Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Transportation Noise Assessment

Hammond Road Duplication – Branch Circus to Bartram Road

Reference: 19055001-01a

Prepared for:
City of Cockburn

Report: 19055001-01a

Lloyd George Acoustics Pty Ltd

ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

www.lgacoustics.com.au

Contacts	General	Daniel Lloyd	Terry George	Matt Moyle
E:	info@lgacoustics.com.au	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	matt@lgacoustics.com.au
P:	9401 7770	0439 032 844	0400 414 197	0412 611 330
Contacts	**Ben Hillion**	**Rob Connolly**	**Daryl Thompson**	**Hao Tran**
E:	ben@lgacoustics.com.au	rob@lgacoustics.com.au	daryl@lgacoustics.com.au	hao@lgacoustics.com.au
P:	0457 095 555	0410 107 440	0420 364 650	0438 481 207

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1 INTRODUCTION

City of Cockburn is proposing a duplication of Hammond Road, between Branch Circus and Bartram Road, located as shown in *Figure 1-1*. In this section, Hammond Road is single carriageway, with one lane in each direction. North of Branch Circus, the road is dual carriageway, with two lanes in each direction up until Beeliar Drive. Similarly, south of Bartram Road is also dual carriageway, two lanes in each direction until Russell Road. The proposed road design is provided in *Appendix A*.

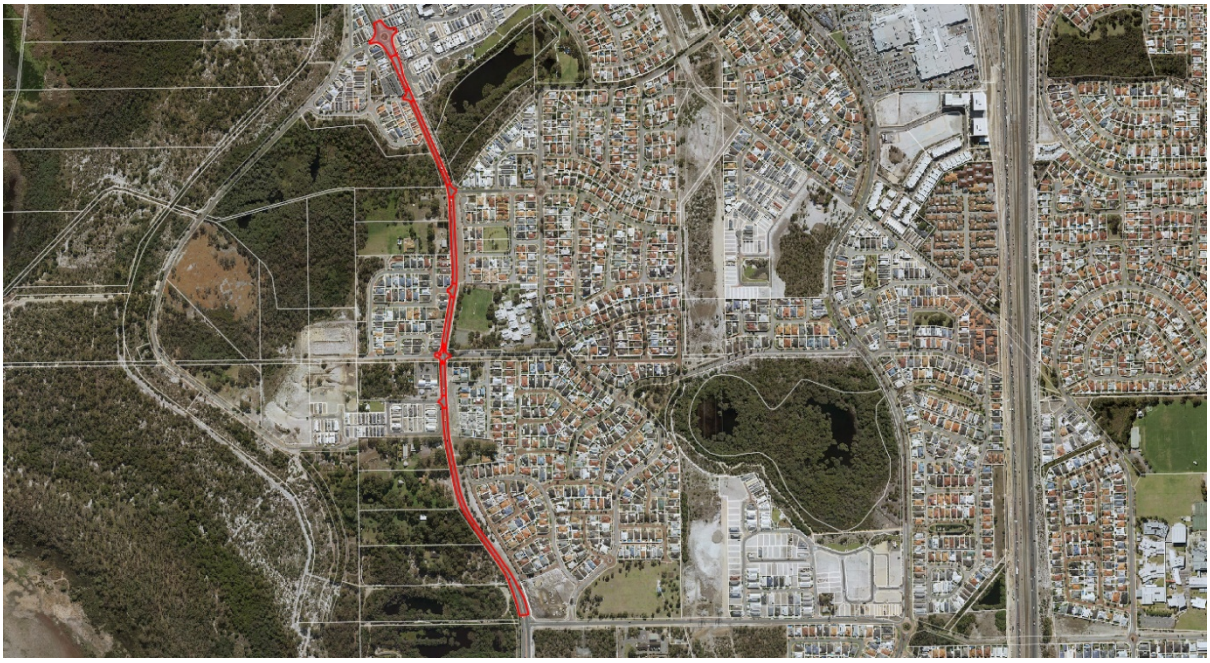


Figure 1-1 Road Project Locality

This report considers the potential road traffic noise impacts associated with the duplication, in accordance with *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*. The scope involved:

- Quantification of existing noise levels by noise monitoring at two locations;
- Setting up a noise model for existing conditions and calibrating against the noise monitoring (Existing Scenario);
- Use the calibrated noise model and modify for future traffic volumes on the existing road (No Build Scenario); and
- Use the calibrated noise model and modify for future traffic volumes on the proposed road design (Build Scenario).

Appendix B 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.

For a major redevelopment, practicable noise management and mitigation measures should be considered, having regard to –

- The existing transport noise levels;
- The likely change in noise emissions resulting from the proposal; and
- The nature and scale of the works and potential for noise amelioration.

When considering the noise levels, the Policy's outdoor noise criteria, shown below in *Table 2-1*, can be used for some guidance. These criteria apply for new road projects rather than upgrades/modifications and at any point 1-metre from a ground floor habitable façade of a noise sensitive premises.

Table 2-1 Outdoor Noise Criteria

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

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

3 METHODOLOGY

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

3.1 Site Measurements

Noise monitoring was undertaken at two (2) locations between 21 July to 30 July 2019 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 instruments used were ARL Ngara Type noise data loggers as follows:

1. Ngara 8780F6 at 14 Gandossi Court, Success (refer *Figure 3-1*); and
2. Ngara 87803e at 16 Muirfield Avenue, Success (refer *Figure 3-2*).

Each microphone was 1.4 metres above ground level with the logger programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The instruments comply with the requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The loggers were 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 14 Gandossi Court

Figure 3-2 16 Muirfield Avenue

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value was inserted.

3.2 Noise Modelling

The computer programme *SoundPLAN 8.1* 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 a -8.0 dB correction is applied to the exhaust and -0.8 dB to the engine (based on Transportation Noise Reference Book, Paul Nelson, 1987), 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 $L_{Aeq(Day)}$ levels where noise levels are predicted to a facade, 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 (March 1983).

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

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

3.2.1 Ground Topography & Road Design

General topography is on file from previous projects based on Landgate data. This data also contained building outlines for existing properties. This was checked against aerial photography and updated as necessary. Single storey houses are modelled as 3.5 metres high and double storey houses at 7.0 metres high.

The road design information was provided by City of Cockburn via email on 1 August 2019.

3.2.2 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different 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	-1.5 dB	-2.5 dB

The existing road surface is dense graded asphalt and is assumed to be the same in the future.

- Vehicle Speed – The existing and future posted speeds are generally 70km/hr. North of Branch Circus the posted speed is 60 km/hr. A school zone (2.30pm to 4.00pm 40 km/hr) exists between Makjanich Place and Windermere Circuit.

