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Environmental Noise Assessment - Fast Food Development

Lot 200 (#915) Wanneroo Road, Wanneroo

Reference: 24018652-01

Prepared for:
Properties and Pathways Ltd

Reference: 24018652-01

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Date	Rev	Description	Author	Verified
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EXECUTIVE SUMMARY

Lloyd George Acoustics was engaged by Properties and Pathways Ltd to undertake an environmental noise assessment for a proposed commercial development to be located at Lot 200 (#915) Wanneroo Road, Wanneroo. This report considered noise emissions from the proposed development to surrounding properties by way of noise modelling. The proposed development is to comprise of a fast food outlet (with drive-through) operating between the hours of 10.00am and 10.00pm, 7-days a week. Noise impacts considered include those of mechanical plant, vehicles, drive-through speakers and deliveries.

Noise emissions are predicted by way of computer noise modelling and assessed against assigned levels in accordance with the *Environmental Protection (Noise) Regulations 1997*.

The predicted noise levels are demonstrated to be compliant without the need for mitigation measures.

1. INTRODUCTION

Lloyd George Acoustics was engaged by Properties and Pathways Ltd to undertake an environmental noise assessment of a proposed commercial development to be located at Lot 200 (#915) Wanneroo Road, Wanneroo (refer *Figure 1-1*) with the site plan shown in *Figure 1-2* and Development Application (DA) plans provided in *Appendix A*. The development will remove the existing building on site and replace it with a standalone restaurant building.

Figure 1-1: Subject Site Location (Source: DPLH PlanWA)

The proposed fast food restaurant is to operate between 10.00am to 10.00pm, 7-days a week. With regard to noise emissions, consideration is given to noise at neighbouring properties from mechanical plant, drive through speakers as well as vehicles and deliveries, against the prescribed standards of the *Environmental Protection (Noise) Regulations 1997*.

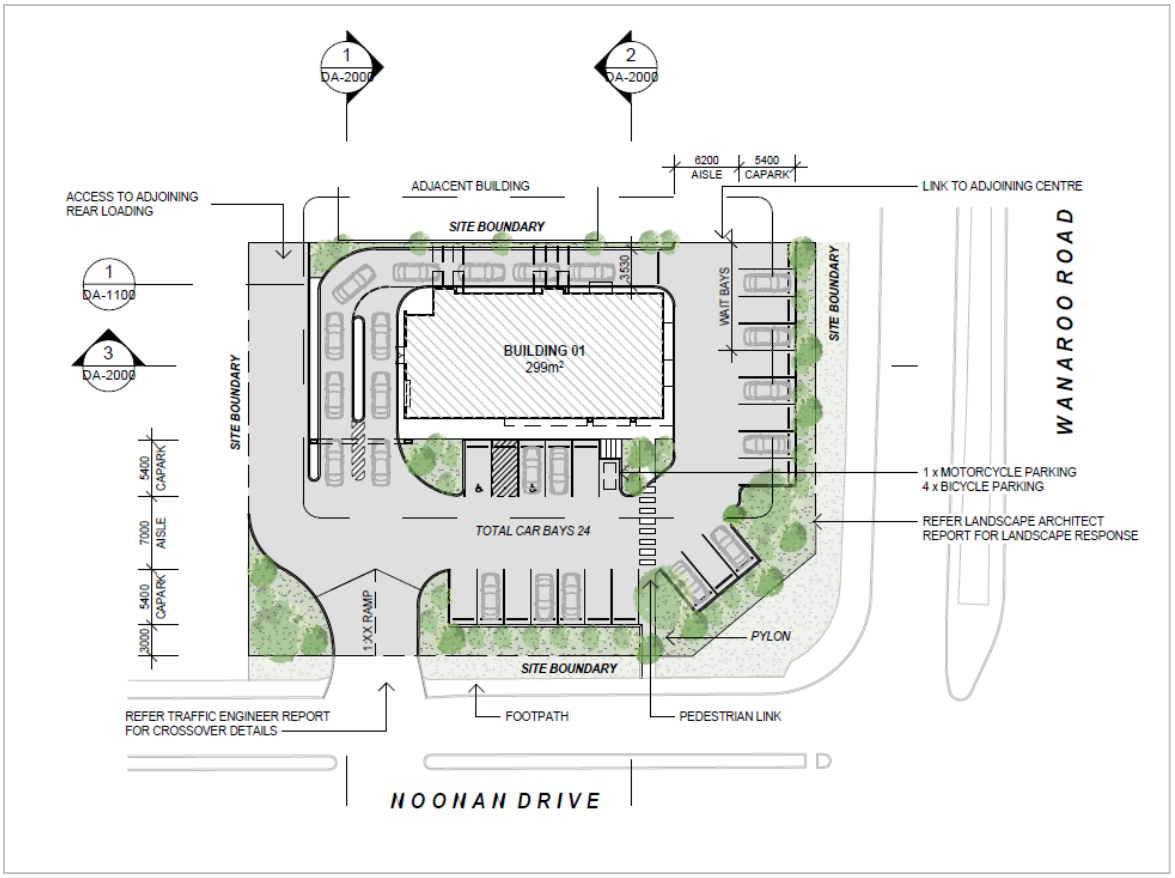

Figure 1-2: Proposed Site Plan

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

2. CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

2.1. Regulations 7, 8 & 9

This group of regulations provide the prescribed standard for noise as follows:

"7. Prescribed standard for noise emissions

(1) Noise emitted from any premises or public place when received at other premises –

(a) must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) must be free of –

(i) tonality; and

(ii) impulsiveness; and

(iii) modulation,

when assessed under regulation 9.

(2) For the purposes of subregulation (1)(a), a noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level at the point of reception."

Tonality, impulsiveness and modulation are defined in regulation 9 (refer *Appendix C*). Under regulation 9(3), *"Noise is taken to be free of the characteristics of tonality, impulsiveness and modulation if -*

(a) the characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) the noise emission complies with the standard prescribed under regulation 7(1)(a) after the adjustments in the table [Table 2-1] … are made to the noise emission as measured at the point of reception."

