CHRISTCHURCH SOUTHERN MOTORWAY STAGE 2 & MAIN SOUTH ROAD FOUR-LANING

Assessment of Operational Noise Effects

Rp008 R02 2010286C

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Project: **CHRISTCHURCH SOUTHERN MOTORWAY STAGE 2 & MAIN SOUTH ROAD FOUR-LANING**

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This Technical Report has been produced in support of the Assessment of Environmental Effects (AEE) for the Main South Road Four Laning and Christchurch Southern Motorway Stage 2 Project. It is one of 20 Technical Reports produced (listed below), which form Volume 3 of the lodgement document. Technical information contained in the AEE is drawn from these Technical Reports, and cross-references to the relevant reports are provided in the AEE where appropriate.

A Construction Environmental Management Plan (CEMP) has been prepared to provide the framework, methods and tools for avoiding, remedying or mitigating environmental effects of the construction phase of the Project. The CEMP is supported by Specialised Environmental Management Plans (SEMPs), which are attached as appendices to the CEMP. These SEMPs are listed against the relevant Technical Reports in the table below. This Technical Report is highlighted in grey in the table below. For a complete understanding of the project all Technical Reports need to be read in full along with the AEE itself; however where certain other Technical Reports are closely linked with this one they are shown in bold.

Schedule of Technical Reports for the AEE

No.	Technical Report Title	Primary AEE Chapter Reference	SEMPs
1	Design philosophy statement	4	
2	Traffic and transportation effects report	11	Construction Traffic Management Plan
3	Assessment of stormwater disposal and water quality	19	Erosion and Sediment Control Plan, Accidental Aquifer Interception Management Plan
4	Landscape and visual effects	15	Landscape Management Plan
5	Assessment of effects - urban design	14	Landscape Management Plan
6	Urban and landscape design framework	14, 15	Landscape Management Plan
7	Landscape context report	15	Landscape Management Plan
8	Assessment of operational noise effects	17	
9	**Assessment of construction noise & vibration**	**17**	**Construction Noise and Vibration Management Plan**
10	Assessment of air quality effects	18	Air Quality Management Plan
11	Geotechnical engineering and geo-hazards assessment	3, 21	
12	Assessment of archaeological effects	24	
13	Social impact assessment	26	
14	Economic impact assessment	25	
15	Cultural impact assessment	23	
16	Contaminated land assessment	22	
17	Aquatic ecology assessment	20	
18	Terrestrial ecology assessment	20	
19	Lighting assessment	16	
20	Statutory provisions report	6, 28	
-	Construction Environmental Management Plan	5	

For further information on the structure of the lodgement documentation, refer to the 'Guide to the lodgement documentation' document issued with the AEE in Volume 1.

TABLE OF CONTENTS

EXECUTIVE SUMMARY 7

1.0 INTRODUCTION 8
1.1 Project Description 8
1.2 MSRFL 8
1.3 CSM2 9
1.4 Key Design Features 9

2.0 CRITERIA 12
2.1 New Zealand Standard NZS 6806:2010 12
2.2 NZTA (Transit) Noise Guidelines 15
2.3 NZTA Environmental Plan 16
2.4 District Plans 16
2.5 Discussion and conclusion on noise performance standards 16

3.0 EXISTING NOISE ENVIRONMENT 17
3.1 Summary of monitoring locations & measured levels 17
3.2 Measurement uncertainty 19
3.3 Dwellings affected by traffic 20

4.0 TRAFFIC NOISE MODELLING 20
4.1 Existing Ambient Noise Environment 20
4.2 Road Parameters 20
4.3 Noise Assessment Sections 22
4.4 Identification of Protected Premises and Facilities (PPFs) 23
4.5 Computer Modelling 23

5.0 DESIGN AND MITIGATION 26
5.1 Methodology 26
5.2 Weedons Road Interchange to CSM2/MSRFL Interchange (Section 5, 6 & 7) 26
5.3 Waterholes & Hamptons Roads (Section 4) 28
5.4 Trents & Blakes Roads (Section 3) 29
5.5 Shands Road (Section 2) 31
5.6 Springs Road (Section 1) 32
5.7 Summary of Preferred Mitigation Options 33
5.8 Traffic noise level generation 34

6.0 ASSESSMENT OF TRAFFIC NOISE LEVELS 35

6.1 Subjective perception of noise level changes 35
6.2 Weedons Road Interchange to CSM2/MSRFL Interchange (Section 5, 6 & 7) 36
6.3 Waterholes & Hamptons Roads (Section 4) 36
6.4 Trents & Blakes Roads (Section 3) 36
6.5 Shands Road (Section 2) 36
6.6 Springs Road (Section 1) 36
6.7 Summary of potentially adversely affected dwellings 37

7.0 ROAD TRAFFIC VIBRATION 38

8.0 SUMMARY 39

9.0 CONDITIONS 40

APPENDIX A GLOSSARY OF TERMINOLOGY 41

APPENDIX B ROUTE PLAN & NOISE MEASUREMENT LOCATIONS 42

APPENDIX C NOISE MITIGATION OPTIONS 43

APPENDIX D PREDICTED TRAFFIC NOISE CONTOURS 44

APPENDIX E EXISTING AND PREDICTED NOISE LEVELS AT DWELLINGS 45

EXECUTIVE SUMMARY

This report provides an assessment of traffic noise and vibration effects associated with the operation of the proposed Christchurch Southern Motorway Stage 2 and Main South Road four-laning.

Existing ambient noise levels at dwellings along the proposed route are controlled by their proximity to existing roads. Away from busy roads, traffic noise levels are in the order of 50 dB $L_{Aeq(24h)}$. Dwellings close to Main South, Shands and Springs Roads currently experience noise levels of around 70 dB $L_{Aeq(24h)}$.

