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Transportation Noise Assessment

Albany Ring Road Stages 2 and 3

Project Case

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Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

Main Roads Western Australia (Main Roads) is investigating development of the Albany Ring Road Stages 2 and 3 in the City of Albany, Western Australia (herein termed the 'Project'). The Project will involve the construction of a new dual carriageway heavy haulage freight route connecting Albany Port with existing intrastate freight routes, as identified by *Figure 1-1*.

It is anticipated that construction of the Project will comprise –

a) 'Phase 1' two-way single lane haulage route; then later

b) 'Phase 2' duplication to form two-way dual carriageway (anticipated year 2050+).

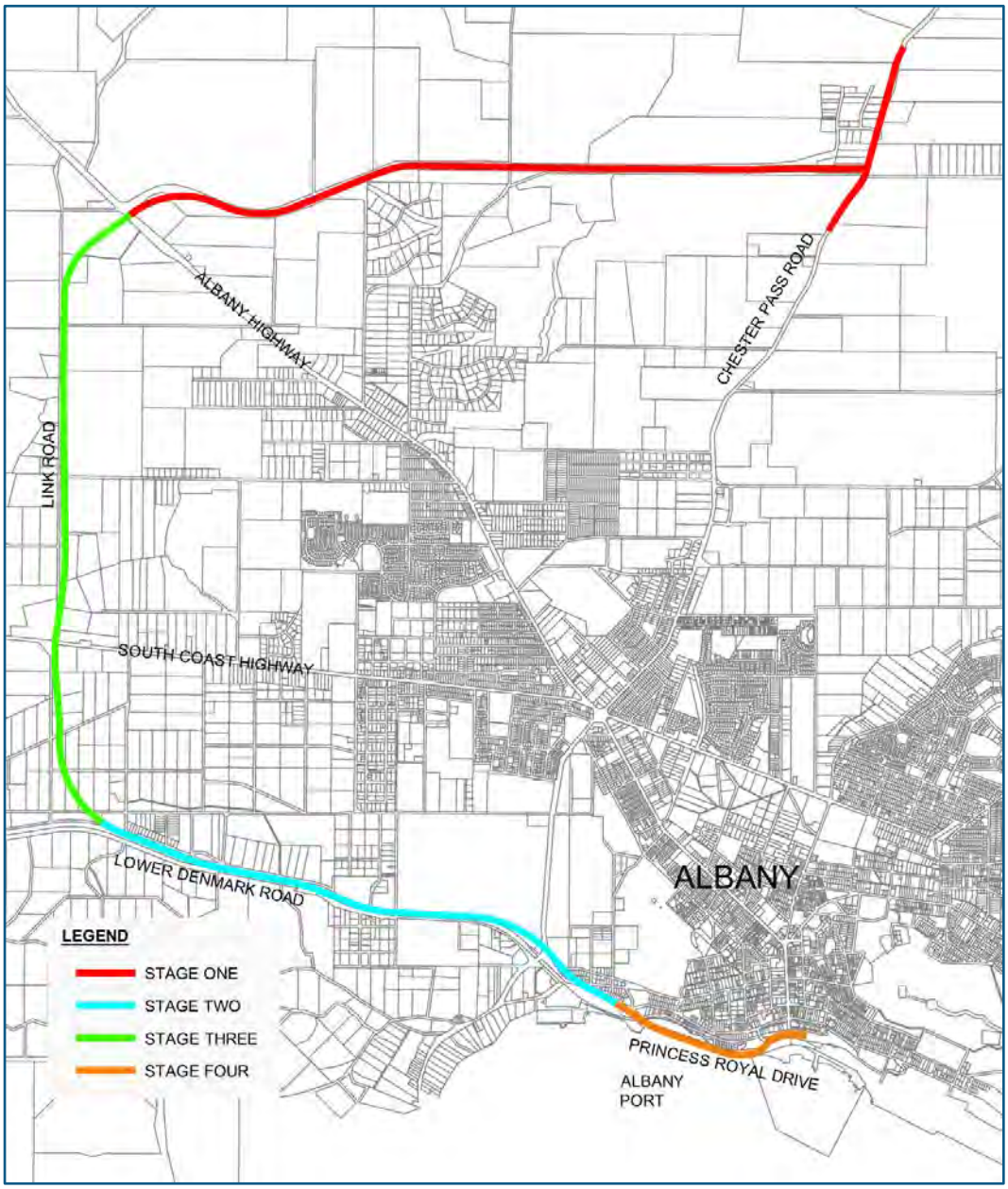

Figure 1-1 Road Project Locality

Following a detailed noise assessment of a number of road design scenarios (*Transportation Noise Assessment -Albany Ring Road Stages 2 and 3; Ref 19034912-01; dated 6 Dec 2019*), the "Project Case" scenario has been chosen as the "Grade Separated" scenario, consisting of a limited number of connecting roads and grade-separated intersections at South Coast Highway and Albany Highway. This scenario is the focus of this assessment.

The purpose of the Noise Assessment is to identify the anticipated noise impacts from the Project and to provide recommended noise mitigation measures to ensure compliance with the relevant criteria.

The Noise Assessment considers:

a) 'Phase 1' of the Project independently; and

b) 'Phase 1' and 'Phase 2' combined.

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

2 CRITERIA

The criteria relevant to this assessment is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1 Noise Targets for Roads

Scenario	Outdoor Noise Target	
New Road	55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$
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-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines. For instance, it is likely unreasonable for a transport infrastructure provider to achieve the outdoor targets at more than 1 or 2 floors of an adjacent development with direct line of sight to the traffic

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken.

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

[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 generally in accordance with the requirements of SPP 5.4 and associated Guidelines[2] as described in *Section 3.1* and *Section 3.2*.

3.1 Site Measurements

Noise monitoring was undertaken between the 20th and 25th May 2019, at three (3) locations 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 measurement locations, detailed below in *Figure 3-1*, were chosen to represent the changing conditions along the project route.

Figure 3-1 Noise Monitoring Locations

The instrumentation used was ARL Type 316 and Ngara noise data loggers. The loggers were positioned either one-metre from the facade of the house or in free-field (Link Road), with the microphone 1.4 metres above ground level (refer *Figure 3-2*).

[2] Road and Rail Noise Guidelines, September 2019

Each logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. These instruments comply with the instrumentation 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.

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

The weather conditions during the measurement period were obtained from the Bureau of Meteorology's Albany weather station. This data was compared against the Main Roads Western Australia (MRWA) specifications for measurement conditions.

Figure 3-2 Typical Location of Noise Data Logger

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;

- Adjustments of -0.8 dB and -1.7 dB have been applied to the predicted levels for the 'free-field' and 'at facade' cases respectively, 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 for single storey houses. The noise is predicted 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

Topographical and road design data for this project was provided by Main Roads and GHD.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, in much the same way as a hill or wall provides noise shielding. All buildings are assumed to be single storey with a height of 3.5 metres. Note for new and upgraded roads and railways, the noise target applies to the first two floors (ground and Level 1).

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

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

For both Phase 1 and 2, a 10mm chip seal road surface has been assumed.

- Vehicle Speed – The posted speeds assumed in the assessment are 90 km/h for the north-south section between Albany Highway and George Street and 80 km/h for the east-west section from George Street to Princess Royal Drive.

- Traffic Volumes – The traffic volumes for the "Project Case" scenario are provided in *Table 3-2.* For 'Phase 1' of the project (two-way single lane haulage route), 2039 traffic volumes are assumed; and for 'Phase 2' (duplication to form two-way dual carriageway) 2050 traffic volumes are assumed.

The 2021 and 2031 traffic volumes were provided by Main Roads (ref Clare Yu; #41270 and #40792). The 2039 and 2050 traffic volumes were calculated using a linear relationship.

Table 3-2 Traffic Volumes Used in the Modelling

Road Segment	Scenario (AAWT)				Percentage Heavy Veh
	2021	2031	2039	2050	
Frenchman Bay to Roundhay	3961	4791	5455	6368	7.1
Roundhay to Charles	3493	4791	5829	7257	7.1
Charles to George	3493	4791	5829	7257	7.1
George St	3133	3911	4533	5389	12.4
Link Rd S	2176	3297	4194	5427	16.8
Link Rd N	2176	3297	4194	5427	19.8

Note: The CoRTN algorithms require 18hr traffic volumes. These are assumed to be 94% of the AAWT volumes, which is a value considered to be appropriate when more detailed traffic modelling is not available.

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road and 1.00 (100%) between the road and the sensitive receivers. This is considered to be appropriate for a rural residential area such as this. 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. SPP 5.4 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).

Guidance on the relationship between these parameters has been taken from *Converting the UK Traffic Noise Index $L_{A10,18h}$ to EU Noise Indices for Noise Mapping*; TRL Limited and has been calibrated against measured noise levels

4 RESULTS

4.1 Noise Monitoring

A summary of the noise monitoring are summarised in *Table 4-1* below. Full details of the noise monitoring results can be found at *Appendix B.*

Table 4-1 Summary of Measurement Results

Measurement Location	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Link Road (Free Field)	51	58	60	52
52 George Street	51	51	53	43
28 Old Elleker Road	46	51	50	52

The results show that as the $L_{Aeq(day)}$ levels are greater than 5 dB above the $L_{Aeq(night)}$ levels, it is the $L_{Aeq(day)}$ traffic noise levels that would dictate compliance or otherwise with the Policy criteria.

4.2 Noise Model Calibration

To calibrate the noise prediction model using the as-constructed design files, the noise at each of the monitoring locations is predicted based on the current traffic volumes. The results are then compared against the measured values and the model is adjusted accordingly. *Table 4-2* shows this comparison and comments on any differences between the two values.