Table 2-1 Adjustments Where Characteristics Cannot Be Removed

Where Noise Emission is Not Music*			Where Noise Emission is Music	
Tonality	Modulation	Impulsiveness	No Impulsiveness	Impulsiveness
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

* These adjustments are cumulative to a maximum of 15 dB.

The assigned levels (prescribed standards) for all premises are specified in regulation 8(3) and are shown in *Table 2-2*. The L_{A10} assigned level is applicable to noises present for more than 10% of a representative assessment period, generally applicable to "steady-state" noise sources. The L_{A1} is for short-term noise sources present for less than 10% and more than 1% of the time. The L_{Amax} assigned level is applicable for incidental noise sources, present for less than 1% of the time.

Table 2-2 Baseline Assigned Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial Premises	All hours	60	75	80
Industrial and Utility Premises	All hours	65	80	90

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

The influencing factor (IF), in relation to noise received at noise sensitive premises, has been calculated as 9 dB, as determined in *Appendix B*. *Table 2-3* shows the assigned noise levels including the influencing factor and transport factor at the receiving premises groups shown in *Figure 2-1*.

Table 2-3 Assigned Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
All Nearest +9 dB IF Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	54	64	74
	0900 to 1900 hours Sunday and public holidays (Sunday)	49	59	74
	1900 to 2200 hours all days (Evening)	49	59	64
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	44	54	64
Commercial Premises	All hours	60	75	80

It must be noted the assigned levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces.

The assigned levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as "*a period of time of not less than 15 minutes, and not exceeding 4 hours*, *determined by* an *inspector* or *authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission"*. An inspector or authorised person is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Water Environmental Regulation. Acoustic consultants or other environmental consultants are not appointed as an inspector or authorised person. Therefore, whilst this assessment is based on a 4-hour RAP, which is assumed to be appropriate given the nature of the operations, this is to be used for guidance only.

2.2. Regulation 3

"3. Regulations do not apply to certain noise emissions

(1) Nothing in these regulations applies to the following noise emissions –

(a) Noise emissions from the propulsion and braking systems of motor vehicles operating on a road;"

The restaurant car park is considered a road and therefore vehicle noise (propulsion and braking) is not assessed. Noise from vehicle car doors and refrigeration units on delivery trucks however are assessed, since these are not part of the propulsion or braking system. However, vehicle propulsion noise in the drive-through area has been considered assessable in this report due to the nature of the lanes being solely for food ordering purposes and not road access.

2.3. Regulation 14A

"14A. Waste Collection and Other Works

(2) Regulation 7 does not apply to noise emitted in the course of carrying out class 1 works if –

(a) The works are carried out in the quietest reasonable and practicable manner; and

(b) The equipment used to carry out the works is the quietest reasonably available;

class 1 works means specified works carried out between -

(a) 0700 hours and 1900 hours on any day that is not a Sunday or a public holiday; or

(b) 0900 hours and 1900 hours on a Sunday or public holiday.

specified works means -

(a) The collection of waste; or

(b) The cleaning of a road or the drains for a road; or

(c) The cleaning of public places, including footpaths, cycle paths, car parks and beaches;"

In the case where specified works are to be carried out outside of class 1, a noise management plan is to be prepared and approved by the CEO.

3. METHODOLOGY

Computer modelling has been used to predict the noise emissions from the development. The software used was *SoundPLAN 9.0* with the ISO 9613 algorithms (ISO 17534-3 improved method) selected, as they include the influence of wind and are considered appropriate given the relatively short source to receiver distances. Input data required in the model are listed below and discussed in *Section 3.1* to *Section 3.4*:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

3.1. Meteorological Conditions

Meteorological information utilised is provided in *Table 3-1* and is considered to represent worst-case conditions for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

Table 3-1: Modelling Meteorological Conditions

Parameter	Night (7.00pm to 7.00am)
Temperature (°C)	15
Humidity (%)	50
Wind Speed (m/s)	Up to 5
Wind Direction*	All

* The modelling package allows for all wind directions to be modelled simultaneously.

Alternatives to the above default conditions can be used where one year of weather data is available and the analysis considers the worst 2% of the day and night for the month of the year in which the worst-case weather conditions prevail (source: *Draft Guideline on Environmental Noise for Prescribed Premises*, May 2016). In most cases, the default conditions occur for more than 2% of the time and therefore must be satisfied.

3.2. Topographical Data

Topographical data was adapted from publicly available information (e.g. *Google*) in the form of spot heights and combined with the site plan, including a 1.2-metre high parapet around the new building.

Surrounding existing buildings were also incorporated in the noise model, as these can provide noise shielding as well as reflection paths. Single storey buildings are modelled with a height of 3.5 metres with receivers 1.4 metres above ground. Neighbouring commercial buildings are modelled at 6.0 metres high.

Figure 3-1 shows a 2D overview of the noise model with the location of all relevant receivers and noise sources identified. The west boundary fence (Fibre cement) is assumed to be 1.8m high and is noted to be at a higher ground level than lots directly adjacent to the west.

Figure 3-1: Overview of Noise Model

3.3. Ground Absorption

The ground absorption has been assumed to be 0.0 (0%) for the roads and 0.5 (50%) elsewhere, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

3.4. Source Sound Levels

The source sound levels used in the modelling are provided in *Table 3-2*.

Table 3-2: Source Sound Levels, dB

Description	Octave Band Centre Frequency (Hz)								Overall dB(A)
	63	125	250	500	1k	2k	4k	8k	
Refrigeration Condenser Packages – L_{A10}	88	87	85	81	76	70	64	59	**82**
General Exhaust Fan – L_{10}	72	70	64	61	53	53	51	45	**63**
Toilet Exhaust Fan – L_{10}	-	61	67	61	64	60	52	46	**67**
Typical AC Condensers – L_{10}	-	77	75	72	70	67	62	56	**75**
Car Door Closings – L_{max}	71	74	77	81	80	78	72	61	**84**
Refrigerated Truck delivery – L_{A1}	100	91	87	88	83	81	79	75	**90**
Drive-Through Speaker – L_{A1}	62	64	66	77	80	73	57	42	**82**
Drive-Through Car Idling – L_{A10}	81	78	74	72	74	74	67	64	**79**

The following is noted in relation to *Table 3-2*:

- Mechanical plant sound levels are estimated from previous projects;
- Exhaust fans are located 0.5m above roof;
- A/C plant (Condensers) are assumed located on the rooftop (1.0m above roof level) and screened with parapets;
- Refrigerated truck condenser is modelled at 2.3m above ground;
- Car door and all engine sources are modelled at 0.5m above ground;
- 5 to 10 vehicles are modelled idling in the Drive-Through queuing, ordering and waiting areas, depending on the calculation scenario (see following page).