A detailed assessment of traffic noise level generation and noise control has been conducted in line with the requirements of NZS 6806 "Acoustics - Road-traffic noise - New and altered roads". NZS 6806 provides a framework by which a number of noise mitigation measures are assessed in line with the best practicable option (BPO) approach of the Resource Management Act. This assessment process by the design team has resulted in a number of preferred mitigation options for the various sections of the Project. The preferred noise control measures include the use of low noise road surface and noise barriers. An Open Graded Porous Asphalt (low noise) surface is proposed as part of the "Do-Minimum" design along the majority of the scheme.

Comprehensive design of the proposed noise control measures will be conducted during the detailed design phase of the Project.

A detailed assessment of traffic vibration effects has not been conducted as the risk of adverse effects is considered to be minor, as adverse vibration effects from this Project will be mitigated through standard road maintenance procedures.

The noise assessment has identified that, through the application of the best practicable option, all Protected Premises and Facilities (PPFs) along the route will meet the Category A (quietest) noise criteria for new and altered roads. An assessment of effects has been conducted based on the predicted change in traffic noise level at each PPF.

Overall, the Christchurch Southern Motorway and Main South Road four-laning Project can be operated such that adverse noise effects from traffic will, at worst, be no more than minor In general, noise effects will be slightly positive or less than minor for the majority of PPFs. These noise levels have been achieved through the utilisation of the best practicable option approach to noise mitigation.

1.0 INTRODUCTION

This report assesses the potential traffic noise effects associated with the operation of the proposed Christchurch Southern Motorway Stage 2 (CSM2) and the associated four-laning of Main South Road (MSRFL) (the Project).

This report provides:

- A description of the Project in respect of noise generation and noise sensitive receivers;
- A discussion of the appropriate traffic noise assessment criteria;
- Consideration of the existing noise environment;
- A review of the noise mitigation options that have been assessed for the Project;
- An assessment of the Project's potential traffic noise effects; and
- A discussion of the Project's potential traffic vibration effects.

A glossary of acoustics terminology used in this report is provided in **Appendix A**.

1.1 Project Description

The NZ Transport Agency (NZTA) seeks to improve access for people and freight to and from the south of Christchurch via State highway 1 (SH1) to the Christchurch City centre and Lyttelton Port by constructing, operating and maintaining the Christchurch Southern Corridor. The Government has identified the Christchurch motorway projects, including the Christchurch Southern Corridor, as a road of national significance (RoNS).

The proposal forms part of the Christchurch Southern Corridor and is made up of two sections: Main South Road Four Laning (MSRFL) involves the widening and upgrading of Main South Road (MSR), also referred to as SH1, to provide for a four-lane median separated expressway; and the construction of the Christchurch Southern Motorway Stage 2 (CSM2) as a four-lane median separated motorway. The proposed construction, operation and maintenance of MSRFL and CSM2, together with ancillary local road improvements, are referred to hereafter as 'the Project'.

1.2 MSRFL

Main South Road will be increased in width to four lanes from its intersection with Park Lane north of Rolleston, for approximately 4.5 km to the connection with CSM2 at Robinsons Road. MSRFL will be an expressway consisting of two lanes in each direction, a median with barrier separating oncoming traffic, and sealed shoulders. An interchange at Weedons Road will provide full access on and off the expressway. MSFRL will connect with CSM2 via an interchange near Robinsons Road, and SH1 will continue on its current alignment towards Templeton.

Rear access for properties fronting the western side of MSRFL will be provided via a new road running parallel to the immediate east of the Main Trunk rail corridor from Weedons Ross Road to just north of Curraghs Road. For properties fronting the eastern side of MSRFL, rear access is to be provided via an extension of Berketts Drive and private rights of way.

The full length of MSRFL is located within the Selwyn District.

1.3 CSM2

CSM2 will extend from its link with SH1 / MSRFL at Robinsons Road for approximately 8.4 km to link with Christchurch Southern Motorway Stage 1(CSM1, currently under construction) at Halswell Junction Road. The road will be constructed to ~~a~~ motorway standard comprising four lanes, with two lanes in each direction, with a median and barrier to separate oncoming traffic and provide for safety.[1] Access to CSM2 will be limited to an interchange at Shands Road, and a half-interchange with eastward facing ramps at Halswell Junction Road. At four places along the motorway, underpasses (local road over the motorway) will be used to enable connectivity for local roads, and at Robinsons / Curraghs Roads, an overpass (local road under the motorway) will be provided. CSM2 will largely be constructed at grade, with a number of underpasses where elevated structures provide for intersecting roads to pass above the proposed alignment.

CSM2 crosses the Selwyn District and Christchurch City Council boundary at Marshs Road, with approximately 6 km of the CSM2 section within the Selwyn District and the remaining 2.4 km within the Christchurch City limits

1.4 Key Design Features

The key design features and changes to the existing road network (from south to north) proposed are:

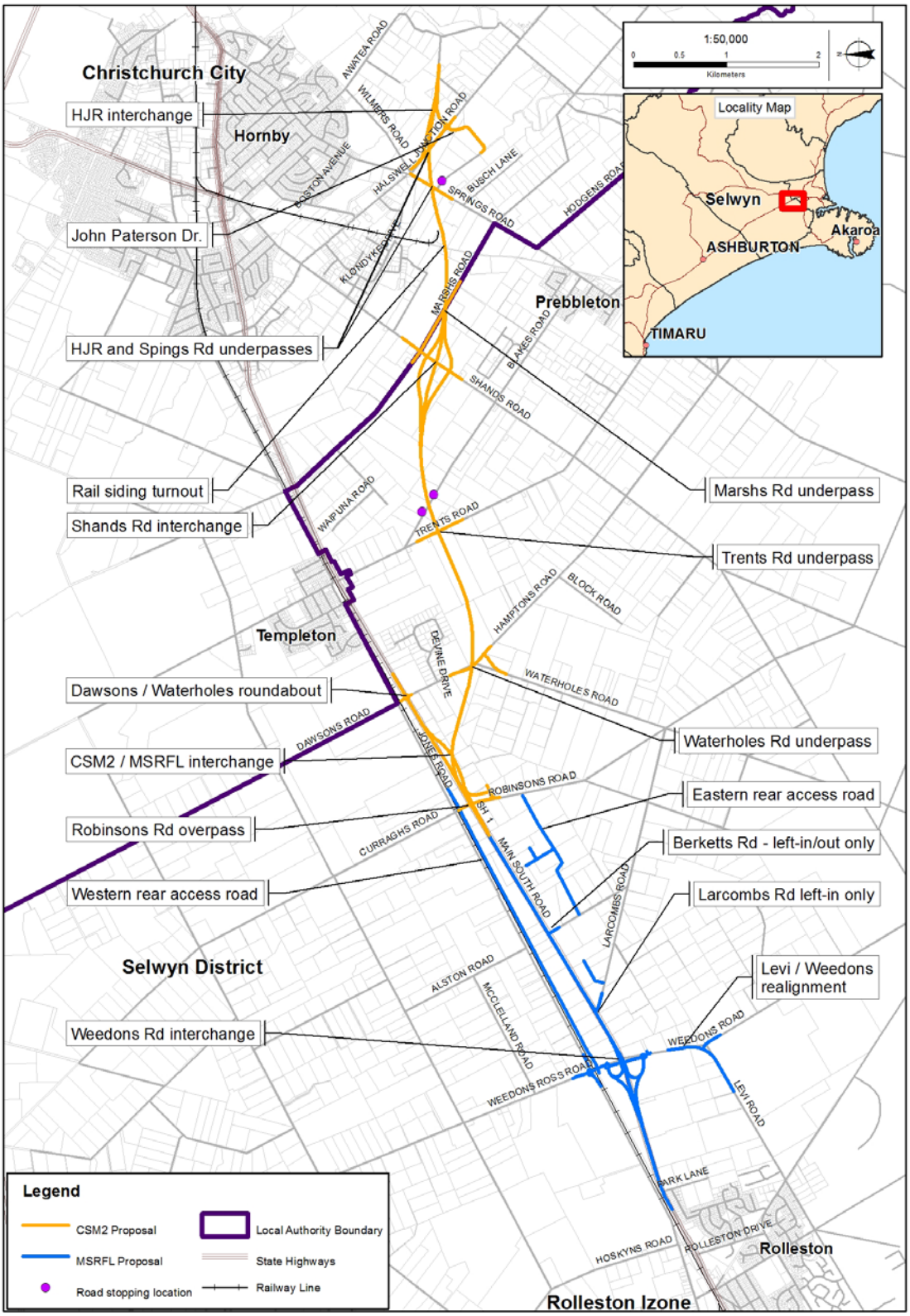
- a new full grade separated partial cloverleaf interchange at Weedons Road;
- a new roundabout at Weedons Ross / Jones Road;
- a realignment and intersection upgrade at Weedons / Levi Road;
- a new local road running to the immediate east of the rail corridor, to the west of Main South Road, between Weedons Ross Road and Curraghs Road;
- alterations and partial closure of Larcombs Road intersection with Main South Road to left in only;
- alterations to Berketts Road intersection with Main South Road to left in and left out only;
- a new accessway running to the east of Main South Road, between Berketts Road and Robinsons Road;

[1] CSM2 will not become a motorway until the Governor-General declares it to be a motorway upon request from the NZTA under section 71 of the Government Roading Powers Act 1989 (GRPA). However, for the purposes of this report, the term "motorway" may be used to describe the CSM2 section of the Project.

- an overpass at Robinsons and Curraghs Roads (the local roads will link under the motorway);
- construction of a grade separated y-junction (interchange) with Main South Road near Robinsons Road;
- a link road connecting SH1 with Robinsons Road;
- a short new access road north of Curraghs Road, adjacent to the rail line;
- a new roundabout at SH1 / Dawsons Road / Waterholes Road;
- an underpass at Waterholes Road (the local road will pass over the motorway);
- an underpass at Trents Road (the local road will pass over the motorway);
- the closure of Blakes Road and conversion to two cul-de-sacs where it is severed by CSM2;
- a new full grade separated diamond interchange at Shands Road;
- an underpass at Marshs Road (the local road will pass over the motorway);
- providing a new walking and cycling path linking the Little River Rail Trail at Marshs Road to the shared use path being constructed as part of CSM1;
- an underpass at Springs Road (the local road will pass over the motorway);
- a new grade separated half interchange at Halswell Junction Road with two east facing on and off ramps linking Halswell Junction Road to CSM1; and
- closure of John Paterson Drive at Springs Road and eastern extension of John Paterson Drive to connect with the CSM1 off-ramp via Halswell Junction Road roundabout (east of CSM2).

The proposed alignment is illustrated on Figure 1 and encompasses the MSRFL and CSM2 alignments between Rolleston and Halswell Junction Road.

Figure 1: Location Map of MSRFL and CSM2 Project



2.0 CRITERIA

The following sections outline the relevant published guidance within New Zealand that relate to the assessment of traffic noise.

2.1 New Zealand Standard NZS 6806:2010

A Standard for the assessment and control of road-traffic noise, NZS 6806, was published in April 2010. NZS 6806 is the first New Zealand road-traffic noise standard and was developed by an independent multidisciplinary committee of Standards New Zealand. It is based on both International and New Zealand research, in addition to the committee's experience in assessing traffic noise in New Zealand.

The Standard is intended for use on all road-traffic noise assessments including State Highways and local roads (provided that the project is within the scope of the Standard). The NZTA has adopted this Standard for assessment of road-traffic noise from new and altered State Highways.

The Standard is an extensive and complex document and therefore it is only practicable to present the key concepts for the purposes of this report.

The Standard retains some of the methodology previously used in the NZTA Guidelines (discussed in Section 2.2 below) such as the noise measurement index, $L_{Aeq(24h)}$ and the concept of a "design year" (the year for which the assessment is undertaken) at least ten years after opening of a project.