Table 4-2 Comparison of Predicted and Measured Noise Levels

Receiver Location	Traffic Noise Level $L_{Aeq\ (Day)}$ dB			
	Measured	Predicted	Variation	Comment
Link Road (Free Field)	60	60.8	-0.8	Good Correlation
52 George Street	53	54.7	-1.7	Good Correlation
28 Old Elleker Road	50	50.2	-0.2	Good Correlation

4.3 Noise Modelling

The future traffic noise level has been predicted to 98 receiver locations (provided in *Figures 4-1 and 4-2*) adjacent to the project route. The results are provided in *Table 4-3*. Where the predicted noise levels exceed the Policy criteria, the cell has been shaded. Noise contours maps for the full alignment are provided at *Appendix C.*

Figure 4-1

Length Scale

0 100 200 400 600 800 m

The Albany Ring Road Stages 2 & 3
Receiver Locations 1 of 2

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Figure 4-2

Length Scale

0 100 200 400 600 800 m

The Albany Ring Road Stages 2 & 3
Receiver Locations 2 of 2

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Table 4-3 Noise Prediction Results

Rec No	Scenario		Rec No	Scenario		Rec No	Scenario	
	Phase 1	Phase 2		Phase 1	Phase 2		Phase 1	Phase 2
1	49	50	34	57	59	67	55	56
2	46	47	35	46	47	68	54	56
3	48	50	36	48	49	69	54	56
4	63	67	37	52	53	70	50	51
5	50	52	38	59	59	71	47	48
6	53	54	39	45	46	72	59	59
7	54	56	40	49	51	73	55	55
8	54	57	41	49	50	74	53	53
9	54	55	42	52	53	75	53	53
10	53	55	43	49	50	76	59	59
11	52	53	44	51	52	77	54	54
12	53	55	45	49	50	78	58	59
13	51	52	46	53	54	79	46	47
14	53	54	47	56	56	80	61	62
15	51	53	48	50	51	81	58	58
16	53	55	49	49	50	82	53	53
17	50	52	50	53	56	83	60	60
18	48	49	51	49	51	84	59	59
19	53	54	52	52	52	85	52	52
20	54	55	53	57	57	86	46	47
21	60	60	54	55	57	87	47	48
22	53	55	55	51	52	88	53	54
23	51	52	56	50	52	89	47	48
24	49	50	57	49	50	90	47	48
25	51	52	58	47	48	91	42	43
26	52	53	59	46	47	92	42	43
27	46	47	60	47	48	93	44	45
28	47	48	61	47	48	94	44	45
29	41	42	62	46	48	95	43	44
30	55	56	63	45	46	96	44	45
31	46	47	64	47	48	97	45	46
32	50	50	65	52	53	98	45	45
33	56	58	66	51	52		55	56

5 ASSESSMENT

Under the Policy, the outdoor noise target for a new road is 55 dB $L_{Aeq(Day)}$ and 50 dB $L_{Aeq(Night)}$. In this project, the $L_{Aeq(Day)}$ is at least 5 dB more than the $L_{Aeq(Night)}$ so that the $L_{Aeq(Day)}$ noise levels determine whether noise mitigation is to be considered.

The assessment considers the following scenarios:

- Phase 1, which consists a two-way single lane haulage route. Two designs are assessed, being a controlled access highway and a highway with a higher number of connecting roads, which results in higher traffic volumes. As required under the Policy, these scenarios are assessed for traffic volumes expected to occur in 20 years (2039). Our assessment also considers both dense graded asphalt and 10mm chip seal road surfaces.

- Phase 2, which is a duplication of Phase 1 to form two-way dual carriageway. Similar to the Phase 1 assessment, two designs are assessed, being a controlled access highway and a highway with a higher number of connecting roads, which results in higher traffic volumes. As Phase 2 is not expected to occur for at least 30 years, the 2050 traffic volumes have been used. Both dense graded asphalt and 10mm chip seal road surfaces are considered.

From the results it can be seen that a number of properties are predicted to exceed the noise criteria. The recommended mitigation measures to meet these criteria are provided in Section 6.

6 RECOMMENDATIONS

Noise mitigation measures recommended for this project will be in the form of building facade protection, solid barriers or a combination of the two. For existing houses, the building facade protection that can be applied will be dependent on the house construction and negotiations with the property owners.

For individual properties in a rural residential setting, which is typical for this project, the construction of noise barriers is generally considered to be cost prohibitive as fairly long barrier lengths are often required to achieve a reduction in noise levels at only one receiver location. In these cases it is considered more appropriate to offer facade protection, particularly when the criteria are only marginally exceeded.

The recommended facade protection is aligned with the packages provided in the SPP 5.4 Policy Guidelines reproduced at *Appendix D*. Recommended noise wall locations are provided *in Appendix E.*

6.1 Phase 1 Recommendations

The results presented in *Table 4-3* show that for Phase 1, 13 properties are predicted to exceed the Policy criteria of $L_{Aeq(Day)}$ 55 dB and would require consideration of noise mitigation. Noise mitigation recommendations for this phase are summarised in *Table 6-1.*

Table 6-1 Noise Mitigation Options Phase 1

Receiver No	Noise Wall	Facade Protection	Comments
4	5.0m high wall (Figure E-1)	Package C	Facade package or a combination of 5.0m high wall and facade protection
21	Not recommended	Package B	Facade package only
33	2.5m high wall (Figure E-2)	Package A	Either a noise wall or facade package
34	2.5m high wall (Figure E-2)	Package A	Either a noise wall or facade package
38	Not recommended	Package B	Facade package only
47	Not recommended	Package A	Facade package only
53	Not recommended	Package A	Facade package only
72	Not recommended	Package B	Facade package only
76	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package
78	4.8m high wall (Figure E-3)	Package A	Either a noise wall or facade package
80	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package
81	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package
83	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package
84	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package

6.2 Phase 2 Recommendations

The additional traffic volumes associated with Phase 2 results in more properties predicted to receive traffic noise exceeding the Policy criteria than for Phase 1.

The results presented in *Table 4-3* show that 22 properties are predicted to exceed the Policy criteria of $L_{Aeq(Day)}$ 55 dB and would require consideration of noise mitigation.

These noise mitigation recommendations are summarised in *Table 6-2*.

Table 6-2 Noise Mitigation Options Phase 2

Receiver No	Noise Wall	Facade Protection	Comments
4	5.0m high wall (Figure E-1)	Specialist Advice	Facade package or a combination of 5.0m high wall and facade protection
7	Not recommended	Package A	Facade package only
8	Not recommended	Package A	Facade package only
21	Not recommended	Package B	Facade package only
30	Not recommended	Package A	Facade package only
33	4.5m high wall (Figure E-2)	Package A	Either a noise wall or facade package
34	4.5m high wall (Figure E-2)	Package B	Either a noise wall or facade package
38	Not recommended	Package B	Facade package only
47	Not recommended	Package A	Facade package only
50	Not recommended	Package A	Facade package only
53	Not recommended	Package A	Facade package only
54	Not recommended	Package A	Facade package only
67	Not recommended	Package A	Facade package only
68	Not recommended	Package A	Facade package only
69	Not recommended	Package A	Facade package only
72	Not recommended	Package B	Facade package only
76	4.8m high wall (Figure E-3)	Package B	Either a noise wall or facade package
78	4.8m high wall (Figure E	Package B	Either a noise wall or facade package
80	4.8m high wall (Figure E	Package B	Either a noise wall or facade package
81	4.8m high wall (Figure E	Package B	Either a noise wall or facade package
83	4.8m high wall (Figure E	Package B	Either a noise wall or facade package
84	4.8m high wall (Figure E	Package B	Either a noise wall or facade package

7 CONCLUSION

The results of this assessment has shown that future noise levels from the Albany Ring Road are predicted to exceed the criteria prescribed in *State Planning Policy No. 5.4 Road and Rail Noise* at a number of noise sensitive premises adjacent to the project route. As such, noise mitigation measures must be considered as a part of the road design.

As the project alignment is predominantly in a rural residential area, either facade protection or combination of noise barriers and house facade protection is recommended.

Appendix A

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 $L_{A10,18hour}$.

Noise-sensitive land use and/or development
Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

About the Term 'Reasonable'

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

About the Term 'Practicable'

'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

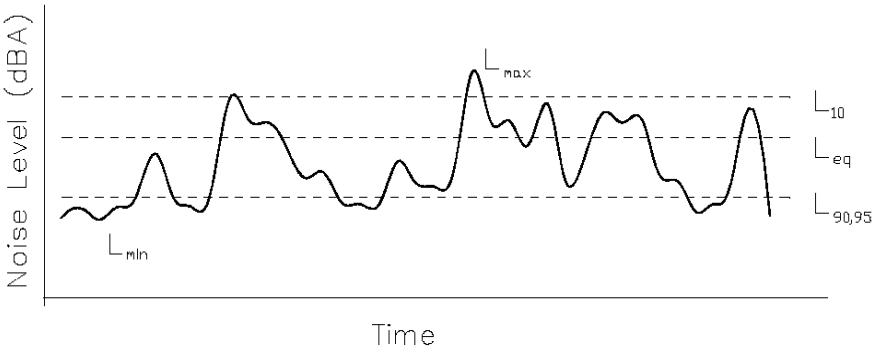
R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