- Traffic Volumes – Existing (2016) and forecast (2031) traffic volumes were provided by Main Roads WA (Clare Yu, Traffic Modelling Analyst, Reference: #41260, dated 01 August 2019). A validation plot was also provided allowing the Main Roads WA traffic volume model to be calibrated. *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Traffic Information Used in the Modelling for Hammond Road

Section	Scenario			
	Existing - 2016		Future - 2031	
	Northbound	Southbound	Northbound	Southbound
North of Branch Circus	3500 (8)	3100 (6)	5900 (8)	6600 (6)
South of Branch Circus	3500 (8)	3100 (6)	5900 (8)	6600 (6)
South of Bartram Road	5000 (8)	4700 (6)	4000 (7)	4200 (8)

Notes:

1. Numbers shown in brackets are % heavy vehicles obtained direct from ROM plots.

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road and 0.5 (50%) elsewhere. 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 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).

As noise monitoring was undertaken, the relationship between the parameters is based on the results of the monitoring – refer *Section 4.1*.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1* and *Table 4-2* and shown graphically in *Figure 4-1* and *Figure 4-2* for 14 Gandossi Court and 16 Muirfield Avenue respectively.

Table 4-1 Measured Average Noise Levels – 14 Gandossi Court

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Monday 22 July 2019	59.5	56.8	58.2	51.4
Tuesday 23 July 2019	59.6	56.7	58.1	50.9
Wednesday 24 July 2019	60.1	57.5	58.9	50.7
Thursday 25 July 2019	58.7	56.6	58.0	50.7
Friday 26 July 2019	59.1	56.1	57.6	49.7
Monday 29 July 2019	57.8	55.1	56.3	50.6
Weekday Average	**59.1**	**56.5**	**57.8**	**50.7**

Table 4-2 Measured Average Noise Levels – 16 Muirfield Avenue

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Monday 22 July 2019	61.2	58.9	60.3	52.6
Tuesday 23 July 2019	61.0	58.0	59.5	50.5
Wednesday 24 July 2019	61.0	58.3	59.8	50.6
Thursday 25 July 2019	60.9	59.0	60.6	50.8
Friday 26 July 2019	60.9	58.0	59.6	49.8
Monday 29 July 2019	59.6	57.0	58.3	51.8
Weekday Average	**60.8**	**58.2**	**59.7**	**51.0**

The results indicate that the $L_{Aeq(Night)}$ is around 8 dB less than the $L_{Aeq(Day)}$ so that the $L_{Aeq(Day)}$ parameter will determine compliance or otherwise. As such, the focus of this report will be the $L_{Aeq(Day)}$ noise levels.