2.1.1 Assessment Positions

The Standard specifies a list of types of protected premises and facilities (PPFs), which are assessed in accordance with the provisions of the Standard. In addition to premises that were protected under the NZTA Guidelines (refer Section 2.2 below), such as dwellings and educational facilities, NZS 6806 extends its protection to other premises such as marae, hospitals which contain in-patient facilities, motels and hotels in residential zones and playgrounds within 20 metres of educational facilities.

Premises and facilities which are not yet built, other than premises for which building consent has been obtained which has not yet lapsed are not included as PPFs, and any reverse sensitivity effects resulting from the construction of future dwellings is therefore not considered under the Standard.

The assessment position for existing buildings is at the façade (i.e. an 'incident' noise level) rather than one metre in front of the façade (as was previously the case under the NZTA Guidelines), thus a façade correction is no longer included. For this Project, each two storey dwelling has an assessment location on each floor. The worst-affected position at each floor is considered.

Commercial and business uses are not considered by NZS 6806 to be noise sensitive and are therefore excluded from the assessment.

NZS 6806 stipulates that in an "urban" area, all PPFs within 100 metres of the alignment shall be assessed. In "rural" areas, PPFs within 200m of the alignment shall be assessed. The classifications for "rural" and "urban" are as defined by Statistics New Zealand and are shown in **Appendix B**. For this Project, the majority of PPFs along CSM2 are characterised by similar noise environments even though they may have been classified as different environments. Therefore NZTA has elected to include all PPFs within 200 metres in both "urban" and "rural" areas.

2.1.2 Noise Criteria

The noise criteria of the Standard are not based on existing ambient noise levels, but distinguish between new and altered roads. There are three levels of criteria (A, B and C) as summarised in Table 1. For this Project, traffic volumes will be under the NZS 6806 nominated threshold of 75,000 vehicles per day.

Table 1: NZS 6806 Noise criteria

Category	Altered Roads dB $L_{Aeq(24h)}$	New Roads with a predicted traffic volume of 2,000 to 75,000 AADT at the design year dB $L_{Aeq(24h)}$
A (primary external noise criterion)	64	57
B (secondary external noise criterion)	67	64
C (internal noise criterion)	40	40

For CSM2 the appropriate criteria are as follows:

- A (or primary external) noise criterion is 57 dB $L_{Aeq(24h)}$;
- B (or secondary external) noise criterion is 64 dB $L_{Aeq(24h)}$;
- C (or internal) noise criterion is 40 dB $L_{Aeq(24h)}$; except where
- Altered road criteria have been applied at PPFs that are within 200 metres of a new road, and which are significantly affected by noise from existing roads (e.g. within 100 metres of an existing road).

Refer to **Appendix C** for details on where the "Altered Road" and "New Road" criteria apply.

For a road to be assessed as an "Altered Road" under NZS 6806 it must have both physical changes to the horizontal or vertical alignment, and have a effect on the noise environment. The Standard provides specific guidance[2] to determine whether the proposed Main South Road is considered an "Altered Road". Our testing of the criteria at 1312 Main South Road triggers the "Altered Road" thresholds with noise levels of 69 dB $L_{Aeq(24h)}$ and 72dB $L_{Aeq(24h)}$

[2] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads, Section 1.5

for the Do-Nothing and Do-Minimum Scenarios respectively. The corresponding "Altered Road" design criteria for Main South Road are shown in Table 1 above.

The criteria to be used depend on the application of the best practicable option (BPO) test, with the A criterion being met or bettered if this is consistent with the BPO, the B criterion to be met or bettered if criterion A is not achievable with the BPO, and criterion C to be achieved, if criterion B is not achievable with the BPO.

The Category C criterion is an internal design level for habitable rooms. However, while not specifically noted in NZS 6806, it is assumed that the internal criterion applies to all noise sensitive rooms in protected premises and facilities, including teaching areas and in-patient care rooms where patients sleep.

The 40 dB $L_{Aeq(24h)}$ internal criterion is required to be achieved by the adoption of the BPO, for habitable rooms which would otherwise receive internal noise levels greater than 45 dB $L_{Aeq(24h)}$, i.e. a minimum noise level reduction of five decibels is required to be achieved.

The criteria contained in NZS 6806 have been developed with the intention that they are *"reasonable criteria for the road-traffic noise from new or altered roads taking into account health issues associated with noise, the effects of relative changes in noise levels on people and communities, and the potential benefits of new and altered roads to people and communities*".[3]

2.1.3 Noise Assessment Scenarios

NZS 6806 provides for several operational scenarios to be assessed and compared. These include:

- The existing noise environment which, for altered roads, represents the current road layout and traffic volume and, for new roads, represents the current ambient noise level;
- A future Do-Nothing scenario, which represents the design year where a project has not been implemented, but where traffic volumes have changed (generally increased) over time;
- A future Do-Minimum scenario, which represents the design year where a project has been implemented without any specific noise mitigation. This means that the choice of road surface material is independent of its noise generating characteristics and the only barriers included are solid safety barriers, which are required for reasons other than noise mitigation; and
- Several future mitigation options, which represent scenarios whereby mitigation is designed specifically to reduce noise levels in order to achieve compliance with the relevant noise criteria and fulfill the BPO test.

[3] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads, Section 1.1.4

2.1.4 Mitigation Options

The fundamental basis of compliance with NZS 6806 is the determination of the BPO for noise mitigation measures.

In order to ensure that the BPO is identified, NZS 6806 requires that several mitigation options be developed and compared, not only in terms of noise level reductions but also in relation to other considerations such as urban design, safety, cost etc. Table 3 of the Standard sets out the recommended number of mitigation options to be assessed, depending on the scale of noise impact. For any new or altered road where there are more than 50 PPFs, the Standard recommends that up to four mitigation options should be developed and a preferred option chosen.

The process of comparing mitigation options is interactive, involving a number of Project disciplines. Therefore, the assessment result generally consists of a number of options and a nominated preference developed by the entire Project team. For that reason the selected mitigation option may not provide the greatest noise level reduction, but one which is considered optimal and practicable on balance, when evaluated against relevant criteria. For further explanation of the process of determining the selected mitigation option, refer to Section 5.0 below.