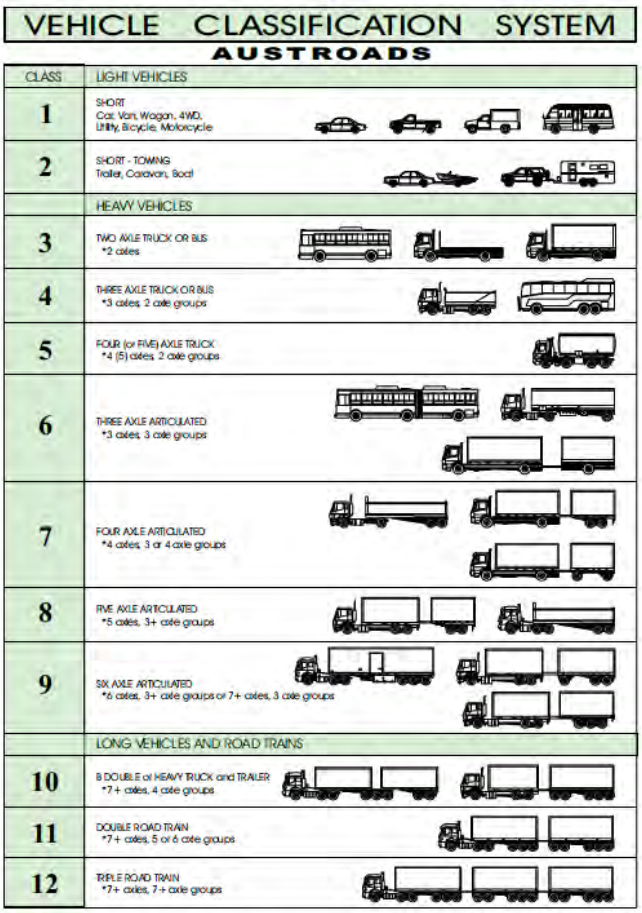
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

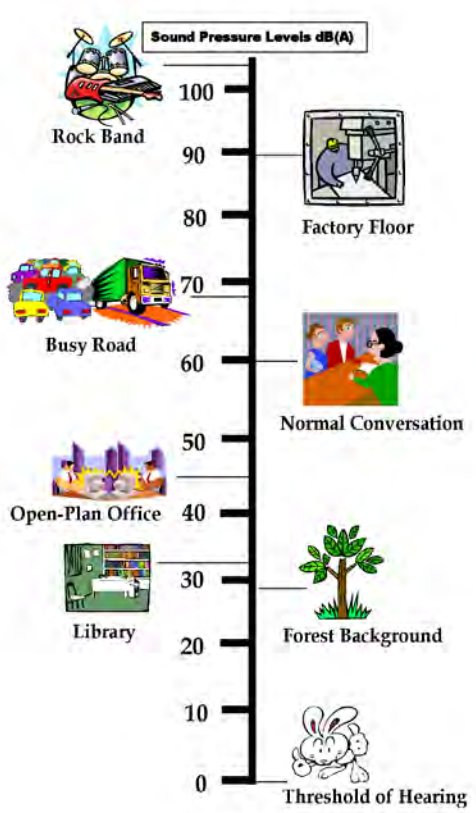
Chart of Noise Level Descriptors



Austroads Vehicle Class

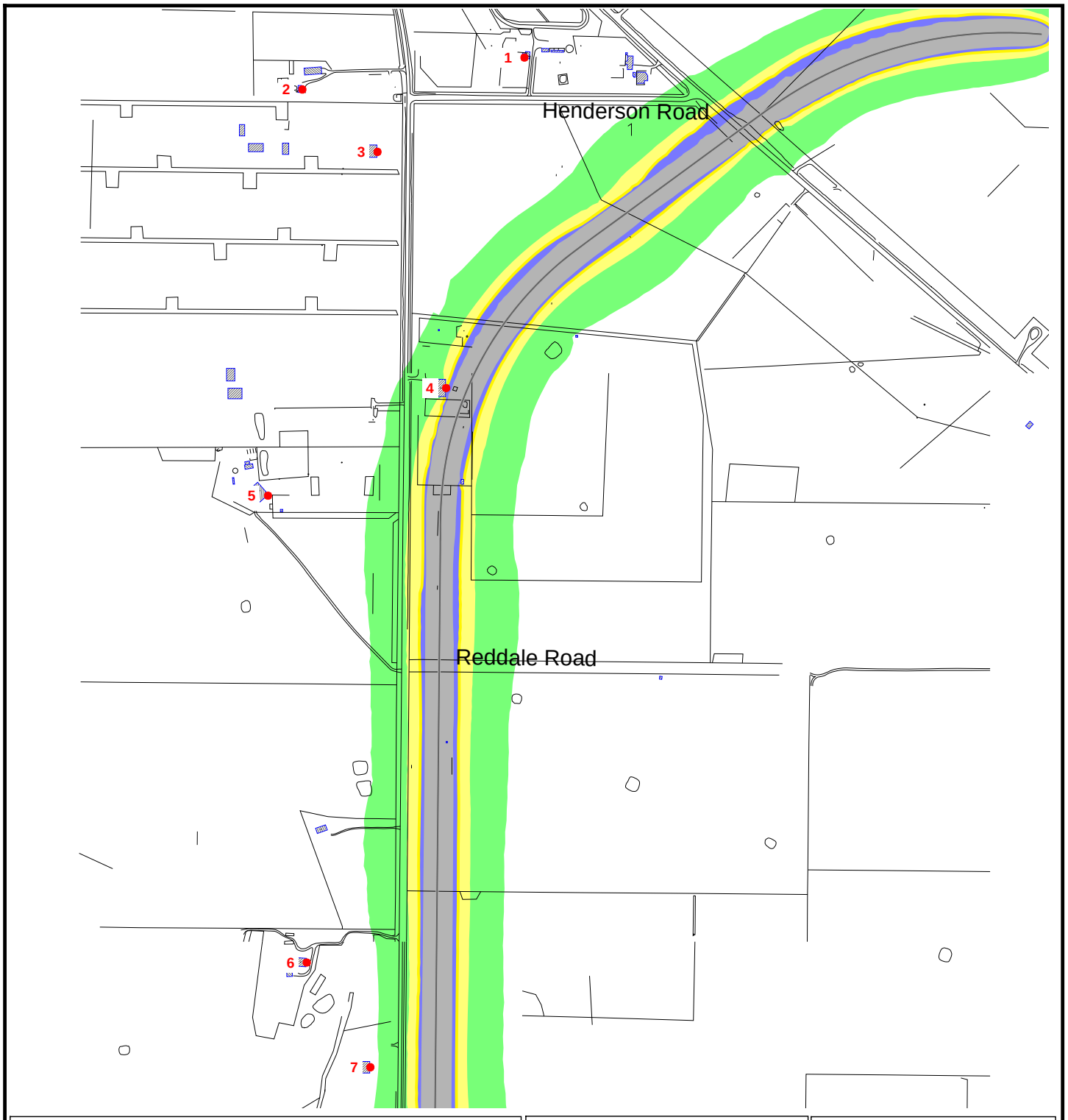


Typical Noise Levels



Appendix C

Noise Level Contour Maps



Albany Ring Road
Phase 1 - "Grade-Separated"
Chip Seal Road Surface: Map 1 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

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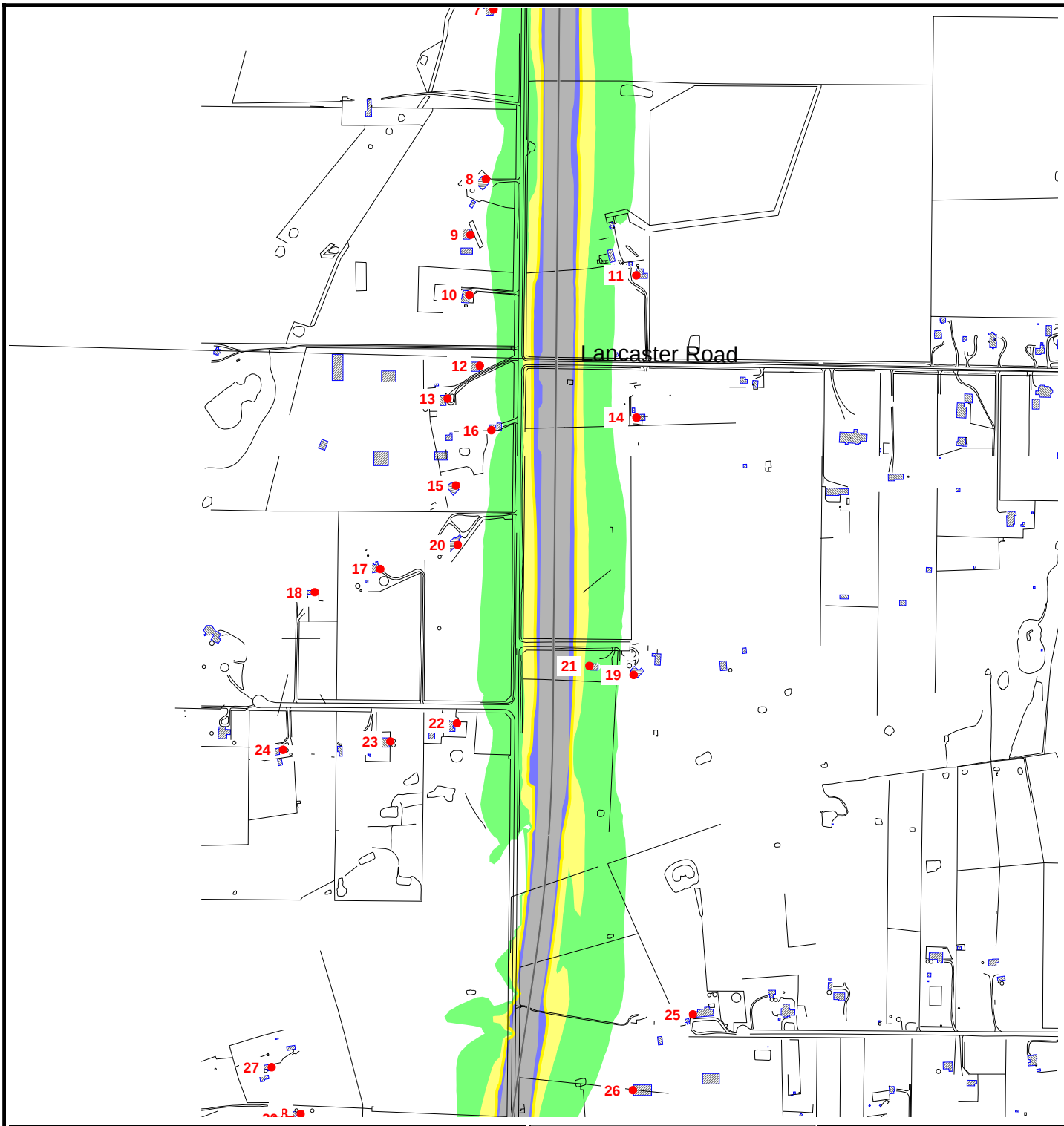
Scale
0 50 100 200 300 400 m

