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Transportation Noise Assessment - Proposed Road Upgrade – 85%

Mandurah Estuary Bridge Duplication

Reference: 23017811-04 Draft 2

Prepared for:
Georgiou / BG&E



Reference: 23017811-04 Draft 2

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29-Oct-23	A1	Issued as Draft 15% Design	Terry George	-
13-Nov-23	A2	Updated with 15% Design dated 27/10/23 and with supplied noise wall strings. Also considered Packages and SMA implications.	Terry George	-
3-Dec-23	A3	Updated following 15% IV and now 85% Design	Terry George	-
16-Dec-23	B1	Issued as Draft 85% Design	Terry George	-
17-Jan-23	B2	Updated to reflect new alignment for NW-1 (North west quadrant near bus bay).	Terry George	-

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1. INTRODUCTION

It is proposed to duplicate the Mandurah Estuary Bridge in order to ease congestion in the approach to the Mandurah Estuary and reduce travel times. The project will deliver a safe, more efficient and reliable transport link for motorists, with the inclusion of a four-metre wide shared path improving access for riders and walkers. The general project locality is shown in *Figure 1-1*.

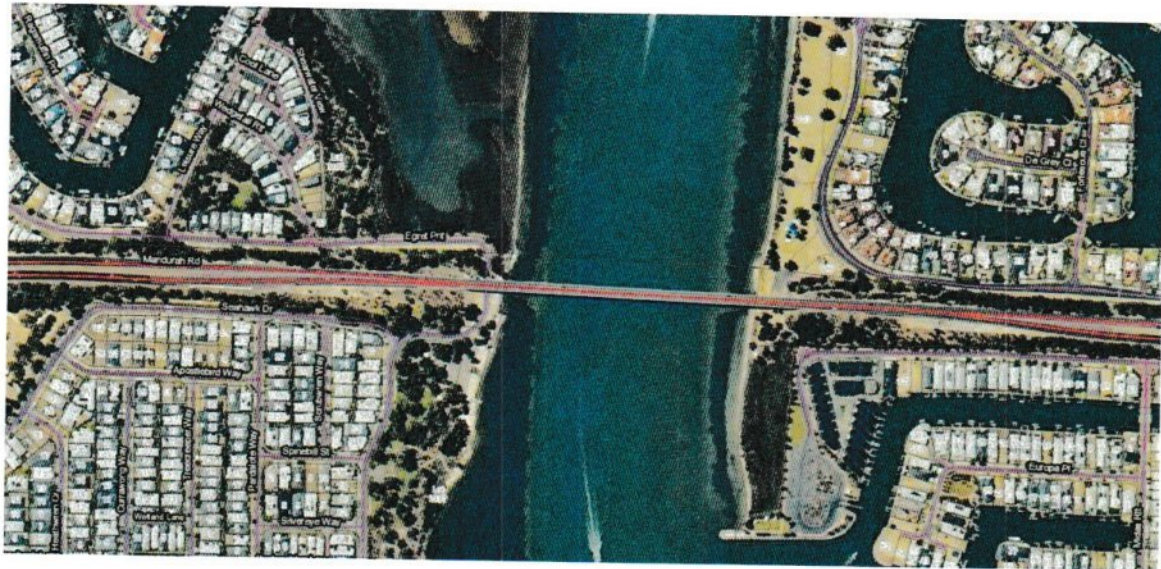


Figure 1-1: Road Project Locality

The purpose of this report is to consider the road traffic noise impacts associated with the 85% Design and consider noise wall design to meet the requirements of the Scope of Works & Technical Criteria (SWTC) document.

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

2. CRITERIA

The criteria relevant to this project are provided in the Scope of Works & Technical Criteria (SWTC) document. *Table 2-1* sets out noise targets that are to be achieved at ground floor of residential buildings and other noise sensitive land.

Table 2-1: Noise Targets for Roads

Scenario	Outdoor Noise Target	
Road Upgrade	60 dB L _{Aeq} (Day)	55 dB L _{Aeq} (Night)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1.0-metre from the most exposed, habitable¹ facade of a noise sensitive building.

Section 4.14 of the SWTC also provides the following:

- The Design Year is 2041 (4.14(a)(i));
- The Noise Target applies to ground floors only (4.14(b)(i));
- Noise walls shall not exceed 5.0 metres in height (4.14(b)(ii));
- Noise walls are to be constructed of certain materials with only one acceptable across the project (4.14(f)), including recycled plastic (4.14(f)(vi));
- Noise walls are not permitted on the bridge superstructure (4.14(f)(vii));
- Noise walls must be of height, relative to finished ground level on the residential side, not less than 2.4 m when located on residential boundaries and not less than 1.8 m elsewhere (xvii);
- Noise walls must be of height, relative to finished ground level on the residential side, not less than 2.4 m when located on residential boundaries and not less than 1.8 m elsewhere. Where noise walls ... are located on top of retaining walls, the height of the noise wall ... must be measured from the top of the retaining wall (4.14(f)(xvii));
- Noise wall panels must be buried at least 200 mm below ground (4.14(f)(xviii)).

¹ A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

3. METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of SPP 5.4 and associated Guidelines as described in *Section 3.1* and *Section 3.2*.

3.1. Site Measurements

Noise monitoring was undertaken at four (4) locations between 10 October 2023 and 17 October 2023 in order to:

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

The instruments used were Acoustic Research Laboratories (ARL) Type noise data loggers. Details of the monitoring are provided in the *Appendix A Noise Monitoring Report*.

3.2. Noise Modelling

The computer program *SoundPLAN 8.2* 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 Class 1 and 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two source heights at 1.5 metres and 3.6 metres above road level;
- A -0.8 dB correction has been applied to the lower level heavy vehicle noise source and -8.0 dB to the higher level noise source based on the *Transportation Noise Reference Book*; Paul Nelson (1987), so as to provide consistent results with the CoRTN algorithms.
- An adjustment of -1.7 dB has been applied to the predicted levels at a façade, 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).

Receivers are located 1.4 metres above ground floor level of a residence and at 1.0 metre from the façade, resulting in a + 2.5 dB façade reflection.

Various input data are included in the modelling and these are discussed in *Section 3.2.1* and *Section 3.2.2*.

3.2.1. Ground Topography

Some topographical data was on file obtained during the tender stage of the project from the AECOM noise model. This was supplemented with survey data provided by the design team, including finished floor levels as shown in *Figure 3-1*.

This report uses the 15% design provided by BG&E via email on 2-Nov-23, with the design dated 27-Oct-23 where it is understood there has been no change to the civil design to 85%. Also provided via email on 3-Nov-23 were bottom of noise wall strings, to ensure location and relative wall heights are the same within the design team. On 16-Jan-24, the noise wall design for NW-1 and NW-2 was modified by the Design Team with this report including this update.



Figure 3-1: Finished Floor Levels of Closest Houses

3.2.2. Traffic Information

3.2.2.1. Road Surface

The corrections applied for different road surface finishes are provided in *Table 3-1*.