4. RESULTS AND ASSESSMENT

Noise modelling was undertaken for the following scenarios:

- Evening (L_{A10}) – Includes all L_{A10} noise sources of *Table 3-2,* with a total of 5 idling cars in drive through lanes;
- Evening (L_{A1}) – Includes a refrigerated delivery truck in the nominated loading area (cold deliveries) and 10 cars in drive though lanes and the drive through speakers operating;
- Evening (L_{Amax}) – Considers car door closings.

4.1. Scenario 1 – All Plant and Drive Thru Vehicles L_{A10}

Given the proposed hours of operations, the most critical period of assessment is the Evening and Sundays, presented with modelling results in *Table 4-1*. A noise contour plot is also provided in *Figure 4-1* showing noise levels at ground floor. It should be noted that the assessment has assumed all plant will be used simultaneously during the night, which is conservative as they will generally cycle intermittently.

Table 4-1: Scenario 1 Predicted Levels and Assessment, dB L_{A10}

Receiver	5 Drive Through Vehicles	All Mech Plant	Total	Evening Assigned Noise Level	Assessment
3 Noonan Dr (Comm)	40	27	41	**60**	*Complies*
4 Noonan Dr	41	26	41	**49**	*Complies*
6 Noonan Dr	38	25	39	**49**	*Complies*
902 Wanneroo Rd	33	18	33	**49**	*Complies*
904 Wanneroo Rd	31	18	31	**49**	*Complies*
906 Wanneroo Rd	33	20	34	**49**	*Complies*
908 Wanneroo Rd	36	22	36	**49**	*Complies*
910 Wanneroo Rd	37	22	37	**49**	*Complies*
912 Wanneroo Rd	38	24	39	**49**	*Complies*

The vehicles in drive through lanes are the dominant sources and given the range of motor speeds and tones, tonality is not considered detectable. Therefore, the predicted level is compliant at all the worst-case locations. Note, compliance is still achieved at night and even if the + 5 dB tonality adjustment was applied to the mechanical plant noise only. Therefore, if staff remain after 10pm or some refrigeration units are left on, the operations will remain compliant.

As the analysis is based on file data, it is recommended that a follow up verification of mechanical plant selections be carried out at detailed design by a suitably qualified acoustical consultant.

Figure 4-1 Scenario 1: Evening Noise Ground Floor (1.5m AGL), dB L_{A10}

Lot 200 (#915) Wanneroo Road, Wanneroo

Predicted Noise level

	= 40
	= 45
	= 50
	= 55
	= 60

Legend

- Receiver
- Proposed Building
- Mech Plant Source

N

Scale 1:1200

0 5 10 20 30 m

Project No: 24018652
Consultant: MM
Date: 13/02/2024
Algorithm: ISO 9613
SoundPLAN Version: 9.0

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4.2. Scenario 2 – Refrigerated Trucks and Full Drive-Through Lanes L_{A1}

The predicted noise levels from drive thru speakers, a refrigerated delivery truck and with the drive through lanes at capacity are provided in *Table 4-2*. A noise contour plot is also provided in *Figure 4-2* showing noise levels at ground floor. This assumes deliveries will take less than 24 minutes in a 4-hour period, which is considered sufficient time for a small scale store.

Table 4-2: Scenario 2 Predicted Levels and Assessment, dB L_{A1}

Receiver	Delivery Truck	Drive Thru Speakers	10 Drive Through Vehicles	Total*	Evening Assigned Noise Level	Assessment
3 Noonan Dr (Comm)	51	43	43	52	**75**	*Complies*
4 Noonan Dr	50	43	43	52	**59**	*Complies*
6 Noonan Dr	44	39	41	47	**59**	*Complies*
902 Wanneroo Rd	42	32	36	43	**59**	*Complies*
904 Wanneroo Rd	43	27	35	43	**59**	*Complies*
906 Wanneroo Rd	46	28	37	47	**59**	*Complies*
908 Wanneroo Rd	47	28	39	48	**59**	*Complies*
910 Wanneroo Rd	48	22	39	48	**59**	*Complies*
912 Wanneroo Rd	49	25	40	49	**59**	*Complies*

*Includes all Mech Plant Sources from Scenario 1

Compliance at all receivers is predicted in the evening, being the worst case time period for the restaurant operational hours, and therefore mitigation measures are not required. Note that with the number of vehicle sources (including a delivery truck) present in the scenario, it is unlikely that tonality would be detectable in the L_{A1} measured level.

Figure 4-2 Scenario 2: Evening Noise Ground Floor (1.5m AGL), dB L_{A1}

Lot 200 (#915) Wanneroo Road, Wanneroo

Predicted Noise level

	= 50
	= 55
	= 60
	= 65
	= 70

Legend

- Receiver
- Proposed Building
- Mech/Car Source
- Delivery Truck

N

Scale 1:1200

0 5 10 20 30 m

Project No: 24018652
Consultant: MM
Date: 13/02/2024
Algorithm: ISO 9613
SoundPLAN Version: 9.0

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4.3. Scenario 3 – Evening L_{Amax}

The results for Evening L_{Amax} scenario (car doors) are provided in *Table 4-3*. A noise contour plot (non-cumulative) is also provided in *Figure 4-3* showing noise levels at ground floor. Car door closing noise levels are adjusted by + 10 dB for impulsiveness and assessed against the night-time L_{Amax} assigned level.

Table 4-3: Scenario 3 Predicted Levels and Assessment, dB L_{Amax}

Receiver	Car Door Closing#	Evening Assigned Noise Level	Assessment
3 Noonan Dr (Comm)	50	**80**	*Complies*
4 Noonan Dr	48	**64**	*Complies*
6 Noonan Dr	45	**64**	*Complies*
902 Wanneroo Rd	47	**64**	*Complies*
904 Wanneroo Rd	46	**64**	*Complies*
906 Wanneroo Rd	49	**64**	*Complies*
908 Wanneroo Rd	51	**64**	*Complies*
910 Wanneroo Rd	52	**64**	*Complies*
912 Wanneroo Rd	54	**64**	*Complies*

Adjusted by + 10 dB for impulsiveness

Noise levels are predicted to comply at all receivers, inclusive of the impulsiveness adjustment.