Figure C-1



Albany Ring Road
Phase 1 - "Grade-Separated"
Chip Seal Road Surface: Map 2 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

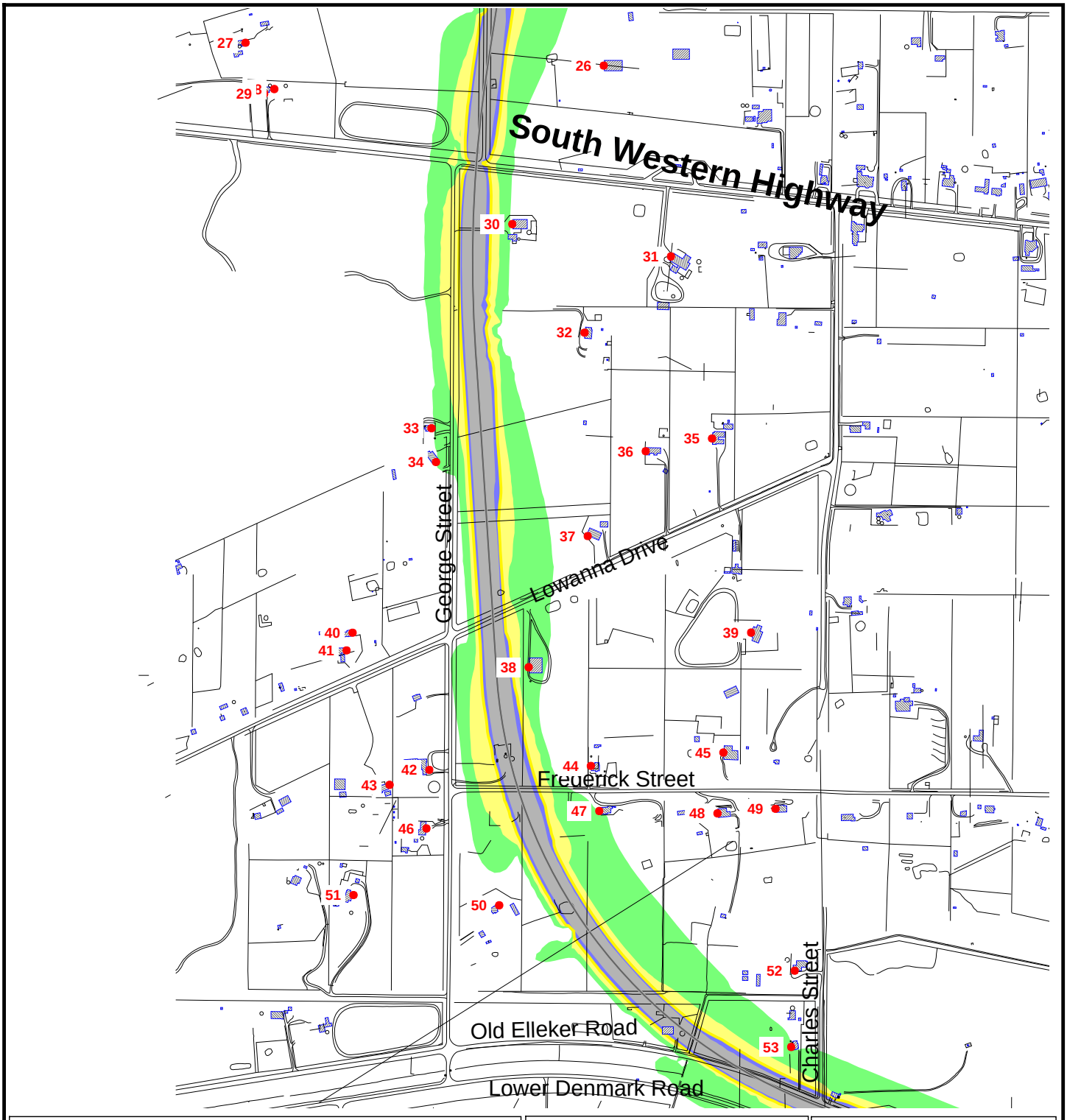
<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

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

Scale
0 50 100 200 300 400 m

Figure C-2



Albany Ring Road
Phase 1 - "Grade-Separated"
Chip Seal Road Surface: Map 3 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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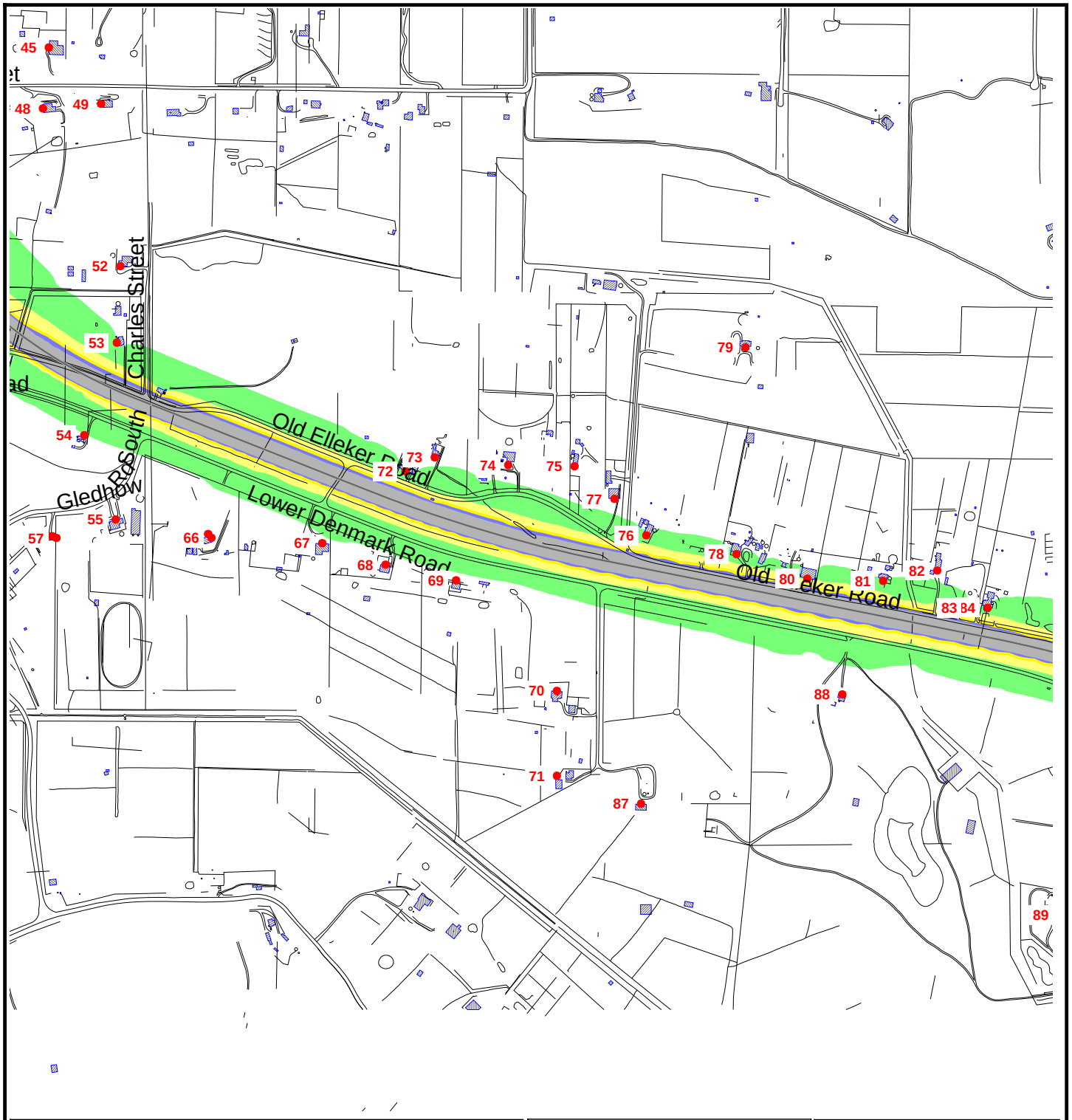
Scale
0 50 100 200 300 400 m