Table 3-1: Noise Relationship Between Different Road Surfaces

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

The existing Mandurah Road surface is a mix of road surfaces as shown in *Table 3-2* with reference to Straight Line Kilometre (SLK) used by Main Roads WA. As part of the project, the road surface will be DGA within the bounds of the project area.

Table 3-2: Mandurah Road Existing and Project Road Surfaces

Road	SLK	Road Surface - Existing	Road Surface - Proposed
Eastbound Traffic			
M074 – Mandurah Road	12.86 to 12.82	DGA	DGA
	12.82 to 12.43	Slurry	Slurry
	12.43 to 12.31	Slurry	DGA
	12.31 to 11.14	DGA	DGA
	11.14 to 10.40	Slurry	Slurry
Westbound Traffic			
M074 – Mandurah Road	10.40 to 11.14	Slurry	Slurry
	11.14 to 12.31	DGA	DGA
	12.31 to 12.66	Slurry	DGA
	12.66 to 12.82	Slurry	Slurry
	12.82 to 12.86	DGA	DGA

3.2.2.2. Vehicle Speed

The posted speed throughout the study area is 70 km/hr and is to remain the same in the future. From Main Roads WA Traffic Map, the median speed is provided either side of the bridge and shown in *Figure 3-2*. It can be seen that on the west side of the bridge, eastbound traffic becomes congested in the morning peak period whilst traffic is reasonably consistent in speed at all other times, directions and locations.

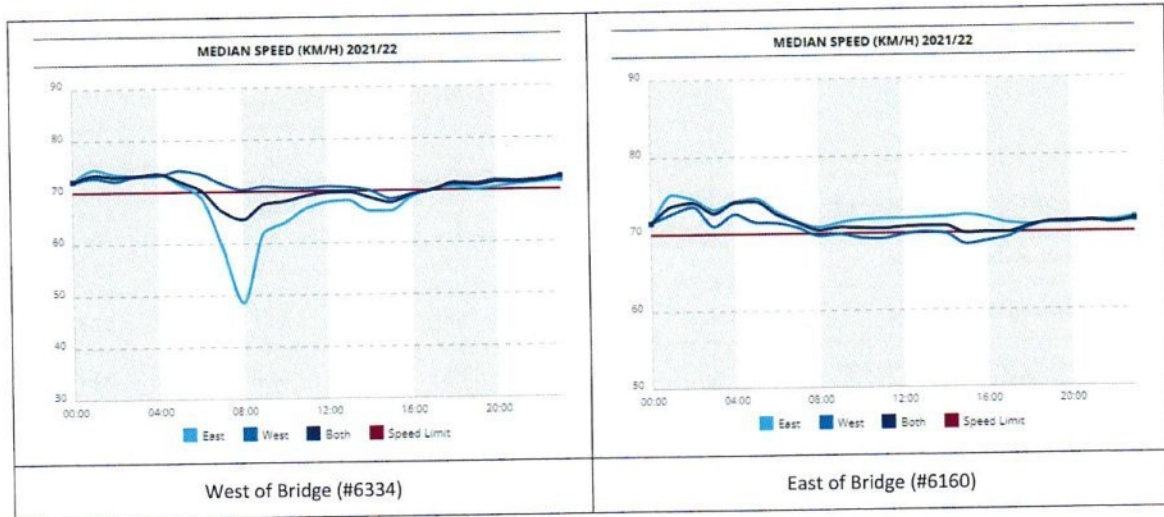


Figure 3-2: Median Speed Near Bridge

3.2.2.3. Traffic Volumes

Existing traffic volumes were obtained from Main Roads WA Traffic Map. Two counts are provided either side of the bridge (#6160 & 6334), both recorded in 2021/22, with #6160 used as the basis for existing traffic volumes. Future volumes are provided in the SWTC. *Table 3-3* provides the volumes used in the noise modelling.

Table 3-3: Modelled Traffic Volumes

Road	Section	Existing (2021/22)		Future (2041)	
		Eastbound	Westbound	Eastbound	Westbound
Mandurah Road	At Mandurah Estuary Bridge	17,363 (10.1)	18,599 (9.2)	25,208 (10.1)	24,513 (9.0)

Note: Numbers shown in brackets are percentage heavy vehicles.

3.2.3. Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the roads and water, 1.0 (100%) in grassed/vegetated areas and 0.0 (0%) elsewhere, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

4. RESULTS

4.1. Existing Noise Monitoring

The results of the noise monitoring are summarised below in *Table 4-1*. The full report is provided in *Appendix A*.

Table 4-1: Average Weekday Noise Measurement Results, dB

Location	Average Weekday Noise Level, dB			
	L _{A10,18hour}	L _{Aeq,24hour}	L _{Aeq(Day)}	L _{Aeq(Night)}
1. 117 Waterlily Drive, Dudley Park	59.7	57.3	58.6	52.8
2. 78 Seahawk Drive, Erskine	60.4	57.8	59.0	53.1
3. 21 Egret Point, Halls Head	65.4	62.4	63.7	57.3
4. 40 Waterside Drive, Dudley Park	62.3	59.7	61.1	53.7

Note that since the daytime noise levels are at least 5 dB higher than the night-time, only the daytime levels will be considered, since these will be more critical in comparison to the *Section 2* criteria.

It was noted from the monitoring data that the direction of the wind significantly influenced the measured levels with the two south locations (Locations 1 & 2) experiencing only 1 downwind day and the two north locations (Locations 3 & 4) with three downwind days. *Table 4-2* compares the overall average L_{Aeq(Day)} noise levels from *Table 4-1* with the average upwind and downwind L_{Aeq(Day)} noise levels.

Table 4-2: Average Weekday Downwind Noise Measurement Results, dB

Location	Weekday Noise Level, dB		
	Average All Days L _{Aeq(Day)}	Average Upwind Days L _{Aeq(Day)}	Average Downwind Days L _{Aeq(Day)}
1. 117 Waterlily Drive, Dudley Park	58.6	57.3	61.6
2. 78 Seahawk Drive, Erskine	59.0	57.9	60.2
3. 21 Egret Point, Halls Head	63.7	62.3	64.2
4. 40 Waterside Drive, Dudley Park	61.1	59.6	61.5

4.2. Noise Modelling

4.2.1. Existing Noise Model

Initially, the noise model is set-up to reflect existing conditions and then calibrated against the noise monitoring results, with the calibration factor determined to be -3.6 dB. *Table 4-3* compares the modelled levels to the reported average noise levels as well as the downwind only noise levels. With regard to the latter, the model accuracy is -0.7 dB to 0.8 dB, thus generally equally under and over-predicting. In comparison to the reported average, the model accuracy is 0.0 to 2.3 dB, meaning that the model is generally over-predicting. Given the requirement to meet the noise level objectives, it is considered appropriate for the noise model to generally over-predict the average measured levels in this instance.

