZ) in the immediate environs. The relevant planning map is provided in Figure 2.

Figure 2: Planning map



3.0 LEGISLATION AND GUIDELINES

A range of guidelines and legislation is used in Victoria to assess environmental noise. This section provides an overview of the key road traffic noise guidelines that are applicable to the PSP for the Pakenham East area.

3.1 Impacts on the development from the surrounding environment

The proposed residential uses of land within the PSP will be impacted by the following noise sources:

- Road traffic noise from the Princes Freeway to the south of the site and the Princes Highway that intersects the site;
- Local industrial sites including the City Gate Gas site and the transformer substation at the south end of Ryan Road;
- Existing local commercial or industrial sites and associated operations (e.g. commercial deliveries or waste collection);
- Train noise from the Pakenham line adjacent to the south-west corner of the PSP.

This report considers impacts associated with road traffic noise only, as it is expected that the external traffic noise insulation requirements to protect the amenity of future occupants will control the acoustic design of the residential building envelope.

3.2 Acoustic Design Criteria

A range of guidelines and legislation is used in Victoria to assess and control road traffic noise ingress for new residential developments. A summary is presented in Table 1. Refer to Appendix B for further details.

Table 1: Relevant Victorian references and guidelines

Reference	Overview
Australian/New Zealand Standard AS/NZS 2107:2016 *"Acoustics - Recommended design sound levels and reverberation times for building interiors"* (AS 2107)	Provides recommendations for acceptable internal noise levels. Table 1 of AS 2107 presents the recommended internal noise levels for "houses and apartments near major roads", which is considered to be applicable to the development site. Refer to Appendix C1 for further detail.
VicRoads' *Traffic Noise Reduction Policy*	VicRoads has developed guidelines for noise mitigation at residential developments near major roads. Refer to Appendix B2 for further detail.

4.0 SITE NOISE SURVEYS

The following sections detail measurements of existing road traffic noise taken within the proposed PSP area.

4.1 Traffic noise

Traffic noise levels have been measured at 2 locations along the Princes Freeway and 2 locations along the Princes Highway along with an intermediary location to allow the contribution of noise from each road to be quantified. The measurement locations are shown in Appendix C.

Noise levels were continuously measured in general accordance with Appendix B4 of VicRoads Road Design Note RDN 06-01 *Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005*. The microphones were mounted on a tripod at a height of 1.5 m above local ground level under free field conditions.

A summary of the measured traffic noise levels are detailed in Table 2 additional detailed measurement information is provided in Appendix D.

Table 2: Average measured traffic noise levels under acceptable weather conditions

Parameter	Average measured noise level, dB				
	Location 1	Location 2	Location 3	Location 4	Location 5
$L_{A10(18h)}$ (6am-midnight)	59	45	60	64	66

5.0 ROAD TRAFFIC NOISE ASSESSMENT

5.1 Noise model

The measurements of traffic noise provide the benefit of offering accurate representation of the noise at the time and location of the measurements. However, noise levels associated with traffic are inherently variable, owing to variations in traffic composition and meteorological effects etc. that affect noise propagation. The challenge in using the measurements is the extent to which the information can be relied upon to consider other times or locations, or to represent wider areas of interest than can be practically assessed with measurements.

As such, noise modelling of road traffic noise has been conducted to consider a wider area of interest. While the model is limited by the accuracy of the calculation's ability to represent actual sound emission and propagation in the environment, they do provide the benefit of enabling wider ranges of time periods and locations to be considered. Importantly, the model provides a practical way of enabling a controlled like-for-like comparison of situations, such as before and after the introduction of a new noise source, a change in traffic flow or the implementation of noise control barriers.

Road traffic noise modelling has been undertaken in accordance with the *Calculation of Road Traffic Noise* (CoRTN) method as implemented in SoundPLAN v7.4 noise modelling software.