Figure C-3



Albany Ring Road
Phase 1 - "Grade-Separated"
Chip Seal Road Surface: Map 4 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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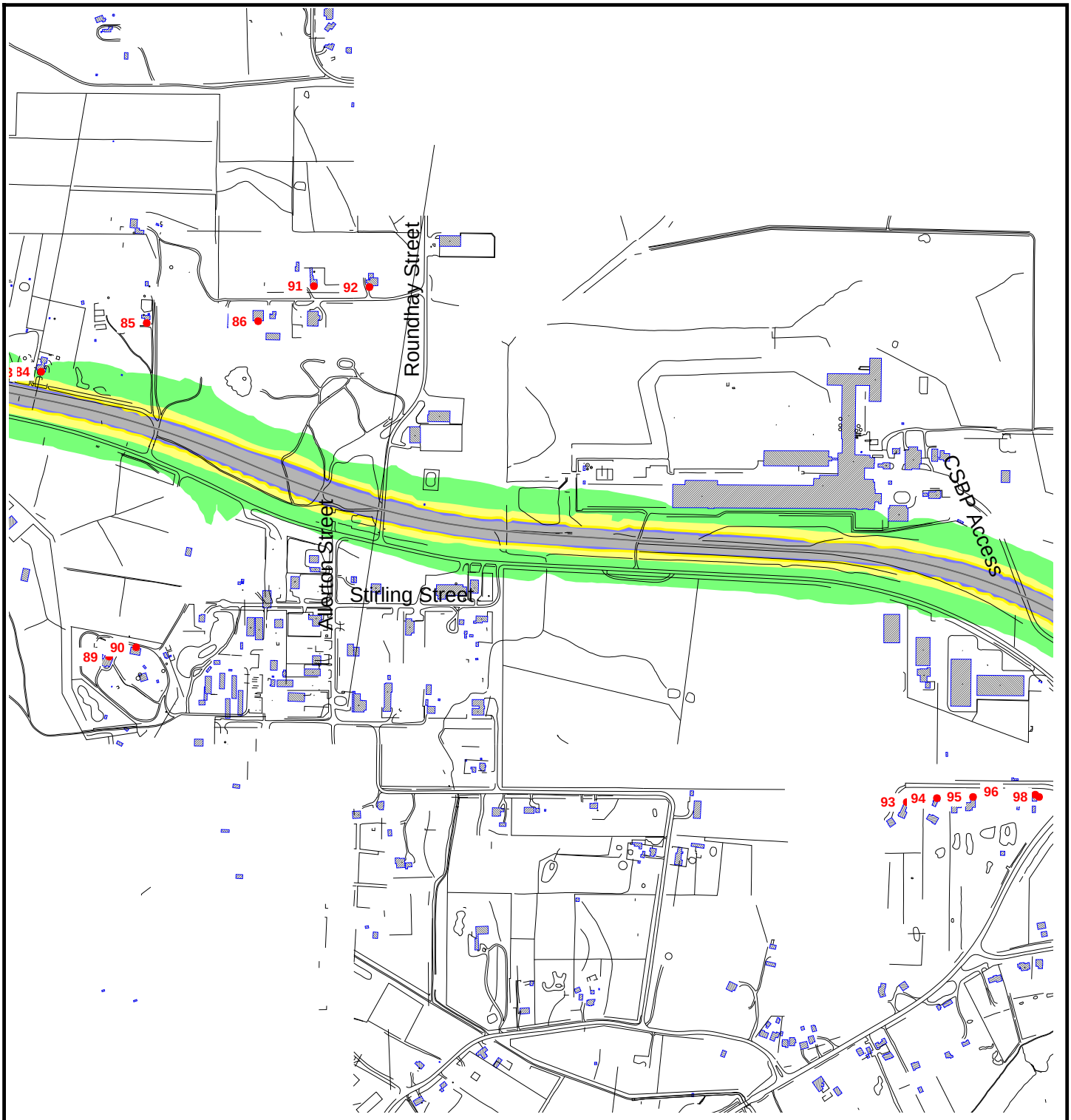
Scale
0 50 100 200 300 400 m

Figure C-4



Albany Ring Road
Phase 1 - "Grade-Separated"
Chip Seal Road Surface: Map 5 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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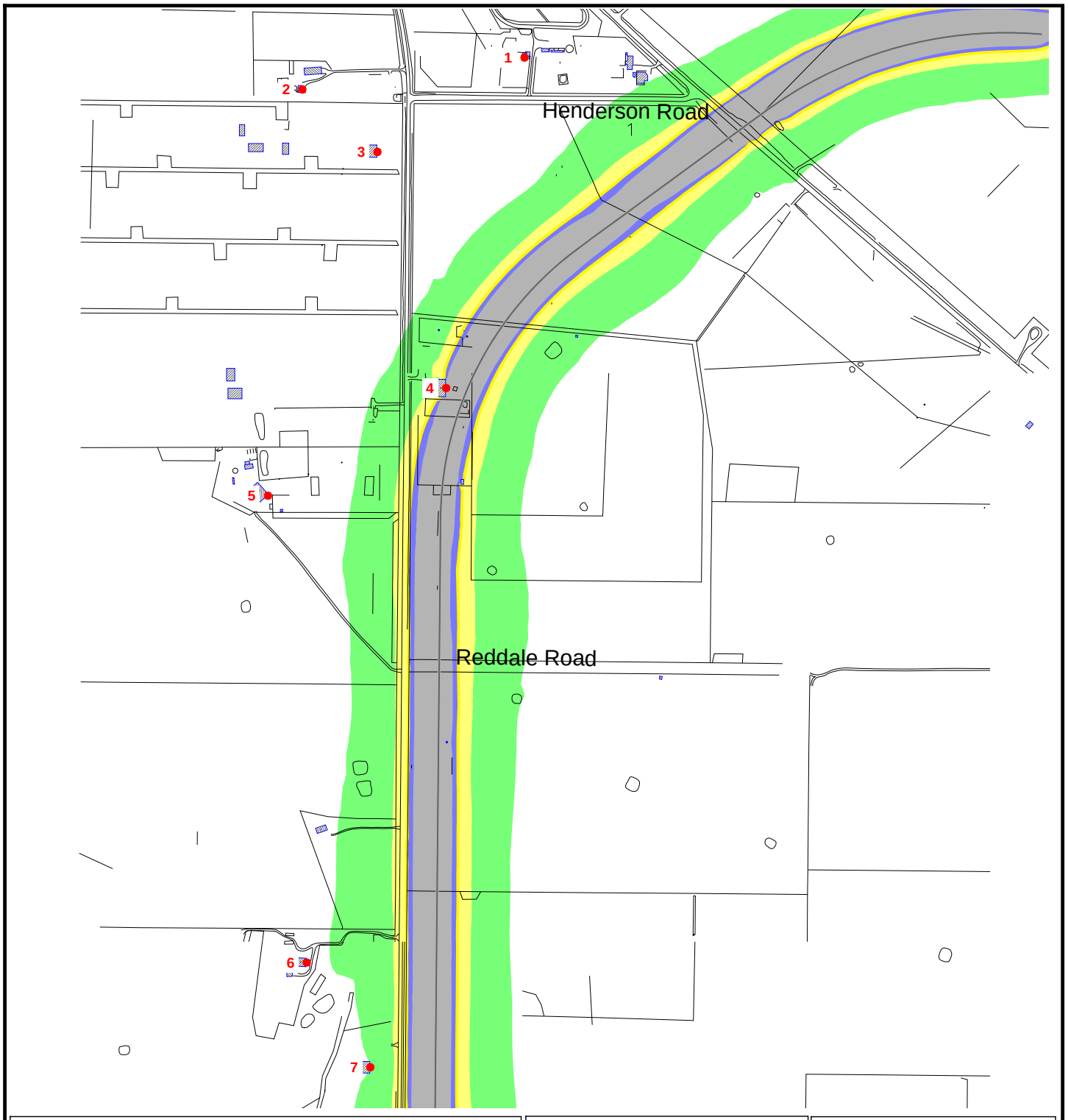
Scale
0 50 100 200 300 400 m

Figure C-5



Albany Ring Road
Phase 2 - "Grade-Separated"
Chip Seal Road Surface: Map 1 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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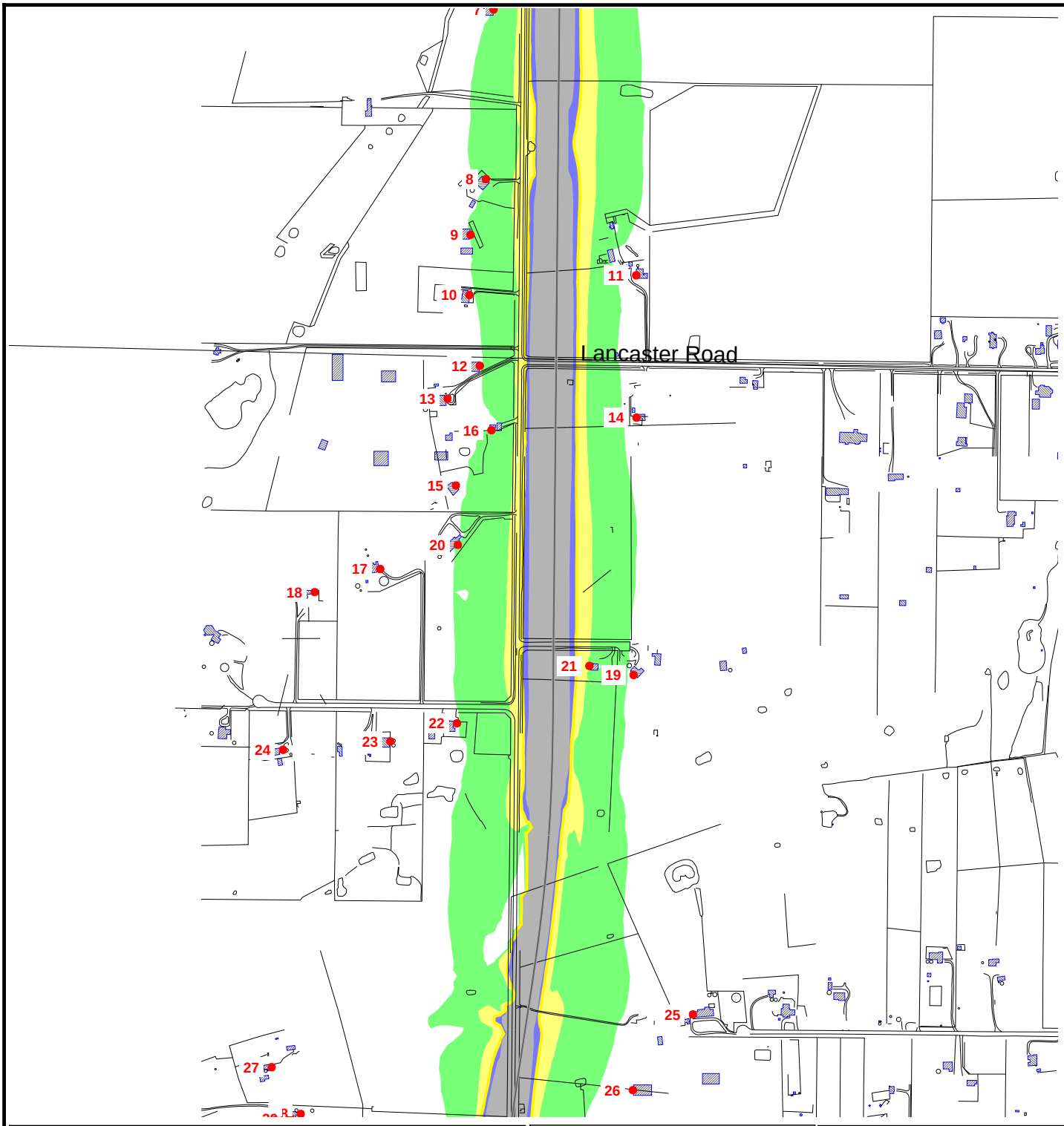
Scale
0 50 100 200 300 400 m