Table 4-3: Noise Model Accuracy

Location	Modelled $L_{Aeq(Day)}$, dB	Average All Days, dB		Downwind Days, dB	
		Measured	Difference	Measured	Difference
1. 117 Waterlily Drive, Dudley Park	60.9	58.6	+2.3	61.6	-0.7
2. 78 Seahawk Drive, Erskine	61.0	59.0	+2.0	60.2	+0.8
3. 21 Egret Point, Halls Head	63.9	63.7	+0.2	64.2	-0.3
4. 40 Waterside Drive, Dudley Park	61.1	61.1	0.0	61.5	-0.4

Table 4-4 provides the predicted noise levels at each residence for the existing scenario, with a noise contour plot provided in *Figure 4-1A*. It is evident that at many of the residences, noise levels are above the outdoor noise target (red text).

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

Residence – North Side	$L_{Aeq(Day)}$, dB	Residence – South Side	$L_{Aeq(Day)}$, dB
21 Leisure Way, Halls Head	63	89 Waterlily Drive, Dudley Park	63
22 Leisure Way, Halls Head	64	91 Waterlily Drive, Dudley Park	63
23 Leisure Way, Halls Head	64	93 Waterlily Drive, Dudley Park	62
24 Leisure Way, Halls Head	63	95 Waterlily Drive, Dudley Park	61
25 Leisure Way, Halls Head	62	97 Waterlily Drive, Dudley Park	61
3 Egret Point, Halls Head	64	99 Waterlily Drive, Dudley Park	60
3 Egret Point, Halls Head	64	101 Waterlily Drive, Dudley Park	60
7 Egret Point, Halls Head	64	103 Waterlily Drive, Dudley Park	60
9 Egret Point, Halls Head	64	105 Waterlily Drive, Dudley Park	60
11 Egret Point, Halls Head	64	107 Waterlily Drive, Dudley Park	59
15 Egret Point, Halls Head	64	109 Waterlily Drive, Dudley Park	60

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
17 Egret Point, Halls Head	64	111 Waterlily Drive, Dudley Park	60
19 Egret Point, Halls Head	64	113 Waterlily Drive, Dudley Park	60
21 Egret Point, Halls Head	64	115 Waterlily Drive, Dudley Park	61
20 Wedgetail Retreat, Halls Head	58	117 Waterlily Drive, Dudley Park	61
29 Wedgetail Retreat, Halls Head	61	119 Waterlily Drive, Dudley Park	60
29 Wedgetail Retreat, Halls Head	59	121 Waterlily Drive, Dudley Park	61
57 Waterside Drive, Dudley Park	57	123 Waterlily Drive, Dudley Park	61
55 Waterside Drive, Dudley Park	59	125 Waterlily Drive, Dudley Park	61
51 Waterside Drive, Dudley Park	60	127 Waterlily Drive, Dudley Park	61
50 Waterside Drive, Dudley Park	59	127 Waterlily Drive, Dudley Park	61
49 Waterside Drive, Dudley Park	62	127 Waterlily Drive, Dudley Park	61
46 Waterside Drive, Dudley Park	63	127 Waterlily Drive, Dudley Park	61
45 Waterside Drive, Dudley Park	62	127 Waterlily Drive, Dudley Park	60
44 Waterside Drive, Dudley Park	59	127 Waterlily Drive, Dudley Park	57
43 Waterside Drive, Dudley Park	60	127 Waterlily Drive, Dudley Park	56
42 Waterside Drive, Dudley Park	61	42 Egret Point, Erskine	56
41 Waterside Drive, Dudley Park	63	40 Egret Point, Erskine	58
40 Waterside Drive, Dudley Park	61	38 Egret Point, Erskine	59
39 Waterside Drive, Dudley Park	62	38 Egret Point, Erskine	61
38 Waterside Drive, Dudley Park	59	78 Seahawk Drive, Erskine	61
37 Waterside Drive, Dudley Park	63	76 Seahawk Drive, Erskine	61
36 Waterside Drive, Dudley Park	61	74 Seahawk Drive, Erskine	61
35 Waterside Drive, Dudley Park	62	72 Seahawk Drive, Erskine	62
34 Waterside Drive, Dudley Park	62	70 Seahawk Drive, Erskine	62
		68 Seahawk Drive, Erskine	62
		37 Pardalote Way, Erskine	63
		64 Seahawk Drive, Erskine	63
		62 Seahawk Drive, Erskine	63
		60 Seahawk Drive, Erskine	63
		58 Seahawk Drive, Erskine	63
		56 Seahawk Drive, Erskine	63
		54 Seahawk Drive, Erskine	63

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
		52 Seahawk Drive, Erskine	64
		50 Seahawk Drive, Erskine	64
		48 Seahawk Drive, Erskine	64
		46 Seahawk Drive, Erskine	64
		44 Seahawk Drive, Erskine	64
		44 Seahawk Drive, Erskine	61
		26 Apostlebird Way, Erskine	60
		26 Apostlebird Way, Erskine	60
		34 Seahawk Drive, Erskine	57
		32 Seahawk Drive, Erskine	57
		30 Seahawk Drive, Erskine	56
		28 Seahawk Drive, Erskine	55



**Mandurah Estuary Bridge Duplication -
85% Design Stage**

$L_{Aeq(Day)}$ Noise Level Contours Based on Existing Road Conditions with Existing (2020/21) Traffic
Ground Floor Level

SoundPLAN v8.2
CoRTN Algorithms

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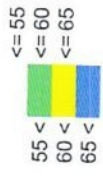
15 December 2023