5.2 Noise modelling assumptions

5.2.1 Model inputs

The following assumptions were made:

- 50% soft ground was assumed for ground effect attenuation, this was based on the site survey where it was determined the existing vegetation on the site was representative of medium ground
- A facade correction of +2.5 dB was applied to the predicted future road traffic noise levels, such that they could be directly compared with VicRoads' *Traffic Noise Reduction Policy* criteria levels
- No dwellings or other structures were entered into the model. This means the effect of shielding by intervening buildings has not been accounted for and the future road traffic noise levels at a number of locations within the development site are likely to be lower than predicted once development commences.

5.2.2 Traffic and road conditions

VicRoads require noise levels to be considered based on the traffic volumes expected 10 years after construction of the dwellings has begun. It is assumed that construction would commence in 2018, therefore the horizon year for the design of the noise barriers is 2028. In addition, traffic conditions for 2017 are required for the noise model calibration. Table 3 provides a summary of the traffic information obtained from VicRoads' website[1] as 24 hr annual average daily traffic (AADT) volumes and relative percentage of commercial heavy vehicles (%HV) for the Princes Freeway and Princes Highway.

Table 3: Traffic volumes (vehicles per day – 24 hr AADT)

Road/Location		2006	2013	2014	2015	2016
Princes Freeway Eastbound	All vehicles	8,100	10,000	11,000	11,000	12,000
	Commercial vehicles	1,100	1,700	1,800	1,800	1,800
	%HV	14 %	17 %	16 %	16 %	15 %
Princes Freeway Westbound	All vehicles	9,100	11,000	12,000	12,000	13,000
	Commercial vehicles	1,300	1,900	1,900	1,900	1,900
	%HV	14 %	17 %	16 %	16 %	15 %
Princes Highway Eastbound	All vehicles	9,700	2,500	2,500	2,500	2,600
	Commercial vehicles	1,300	200	200	200	200
	%HV	13 %	8 %	8 %	8 %	8 %
Princes Highway Westbound	All vehicles	9,900	2,300	2,300	2,300	2,400
	Commercial vehicles	1,400	190	180	180	180
	%HV	14 %	8 %	8 %	8 %	8 %

Daily traffic volumes were calculated for current (2017) and 2028 based on the growth seen between 2013 and 2016. It was assumed that truck traffic would remain steady as indicated by the historic traffic data, such that the proportion of heavy vehicles (%HV) would decrease.

The estimated future traffic volumes for the site are shown in Table 4. Once a fixed date is determined for the commencement of construction, revised traffic forecasts would need to be considered for future scenarios. This is however, unlikely to have any significant effect on the subsequent noise barrier estimates. For example, if the horizon year was 2030, and the estimated traffic volumes were 5 % higher than the 2028 volumes shown in Table 4,then the corresponding noise level increase would be approximately 0.2 dB, which is considered negligible and would not change the outcomes of this report.

[1] VicRoads, 2017, *Road use and Performance*, https://www.vicroads.vic.gov.au/traffic-and-road-use/road-network-and-performance/road-use-and-performance, accessed 22 November 2017

Table 4: Daily traffic volumes used in noise model (vehicles per day – 24 hr AADT)

Road/Location		2017 (calibration)	2028 (10 years post commencement of construction)
Princes Freeway Eastbound	All vehicles	12500	19585
	%HV	15 %	15 %
Princes Freeway Westbound	All vehicles	13500	20447
	%HV	15 %	15 %
Princes Highway Eastbound	All vehicles	2625	2916
	%HV	8 %	7 %
Princes Highway Westbound	All vehicles	2425	2718
	%HV	8 %	7 %

The 18-hour traffic volumes used in the model to calculate $L_{A10(18h)}$ noise levels were set to 95% of the daily volumes.

The traffic speed in the model was set to 100 km/h for all roads of interest. The road surfaces for all the road sections of interest have been confirmed by VicRoads to be a combination of size 14 mm and 7 mm spray seals and asphalt. This corresponds to a correction of +4 dB for spray seals 10 mm or larger, which has been applied to all roads in the model.

5.3 Noise model calibration

The noise monitor locations shown in Appendix C were entered into the noise model and the existing noise levels modelled based on the 2017 traffic data in Table 4 and input data in Section 5.2.2. The modelled noise levels were compared to the measured noise levels to assess the accuracy of the model. Table 5 shows a comparison of the measured and modelled noise levels.