2.1.5 Structural Noise Mitigation Requirements

One aspect of the BPO is the noise level reduction achieved by structural noise mitigation. Structural noise mitigation includes low noise road surface materials and barriers of any type, if these are chosen specifically for their noise reducing characteristics. Barriers, while often effective for noise reduction purposes, can cause adverse effects, such as shading or safety issues. While these are outside the area of expertise of the acoustic consultant, and are dealt with by other disciplines through the BPO process described in Section 2.1.4 above, structural noise mitigation measures need to be designed so that they result in worthwhile noise level reductions.

Therefore, NZS 6806 includes a criterion for the effectiveness of structural mitigation measures. For groups of PPFs (as generally found in urban areas), structural mitigation "should only be implemented if the combination of the structural mitigation measures used would achieve … an average reduction of at least 3 dB $L_{Aeq(24h)}$ "[4]. For individual PPFs (as typically found in rural areas), structural mitigation "should only be implemented if the combination of the structural mitigation measures used would achieve … a minimum reduction of at least 5 dB $L_{Aeq(24h)}$ "[5].

2.2 NZTA (Transit) Noise Guidelines

Prior to the development of NZS 6806, the NZTA (formerly Transit New Zealand) had developed 'Transit New Zealand's Guidelines for the Management of Road Traffic Noise – State Highway Improvements' (the Guidelines). The Guidelines assessed the predicted

[4] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads, Section 8.2.2
[5] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads, Section 8.2.2

future traffic noise level for a design year 10 years from the construction of a highway with respect to the existing ambient noise levels, and provided traffic noise design levels to be met for State highway projects.

As NZS 6806 represents current best practice, it is not proposed to refer to the Guidelines as part of this assessment of noise effects.

2.3 NZTA Environmental Plan

The Transit (NZTA) Environmental Plan published in June 2008 does not contain any specific noise performance standards. However, the Plan states that noise assessments should be undertaken, and designation conditions sought, recognising reasonable noise limits for new or altered designations in areas likely to be affected by road-traffic noise.

Therefore an assessment in accordance with NZS 6806:2010 is also consistent with the policy outlined in the Environmental Plan.

2.4 District Plans

The CSM2 and MSRFL Project traverses the jurisdiction of both Selwyn District and Christchurch City Councils. Road-traffic noise is exempt from assessment under the noise provisions of both District Plans.

2.5 Discussion and conclusion on noise performance standards

NZS 6806 represents current best practice in assessing traffic noise and its development incorporates the combined inputs of numerous organisations including the Ministry of Health, Department of Building and Housing, New Zealand Acoustical Society, New Zealand Institute of Environmental Health and others. The criteria within NZS 6806 take into account the heath issues arising from noise and the effects in relative changes in noise levels on people and communities. Therefore, we consider that utilisation of NZS 6806 to assess the Project's road-traffic noise impacts will result in reasonable noise levels for all affected residents in the vicinity of the Project.

The methodologies for noise level measurement, prediction and assessment set out in the Standard ensure an equitable management of noise effects for all assessment positions in the vicinity of the Project.

The Standard is based on the best practicable option approach, which aligns with RMA requirements. It is therefore considered that for this Project the utilisation of NZS 6806 is appropriate.

3.0 EXISTING NOISE ENVIRONMENT

The existing noise environment provides useful data for assessing noise effects in terms of the RMA, independent of compliance with the criteria of NZS 6806.

The existing noise environment in the vicinity of the Project has been investigated extensively by means of noise level surveys which have in turn been used to calibrate the computer traffic noise modelling of the existing environment. The dominant noise sources affecting the ambient noise environment at those dwellings close to roads is traffic. The further a dwelling is located from a road, the greater the influence of other environmental sounds such as birdsong and rustling leaves.

3.1 Summary of monitoring locations & measured levels

Noise measurements were generally conducted at positions that are representative of the façades of dwellings. The measurements were collected though a combination of long-term unattended noise logging and short-term attended noise measurements. For the long-term logging locations, $L_{Aeq(24h)}$ noise levels are determined directly from the data. For the short-term measurement locations, $L_{Aeq(24h)}$ noise levels are determined by applying appropriate corrections based on Marshall Day Acoustics' analysis.

The measurement distance from existing roads is provided in the location description in Table 2 below. Measurement locations are referenced in Table 2 and shown in **Appendix B**. The measured ambient noise levels (corrected to equivalent free-field) are:

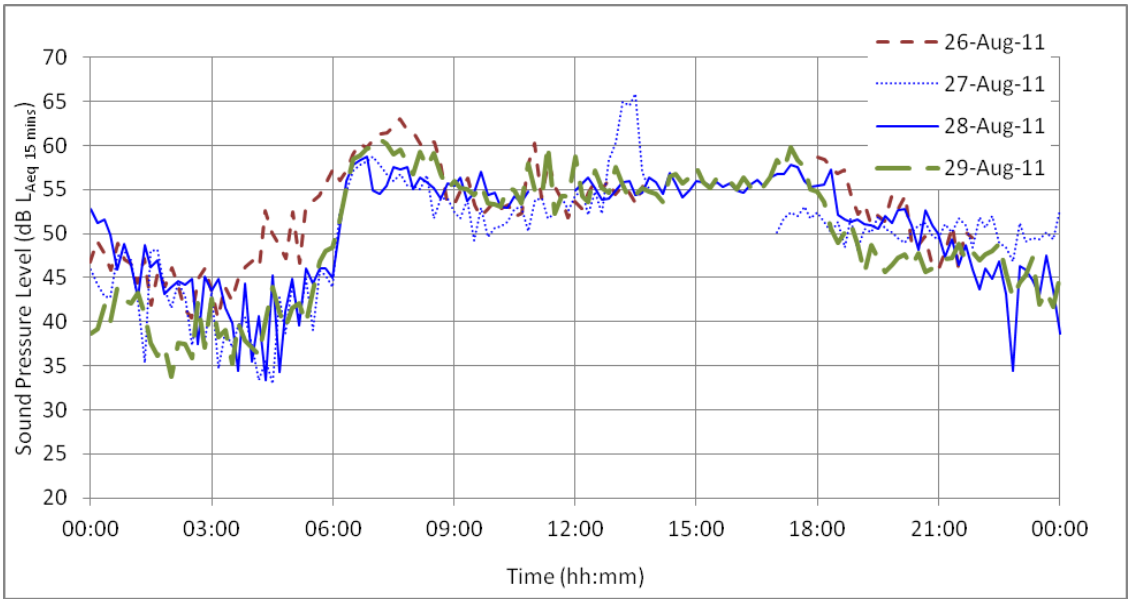
Table 2: Existing ambient noise levels

Ref	Location	Free field noise level, dB $L_{Aeq(24h)}$
1	Main South Road, 10m from carriageway edge	74
2	Block Road (35m from Hamptons Road carriageway edge)	51
3	Blakes Road, 43m from carriageway edge	47
4	In grounds of Trents Estate Winery	47
5	187 Blakes Road, 200m from Shands Road carriageway edge	52
6	Shands Road, 5m from carriageway edge	72
7	Springs Road, 8m from carriageway edge	71

Noise levels at dwellings that are located close to Main South, Springs and Shands Roads are subject to relatively high ambient noise levels in excess of 70 dB $L_{Aeq(24h)}$. Elsewhere, where dwellings are set back further from less busy roads, noise levels are in the order of 50 dB $L_{Aeq(24h)}$.

The variation in ambient noise over a 24 hour period is presented in Figure 2 for 187 Blakes Road (position Ref 5) and Figure 3for Trents Estate Winery (position Ref 4). Figure 2 represents the daily variation in level over four days from 26 to 29 August 2011 inclusive.

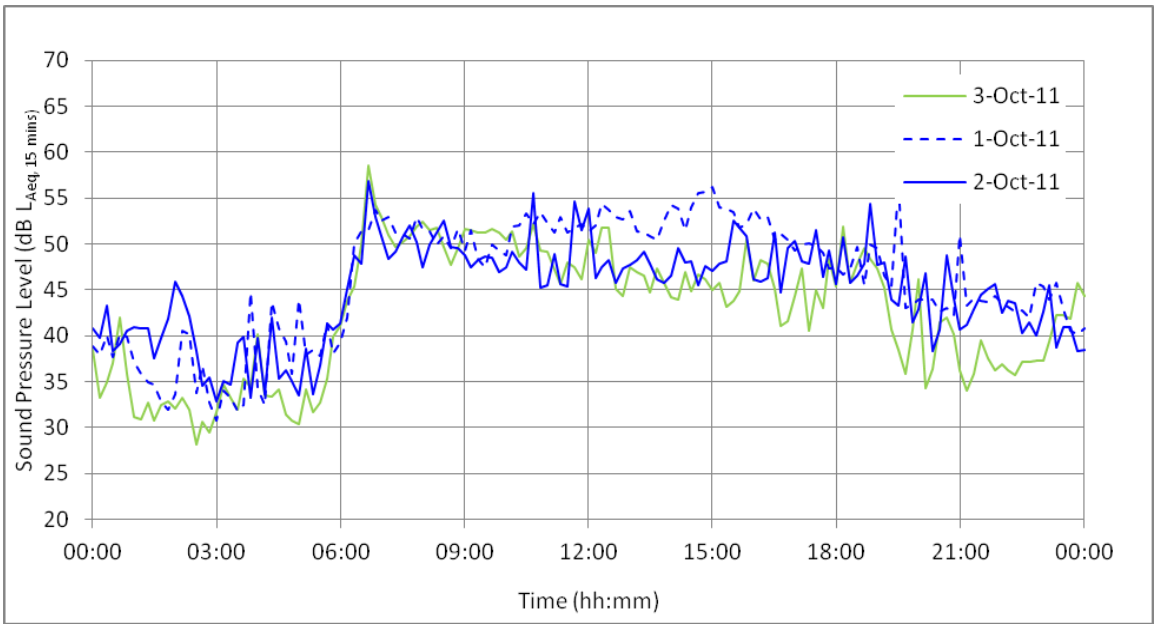
Figure 2: Daily noise level variation at Position 5 (187 Blakes Road), 26 to 29 August 2011



The data indicates that the daytime noise environment at 187 Blakes Road is relatively steady at 55 dB L_{Aeq} and drops to between 35 to 40 dB L_{Aeq} at night. The 24 hour average noise level is 52 dB $L_{Aeq(24h)}$.

Figure 3 represents noise data from 1 to 3 October 2011 inclusive. Noise data affected by wind and rain has been removed.

Figure 3: Daily noise level variation at Position 4 (Trents Estate Winery), 1 to 3 October 2011



At Trents Estate Winery, the data indicates that the daytime noise environment is between 45 to 55 dB L_{Aeq} and drops to between 30 to 40 dB L_{Aeq} at night. The 24 hour average noise level is 47 dB $L_{Aeq(24h)}$.

3.2 Measurement uncertainty

A general uncertainty budget is presented in Table 3 for the noise surveys, based on the methodology proposed by Craven and Kerry[6]. This table provides an indication of the likely statistical variation of the measured noise levels.