Figure 4-1A

Signs and symbols

- Road
- ▨ Houses
- ▨ Package B Houses
- ⬇ Assessment Location
- Existing Wall

Noise levels
 $L_{Aeq(Day)}$ dB



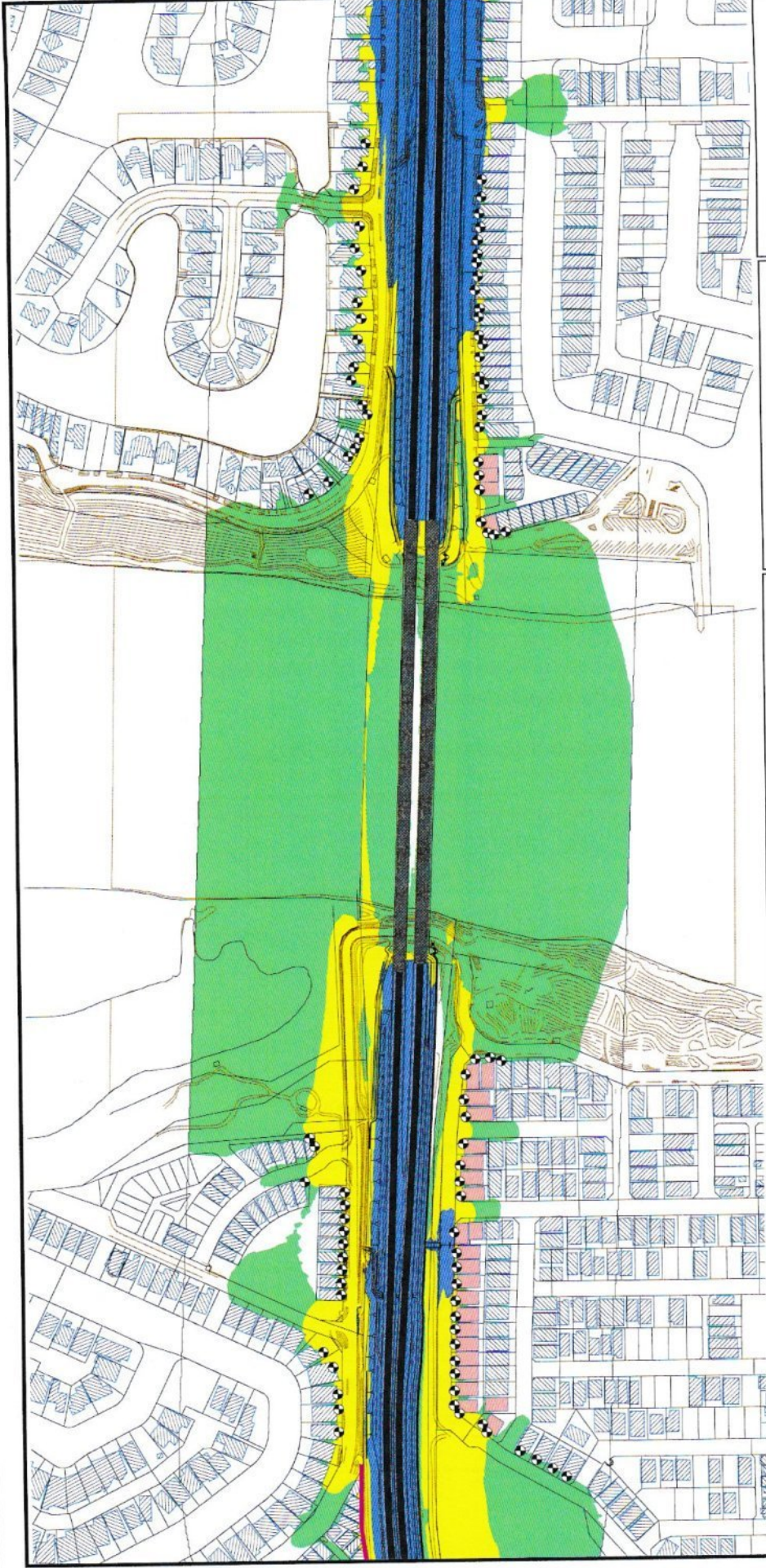
4.2.2. Future Noise Model

Table 4-5 shows the predicted noise level with the road project and for future 2041 traffic volumes. Also shown is the increase compared to the existing noise levels. A noise contour plot is provided in Figure 4-2B.

Table 4-5: Future Predicted Noise Levels, dB $L_{Aeq}(Day)$

Residence – North Side	$L_{Aeq}(Day)$, dB	Increase from Existing, dB	Residence – South Side	$L_{Aeq}(Day)$, dB	Increase from Existing, dB
21 Leisure Way, Halls Head	63	-0.2	89 Waterlily Drive. Dudley Park	66	2.5
22 Leisure Way, Halls Head	64	-0.2	91 Waterlily Drive. Dudley Park	66	3.0
23 Leisure Way, Halls Head	64	0.0	93 Waterlily Drive. Dudley Park	66	4.0
24 Leisure Way, Halls Head	63	0.5	95 Waterlily Drive. Dudley Park	65	4.6
25 Leisure Way, Halls Head	63	0.8	97 Waterlily Drive. Dudley Park	66	5.0
3 Egret Point, Halls Head	65	0.9	99 Waterlily Drive. Dudley Park	66	5.3
3 Egret Point, Halls Head	65	1.0	101 Waterlily Drive. Dudley Park	66	5.5
7 Egret Point, Halls Head	65	0.9	103 Waterlily Drive. Dudley Park	66	5.4
9 Egret Point, Halls Head	65	1.0	105 Waterlily Drive. Dudley Park	66	5.4
11 Egret Point, Halls Head	65	1.0	107 Waterlily Drive. Dudley Park	65	5.3
15 Egret Point, Halls Head	65	1.1	109 Waterlily Drive. Dudley Park	65	4.9
17 Egret Point, Halls Head	65	1.3	111 Waterlily Drive. Dudley Park	65	4.5
19 Egret Point, Halls Head	65	1.1	113 Waterlily Drive. Dudley Park	64	4.2
21 Egret Point, Halls Head	65	0.8	115 Waterlily Drive. Dudley Park	65	3.9
20 Wedgetail Retreat, Halls Head	59	0.9	117 Waterlily Drive. Dudley Park	64	3.2
29 Wedgetail Retreat, Halls Head	62	0.6	119 Waterlily Drive. Dudley Park	63	2.7
29 Wedgetail Retreat, Halls Head	59	0.4	121 Waterlily Drive. Dudley Park	63	2.5
57 Waterside Drive, Dudley Park	57	0.2	123 Waterlily Drive. Dudley Park	63	1.9
55 Waterside Drive, Dudley Park	59	-0.5	125 Waterlily Drive. Dudley Park	63	1.5
51 Waterside Drive, Dudley Park	59	-1.0	127 Waterlily Drive. Dudley Park	62	0.9
50 Waterside Drive, Dudley Park	58	-1.2	127 Waterlily Drive. Dudley Park	62	0.8
49 Waterside Drive, Dudley Park	60	-1.4	127 Waterlily Drive. Dudley Park	62	0.7
46 Waterside Drive, Dudley Park	62	-1.1	127 Waterlily Drive. Dudley Park	61	0.6
45 Waterside Drive, Dudley Park	61	-0.6	127 Waterlily Drive. Dudley Park	60	0.4
44 Waterside Drive, Dudley Park	59	-0.4	127 Waterlily Drive. Dudley Park	58	0.8
43 Waterside Drive, Dudley Park	60	-0.2	127 Waterlily Drive. Dudley Park	57	0.8
42 Waterside Drive, Dudley Park	61	0.3	42 Egret Point, Erskine	57	1.1