Table 5: Measured and modelled noise levels (2017), dB $L_{A10(18h)}$

Description	Location 1	Location 2	Location 3	Location 4	Location 5
Measured	59	45	59	64	66
Modelled	62	49	62	70	71
Difference	+3	+4	+3	+6	+5

Note: values shown do not include facade correction, i.e. comparing free field measurements with free-field predictions

The mean level of these differences was used to adopt a calibration factor of -4 dB to adjust the noise model for local conditions.

5.4 Noise modelling scenarios

In accordance with VicRoads' requirements, two scenarios were modelled to inform the design of future noise barriers for the PSP. These scenarios are based on forecast traffic volumes to the year 2028:

- No noise barriers
- Noise barriers to achieve 63 dB $L_{A10(18h)}$ at the lowest-habitable floor of future dwellings.

5.5 Predicted road traffic noise levels

5.5.1 No noise barrier

Appendix E1 shows predicted noise levels at the ground floor level, for 2028 for the no noise barrier scenario. As shown, VicRoads' target noise objective of 63 dB $L_{A10(18h)}$ is exceeded across a significant portion of the PSP site that is proposed for residential use. Therefore, a noise barrier is required along the northern edge of the Princes Freeway.

5.5.2 Noise barrier to achieve VicRoads criteria at ground floor locations

Appendix E2 shows predicted noise levels for 2028 together with the extent and approximate heights above road level for a noise barrier to achieve compliance with the VicRoads 63 dB $L_{A10(18h)}$ traffic noise objective at the ground floor level. The recommended height of the barrier varies along its length, ranging from 3 m high where the proposed residential regions are set back from the freeway and separated by unaccredited open space to 6 m where the proposed residential regions front directly onto the freeway. No barrier is required along the Princes Highway, however noise mitigation measures to achieve the AS2107 internal criteria detailed in Appendix B2 would be required on houses within the 63 dB contour lines.

5.5.3 Dwellings requiring facade treatments to upper floor levels

Appendix E3 shows predicted noise levels at 4.5 m above ground (i.e. first floor level of double storey dwellings) for 2028 with the noise barrier discussed in Section 5.5.2 in place. Any multi-story dwellings to be constructed within the 63 dB $L_{A10(18h)}$ contour band of the predicted noise levels at 4.5 m above ground will require noise mitigation measures to achieve the AS2107 internal criteria detailed in Appendix B2, for first floor and above levels.

5.5.4 Detailed design

Based on experience on previous projects, it is expected that the alignment of the noise barrier will need to be refined in order to accommodate feedback from VicRoads, the effect of any changes to the horizon year, and any civil engineering considerations. In addition, there may be changes in terrain height on the site to accommodate drainage or other considerations. Once any terrain changes have been determined and the final noise barrier alignment has been agreed, the noise barrier will require detailed noise modelling to optimise the height recommendations.

6.0 ROAD TRAFFIC NOISE CONTROL

6.1 Noise barrier

As described in Section 5.5.2, a noise barrier is required for compliance with VicRoads criteria. With the proposed noise barrier in place, the VicRoads criteria is achieved at the ground level of all dwellings along the Princes Freeway. Construction details for a suitable barrier are included in Appendix F.

6.2 Facade treatment

The upper floor of future potential dwellings within the 63 dB $L_{A10(18h)}$ noise contour of Appendix E3 will likely require the incorporation of upgraded facade construction. The extent of the facade upgrade requirements will be dependent on a number of factors, including the relative location/alignment of dwelling allotments, final noise barrier designs etc. Indicative treatment may include requirements for masonry wall construction and thicker/laminate glazing to upper floor levels. This will need to be reviewed following the detailed design of the site masterplan including relative dwellings' layout.

7.0 SUMMARY

Marshall Day Acoustics (MDA) has been commissioned to undertake a noise assessment of the proposed Pakenham East PSP.