It should be noted that the L_{Amax} assigned level during the evening is the same as during the night, and therefore even staff using the car park at night (after 10.00pm closing) will comply.

Figure 4-3 Scenario 3: Car Park Noise Ground Floor (1.5m AGL), dB L_{Amax}

Lot 200 (#915) Wanneroo Road, Wanneroo

Predicted Noise level

	= 50
	= 55
	= 60
	= 65
	= 70

Legend

- Receiver
- Proposed Building
- Car door Source

N

Scale 1:1200

0 5 10 20 30 m

Project No: 24018652
Consultant: MM
Date: 13/02/2024
Algorithm: ISO 9613
SoundPLAN Version: 9.0

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5. RECOMMENDATIONS

The assessment has demonstrated that noise from the fast food development can comply with the assigned levels determined in accordance with the *Environmental Protection (Noise) Regulations 1997* without the need for mitigation measures.

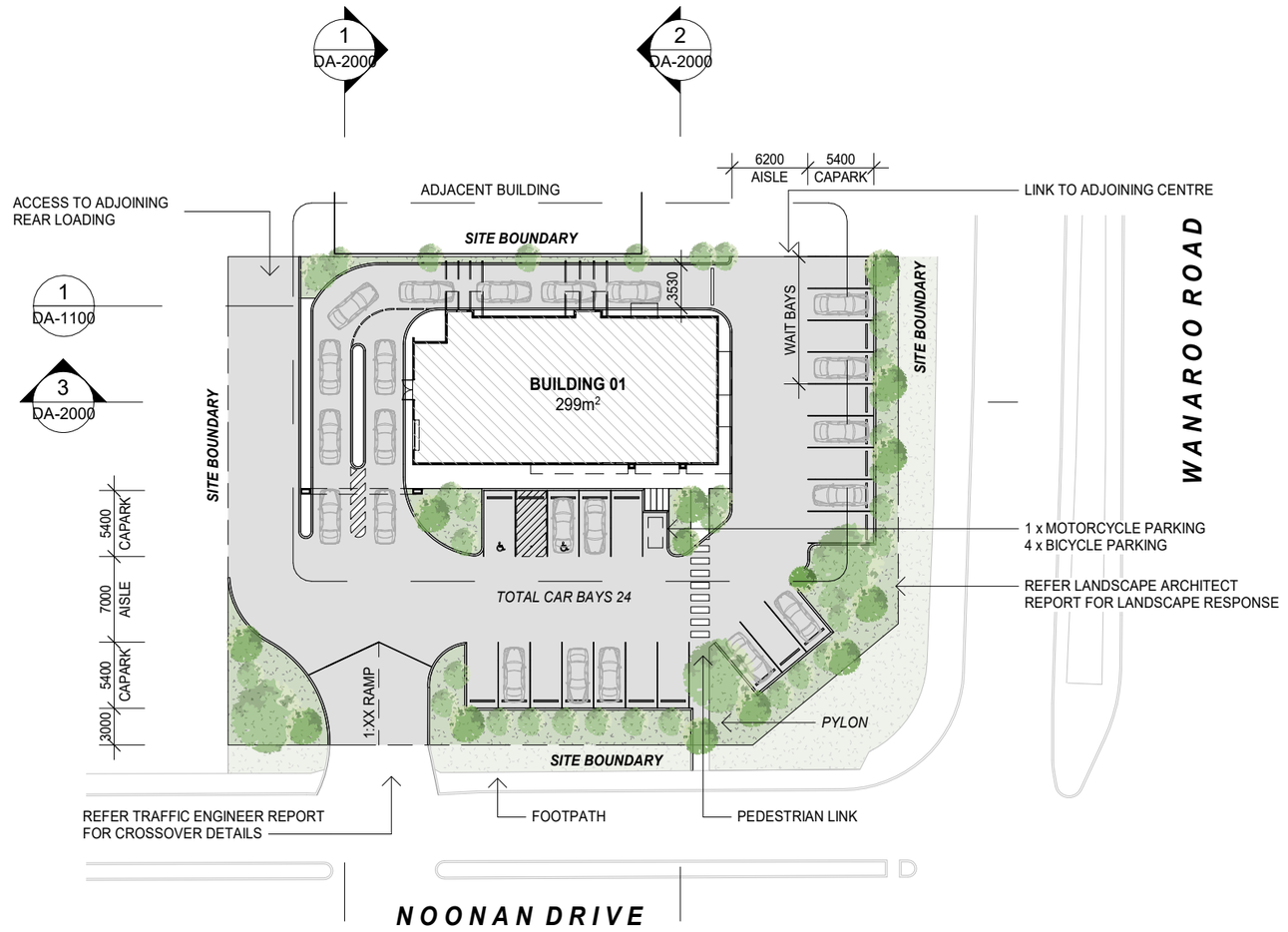
To ensure compliance with the Noise Regulations, delivery vehicles are encouraged to have broadband type reversing alarms fitted rather than standard tonal alarms. This is also inline with the guidance provided by DWER and considered less likely to elicit complaints from the community.

While not required for compliance, noting that the development is at DA stage only, some best practice recommendations have been included below though – to be implemented in the design and operation where practicable:

- Bin servicing shall occur between 7.00am and 7.00pm Mondays to Saturdays. The servicing of bins would fall under Regulation 14A and provided it is carried out within the stipulated hours and undertaken as quietly as reasonably practicable, the 'normal' assigned levels do not apply. Where possible, bins shall be located in areas away from and/or screened from residences. Where this activity also includes truck reversing alarm noise, this would be considered exempt under Regulation 14A within the stipulated hours.
- Access grates or similar to be plastic or metal with rubber gasket and secured to avoid excess banging.
- All refrigerated delivery drivers attending the site are to make all effort to deliver quietly, leave promptly, and not idle trucks on site for longer than necessary.
- Mechanical plant:
  - Once the mechanical plant has been designed and selected, the noise levels shall be reviewed prior to Building Permit;
  - All exhaust fans shall be located inside the ceiling void and shall be axial fan type, allowing the incorporation of an attenuator if required;
  - All fans shall be variable speed drive so that maximum speed is only occurring when necessary with demand;
  - Air-conditioning shall have a 'night' / 'quiet' mode option, in case required for prior to 7.00am operation, subject to final detailed analysis;
  - All plant shall be selected for quiet operation;
  - All plant is to be appropriately vibration isolated to 95% isolation efficiency.