Residence – North Side	L _{Aeq(Day)} , dB	Increase from Existing, dB	Residence – South Side	L _{Aeq(Day)} , dB	Increase from Existing, dB
41 Waterside Drive, Dudley Park	63	0.4	40 Egret Point, Erskine	59	0.8
40 Waterside Drive, Dudley Park	62	0.7	38 Egret Point, Erskine	59	0.6
39 Waterside Drive, Dudley Park	63	1.0	38 Egret Point, Erskine	62	0.9
38 Waterside Drive, Dudley Park	60	1.0	78 Seahawk Drive, Erskine	62	1.2
37 Waterside Drive, Dudley Park	64	1.1	76 Seahawk Drive, Erskine	62	1.3
36 Waterside Drive, Dudley Park	62	1.1	74 Seahawk Drive, Erskine	63	1.7
35 Waterside Drive, Dudley Park	64	1.3	72 Seahawk Drive, Erskine	64	2.0
34 Waterside Drive, Dudley Park	63	1.4	70 Seahawk Drive, Erskine	64	2.2
			68 Seahawk Drive, Erskine	64	2.4
			37 Pardalote Way, Erskine	65	2.1
			64 Seahawk Drive, Erskine	65	1.8
			62 Seahawk Drive, Erskine	65	1.7
			60 Seahawk Drive, Erskine	65	1.6
			58 Seahawk Drive, Erskine	65	1.6
			56 Seahawk Drive, Erskine	65	1.4
			54 Seahawk Drive, Erskine	65	1.4
			52 Seahawk Drive, Erskine	65	1.2
			50 Seahawk Drive, Erskine	65	1.1
			48 Seahawk Drive, Erskine	65	1.0
			46 Seahawk Drive, Erskine	65	0.9
			44 Seahawk Drive, Erskine	64	0.5
			44 Seahawk Drive, Erskine	62	0.8
			26 Apostlebird Way, Erskine	60	0.7
			26 Apostlebird Way, Erskine	60	0.7
			34 Seahawk Drive, Erskine	58	0.8
			32 Seahawk Drive, Erskine	57	0.7
			30 Seahawk Drive, Erskine	57	0.8
			28 Seahawk Drive, Erskine	56	0.9



**Mandurah Estuary Bridge Duplication -
85% Design Stage**

**L_{Aeq(Day)} Noise Level Contours Based on Future Road Conditions with Future (2041) Traffic
Ground Floor Level**

SoundPLAN v8.2
CoRTN Algorithms

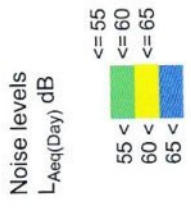
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16 January 2024

Figure 4-2B

- Signs and symbols**
- Road
 - ▨ Houses
 - ▭ Package B Houses
 - Assessment Location
 - Existing Wall



5. ASSESSMENT

With reference to *Section 2*, the Outdoor Noise Target for a Road Upgrade project is 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$ applying to the ground floor of noise sensitive premises. For this project, compliance with the $L_{Aeq(Day)}$ parameter will in turn result in compliance with the $L_{Aeq(Night)}$ parameter, such that the focus of this assessment is on the $L_{Aeq(Day)}$.

The traffic growth in the area is projected to be relatively small, such that the changes in noise level indicated in *Table 4-5* are mostly a result of the project itself. In some areas, the project will result in minor decreases in noise level due to some of the slurry seal replaced with dense graded asphalt, as well as some road traffic moving further away from residences.

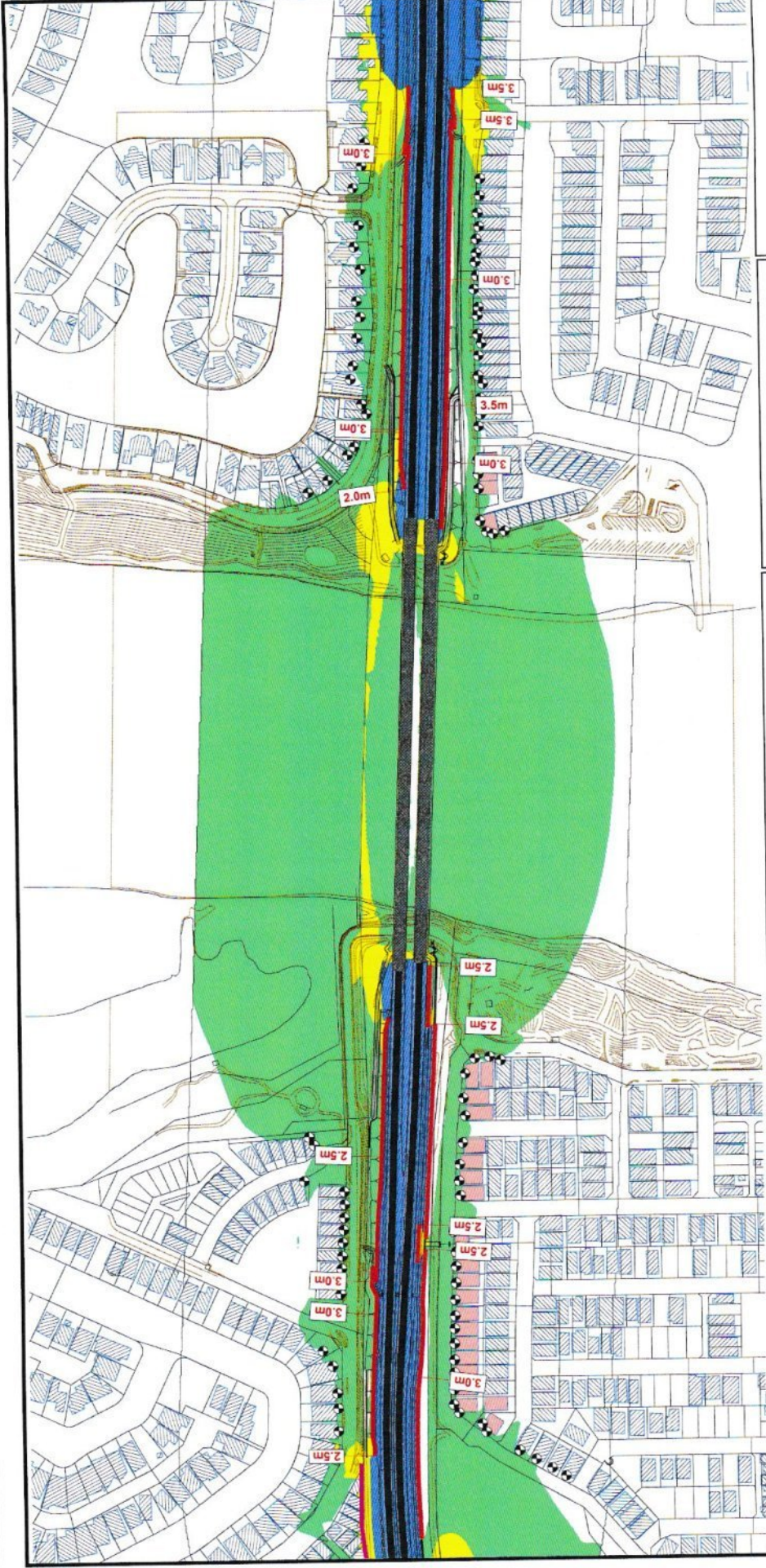
The analysis shows that existing noise levels at many residences are above the outdoor noise target such that mitigation is required. *Figure 5-1B* shows the SWTC Appendix 4 noise wall design and associated contours, with the individual predicted noise levels shown in *Table 5-1*. Note that any walls are to be solid, free of gaps and constructed of a material having a minimum surface mass of 15 kg/m². It should also be noted that this compliant wall design has been used to determine which residences form part of the noise assessment. That is, further west of 21 Leisure Way, Halls Head and further east of 34 Waterside Drive, Dudley Park and 89 Waterlily Drive, Dudley Park noise levels are calculated to exceed the criteria. To achieve compliance further west and east would require noise walls outside of the project extents.