Figure C-6



Albany Ring Road
Phase 2 - "Grade-Separated"
Chip Seal Road Surface: Map 2 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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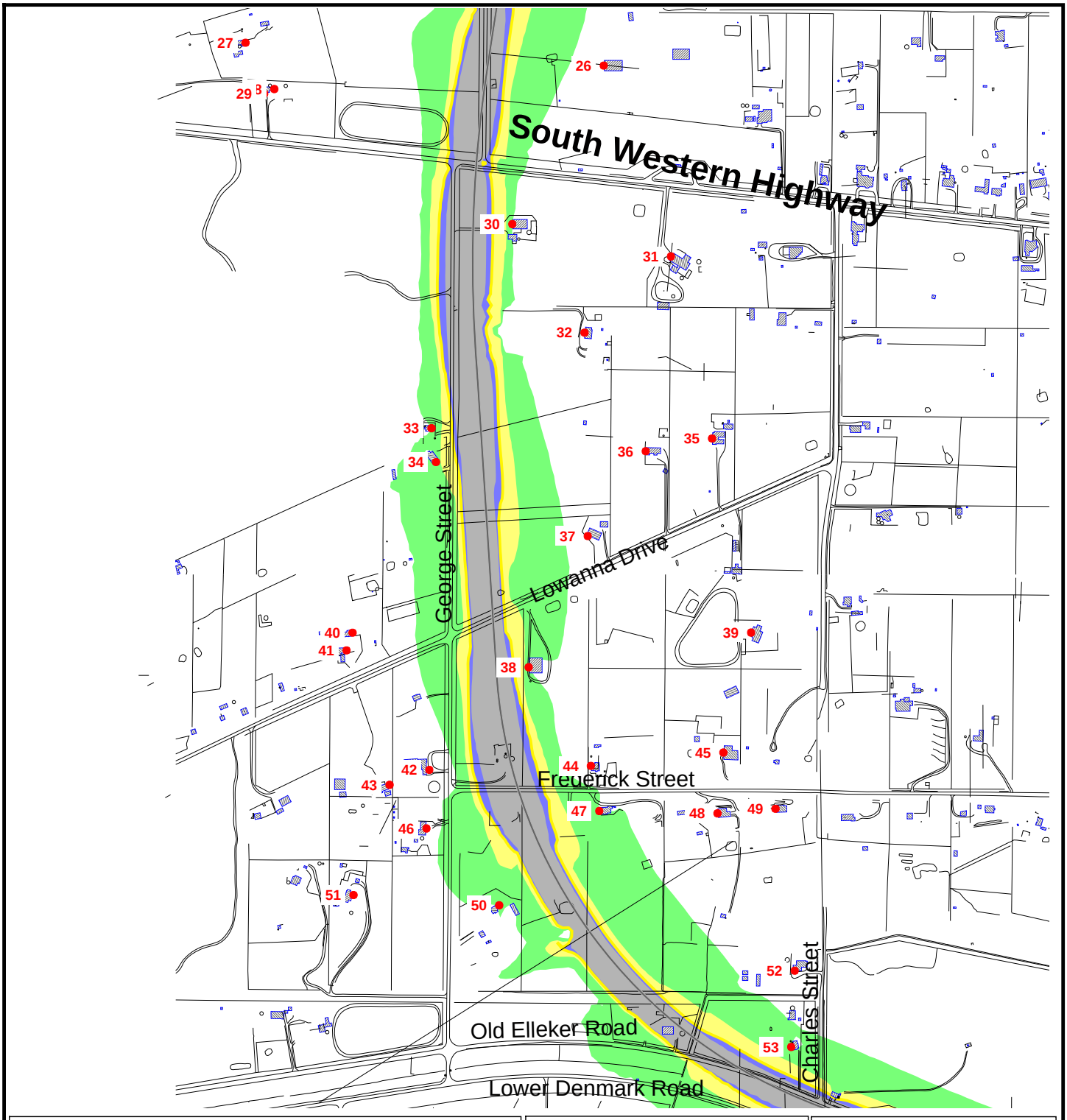
Scale
0 50 100 200 300 400 m

Figure C-7



Albany Ring Road
Phase 2 - "Grade-Separated"
Chip Seal Road Surface: Map 3 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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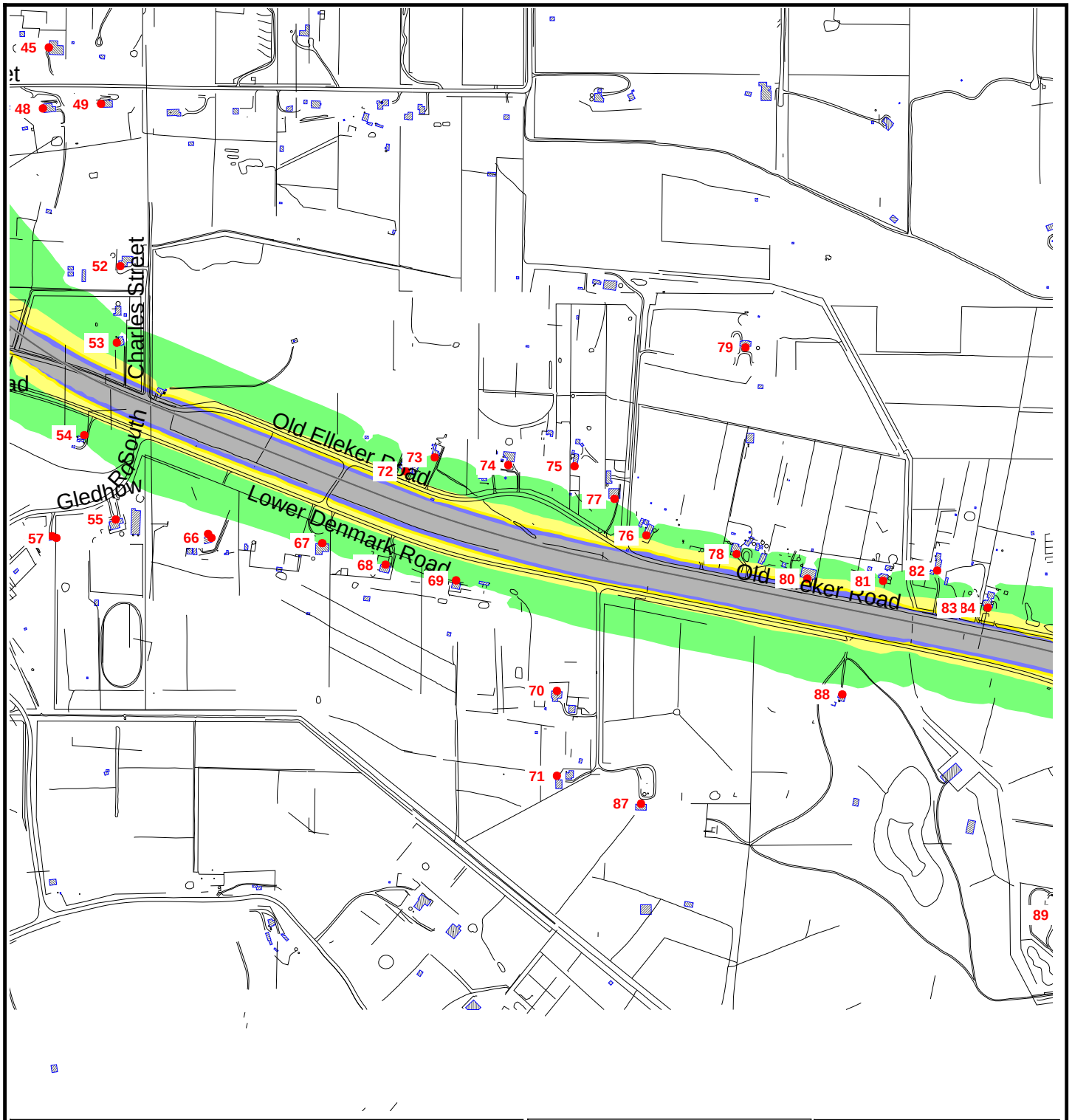
Scale
0 50 100 200 300 400 m