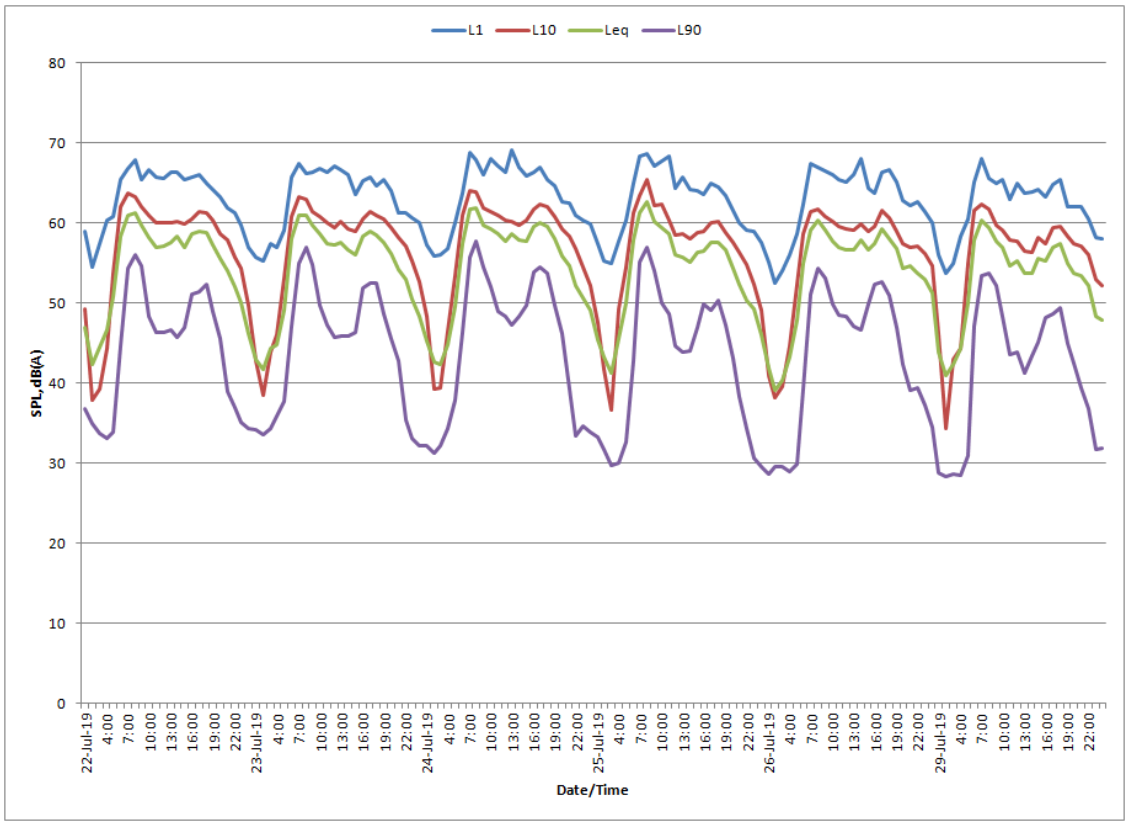


Figure 4-1 Noise Monitoring Results: 14 Gandossi Court

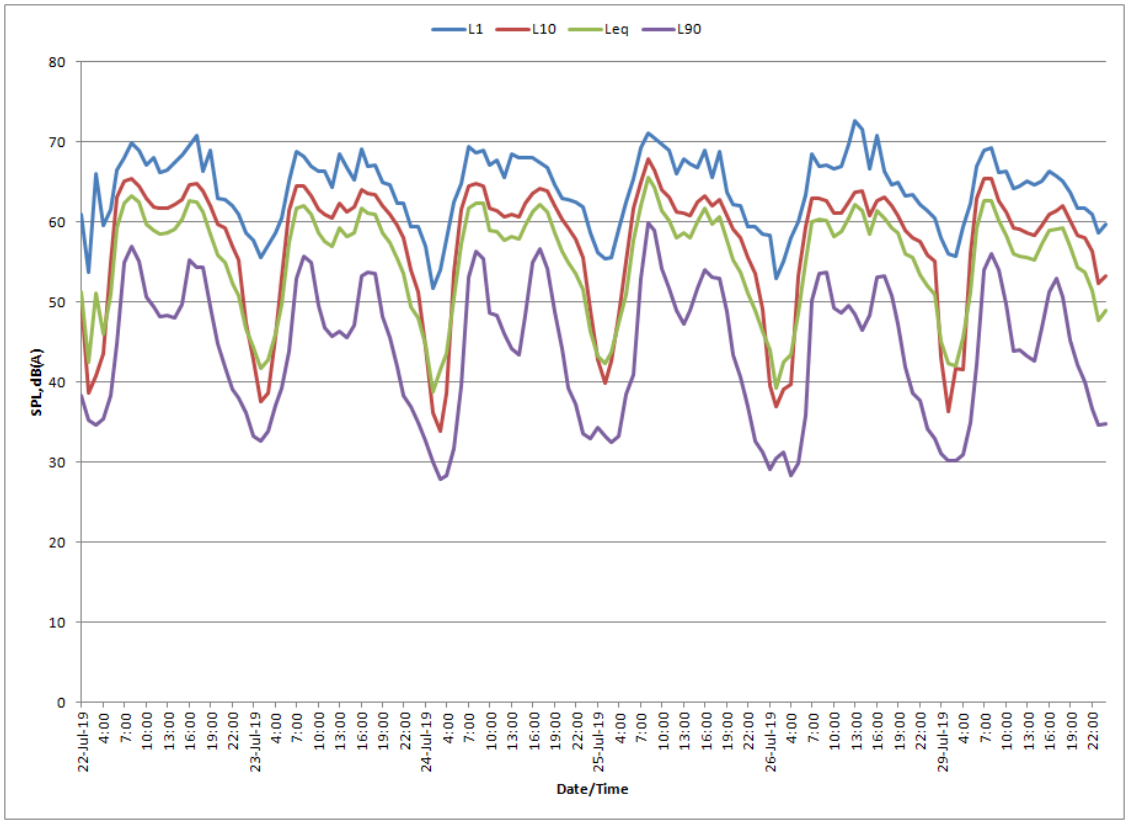


Figure 4-2 Noise Monitoring Results: 16 Muirfield Avenue

4.2 Noise Modelling

Three scenarios are considered in noise modelling being Existing, No Build and Build and each are discussed in *Section 4.2.1* to *Section 4.2.3*.

4.2.1 Existing Scenario

The purpose of the Existing Scenario is to calibrate the noise model. The $L_{Aeq(Day)}$ value is predicted to the two monitoring locations as shown in *Table 4-3* and compared against the measured noise levels of *Table 4-1* and *Table 4-2*. This difference becomes the calibration factor which is applied to the No Build and Build Scenario noise models.

Table 4-3 Model Calibration

Location	Measured $L_{Aeq(Day)}$, dB	Modelled $L_{Aeq(Day)}$, dB	Difference, dB
14 Gandossi Court	57.8	59.1	1.3
16 Muirfield Avenue	59.7	59.8	0.1

The above shows that the model is over-predicting noise levels on average by 0.7 dB. As such, this factor has been applied to all three scenarios. On this basis, the model has an accuracy of ± 0.6 dB to the noise monitoring locations.

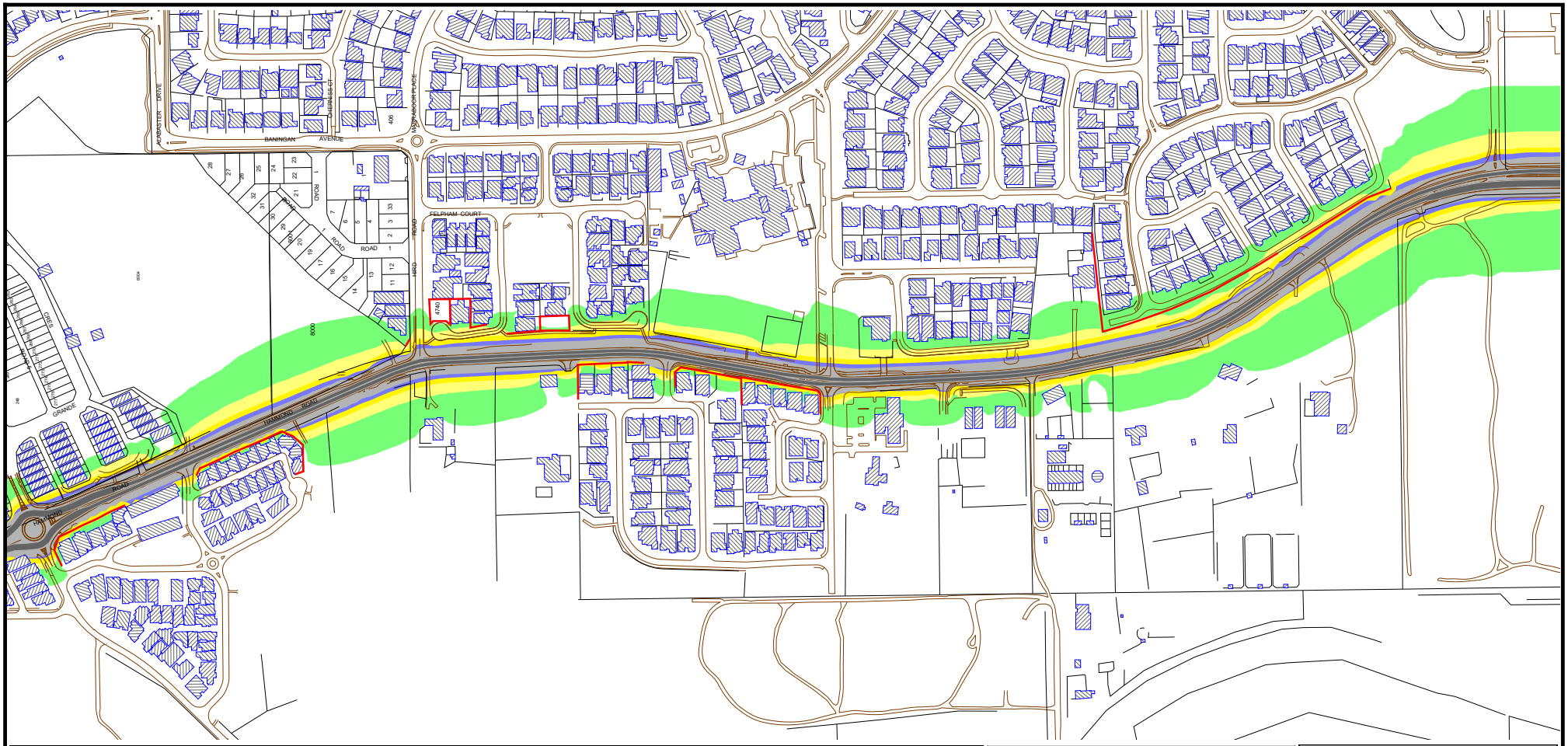
Table 4-4 provides the predicted noise levels for the Existing Scenario to adjoining residences and this is also shown as noise contours on *Figure 4-3*.