Table 5-1: Future Predicted Noise Levels with Appendix 4 Noise Walls, dB $L_{Aeq(Day)}$

Residence – North Side	$L_{Aeq(Day)}$, dB	Residence – South Side	$L_{Aeq(Day)}$, dB
21 Leisure Way, Halls Head	60	89 Waterlily Drive, Dudley Park	60
22 Leisure Way, Halls Head	60	91 Waterlily Drive, Dudley Park	60
23 Leisure Way, Halls Head	60	93 Waterlily Drive, Dudley Park	60
24 Leisure Way, Halls Head	57	95 Waterlily Drive, Dudley Park	59
25 Leisure Way, Halls Head	57	97 Waterlily Drive, Dudley Park	59
3 Egret Point, Halls Head	59	99 Waterlily Drive, Dudley Park	59
3 Egret Point, Halls Head	59	101 Waterlily Drive, Dudley Park	59
7 Egret Point, Halls Head	59	103 Waterlily Drive, Dudley Park	58
9 Egret Point, Halls Head	59	105 Waterlily Drive, Dudley Park	59
11 Egret Point, Halls Head	59	107 Waterlily Drive, Dudley Park	57
15 Egret Point, Halls Head	59	109 Waterlily Drive, Dudley Park	57
17 Egret Point, Halls Head	59	111 Waterlily Drive, Dudley Park	57
19 Egret Point, Halls Head	59	113 Waterlily Drive, Dudley Park	56
21 Egret Point, Halls Head	58	115 Waterlily Drive, Dudley Park	57
20 Wedgetail Retreat, Halls Head	55	117 Waterlily Drive, Dudley Park	57
29 Wedgetail Retreat, Halls Head	57	119 Waterlily Drive, Dudley Park	56

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
29 Wedgetail Retreat, Halls Head	56	121 Waterlily Drive. Dudley Park	57
57 Waterside Drive, Dudley Park	57	123 Waterlily Drive. Dudley Park	56
55 Waterside Drive, Dudley Park	58	125 Waterlily Drive. Dudley Park	57
51 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	57
50 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	57
49 Waterside Drive, Dudley Park	56	127 Waterlily Drive. Dudley Park	57
46 Waterside Drive, Dudley Park	58	127 Waterlily Drive. Dudley Park	59
45 Waterside Drive, Dudley Park	55	127 Waterlily Drive. Dudley Park	58
44 Waterside Drive, Dudley Park	54	127 Waterlily Drive. Dudley Park	58
43 Waterside Drive, Dudley Park	55	127 Waterlily Drive. Dudley Park	57
42 Waterside Drive, Dudley Park	55	42 Egret Point, Erskine	55
41 Waterside Drive, Dudley Park	57	40 Egret Point, Erskine	55
40 Waterside Drive, Dudley Park	56	38 Egret Point, Erskine	56
39 Waterside Drive, Dudley Park	58	38 Egret Point, Erskine	57
38 Waterside Drive, Dudley Park	54	78 Seahawk Drive, Erskine	57
37 Waterside Drive, Dudley Park	59	76 Seahawk Drive, Erskine	57
36 Waterside Drive, Dudley Park	56	74 Seahawk Drive, Erskine	58
35 Waterside Drive, Dudley Park	58	72 Seahawk Drive, Erskine	58
34 Waterside Drive, Dudley Park	59	70 Seahawk Drive, Erskine	58
		68 Seahawk Drive, Erskine	58
		37 Pardalote Way, Erskine	59
		64 Seahawk Drive, Erskine	59
		62 Seahawk Drive, Erskine	59
		60 Seahawk Drive, Erskine	59
		58 Seahawk Drive, Erskine	59
		56 Seahawk Drive, Erskine	59
		54 Seahawk Drive, Erskine	59
		52 Seahawk Drive, Erskine	59
		50 Seahawk Drive, Erskine	59
		48 Seahawk Drive, Erskine	59
		46 Seahawk Drive, Erskine	58
		44 Seahawk Drive, Erskine	58

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
		44 Seahawk Drive, Erskine	56
		26 Apostlebird Way, Erskine	56
		26 Apostlebird Way, Erskine	56
		34 Seahawk Drive, Erskine	55
		32 Seahawk Drive, Erskine	55
		30 Seahawk Drive, Erskine	55
		28 Seahawk Drive, Erskine	54



Signs and symbols

- Road
- Houses
- Package B Houses
- Assessment Location
- Existing Wall
- Noise Walls

Noise levels
L-Aeq(Day) dB

- <= 55
- 55 < <= 60
- 60 < <= 65



**Mandurah Estuary Bridge Duplication -
85% Design Stage - With Appendix 4 Noise Walls**

L-Aeq(Day) Noise Level Contours Based on Future Road Conditions with Future (2041) Traffic Ground Floor Level

North Side Wall Heights Read from Left to Right / South Side Wall Heights Read from Right to Left

SoundPLAN v8.2
CoRTN Algorithms

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Figure 5-1B

6. FURTHER DISCUSSION

6.1. Optimised Walls

What is evident from the SWTC Appendix 4 noise wall analysis, is that these walls are calculated to achieve noise levels better than that required in *Section 2* and as such there may be scope to reduce the wall extents (lengths and heights), whilst still achieving compliance at the same residences. This design process has been undertaken with the results presented in *Figure 6-1B* and *Table 6-1*.

Table 6-1: Future Predicted Noise Levels with Optimised Noise Walls, dB $L_{Aeq}(Day)$

Residence – North Side	$L_{Aeq}(Day)$, dB	Residence – South Side	$L_{Aeq}(Day)$, dB
21 Leisure Way, Halls Head	60	89 Waterlily Drive. Dudley Park	60
22 Leisure Way, Halls Head	60	91 Waterlily Drive. Dudley Park	60
23 Leisure Way, Halls Head	60	93 Waterlily Drive. Dudley Park	60
24 Leisure Way, Halls Head	58	95 Waterlily Drive. Dudley Park	59
25 Leisure Way, Halls Head	57	97 Waterlily Drive. Dudley Park	59
3 Egret Point, Halls Head	60	99 Waterlily Drive. Dudley Park	59
3 Egret Point, Halls Head	60	101 Waterlily Drive. Dudley Park	59
7 Egret Point, Halls Head	60	103 Waterlily Drive. Dudley Park	59
9 Egret Point, Halls Head	60	105 Waterlily Drive. Dudley Park	59
11 Egret Point, Halls Head	60	107 Waterlily Drive. Dudley Park	58
15 Egret Point, Halls Head	60	109 Waterlily Drive. Dudley Park	58
17 Egret Point, Halls Head	60	111 Waterlily Drive. Dudley Park	58
19 Egret Point, Halls Head	60	113 Waterlily Drive. Dudley Park	57
21 Egret Point, Halls Head	60	115 Waterlily Drive. Dudley Park	58
20 Wedgetail Retreat, Halls Head	58	117 Waterlily Drive. Dudley Park	58
29 Wedgetail Retreat, Halls Head	60	119 Waterlily Drive. Dudley Park	57
29 Wedgetail Retreat, Halls Head	59	121 Waterlily Drive. Dudley Park	58
57 Waterside Drive, Dudley Park	58	123 Waterlily Drive. Dudley Park	58
55 Waterside Drive, Dudley Park	59	125 Waterlily Drive. Dudley Park	58
51 Waterside Drive, Dudley Park	59	127 Waterlily Drive. Dudley Park	58
50 Waterside Drive, Dudley Park	58	127 Waterlily Drive. Dudley Park	58
49 Waterside Drive, Dudley Park	59	127 Waterlily Drive. Dudley Park	59
46 Waterside Drive, Dudley Park	60	127 Waterlily Drive. Dudley Park	59
45 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	59
44 Waterside Drive, Dudley Park	56	127 Waterlily Drive. Dudley Park	58