Figure C-8



Albany Ring Road
Phase 2 - "Grade-Separated"
Chip Seal Road Surface: Map 4 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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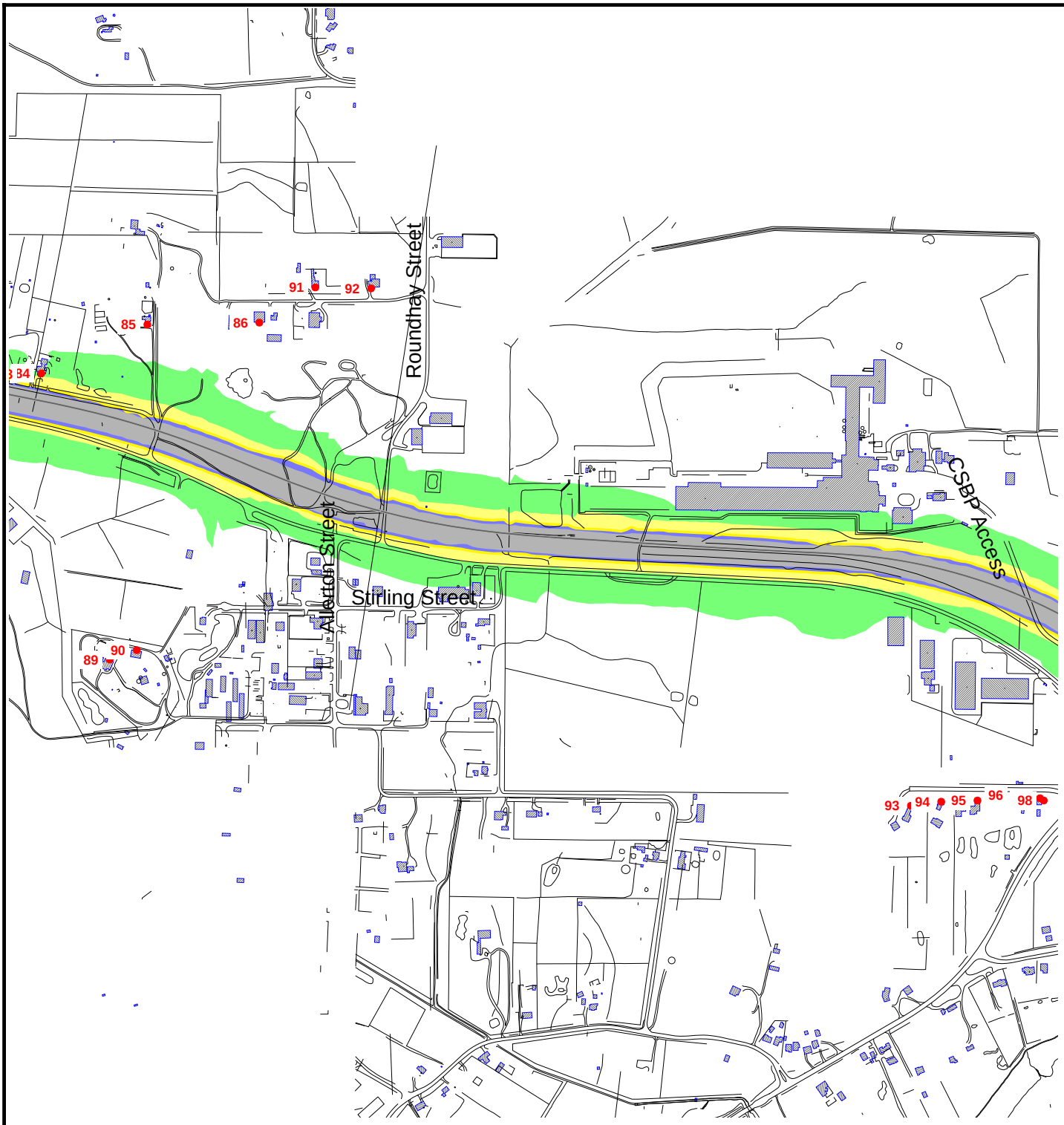
Scale
0 50 100 200 300 400 m

Figure C-9



Albany Ring Road
Phase 2 - "Grade-Separated"
Chip Seal Road Surface: Map 5 of 5

$L_{Aeq(Day)}$ Noise Level Contours
Ground Floor Level

SoundPlan v8.1
CoRTN Algorithms

Signs and symbols

- Road
- Building
- Point receiver

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

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Scale
0 50 100 200 300 400 m

Figure C-10

Appendix D

Building Facade Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

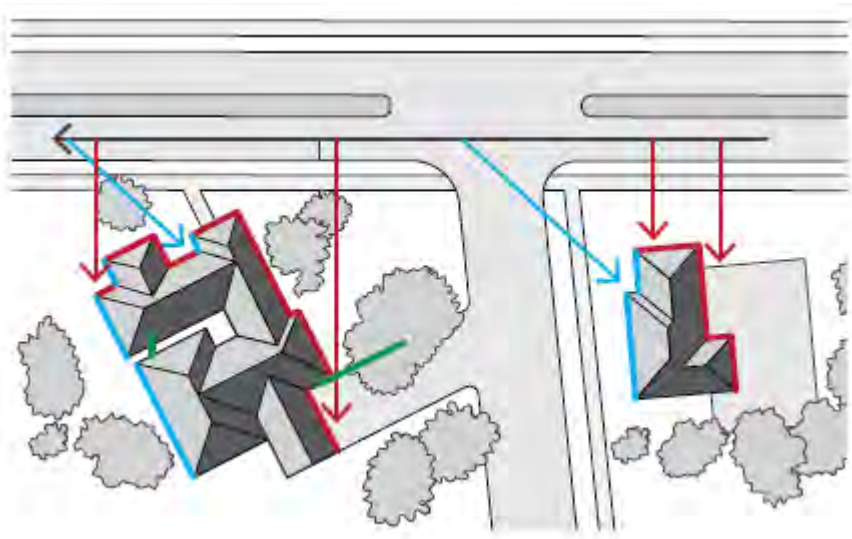
The quiet house packages are not the only solution to achieving acceptable internal transport noise levels. A suitably qualified acoustical engineer or consultant may also determine more tailored acoustic design requirements for buildings in a transport noise corridor by carrying out acoustic design in accordance with relevant industry standards. This includes the need to meet the relevant design targets specified in AS/NZS 2107:2016 for road traffic noise.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): o Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): o Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: o 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; o Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: o Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; o Single leaf of 150mm brick masonry with 13mm cement render on each face. o One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2 metres height above ground level.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): o Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): o Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): o Sliding or double hung with 6mm-12mm-10mm double insulated glazing; o Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: o 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; o Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: o Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 50mm glasswool or polyester insulation (R2.0+). Resilient ties used where required to connect leaves. o Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 50mm glasswool or polyester insulation (R2.0+). o Single leaf of 220mm brick masonry with 13mm cement render on each face. o 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. o Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (R2.0+) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: o Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): o Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): o Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): o Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): o Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: o Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; o 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: o Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 50mm glasswool or polyester insulation (R2.0+). Resilient ties used where required to connect leaves. o Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 50mm glasswool or polyester insulation (R2.0+). o Single leaf of 220mm brick masonry with 13mm cement render on each face. o 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. o Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (R2.0+) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: o Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; o R3.0+ insulation batts above ceiling; o 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

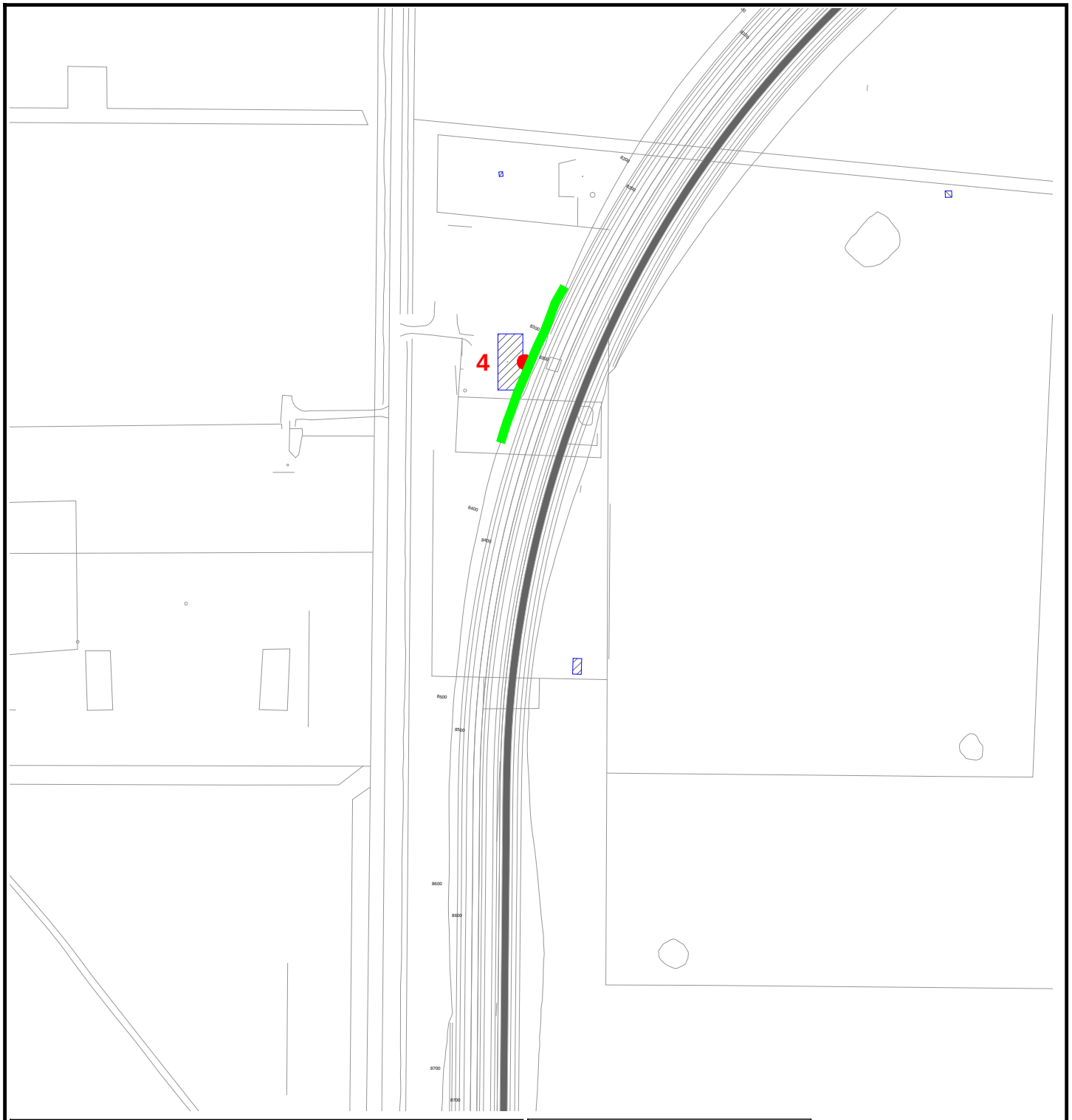
Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix E