The assessment concludes that:

- The site is affected by noise from the Princes Highway and the Princes Freeway
- Noise modelling conducted in accordance with VicRoads requirements demonstrates that noise levels on the subject site can be mitigated in accordance with VicRoads' requirements. The preferred solution achieves this outcome by utilizing:
    - A noise barrier along the northern edge of the Princes Freeway with heights varying between 3 m and 6 m
    - All dwellings within the 63 dB $L_{A10(18h)}$ predicted noise contour at 1.5 m to incorporate facade treatments to achieve internal noise levels consistent with AS2107 (ie. dwelling located immediately north and south of the Princes Highway).
    - Two storey dwellings within the 63 dB $L_{A10(18h)}$ predicted noise contour at 4.5 m to incorporate facade treatments to achieve internal noise levels consistent with AS2107.

APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	Decibel The unit of sound level.
L_{A90}	The noise level exceeded for 90% of the measurement period, measured in dB. This is commonly referred to as the background noise level.
$L_{A10\,(t)}$	The A-weighted noise level equalled or exceeded for 10% of the measurement period. This is commonly referred to as the average maximum noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Aeq}	The equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dB.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
Sound Insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to ability of a material to stop sound travelling through it.
R_w	Weighted Sound Reduction Index A single number rating of the sound insulation performance of a specific building element. Rw is measured in a laboratory. Rw is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.
Hertz (Hz)	Vibration can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. The frequency of vibration and sound is measured in hertz (Hz). Once hertz is one cycle per second. Structural Vibration is generally measured over the frequency range from 1Hz to 500Hz (0.5kHz).

APPENDIX B LEGISLATION AND GUIDELINES

B1 Australian/New Zealand Standards

Australian/New Zealand Standard 2107-2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors* (AS/NZS 2107) provides recommendations for acceptable internal noise levels. Table 9 shows the recommended internal design sound levels stated in AS/NZS2107 for "*houses and apartments in inner city areas or entertainment districts or near major roads*", which is considered to be applicable to the proposed development.

Table 6: AS/NZS2107 recommended internal noise levels

Area	Recommended design sound level range, dB L_{Aeq}
Living areas	35-45
Sleeping areas	35-40
Work areas	35-45
Apartment common areas (e.g. lobbies)	45-50

Compliance with the lower level is preferred, but compliance with the upper noise level is considered to be acceptable.

Higher quality developments should aim to achieve lower levels of traffic noise intrusion. MDA's project experience shows that if internal noise levels in bedrooms or living areas exceed an hourly average of approximately 40 dB L_{Aeq} that the level of occupant dissatisfaction is likely to be relatively high. Therefore, an internal level of 35 dB L_{Aeq} within bedrooms would typically be recommended.

Australian Standard 3671-1989 *Acoustics – Road traffic noise intrusion* (AS3671) provides recommended minimum façade constructions based on measured road traffic noise levels. Four categories of construction, determined by the amount of traffic noise reduction (TNR) expected, are identified. Table 7 details the AS3671 construction categories.

Table 7: AS3671 construction categories

Category	Description	Expected TNR – dB (A)
1	Standard construction; openings, including open windows and doors may comprise up to 10% of the exposed façade.	10
2	Standard construction, except for lightweight elements such as fibrous cement, metal cladding or all-glass façades. Windows, doors and other openings must be closed.	25
3	Special construction, windows, doors and other openings must be closed.	25-35
4	Specialist acoustic advice should be sought	>35

B2 VicRoads Traffic Noise Reduction Policy

VicRoads has an internal policy which is used to determine entitlement to noise barriers in situations where VicRoads takes responsibility for noise mitigation at existing noise sensitive developments. Since October 1997, this policy has been known as the Traffic Noise Reduction Policy. The Policy recommends design objectives for traffic noise in Victoria.

Where new noise sensitive developments are planned close to existing major traffic routes, the developer must take responsibility for noise mitigation. VicRoads is a referral authority, and so has the right to seek to impose requirements on residential developers seeking planning approvals for land adjacent to VicRoads-controlled roads.