Table 4-4 Predicted $L_{Aeq(Day)}$ Noise Levels: Existing Scenario

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
01 Condil Way	60	8 Muirfield Avenue	59
03 Condil Way	60	10 Muirfield Avenue	58
05 Condil Way	57	12 Muirfield Avenue	59
07 Condil Way	57	14 Muirfield Avenue	59
09B Condil Way	58	16 Muirfield Avenue (Logger)	59
1/1 Coojong Link	58	18 Muirfield Avenue	59
2/1 Coojong Link	57	20 Muirfield Avenue	59
3/1 Coojong Link	57	22 Muirfield Avenue	58
4/1 Coojong Link	57	24 Muirfield Avenue	58
5/1 Coojong Link	57	26 Muirfield Avenue	58

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
6/1 Coojong Link	57	28 Muirfield Avenue	56
7/1 Coojong Link	57	40 Carnegie Parade	57
8/1 Coojong Link	57	275 Hammond Road	54
9/1 Coojong Link	57	17 Joindre Way	59
9/1 Coojong Link	57	15 Joindre Way	60
210 Hammond Road	57	11B Joindre Way	60
222 Hammond Road	52	11A Joindre Way	60
30 Calytrix Crescent	58	09 Joindre Way	59
28 Calytrix Crescent	58	07 Joindre Way	59
26 Calytrix Crescent	59	05B Joindre Way	58
2 Aphelia Brace	**61**	05A Joindre Way	58
2 Aphelia Brace	**62**	08 Joindre Way Goodstart Early Learning	59
22 Calytrix Crescent	57	53 Baningan Avenue - Jandakot Primary	53
20 Calytrix Crescent	57	15 Makjanich Place	56
16 Calytrix Crescent	54	13 Makjanich Place	59
21 Wedgetail Crescent	57	11B Makjanich Place	60
25 Wedgetail Crescent	56	11A Makjanich Place	56
27 Wedgetail Crescent	57	12 Makjanich Place	54
272 Hammond Road	60	13 Gandossi Court	54
282 Hammond Road	54	13 Gandossi Court	59
300 Hammond Road	56	13 Gandossi Court	58
304 Hammond Road	53	12A Gandossi Court	57
		12A Gandossi Court	57
		14 Gandossi Court (Logger)	58
		01 Hird Road	57
		01 Hird Road	59
		01 Hird Road	57

Note: Numbers shown in Bold Red are above the *limit*.



Hammond Road Duplication Project (Brach Circus to Bartram Road) - Existing Noise Level Contours

$L_{Aeq(Day)}$ Noise Level Contours Based on Existing Conditions
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

8 August 2019

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Length Scale 1:6000
0 30 60 120 180 240 m

Figure 4-3

Signs and symbols
- Road
- Building
- Existing Fence/Wall
- Elevation line

Noise levels $L_{Aeq,Day}$ dB
- <= 55
- <= 56 Exposure A
- <= 57
- <= 58
- <= 59
- <= 60
- <= 61 Exposure B
- <= 62
- <= 63
- <= 64 Exposure C
- <= 65
- > 65 Exposure D

SPP 5.4 (May 2009)

4.2.2 No Build Scenario

The No Build Scenario assumes the existing road carries the 2031 traffic volumes. The outcome shows the increase in noise level as a result of increased traffic volumes only and represents the noise that will be present if the project does not occur, assuming the current road can carry the projected number of vehicles. The results are provided in *Table 4-5* and *Figure 4-4*.

Table 4-5 Predicted $L_{Aeq(Day)}$ Noise Levels: No Build Scenario

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
01 Condil Way	**63**	8 Muirfield Avenue	**61**
03 Condil Way	**62**	10 Muirfield Avenue	**61**
05 Condil Way	60	12 Muirfield Avenue	**61**
07 Condil Way	59	14 Muirfield Avenue	**61**
09B Condil Way	**61**	16 Muirfield Avenue (Logger)	**62**
1/1 Coojong Link	60	18 Muirfield Avenue	**61**
2/1 Coojong Link	60	20 Muirfield Avenue	**61**
3/1 Coojong Link	59	22 Muirfield Avenue	60
4/1 Coojong Link	59	24 Muirfield Avenue	60
5/1 Coojong Link	60	26 Muirfield Avenue	60
6/1 Coojong Link	59	28 Muirfield Avenue	59
7/1 Coojong Link	59	40 Carnegie Parade	60
8/1 Coojong Link	59	275 Hammond Road	57
9/1 Coojong Link	60	17 Joindre Way	**62**
9/1 Coojong Link	60	15 Joindre Way	**62**
210 Hammond Road	N/A	11B Joindre Way	**62**
222 Hammond Road	53	11A Joindre Way	**62**
30 Calytrix Crescent	60	09 Joindre Way	**62**
28 Calytrix Crescent	60	07 Joindre Way	**62**
26 Calytrix Crescent	**61**	05B Joindre Way	**61**
2 Aphelia Brace	**64**	05A Joindre Way	**61**
2 Aphelia Brace	**65**	08 Joindre Way Goodstart Early Learning	**62**
22 Calytrix Crescent	60	53 Baningan Avenue - Jandakot Primary	56
20 Calytrix Crescent	59	15 Makjanich Place	58
16 Calytrix Crescent	56	13 Makjanich Place	**62**

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
21 Wedgetail Crescent	59	11B Makjanich Place	**62**
25 Wedgetail Crescent	58	11A Makjanich Place	59
27 Wedgetail Crescent	59	12 Makjanich Place	56
272 Hammond Road	**62**	13 Gandossi Court	57
282 Hammond Road	57	13 Gandossi Court	**62**
300 Hammond Road	59	13 Gandossi Court	**61**
304 Hammond Road	55	12A Gandossi Court	60
		12A Gandossi Court	60
		14 Gandossi Court (Logger)	**61**
		01 Hird Road	60
		01 Hird Road	**62**
		01 Hird Road	60

Note: Numbers shown in Bold Red are above the *limit*.

Note that the existing residence at 210 Hammond Road is to be demolished and a Medical Centre constructed. Residential apartments will also form part of the new development, however if these are affected by road traffic noise, this will be the developers responsibility by way of facade upgrades and the like.