Appendix A – Development Plans

DA-1000
OVERALL FLOOR PLAN



0 5 10 15 20 25

SCALE 1500 @ A3 SIZE m

ISSUE C

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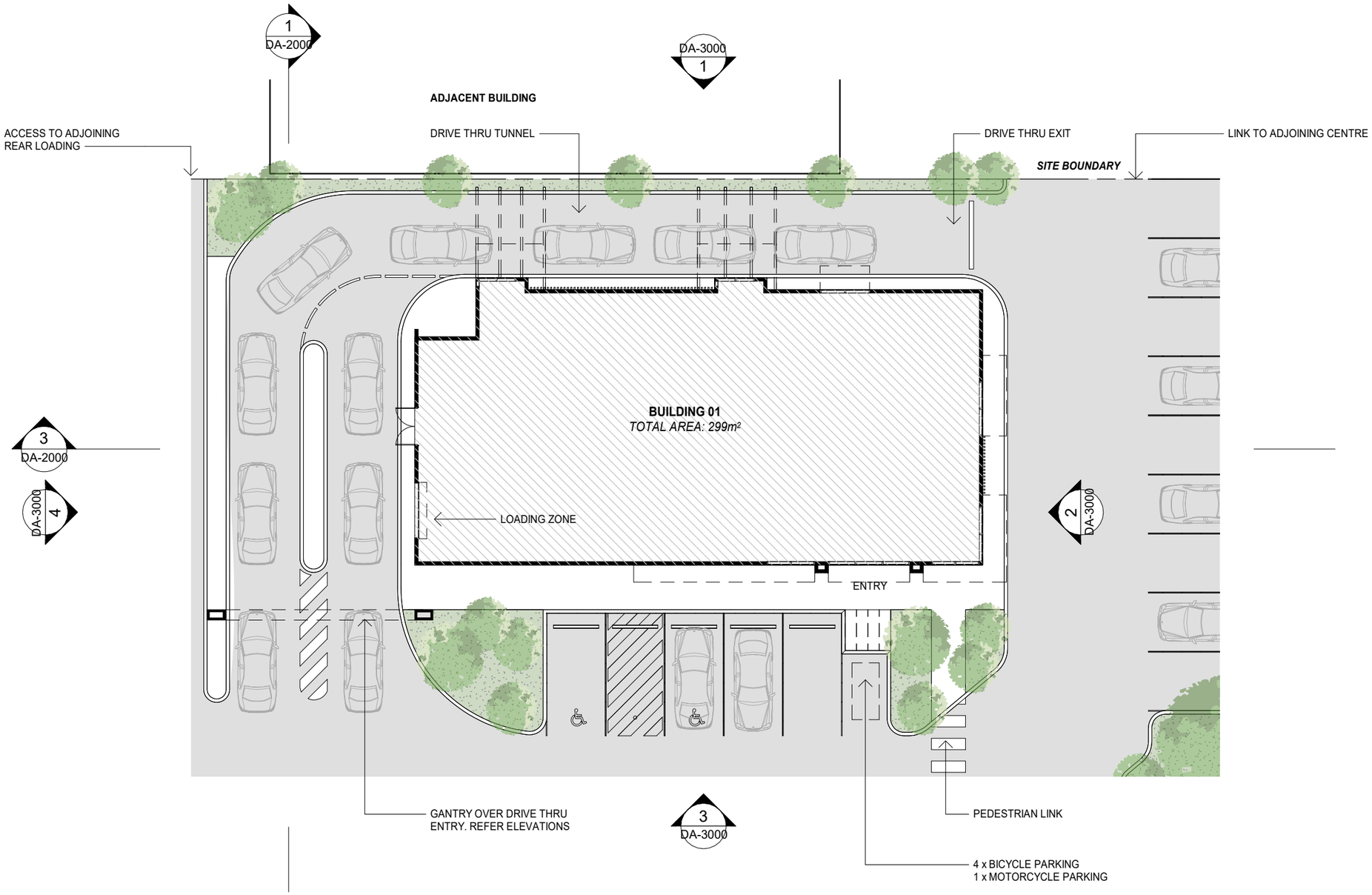
DA-1100
BUILDING 01 FLOOR PLAN



0 2 4 6 8 10

SCALE 1200 @ A3 SIZE m

ISSUE A

Date of Issue | 10.01.2024

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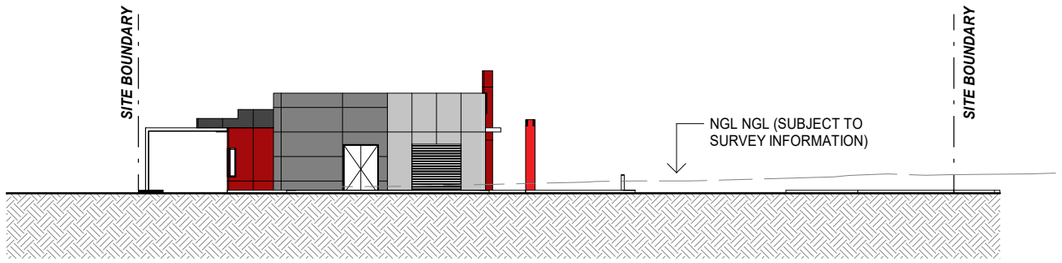
DA-2000
SECTIONS