VicRoads' Traffic Noise Reduction Policy recommends traffic noise level objectives that are used by VicRoads when building new roads or upgrading existing roads. In addition, VicRoads has developed guidelines for noise mitigation at residential developments near major roads. These guidelines recommend developers undertake some combination of the following:

- Erect traffic noise barriers of sufficient height and suitable construction in order to reduce external noise levels to 63 dB $L_{A10(18h)}$ or less at the ground floor level of the worst-affected dwellings

Provide sound insulation treatment to residential dwellings sufficient to achieve compliance with the recommended internal noise levels specified in Australian Standard 2107:2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors.*

APPENDIX C NOISE MEASUREMENT LOCATIONS

APPENDIX D UNATTENDED NOISE MEASUREMENT SURVEY

Traffic noise levels were measured using sound level meters fitted with weatherproof windshields. The microphones were mounted 1.5m above local ground level under freefield conditions. Details of the noise monitors used are provided in Table 8.

Table 8: Noise monitor details and locations – MGA 94 Zone 55

Noise Monitor	Model No.	Serial No.	Easting (m)	Northing (m)
1	ARL 316	316-004-012	370515	5786040
2	ARL 316	316-004-024	370525	5786733
3	ARL 316	316-004-027	371165	5786094
4	ARL 316	316-207-029	372164	5785036
5	01dB Cube	10516	370994	5784619

Measurements were obtained using the ‘F’ response time and A-weighting frequency network. The equipment was calibrated before and after the survey and no significant calibration drifts were observed.

The local noise environment was characterised by typical rural noise sources, including traffic from surrounding highways and train pass by events at the southern end of the site.

Consecutive measurements were obtained between Wednesday 1 November 2017 and Friday 10 November 2017.

Weather data has been taken from the Bureau of Meteorology’s weather station at Scoresby, with periods of high wind or significant rainfall highlighted Table 9.

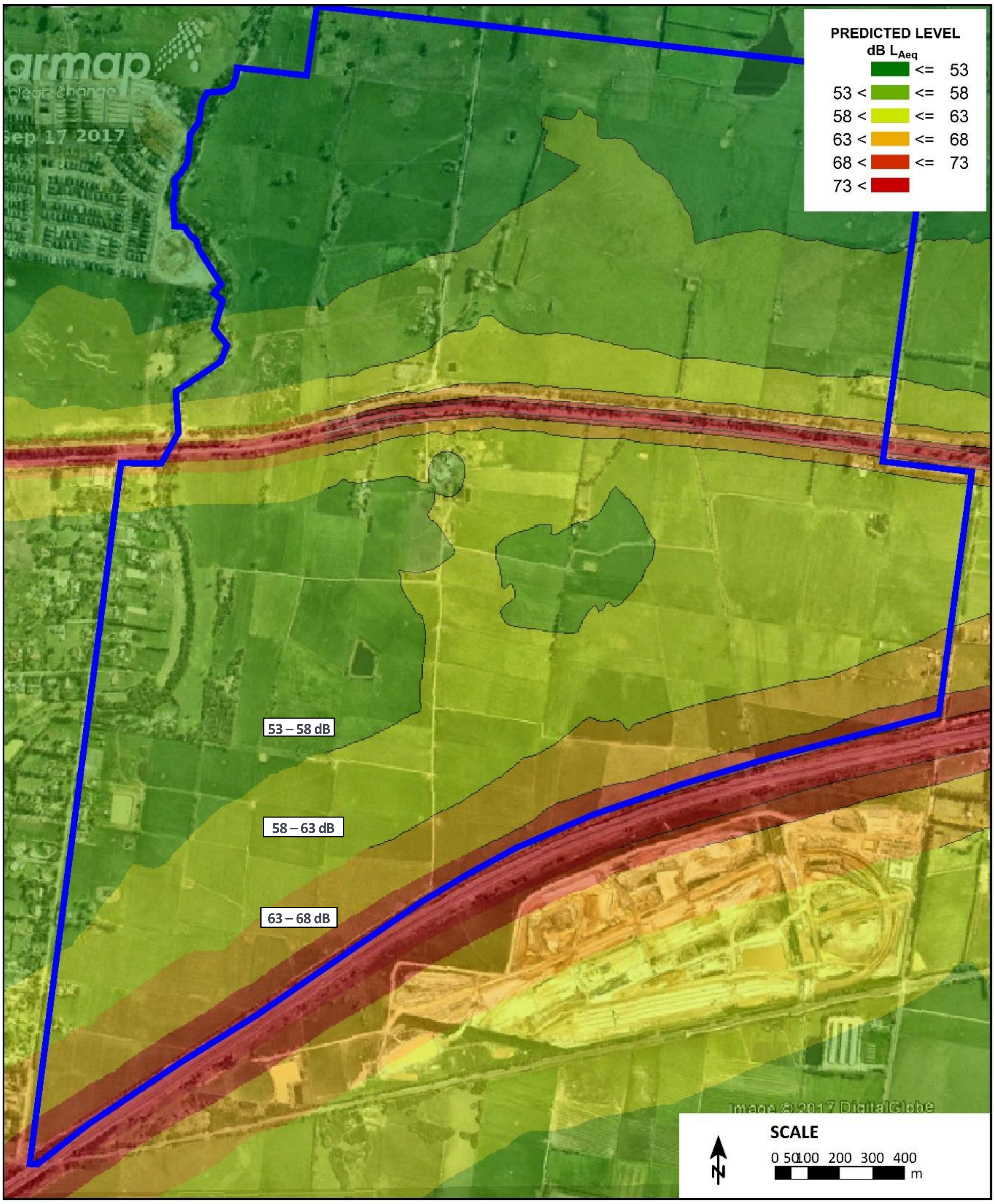
Table 9: Measured noise levels at subject site, $L_{A10\,(18hr)}$ (0600 hrs – 0000 hrs)