Table 3: Measurement uncertainty budget

Sources of uncertainty	Value (half width)	Conversion	Distribution	Standard uncertainty
Source				
Traffic Flow	0.7 dBA[7]	n/a	normal	0.35 dBA
% HGV	0.55 dBA[7]	n/a	normal	0.28 dBA
Mean Speed	0.65 dBA[7]	n/a	normal	0.33 dBA
Road Surface	0.5 dBA[7]	n/a	normal	0.25 dBA
Transmission Path				
Weather	4 dBA[7]	n/a	normal	2.00 dBA
Ground	0.5dBA[7]	n/a	normal	0.25 dBA
Topography	Nil	n/a	-	0
Receiver				
Position	0.5m	0.1 dBA	normal	0.05 dBA
Instrumentation	1.7 dBA[8]	n/a	rectangular	0.98 dBA
Background				
Reflective Surfaces	Nil	n/a	-	0
Combined uncertainty				2.3 dBA
Expanded uncertainty (95% confidence)				4.6 dBA

[6] N.J. Craven and G. Kerry. *A good practice guide on the sources and magnitude of uncertainty arising in the practical measurement of environmental noise.* University of Salford. 2001
[7] NZTA Report 446
[8] Standard uncertainty for Type 1 sound level meter

3.3 Dwellings affected by traffic

3.3.1 General

The following broad descriptions are appropriate for most of the receiving environment along the route.

The vast majority of dwellings in the assessment areas are accessed directly from, or are in close proximity to existing roads, most notably Springs, Shands and Main South Roads. Ambient noise levels at these locations are directly affected by traffic flow and by local obstacles such as perimeter fences and other dwellings. Dwellings in these locations are in the *Rural 2* and *Inner Plains* zones under the Christchurch City Plan and Selwyn District Plan respectively. Existing noise levels have been measured through attended and un-attended measurements.

3.3.2 Trents Estate Winery

Our original brief for the Project requested a noise assessment at Trents Estate Winery. Under NZS 6806, Trents Estate Winery is not a PPF nor does it lie within the defined assessment area for the Project. However, potential traffic noise effects at Trents Estate Winery are discussed in Section 5.4. This location is approximately 350 metres from the proposed CSM2 and 450 metres from Trents Road. Whist traffic noise from Main South Road and local roads is audible at this location, leaf rustle, wind generated noise, livestock and farming activities form the general soundscape.

4.0 TRAFFIC NOISE MODELLING

4.1 Existing Ambient Noise Environment

The existing noise environment of the Project provides useful background for assessing noise effects independent of compliance with the criteria of NZS 6806 and for calibration of the noise prediction model. The existing noise environment in the vicinity of the Project has been investigated extensively by means of noise level surveys and computer noise modelling of the existing circumstances.

Ambient noise measurements show a range of noise levels from 47 dB to 74 dB $L_{Aeq(24h)}$ (refer Section 3.1) demonstrating the varying effect of relative proximity to busy roads, with noise levels at the lower end representing positions located away from the existing roading network and at the higher end representing positions close to existing major roads.

4.2 Road Parameters

The traffic noise prediction method most commonly used in New Zealand is the UK Department of Transportation, Welsh Office "Calculation of Road Traffic Noise", adjusted for New Zealand conditions, specifically the road surfaces, in accordance with the Land Transport New Zealand (LTNZ) Report No. 326.

This calculation methodology takes into consideration multiple factors which affect the road noise level. These include, amongst others, the traffic volume, vehicle speed, road gradient, angle of view, percentage of heavy vehicles and road surface material. The calculation methodology also takes into account limited meteorological conditions, namely for slightly enhancing weather conditions with an average wind speed of approximately 2 m/s and a wind direction of no less than 45 degrees from the road, i.e. downwind.[9]

4.2.1 Design year

NZS 6806 requires the assessment of traffic noise at least 10 years, but no more than 20 years, after the opening of a new or altered road.The year 2026 has been selected as the design year for the traffic modelling of the Project based on a predicted opening year of 2016.

4.2.2 Road surface material

The selection of road pavement has a significant effect on traffic noise generation as road/tyre interaction is the major source of traffic noise at open road speeds (40 km/h and above). This has been shown in numerous studies and is described in detail by Prof. Ulf Sandberg in the Tyre/Road Noise Reference Book[10]. The following table is an excerpt from that book, describing the cross-over speed at which the road/tyre interaction becomes the controlling noise source over engine noise.[11]

Table 4: Crossover speeds for various cases, i.e. the speed above which tyre/road noise is more important than power unit noise.

Vehicle type	Cruising	Accelerating
Cars made 1985-95	30-35 km/h	45-50 km/h
Cars made 1996-	15-25 km/h	30-45 km/h
Heavies made 1985-95	40-50 km/h	50-55 km/h
Heavies made 1996-	30-35 km/h	45-50 km/h

Appendix B of NZS 6806 contains extensive discussion of the application of low noise road surfaces. “Open graded porous asphalt” (OGPA) is a porous and smooth layered asphalt surface that is one of a number of “low noise road surfaces”. The NZS 6806 Appendix confirms that OGPA can reduce noise levels by around six decibels when compared with “chip seal”, the noisiest road surface. Six decibels is a noticeable difference. However, in order for this reduction in noise level to be achieved and maintained, OGPA must be laid to a sufficient depth, properly drained and regularly cleaned.

The NZTA has determined that the CSM2 and MSRFL alignment will be paved with OGPA over the majority of the alignment. Updated pavement drawings were received on 26

[9] Department of Transport, Welsh Office: Calculation of Road Traffic Noise, Sections 4 and 39.2
[10] Ulf Sandberg, Jerzy A. Ejsmont: Tyre/Road Noise Reference Book, Informex 2002, ISBN 91-631-2610-9
[11] Table 5.1, Ulf Sandberg, Jerzy A. Ejsmont: Tyre/Road Noise Reference Book, Informex 2002, ISBN 91-631-2610-6.

September 2012 and were incorporated into the current noise modelling results. No change in the BPO assessment results are anticipated as a result of the revised pavement design.

4.2.3 Traffic volume and speed

The speed and volume of traffic on a road are key factors in determining the level of traffic noise generated. Traffic flows generally increase with time. The main alignment of the Project is intended to have a posted speed of 100 km/h, which is the speed used in the computer noise modelling.

Operation of the Project will also result in decreased traffic flows on sections of the existing SH1 north of the MSRFL/CMS2 interchange. This decrease in traffic will provide a beneficial reduction in noise level for most residences adjacent to this section of SH1.