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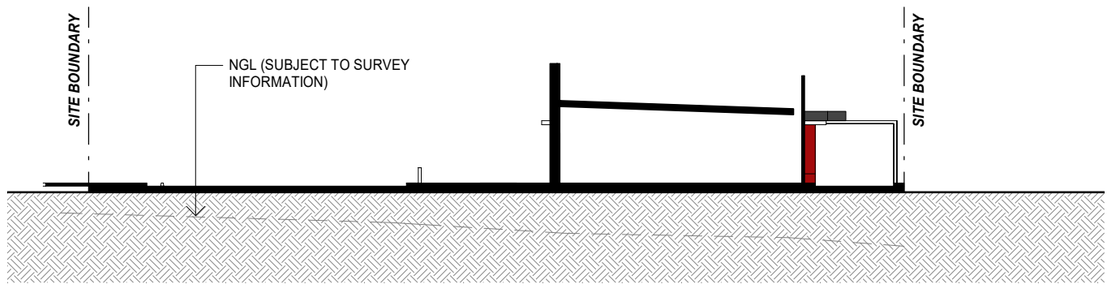

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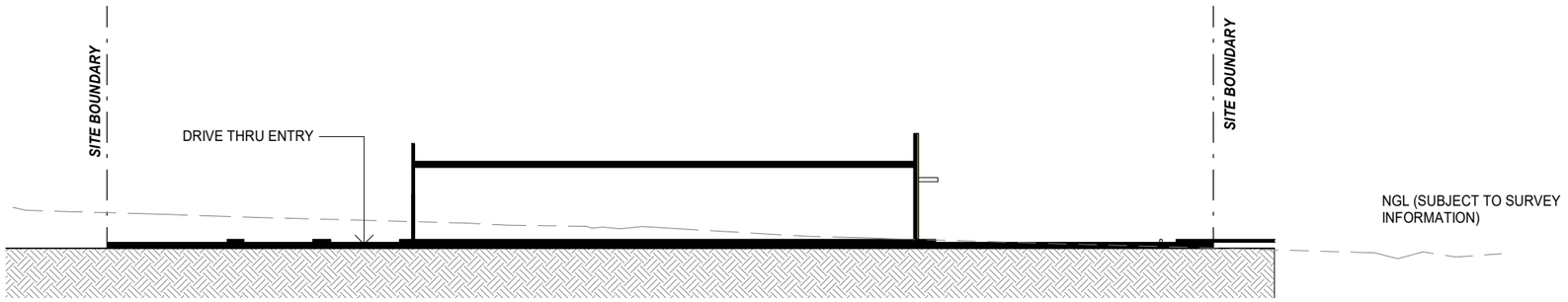

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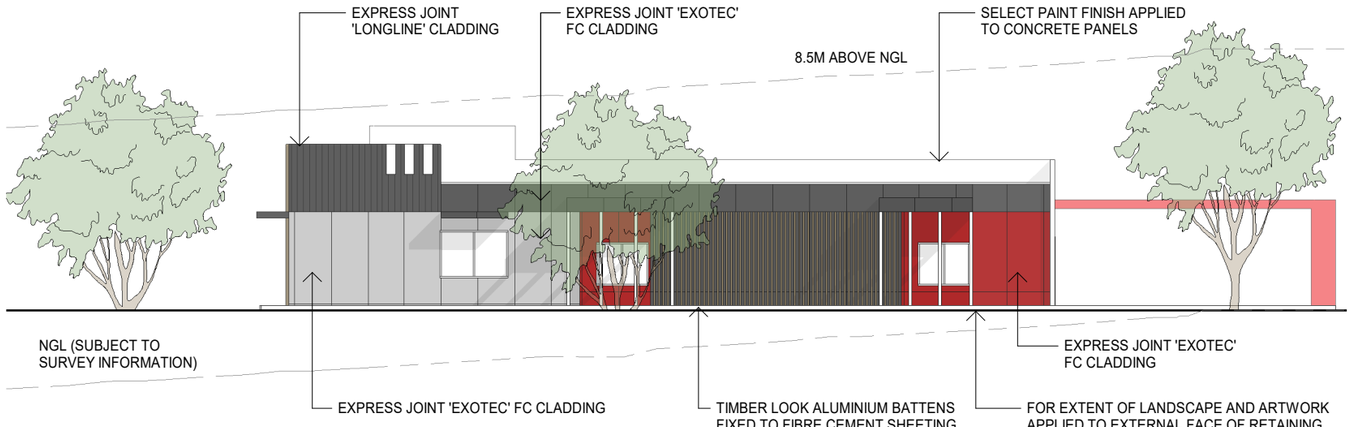
DA-3000
BUILDING 01 ELEVATIONS



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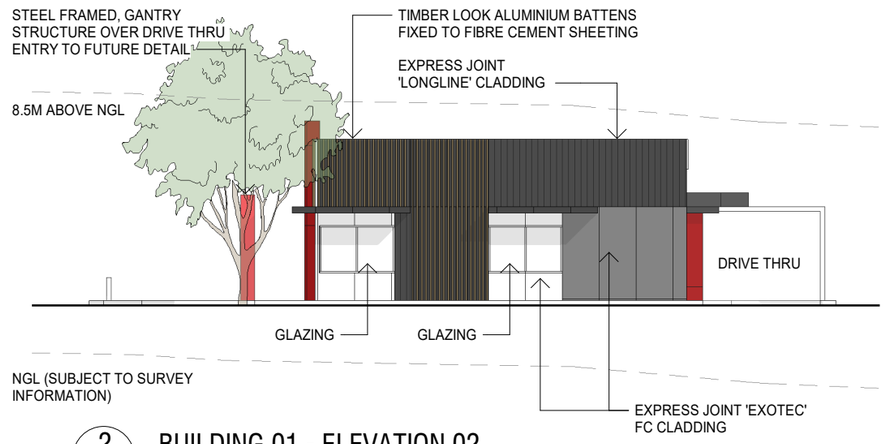