Date	Measured noise level, dB				
	1	2	3	4	5
Wednesday 1 November 2017	60	46	62	66	66
Thursday 2 November 2017	58	45	61	65	66
Friday 3 November 2017*	60	47	62	66	68
Monday 6 November 2017	60	45	61	64	67
Tuesday 7 November 2017	58	47	60	65	66
Wednesday 8 November 2017	58	46	59	63	66
Thursday 9 November 2017	58	43	58	62	66
Friday 10 November 2017	58	44	57	63	65
Averages					
Weekday average	59	45	60	64	66

*Not included due to poor weather conditions

APPENDIX E PREDICTED NOISE CONTOURS

E1 2028 No Noise Barriers (ground level)



Legend

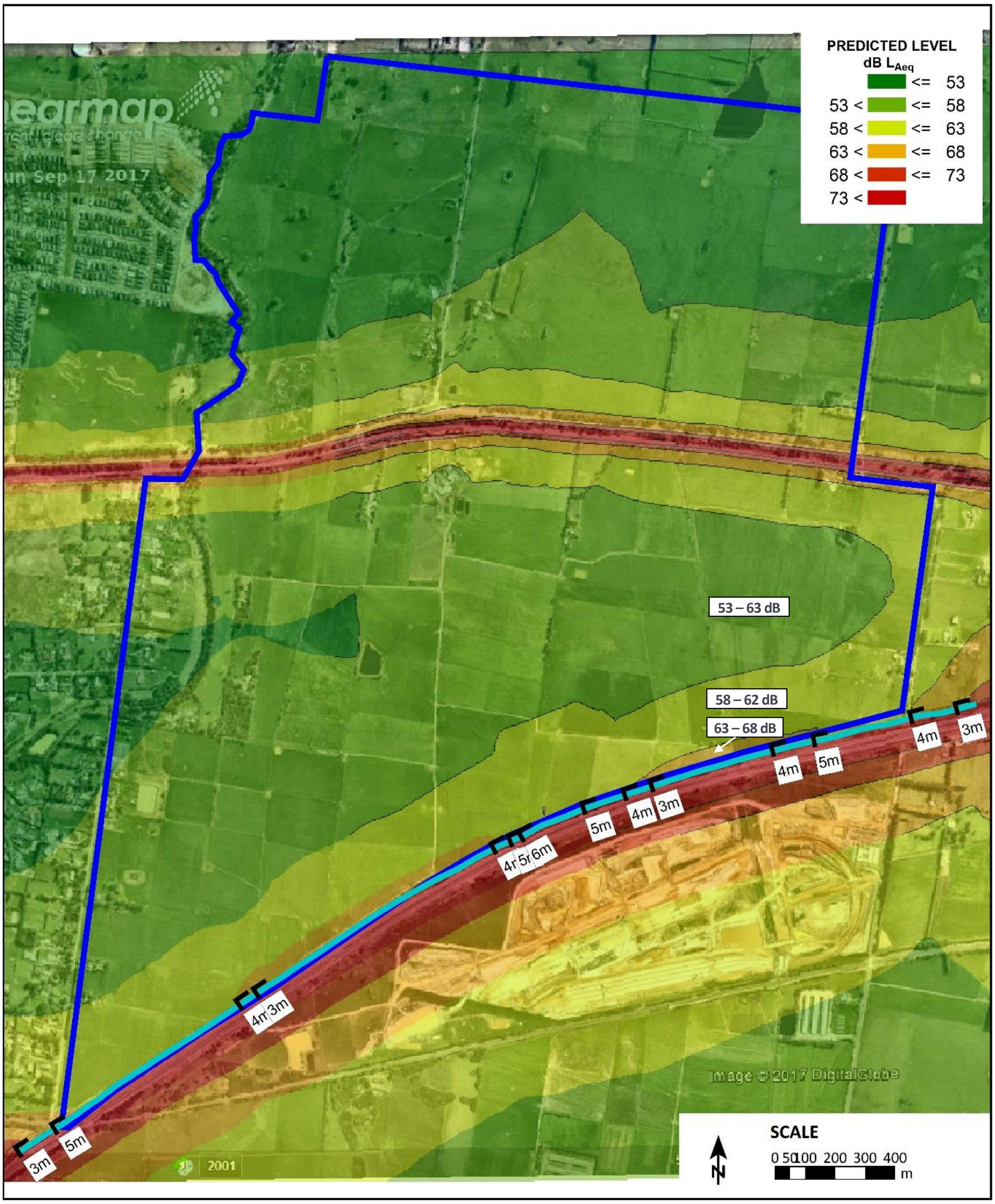
Site boundary

Project: Pakenham East PSP
Project number: 20171138
Client name: Cardinia Shire Council
Version: SoundPLAN 7.4
Prediction method: CoRTN
Model ref: 1
Run number: 2000
File: 2028 Predicted noise levels
Prediction Height: 1.5 m