4.2.3 Build Scenario

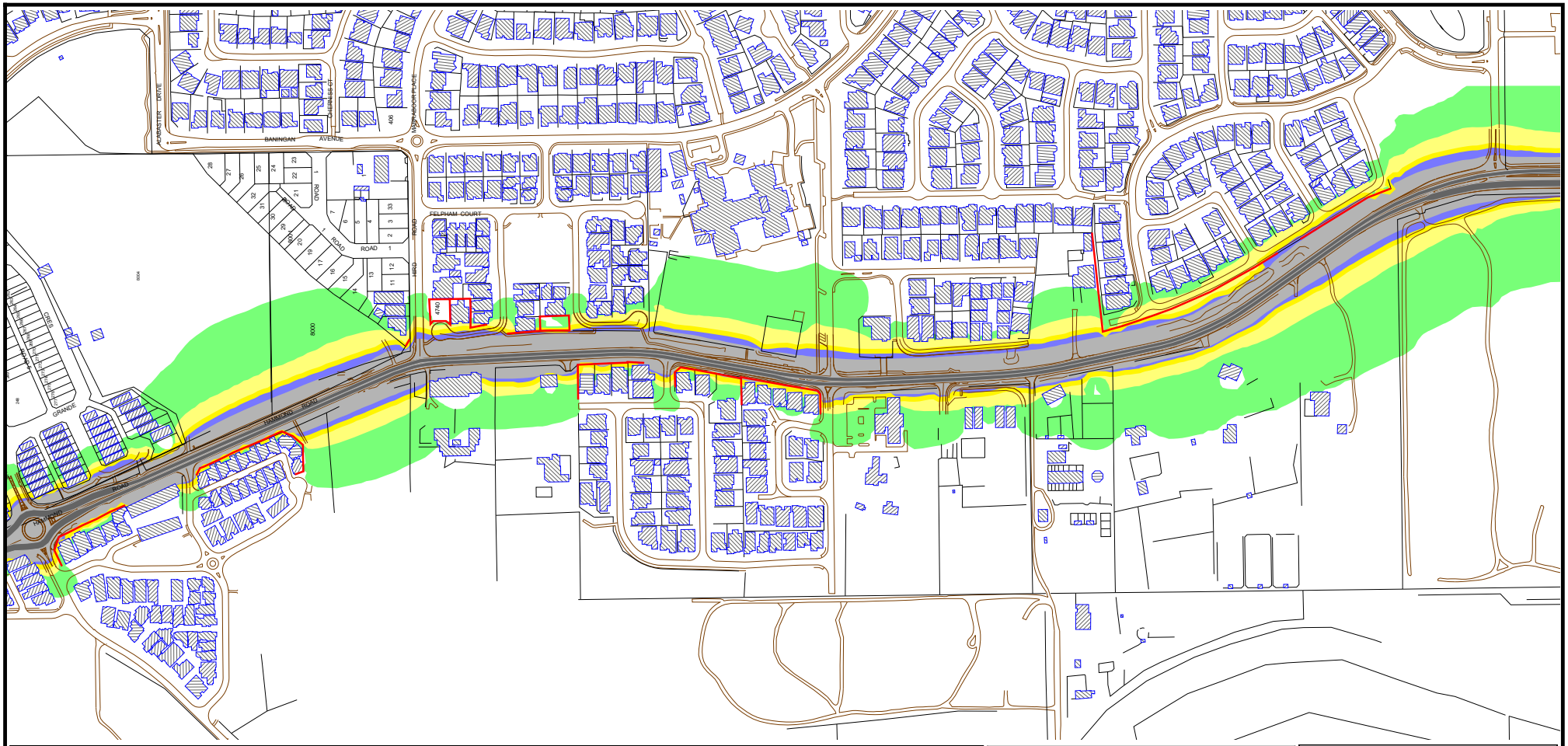
The Build Scenario represents the future traffic volumes on the proposed road design. The results are provided in *Table 4-6* and *Figure 4-5*.

Table 4-6 Predicted $L_{Aeq(Day)}$ Noise Levels: Build Scenario

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
01 Condil Way	**61**	8 Muirfield Avenue	**61**
03 Condil Way	**61**	10 Muirfield Avenue	60
05 Condil Way	59	12 Muirfield Avenue	**61**
07 Condil Way	59	14 Muirfield Avenue	**62**
09B Condil Way	60	16 Muirfield Avenue (Logger)	**63**
1/1 Coojong Link	60	18 Muirfield Avenue	**63**
2/1 Coojong Link	59	20 Muirfield Avenue	**63**

Address	Predicted $L_{Aeq(Day)}$, dB	Address	Predicted $L_{Aeq(Day)}$, dB
West Side Residences		**East Side Residences**	
3/1 Coojong Link	59	22 Muirfield Avenue	**63**
4/1 Coojong Link	59	24 Muirfield Avenue	**63**
5/1 Coojong Link	59	26 Muirfield Avenue	**63**
6/1 Coojong Link	59	28 Muirfield Avenue	**62**
7/1 Coojong Link	59	40 Carnegie Parade	**62**
8/1 Coojong Link	59	275 Hammond Road	58
9/1 Coojong Link	59	17 Joindre Way	**64**
9/1 Coojong Link	59	15 Joindre Way	**64**
210 Hammond Road	N/A	11B Joindre Way	**64**
222 Hammond Road	53	11A Joindre Way	**64**
30 Calytrix Crescent	60	09 Joindre Way	**63**
28 Calytrix Crescent	60	07 Joindre Way	**63**
26 Calytrix Crescent	60	05B Joindre Way	**63**
2 Aphelia Brace	**62**	05A Joindre Way	**62**
2 Aphelia Brace	**63**	08 Joindre Way Goodstart Early Learning	**63**
22 Calytrix Crescent	58	53 Baningan Avenue - Jandakot Primary	56
20 Calytrix Crescent	57	15 Makjanich Place	58
16 Calytrix Crescent	56	13 Makjanich Place	**61**
21 Wedgetail Crescent	57	11B Makjanich Place	**61**
25 Wedgetail Crescent	56	11A Makjanich Place	58
27 Wedgetail Crescent	57	12 Makjanich Place	56
272 Hammond Road	59	13 Gandossi Court	58
282 Hammond Road	55	13 Gandossi Court	**63**
300 Hammond Road	56	13 Gandossi Court	**61**
304 Hammond Road	54	12A Gandossi Court	58
		12A Gandossi Court	**61**
		14 Gandossi Court (Logger)	60
		01 Hird Road	60
		01 Hird Road	**62**
		01 Hird Road	60

Note: Numbers shown in Bold Red are above the *limit*.



Hammond Road Duplication Project (Brach Circus to Bartram Road) - No Build Noise Level Contours

$L_{Aeq(Day)}$ Noise Level Contours Based on Existing Road and Future 2031 Traffic Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