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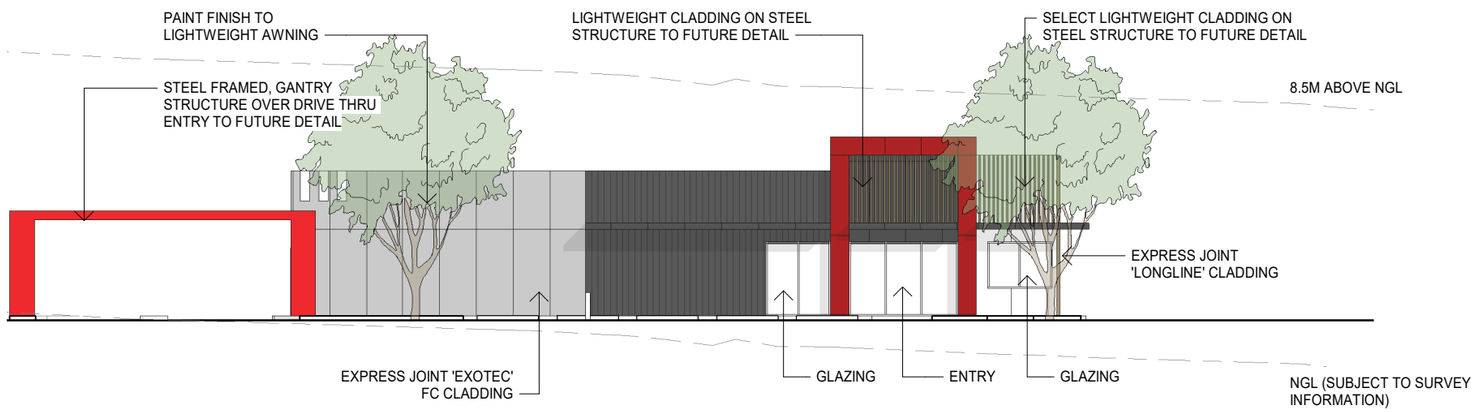

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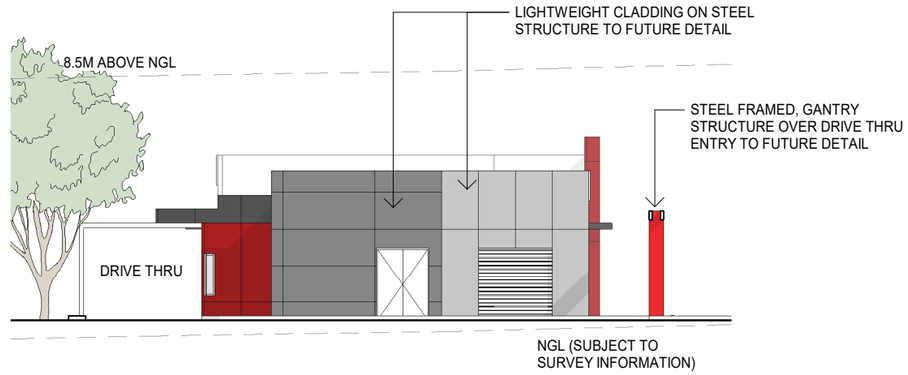

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ISSUE A
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Appendix B – Influencing Factor Calculation

The assigned levels combine a baseline assigned level with an influencing factor, with the latter increasing the assigned level on the basis of the existence of significant roads and commercial or industrial zoned land within an inner circle (100 metre radius) and an outer circle (450 metre radius) of the noise sensitive premises. The calculation for the influencing factor is:

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a 100m radius of the premises receiving the noise

$\%\text{TypeA}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a 100m radius of the premises receiving the noise

$\%\text{TypeB}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Transport Factor (maximum of 6 dB)

= 2 for each secondary road (6,000 to 15,000 vpd) within 100m

= 2 for each major road (>15,000 vpd) within 450m

= 6 for each major road within 100m

The nearest noise sensitive and commercial premises are identified as:

- 3 Noonan Dr (Commercial)
- 4 Noonan Dr
- 6 Noonan Dr
- 902 Wanneroo Rd
- 904 Wanneroo Rd
- 906 Wanneroo Rd
- 908 Wanneroo Rd
- 910 Wanneroo Rd
- 912 Wanneroo Rd

Of the above list, these can be grouped into two categories, being the nearest properties east and west of Wanneroo Road.

Table B-1 shows the percentage of industrial and commercial land within the inner (100 metre radius) and outer (450 metre radius) circles of the noise sensitive premises, with this also shown on *Figure B-1* for Receiver R2.