2028 No Barriers

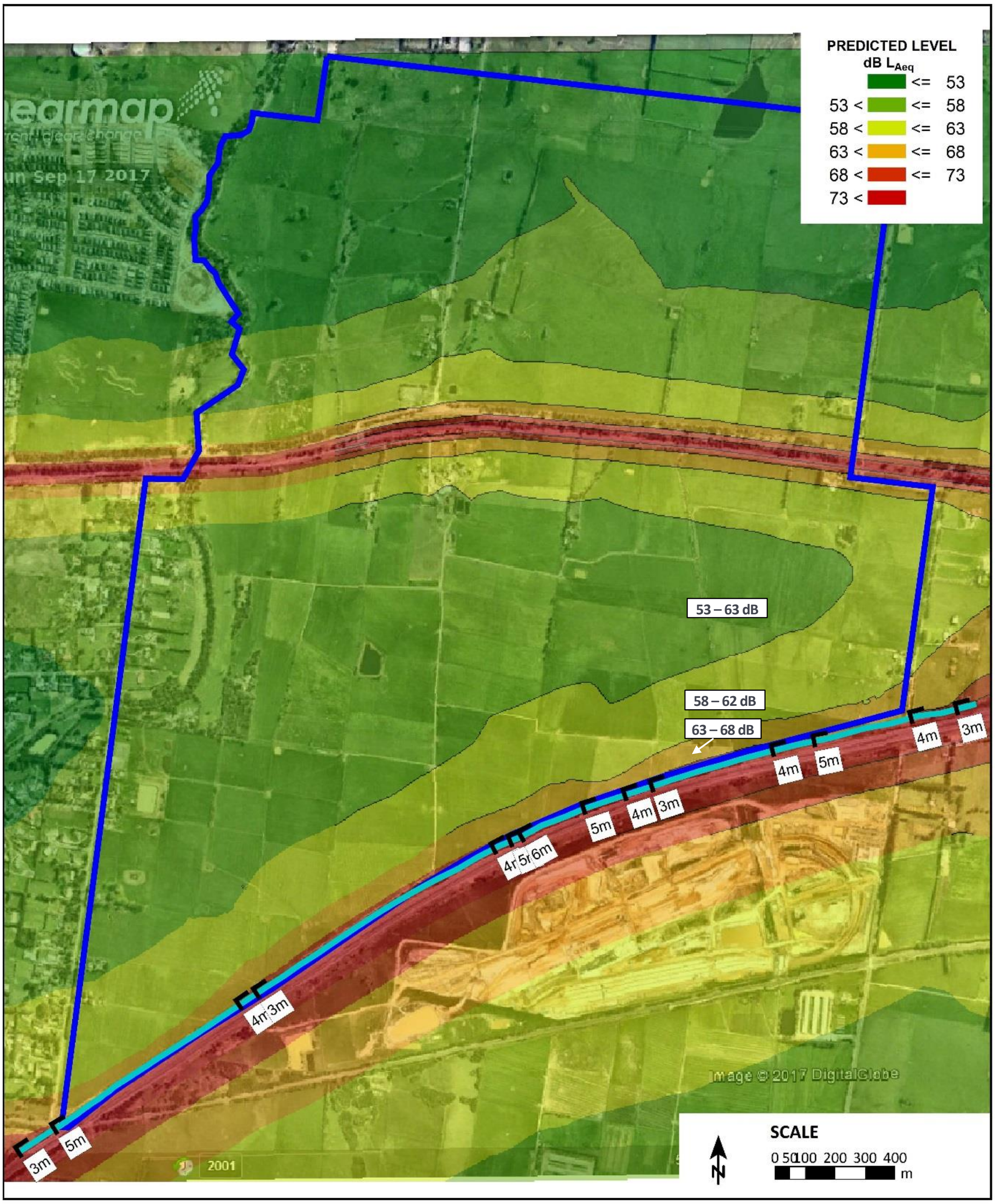
Includes facade correction of +2.5 dB

E2 2028 With noise Barriers (ground level)



Legend			
Wall	Project: Pakenham East PSP	2028 With Barrier	
Site boundary	Project number: 20171138	Includes facade correction of +2.5 dB	
	Client name: Cardinia Shire Council		
	Version: SoundPLAN 7.4		
	Prediction method: CoRTN		
	Model ref: 1		
	Run number: 2002		
	File: 2028 Predicted Noise Levels with Barrier 2		
	Prediction Height: 1.5 m		

E3 2028 With noise Barriers (first-floor level)



Legend	Project: Pakenham East PSP
Wall	Project number: 20171138
Site boundary	Client name: Cardinia Shire Council
	Version: SoundPLAN 7.4
	Prediction method: CoRTN
	Model ref: 1
	Run number: 2003
	File: 2028 Predicted Noise Levels with Barrier 2 First Flo
	Prediction Height: 4.5 m

2028 With Barrier

Includes facade correction of +2.5 dB

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APPENDIX F NOISE BARRIER CONSTRUCTION

There are a number of options available for use as noise barriers. In short, for a barrier of this type any material with a surface density of at least 12 kg/m^2 will provide sufficient noise reduction to perform adequately as a noise barrier. Above this surface density threshold, the barrier performance is limited by sound flanking over and around the barrier, rather than sound passing through it.

It is critical that the barrier is well sealed and free from any holes or gaps. In particular, there must be no gap at the base of the barrier. It is recommended that the base of the barrier is buried to a depth of 10-20 cm.

Suitable materials for noise barriers include:

- 30 mm thick timber
- 15 mm thick Perspex or polycarbonate
- 75 mm brick or concrete
- Earth mounding

Combinations of the above can also be used to construct effective noise barriers, thus providing some variation in barrier appearance. For example, a timber barrier on top of earth mounds can be used.