8 August 2019

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Length Scale 1:6000

0 30 60 120 180 240 m

Figure 4-4

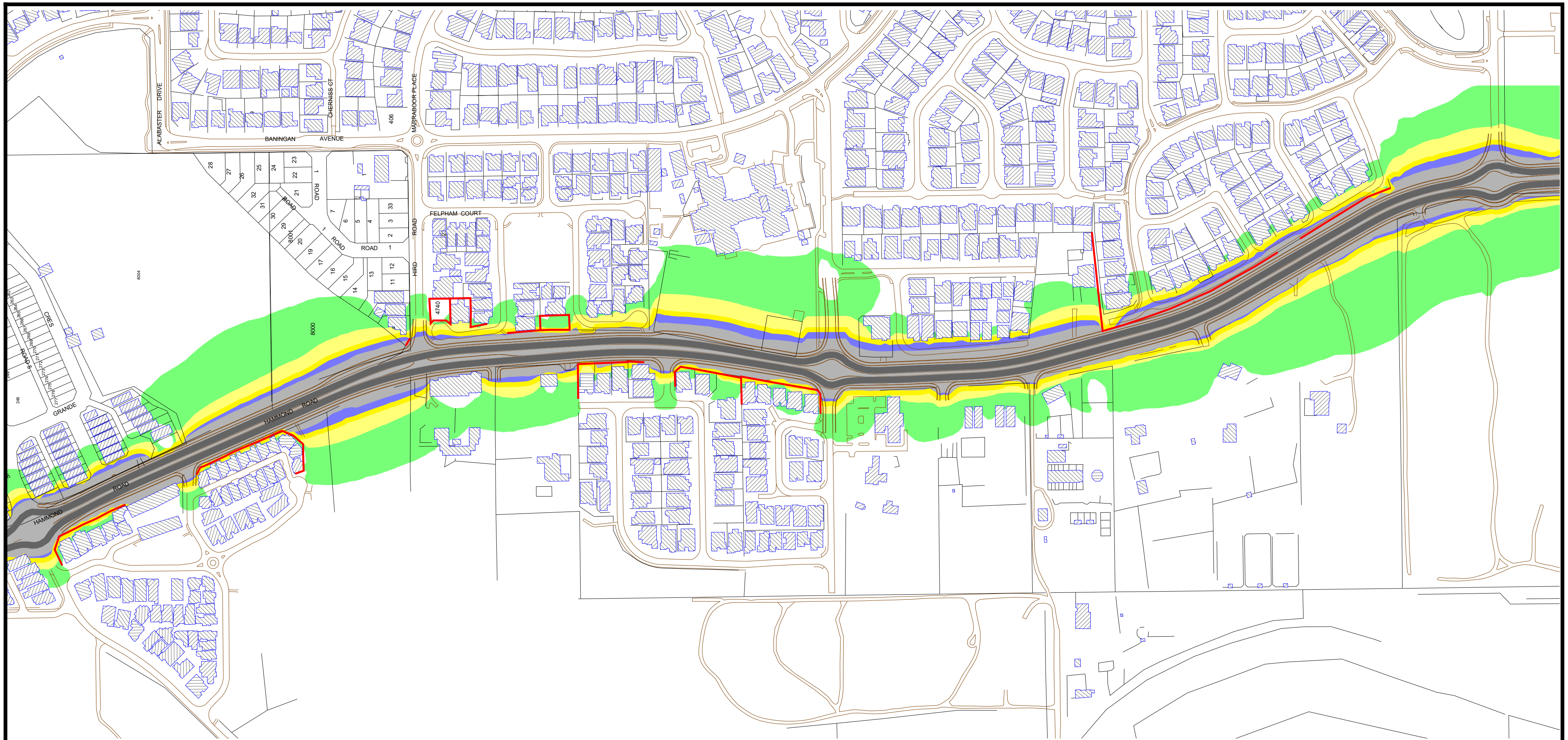
Signs and symbols

- Road
- Building
- Existing Fence/Wall
- Elevation line

Noise levels $L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	
<= 60	
<= 61	Exposure B
<= 62	
<= 63	
<= 64	Exposure C
<= 65	
> 65	Exposure D

SPP 5.4 (May 2009)



Hammond Road Duplication Project (Brach Circus to Bartram Road) - Build Noise Level Contours

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Road and Future 2031 Traffic
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

9 August 2019

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Length Scale 1:6000

0 30 60 120 180 240 m

Figure 4-5

Signs and symbols

- Road
- Building
- Existing Fence/Wall
- Elevation line

Noise levels

$L_{Aeq,Day}$ dB

Level	Exposure
<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	
<= 60	
<= 61	Exposure B
<= 62	
<= 63	
<= 64	Exposure C
<= 65	
> 65	Exposure D

SPP 5.4 (May 2009)

5 ASSESSMENT

For a road upgrade, SPP 5.4 states that practicable noise management and mitigation measures should be considered, having regard to –

- The existing transport noise levels;
- The likely change in noise emissions resulting from the proposal; and
- The nature and scale of the works and potential for noise amelioration.

From the above, there is no clear criteria for when noise mitigation is to occur. For the purposes of this assessment, the following has been used to identify potential areas where noise mitigation may be considered:

- Residences where the Build Scenario results in noise levels above the *limit* and an increase of more than 0.5 dB above the No Build Scenario.

Based on the above criteria guide, *Table 5-1* reviews each of the areas.

Table 5-1 Areas Considered For Noise Mitigation

Area	Comments	Image
Muirfield Avenue	Noise levels are calculated to be above the *limit* and increase by 1-3 dB compared to No Build and 4-6 dB compared to Existing. A retaining wall exists between Muirfield Avenue and the road project. A noise mitigation option would be to provide a new noise wall at a minimum height of 3.0 metres. Whilst the highlighted houses in the image are those that technically satisfy the nominated criteria, best practice would continue the wall further south to the end of Muirfield Avenue.	
Joindre Way	Noise levels are calculated to be above the *limit* and increase by 1-2 dB compared to No Build and 4-5 dB compared to Existing. Space exists between Joindre Way and the proposed alignment. A noise mitigation option would be to provide a wall in this location at a minimum height of 3.0 metres, relative to local road level. The childcare centre has driveway access and therefore the effectiveness of a noise wall may be limited.	

Area	Comments	Image
Gandossi Court	Noise levels are calculated to be above the *limit* and increase by 1 dB compared to the No Build and 4 dB compared to Existing. Whilst only 1 residence qualifies according to the nominated criteria, best practice would consider noise mitigation for all residences adjoining the road on Makjanich Place and Gandossi Court. Again, a noise wall may be practicable in this area, minimum 2.4 metres high, relative to the road design at the proposed location.	

In each of the above, noise control put forward is in the form of noise walls. The modelling assumes the road surface is to remain unchanged (dense graded asphalt). This could be improved to stone mastic or open graded asphalt for reduced noise levels. The advantage of this approach is the noise reduction is achieved at all houses, however maintenance costs may be higher than that of noise walls.

It should be noted that there are other houses that have not been specifically assessed as part of this study, as they are relatively new and therefore noise mitigation would have been part of the development approvals process in the form of architectural upgrades. Such locations would be:

- Savant Grover;
- Jandari Mews
- Volta Way;
- 2 Coojong Link; and
- Windemere Circuit.

6 CONCLUSION

To satisfy the requirements of the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*, *Table 5-1* provides areas where noise mitigation is recommended where in each case, construction of a noise wall is considered practicable. The recommended heights are 2.4 to 3.0 metres, either relative to the proposed road or local road levels, depending on circumstances. Where a noise wall is to be provided, it is to be minimum 15kg/m^2 surface mass with no gaps.

The three proposed walls are described as follows:

- Wall 1 – Proposed to range in height from 3.0 metres to 4.5 metres at the southern end, relative to the provided design strings at the location shown in *Figure 6-1*. The residences are elevated compared to the proposed road and a retaining wall exists alongside the local road. City of Cockburn prefers not to modify the existing retaining wall. As such, the proposed wall is shown to follow the road design, although in reality may be built alongside the existing retaining wall to be determined in detailed design. The retaining wall increases towards the southern end, hence so too does the noise wall. Development to the south (Lot 858 Baningnan Avenue, Success) is expected to be providing their own wall and/or architectural packages). Total wall length is 330 metres with an approximate area of 1100m^2.
- Wall 2 – Proposed to be 3.0 metres high, relative to the local road as shown in *Figure 6-1*, noting the residences are elevated above the local and proposed road. Total wall length is 139 metres with a total area of approximately 420m^2.
- Wall 3 – Proposed to be 2.4 metres high, relative to the provided design strings at the location shown in *Figure 6-1*, noting the road is elevated compared to the residences. Total wall length is 212 metres with a total area of approximately 510m^2.

A limestone noise wall has an indicative cost of $120/m^2, being around $240,000 for all 3 walls.