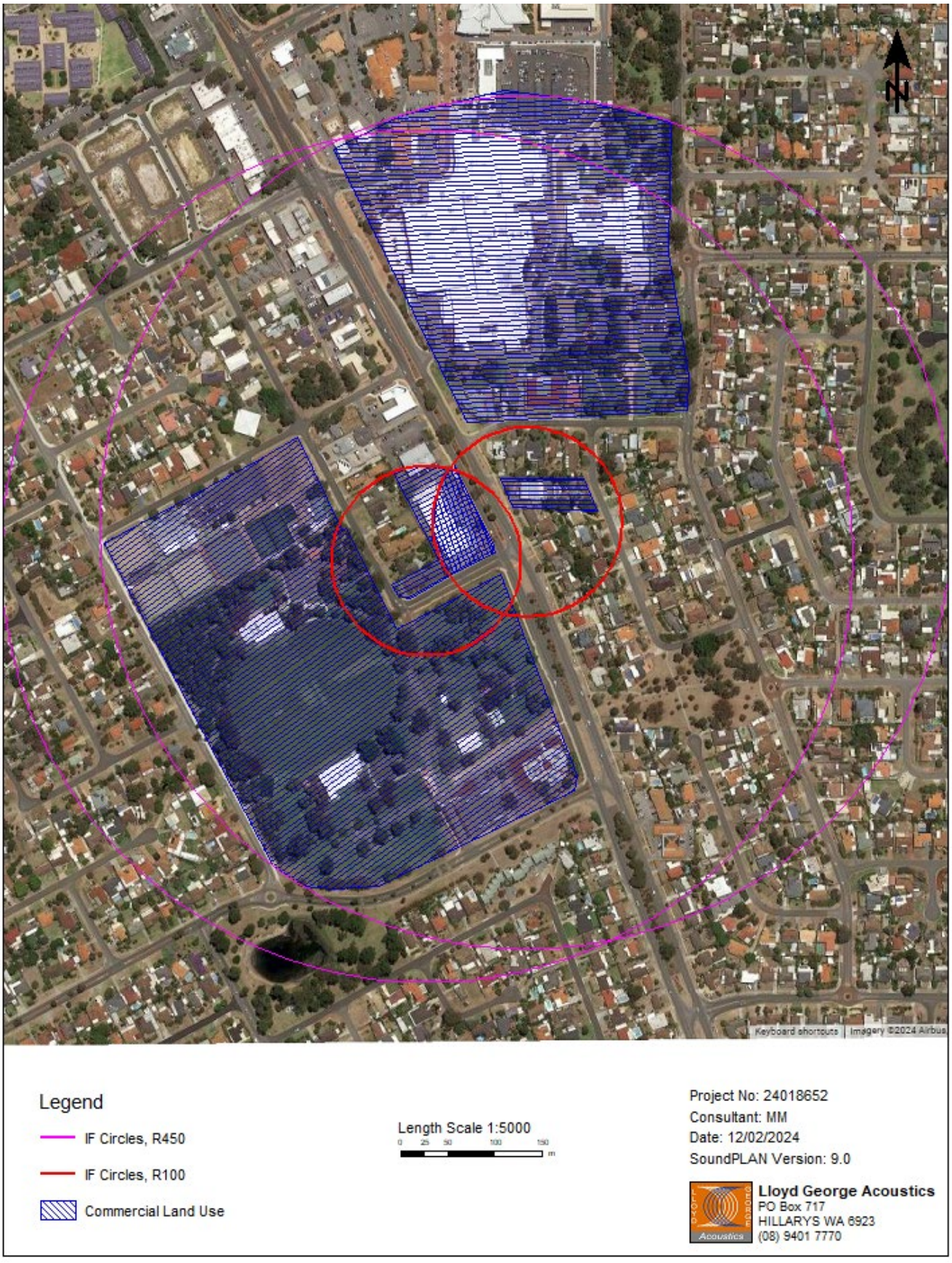


Figure B-1: Land Types within 100m and 450m Radii

Table B-1: Percentage of Land Types within 100m and 450m Radii

Receiver	Land Type	Within 100m	Within 450m
Receivers East of Wanneroo Rd	Type A - Industrial and Utility	0	0
	Type B – Commercial	26	34
Receivers West of Wanneroo Rd	Type A - Industrial and Utility	0	0
	Type B – Commercial	41	24

Table B-2 shows the relevant roads and their traffic estimates within the inner (100 metre radius) and outer (450 metre radius) circles.

Table B-2: Relevant Roads within 100m and 450m Radii

Receiver	Within 100m		Within 450m
	Major Road (+ 6 dB)	Secondary Road (+ 2 dB)	Major Road Not Within 100m (+ 2 dB)
Receivers East of Wanneroo Rd	Wanneroo Road	-	-
Receivers West of Wanneroo Rd	Wanneroo Road	-	-

Table B-3 combines the percentage land types and Transport Factor to calculate the influencing factor.

Table B-3: Influencing Factor Calculation, dB

Receiver	Industrial Land	Commercial Land	Transport Factor	Total
Receivers East of Wanneroo Rd	0.0	3.0	6	**9**
Receivers West of Wanneroo Rd	0.0	3.3	6	**9**

The influencing factor calculated in *Table B-3* is combined with those baseline assigned levels of *Table 2-2*, resulting in the project assigned levels provided in *Table 2-3*.

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 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.

- **Sound Power Level (L_w)**

Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure level at known distances. Noise modelling incorporates source sound power levels as part of the input data.

- **Sound Pressure Level (L_p)**

The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc. and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

- **L_{ASlow}**

This is the noise level in decibels, obtained using the A-frequency weighting and the S (slow) time weighting. Unless assessing modulation, all measurements use the slow time weighting characteristic.

- **L_{AFast}**

This is the noise level in decibels, obtained using the A-frequency weighting and the F (fast) time weighting. This is used when assessing the presence of modulation.

- **L_{APeak}**

This is the greatest absolute instantaneous sound pressure level in decibels using the A-frequency weighting.

- **L_{Amax}**

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

- **L_{A1}**

The L_{A1} level is the A-weighted noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{A10}**

The L_{A10} level is the A-weighted noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level.

- **L_{A90}**

The L_{A90} level is the A-weighted noise level exceeded for 90 percent of the measurement period and is considered to represent the "background" noise level.

- **L_{Aeq}**

The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

- **One-Third-Octave Band**

Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20000 Hz inclusive.

- **Representative Assessment Period**

Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

- **L_{Amax} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded at any time.

- **L_{A1} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 1 percent of the representative assessment period.

- **L_{A10} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 10 percent of the representative assessment period.

- **Tonal Noise**

A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

– the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

- **Modulating Noise**

A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

– a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band; and

(b) is present for at least 10% of the representative assessment period; and

(c) is regular, cyclic and audible.

- **Impulsive Noise**

An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness means:

– a variation in the emission of a noise where the difference between L_{Apeak} and L_{Amax} is more than 15 dB when determined for a single representative event.

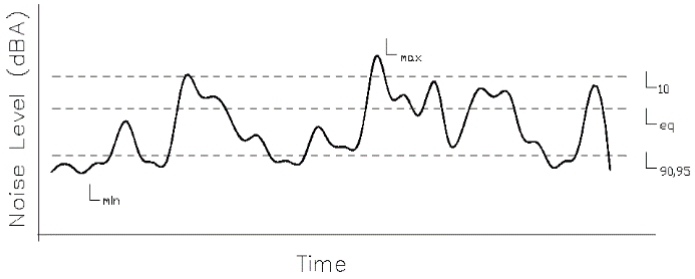
- **Major Road**

Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

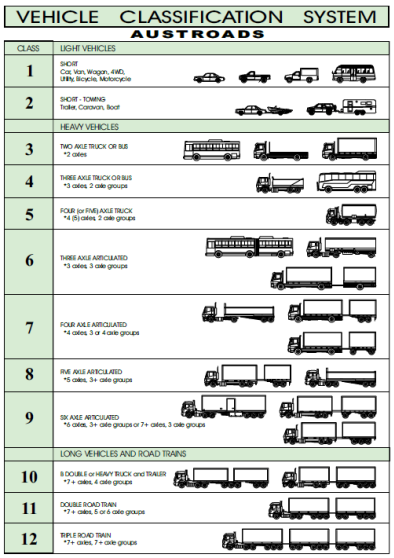
- **Secondary / Minor Road**

Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**