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
43 Waterside Drive, Dudley Park	57	127 Waterlily Drive, Dudley Park	57
42 Waterside Drive, Dudley Park	57	42 Egret Point, Erskine	58
41 Waterside Drive, Dudley Park	59	40 Egret Point, Erskine	59
40 Waterside Drive, Dudley Park	58	38 Egret Point, Erskine	59
39 Waterside Drive, Dudley Park	59	38 Egret Point, Erskine	59
38 Waterside Drive, Dudley Park	55	78 Seahawk Drive, Erskine	59
37 Waterside Drive, Dudley Park	60	76 Seahawk Drive, Erskine	58
36 Waterside Drive, Dudley Park	57	74 Seahawk Drive, Erskine	59
35 Waterside Drive, Dudley Park	59	72 Seahawk Drive, Erskine	59
34 Waterside Drive, Dudley Park	59	70 Seahawk Drive, Erskine	59
		68 Seahawk Drive, Erskine	59
		37 Pardalote Way, Erskine	60
		64 Seahawk Drive, Erskine	59
		62 Seahawk Drive, Erskine	60
		60 Seahawk Drive, Erskine	60
		58 Seahawk Drive, Erskine	59
		56 Seahawk Drive, Erskine	59
		54 Seahawk Drive, Erskine	60
		52 Seahawk Drive, Erskine	60
		50 Seahawk Drive, Erskine	60
		48 Seahawk Drive, Erskine	60
		46 Seahawk Drive, Erskine	60
		44 Seahawk Drive, Erskine	60
		44 Seahawk Drive, Erskine	59
		26 Apostlebird Way, Erskine	58
		26 Apostlebird Way, Erskine	59
		34 Seahawk Drive, Erskine	57
		32 Seahawk Drive, Erskine	57
		30 Seahawk Drive, Erskine	56
		28 Seahawk Drive, Erskine	56



**Mandurah Estuary Bridge Duplication -
85% Design Stage - With Optimised (Minimum) Noise Walls**

$L_{Aeq}(\text{Day})$ Noise Level Contours Based on Future Road Conditions with Future (2041) Traffic
Ground Floor Level

North Side Wall Heights Read from Left to Right / South Side Wall Heights Read from Right to Left

- Signs and symbols**
- Road
 - ▨ Houses
 - ▨ Package B Houses
 - ⬇ Assessment Location
 - Existing Wall
 - Noise Walls

Noise levels
 $L_{Aeq}(\text{Day})$ dB

- 55 < [Green]
- 60 < [Yellow]
- 65 < [Blue]
- <= 55
- <= 60
- <= 65

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Figure 6-1A

6.2. Preferred Walls

The optimised walls of *Figure 6-1A* have been discussed with the team to develop a preferred wall design shown in *Figure 6-5A* along with the noise contours and the predicted noise levels at each house in *Table 6-2*.

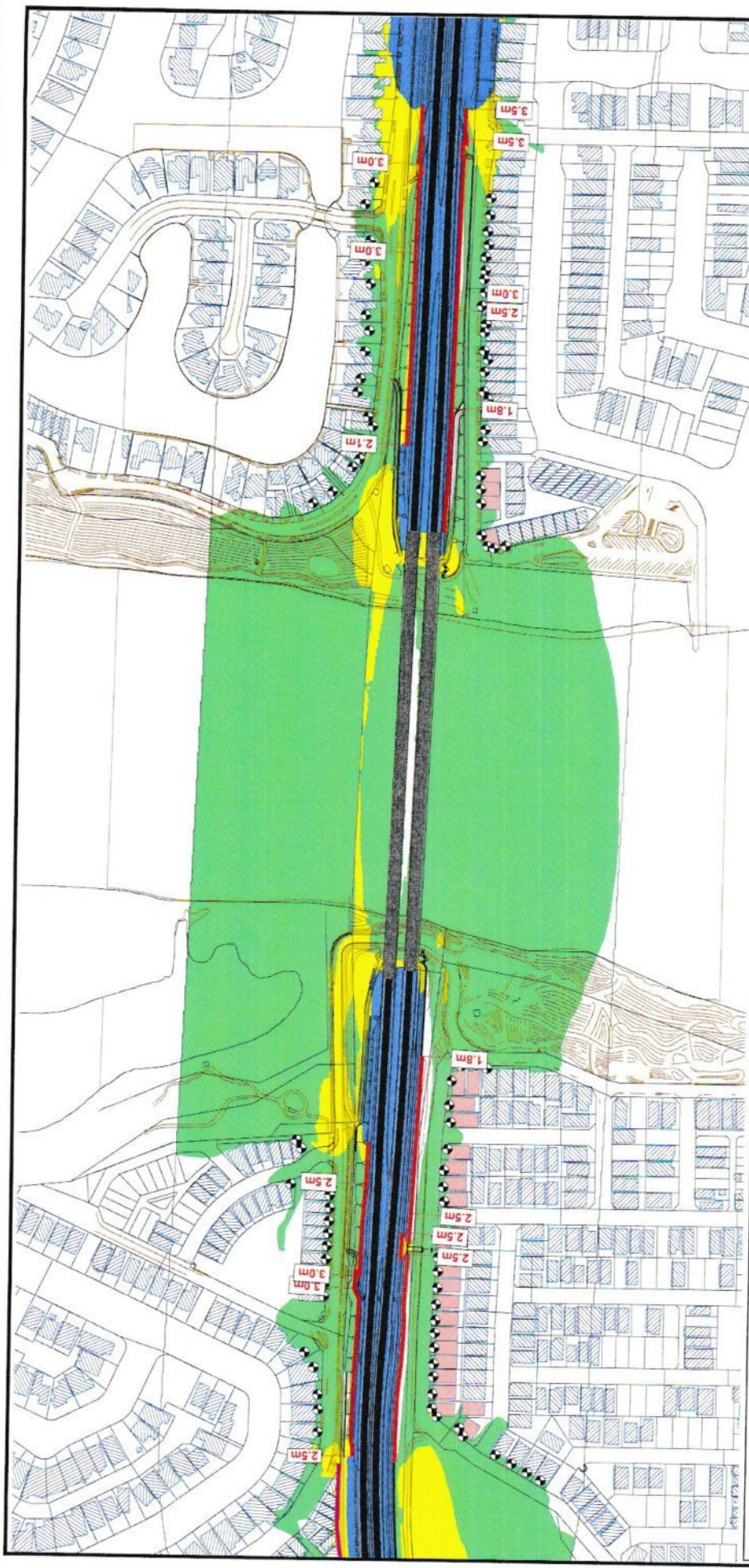
Table 6-2: Future Predicted Noise Levels with Preferred Noise Walls, dB $L_{Aeq}(Day)$