Noise Wall Locations



Albany Ring Road
Noise Barrier A Location

Signs and symbols
- Road
- Building
- Point receiver
- Wall

N

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HILLARYS WA 6923
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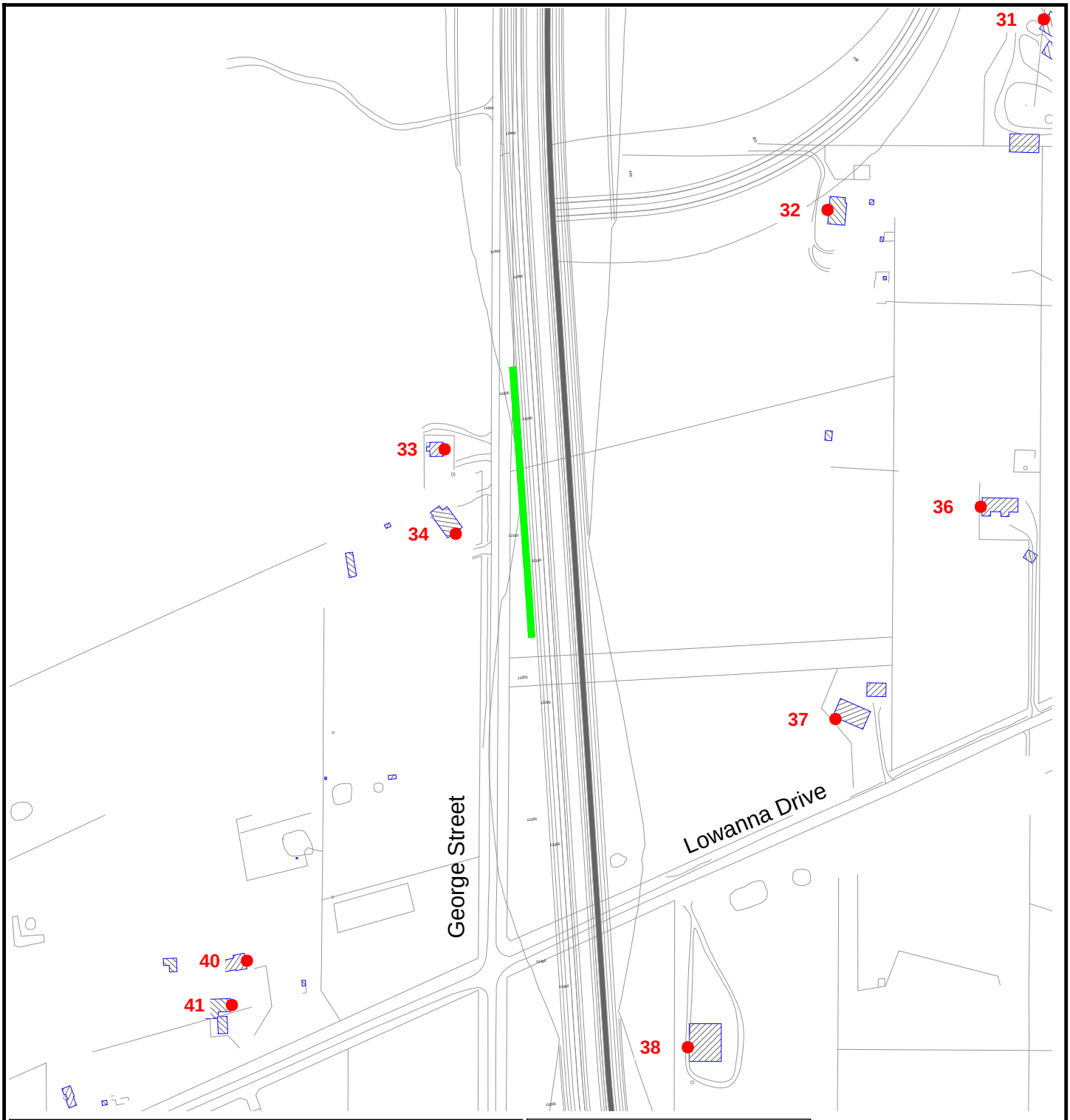
Scale
0 20 40 80 120 1

Figure E-1



Albany Ring Road
Noise Barrier B Location

Signs and symbols
- Road
- Building
- Point receiver
- Wall

N

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HILLARYS WA 6923
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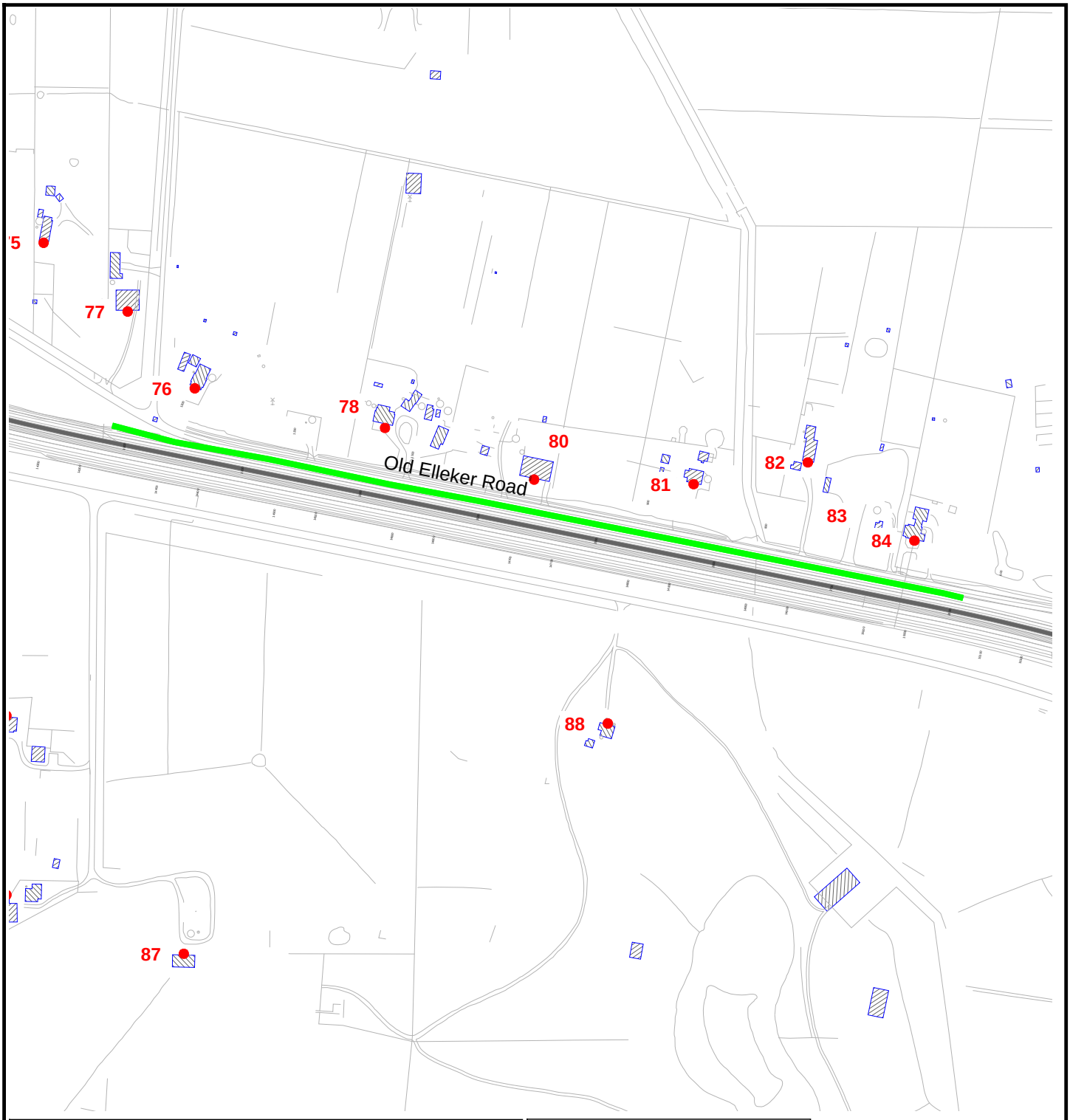
Scale
0 25 50 100 150 200

Figure E-2



Albany Ring Road
Noise Barrier C Location

Signs and symbols
- Road
- Building
- Point receiver
- Wall

N

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PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Scale
0 30 60 120 180 24

Figure E-3