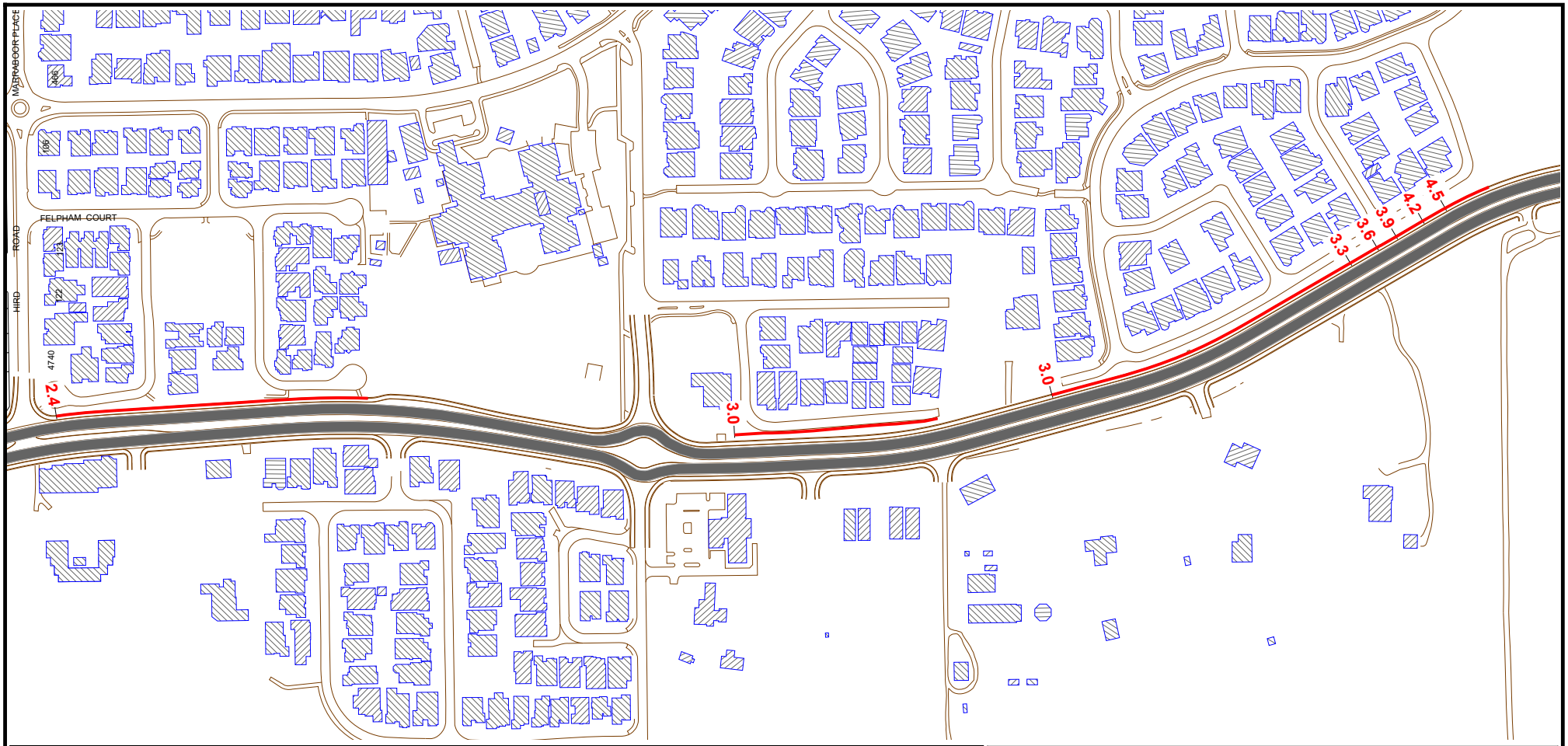
Table 6-1 provides the predicted noise levels at the three wall locations and the noise reduction provided.

Table 6-1 Predicted $L_{Aeq(Day)}$ Noise Levels With Proposed Wall and Noise Reduction

Address	Predicted $L_{Aeq(Day)}$, dB	Noise reduction
Wall 1		
8 Muirfield Avenue	58	2.8
10 Muirfield Avenue	56	4.4
12 Muirfield Avenue	54	6.6
14 Muirfield Avenue	54	7.1
16 Muirfield Avenue (Logger)	55	7.8
18 Muirfield Avenue	55	8.2
20 Muirfield Avenue	55	8.2
22 Muirfield Avenue	54	8.7
24 Muirfield Avenue	55	8.7
26 Muirfield Avenue	55	8.4
28 Muirfield Avenue	54	7.9
40 Carnegie Parade	56	5.6

Address	Predicted $L_{Aeq(Day)}$, dB	Noise reduction
Wall 2		
17 Joindre Way	62	2.4
15 Joindre Way	58	6.5
11B Joindre Way	57	7.5
11A Joindre Way	56	7.8
09 Joindre Way	55	8.0
07 Joindre Way	56	7.8
05B Joindre Way	54	8.4
05A Joindre Way	58	4.6
Wall 3		
15 Makjanich Place	55	3.8
13 Makjanich Place	55	6.2
11B Makjanich Place	55	6.6
11A Makjanich Place	52	6.0
12 Makjanich Place	51	4.8
13 Gandossi Court	52	5.7
13 Gandossi Court	54	8.3
13 Gandossi Court	54	7.7
12A Gandossi Court	52	6.4
12A Gandossi Court	56	5.1
14 Gandossi Court (Logger)	55	4.7

Noise Reduction is the difference between Future Build (Table 4-6) and with Future Build with Noise Walls



Hammond Road Duplication Project (Brach Circus to Bartram Road) - Indicative Noise Walls (Heights continuous from left to right)

Wall 1 (Southern End) - 3.0 metre to 4.5 metres high relative to proposed road design
Wall 2 (Middle) - 3.0 metres high relative to local road level
Wall 3 (Northern End) - 2.4 metres high relative to proposed road design

SoundPlan v8.1

17 September 2019

Signs and symbols
- Road
- Building
- Proposed Wall
- Elevation line

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Length Scale 1:3992
0 20 40 80 120 160 m

Figure 6-1

Appendix A

Proposed Road Design

DWG No. 3557B18 SHEET No. 01

REV	DESCRIPTION	DRAWN	DATE	CHECKED

CITY OF COCKBURN
9 COLEVILLE CRESCENT, SPEARWOOD WA 6163
PHONE: (08) 9411 3444 FAX: (08) 9347 3333

TITLE
HAMMOND ROAD DUPLICATION
FROM BRANCH CIRCUS TO BARTRAM ROAD
CONCEPT (SHEET 01 OF 03)