Residence – North Side	$L_{Aeq}(Day)$, dB	Residence – South Side	$L_{Aeq}(Day)$, dB
21 Leisure Way, Halls Head	59	89 Waterlily Drive. Dudley Park	60
22 Leisure Way, Halls Head	59	91 Waterlily Drive. Dudley Park	60
23 Leisure Way, Halls Head	60	93 Waterlily Drive. Dudley Park	60
24 Leisure Way, Halls Head	57	95 Waterlily Drive. Dudley Park	59
25 Leisure Way, Halls Head	57	97 Waterlily Drive. Dudley Park	59
3 Egret Point, Halls Head	59	99 Waterlily Drive. Dudley Park	59
3 Egret Point, Halls Head	59	101 Waterlily Drive. Dudley Park	59
7 Egret Point, Halls Head	59	103 Waterlily Drive. Dudley Park	59
9 Egret Point, Halls Head	59	105 Waterlily Drive. Dudley Park	59
11 Egret Point, Halls Head	59	107 Waterlily Drive. Dudley Park	58
15 Egret Point, Halls Head	59	109 Waterlily Drive. Dudley Park	58
17 Egret Point, Halls Head	59	111 Waterlily Drive. Dudley Park	58
19 Egret Point, Halls Head	59	113 Waterlily Drive. Dudley Park	57
21 Egret Point, Halls Head	60	115 Waterlily Drive. Dudley Park	58
20 Wedgetail Retreat, Halls Head	57	117 Waterlily Drive. Dudley Park	58
29 Wedgetail Retreat, Halls Head	59	119 Waterlily Drive. Dudley Park	57
29 Wedgetail Retreat, Halls Head	59	121 Waterlily Drive. Dudley Park	58
57 Waterside Drive, Dudley Park	57	123 Waterlily Drive. Dudley Park	58
55 Waterside Drive, Dudley Park	58	125 Waterlily Drive. Dudley Park	58
51 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	58
50 Waterside Drive, Dudley Park	58	127 Waterlily Drive. Dudley Park	58
49 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	58
46 Waterside Drive, Dudley Park	59	127 Waterlily Drive. Dudley Park	59
45 Waterside Drive, Dudley Park	57	127 Waterlily Drive. Dudley Park	59
44 Waterside Drive, Dudley Park	56	127 Waterlily Drive. Dudley Park	58
43 Waterside Drive, Dudley Park	56	127 Waterlily Drive. Dudley Park	57

Residence – North Side	L _{Aeq} (Day), dB	Residence – South Side	L _{Aeq} (Day), dB
42 Waterside Drive, Dudley Park	57	42 Egret Point, Erskine	57
41 Waterside Drive, Dudley Park	59	40 Egret Point, Erskine	58
40 Waterside Drive, Dudley Park	58	38 Egret Point, Erskine	59
39 Waterside Drive, Dudley Park	59	38 Egret Point, Erskine	59
38 Waterside Drive, Dudley Park	55	78 Seahawk Drive, Erskine	59
37 Waterside Drive, Dudley Park	60	76 Seahawk Drive, Erskine	59
36 Waterside Drive, Dudley Park	57	74 Seahawk Drive, Erskine	59
35 Waterside Drive, Dudley Park	58	72 Seahawk Drive, Erskine	59
34 Waterside Drive, Dudley Park	59	70 Seahawk Drive, Erskine	60
		68 Seahawk Drive, Erskine	59
		37 Pardalote Way, Erskine	60
		64 Seahawk Drive, Erskine	60
		62 Seahawk Drive, Erskine	60
		60 Seahawk Drive, Erskine	60
		58 Seahawk Drive, Erskine	59
		56 Seahawk Drive, Erskine	59
		54 Seahawk Drive, Erskine	60
		52 Seahawk Drive, Erskine	60
		50 Seahawk Drive, Erskine	60
		48 Seahawk Drive, Erskine	60
		46 Seahawk Drive, Erskine	60
		44 Seahawk Drive, Erskine	60
		44 Seahawk Drive, Erskine	59
		26 Apostlebird Way, Erskine	58
		26 Apostlebird Way, Erskine	59
		34 Seahawk Drive, Erskine	57
		32 Seahawk Drive, Erskine	57
		30 Seahawk Drive, Erskine	56
		28 Seahawk Drive, Erskine	56

It should be noted that at 15% design, other noise walls were explored and have been removed from this report being:

- *Figure 6-2*: Optimised walls but gave consideration to architectural packages that have been applied to houses as part of the subdivision conditions. This allowed the outdoor noise target to be relaxed at some residences from 60 dB $L_{Aeq(Day)}$ to 63 dB $L_{Aeq(Day)}$.
- *Figure 6-3*: Optimised walls where the road surface either side of the bridge was changed from dense graded asphalt to stone mastic asphalt.
- *Figure 6-4*: A combination of *Figure 6-2* and *Figure 6-3* where stone mastic asphalt is used either side of the bridge and the allowed noise target at dwellings with packages is relaxed.



**Mandurah Estuary Bridge Duplication -
85% Design Stage - With Optimised (Minimum) Noise Walls**

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Road Conditions with Future (2041) Traffic
Ground Floor Level

North Side Wall Heights Read from Left to Right / South Side Wall Heights Read from Right to Left

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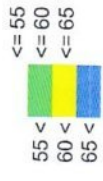
17 January 2024

Figure 6-1B

Signs and symbols

- Road
- ▨ Houses
- ▨ Package B Houses
- ⬤ Assessment Location
- Existing Wall
- Noise Walls

Noise levels
 $L_{Aeq(Day)}$ dB



7. INFRASTRUCTURE SUSTAINABILITY

It is documented in *Babisch W. Stress hormones in the research on cardiovascular effects of noise, Noise Health 2003; 5:1-11* that traffic noise can cause stress reactions similar to other stressors and that the fight-flight response can be prepared even during relatively low indoor levels of traffic noise. To minimise this known impact, the project:

- Takes into consideration future, 2041 traffic volumes, allowing for increased noise over time; and
- The design goal aligns with current Policy (refer *Section 2*).

Road traffic noise is observed to be the dominant noise source at the closest residences.

The monitoring sites for this project are selected as being at four (4) of the closest residences in each quadrant either side of the bridge, at which point road traffic is still the dominant noise source. The noise modelling receiver locations align with the closest residences to the project. The residential locations will still be present in the future both during construction and operation.

Noise monitoring results are shown in the *Appendix A* report and all show the day/night trend expected from road traffic, where road traffic at around 1.00am to 3.00 am drops off significantly, although intermittent noises (e.g. noise truck or motorbike) still occur at higher levels, represented by the L_1 parameter.

Appendix A – Noise Monitoring Report