DESIGNED	M.H
DRAWN	M.H
CHECKED	S.M

APPROVED

SCALE	scale
JOB No.	
DWG No.	3557B18
SHEET No.	01
REV	

DWG No. 3557B18 SHEET No. 02

END OF ROAD WORKS

CARMAL WAY

27.3 27.4 50.0

4.6

TOWN PLANNING SCHEME BOUNDARY

PROPOSED ROAD BOUNDARY

R=250

R=250

LOT 812

MATCH LINE B - B

LOT 50

LOT 51

LOT 1

LOT 118

LOT 119

LOT 120

DARLOT AVE

3.1

PROPOSED 2.5m WIDE SHARED PATH

3.5

MATCH LINE C - C

3.0

3.5

3.5

LOT 125

LOT 126

WINDERMERE CCT

PLAN

SCALE: 1:500

START OF ROAD WORKS

PROPOSED 2.5m WIDE SHARED PATH

3.5

LOT 14

MUIRFIELD AVE

MATCH LINE C - C

MATCH LINE D - D

EXISTING BOUNDARY

PROPOSED ROAD BOUNDARY

7.7

PROPOSED ROAD BOUNDARY

LOT 22

TOWN PLANNING SCHEME BOUNDARY

LOT 3

LOT 13

LOT 12

PLAN

SCALE: 1:500

LEGEND

- TOWN PLANNING SCHEME BOUNDARY
- EXISTING BOUNDARY
- PROPOSED ROAD BOUNDARY
- PROPOSED ROAD KERB
- PROPOSED RETAINING WALL
- PROPOSED MEDIAN CONCRETE
- PROPOSED CONCRETE FOOTPATH
- MODIFIED CROSS OVER

SCALE (HZ) 1:500 0 10 20 30 40 50

A1

REV	DESCRIPTION	DRAWN	DATE	CHECKED

CITY OF COCKBURN
9 COLEVILLE CRESCENT, SPEARWOOD WA 6163
PHONE: (08) 9411 3444 FAX: (08) 9347 3333

TITLE

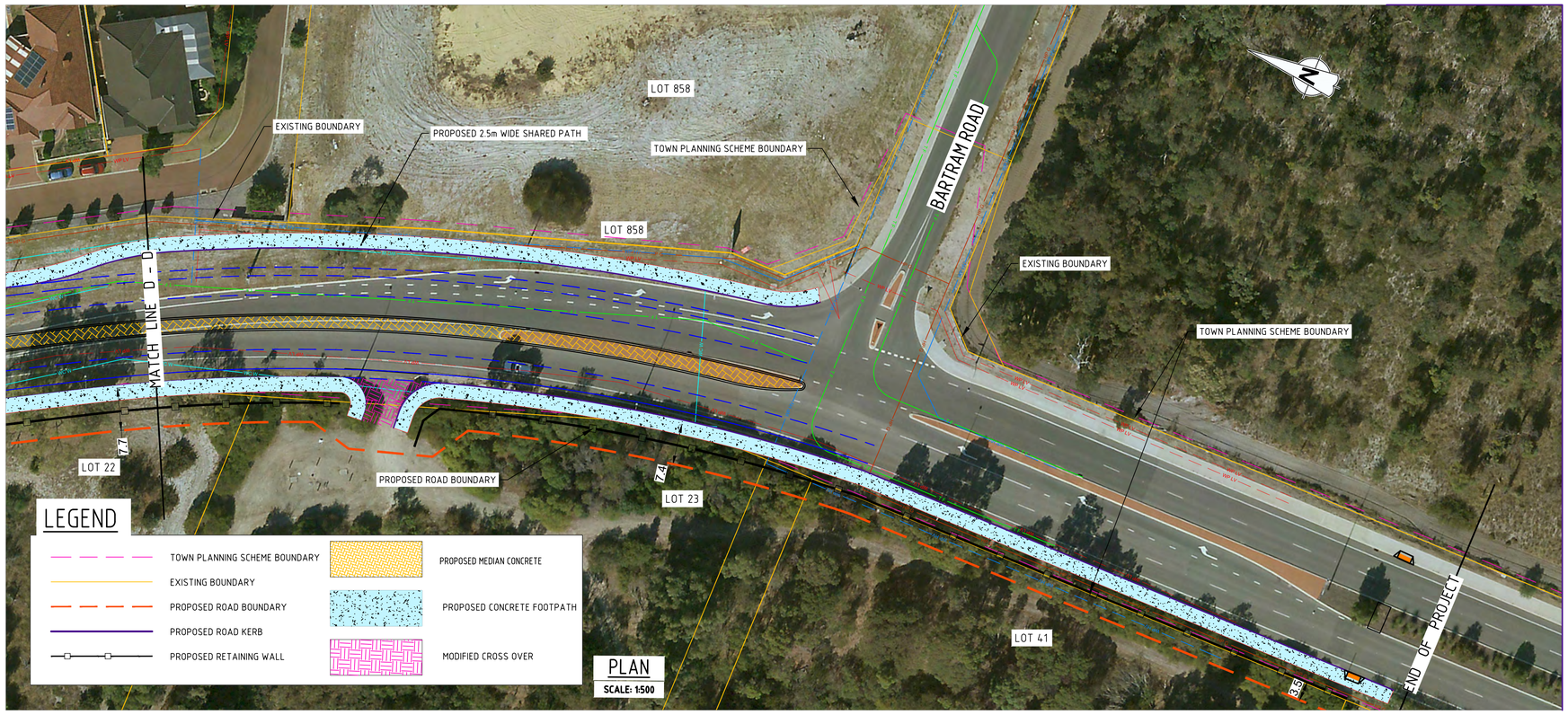
HAMMOND ROAD DUPLICATION
FROM BRANCH CIRCUS TO BARTRAM ROAD
CONCEPT (SHEET 02 OF 03)

DESIGNED	M.H	APPROVED
DRAWN	M.H	
CHECKED	S.M	

SCALE	scale	JOB No.	
DWG No.	3557B18	SHEET No.	02

REV

DWG No. 3557B18 SHEET No. 03



PLAN
SCALE: 1:500

REV	DESCRIPTION	DRAWN	DATE	CHECKED

CITY OF COCKBURN
9 COLEVILLE CRESCENT, SPEARWOOD WA 6163
PHONE: (08) 9411 3444 FAX: (08) 9347 3333

TITLE
HAMMOND ROAD DUPLICATION
FROM BRANCH CIRCUS TO BARTRAM ROAD
CONCEPT (SHEET 03 OF 03)

DESIGNED	M.H	APPROVED
DRAWN	M.H	
CHECKED	S.M	

SCALE	scale	JOB No.	
DWG No.		SHEET No.	REV
3557B18		03	

SCALE (HZ) 1:500 0 10 20 30 40 50
A1

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1
An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}
An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}
An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}
The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$
The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

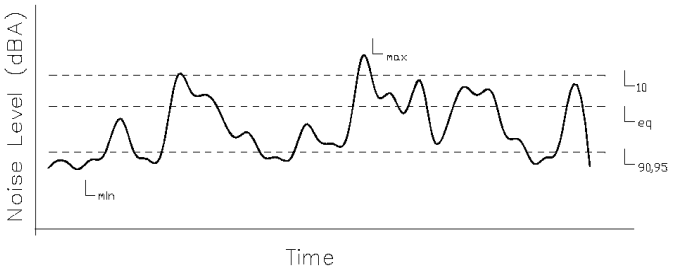
$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

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

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

Chart of Noise Level Descriptors



Austroads Vehicle Class

AUSTROADS Vehicle Classification System

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

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

Typical Noise Levels