Noise level predictions for the Design Year 2026 were based on traffic flow figures provided by Beca for the alignment and its associated ramps and parts of local roads that are proposed to be changed due to the Project, but excluding all other local roads, in accordance with the requirements of NZS 6806.

4.3 Noise Assessment Sections

In order to assist with the noise assessment, potentially affected locations along the route have been considered in seven sections as indicated in **Appendix B** and described in Table 5. NZS 6806 requires dwelling locations be classified into "rural" and "urban" areas as defined by Statistics New Zealand. This classification is also presented in Table 5. "PPFs" and "Assessment Positions" are defined by NZS 6806, and are described in Section 2.1.1 above.

Table 5: Description of assessment areas within each section (refer Appendix B)

Section	Statistics NZ	Description
CSM2/MSRFL interchange to Weedons Road Interchange (Sections 5,6 & 7)	Rural	There are 29 dwellings (and correspondingly 29 PPFs) in these sections that are similarly affected by relatively high existing traffic noise levels. Of these 29 PPFs, one is two-storey giving a total of 30 assessment positions. These totals do not include the dwellings along the route have been identified for Crown purchase.
Waterholes & Hamptons Roads (Section 4)	Urban (east) & Rural (west)	In this section there are four dwellings, two of which are two-storey. This corresponds to four PPFs and six assessment locations. These totals do not include dwellings that are to be Purchased by the crown
Trents & Blakes Roads (Section 3)	Urban	Trents Road will pass over CSM2 and Blakes Road will terminate. Four of the eight dwellings that are closest to CSM2 are to be purchased by the Crown. Our original brief for the Project asked us to consider potential noise effects on Trents Estate Winery which is also located in this section. A total of four PPFs have been assessed. One of these is a two-storey dwelling, giving a total of five assessment

Section	Statistics NZ	Description
		positions.
Shands Road (Section 2)	Urban	With CSM2, Shands Road will be accessed via a grade separated interchange. This section contains three PPFs/assessment positions. Three additional dwellings will be purchased by the Crown.
Springs Road (Section 1)	Urban	There are five dwellings within this section with access off Springs Road. Two of the dwellings are two storey, however it is understood that one of these two storey dwellings will be purchased by the Crown. A Springs Road bridge will be built over CSM2. This section contains four PPFs and five assessment positions.

4.4 Identification of Protected Premises and Facilities (PPFs)

As discussed in Section 2.1.1, a number of PPFs have been identified along the proposed CSM2 & MSRFL alignment. Potential PPFs that are located up to 200 metres from the edge of the road are included in this assessment.

In total, 34 PPFs have been identified within the seven sections of the Project route including four that are two-storey dwellings.

Not included in this total are those dwellings located on Crown owned land or those that it is intended the Crown will purchase. These properties are identified in **Appendix C**. Although Crown ownership does not automatically exclude PPFs from assessment under the Standard it is assumed that these properties will be removed, or affected party approval will be provided. Therefore, they have not been assessed.

4.5 Computer Modelling

4.5.1 Software

For this Project, the internationally recognised noise modelling software, SoundPLAN, has been used to predict traffic noise levels. SoundPLAN uses a digital topographical terrain map of the area as its base. Each noise source (traffic stream) is located on the map and the software then calculates traffic noise generation for multiple directions, allowing for terrain, topography, shielding, and meteorological conditions.

4.5.2 Traffic noise prediction

For this Project the UK Department of Transportation, Welsh Office "Calculation of Road Traffic Noise" (CRTN) traffic noise prediction method is used, as discussed in Section 4.2.

4.5.3 Model inputs

At the basis of the NZS 6806 assessment, noise level predictions are made for the Do-Nothing and Do-Minimum scenarios as well as with noise mitigation implemented (Refer Section 2.1.3). In order to predict noise levels for each scenario, the following data was provided by Beca:

- Three dimensional terrain and road geometry information for CSM2 & MSRFL;
- Road surface information for both existing and proposed roads;
- Design year traffic volumes (including the percentage of heavy vehicles) for the Do-Nothing and Do-Minimum situations.

4.5.4 Model verification

The initial model configuration was used to predict noise from existing road configurations and checked against measured noise levels in order to verify the accuracy of the model. Table 6 indicates the correlation between the calculated noise levels and the measured noise level at the same location.

Table 6: Correlation between calculated noise levels and measurements

Location	Measured Level[12]	Calculated Level
1213 Main South Road	68 dB $L_{Aeq(24h)}$	69 dB $L_{Aeq(24h)}$
Main South Road (South of Weedons Road)	76 dB $L_{Aeq(24h)}$	76 dB $L_{Aeq(24hr)}$

The calculations were within 2 dBA of the measured noise levels which is an acceptable level of accuracy (NZS 6806 Section 5.3.4.2).

4.5.5 Summary of model settings

Table 7 lists the key software settings for the noise model prepared for this assessment.

Table 7: Key SoundPlan model settings

Parameter	Setting/Source
Software	SoundPlan v7.0
Algorithm	CRTN
Order of Reflection	1
Parameter	$L_{Aeq(24h)}$ Free-field
Ground Absorption	Soft ground near receiver, hard ground near source
Receiver Height	1.5m above floor level (on each floor of interest)

[12] Attended noise measurements have been used to validate the model. Data has been collected in line with the procedure outlined in CRTN (section 43) with appropriate corrections to determine an equivalent 24-average ($L_{Aeq,(24h)}$).

4.5.6 Individual receiver noise levels

Noise levels have been calculated for all floor levels of each PPF identified as required by NZS 6806 (see Section 4.4). In most circumstances, the highest floor is the most affected floor which controls the mitigation measures to be implemented. However, it is noted that other floors at lower levels will generally benefit to a greater extent from the proposed mitigation measures and therefore, receive lower noise levels. The design of appropriate noise mitigation measures has been based on compliance with the relevant criteria being complied with at all affected floors.

Individual receiver noise levels have been shown as a graphic representation in **Appendix C** by colouring the buildings with the colour scale showing NZS 6806 Category A buildings in green, Category B buildings in yellow and Category C buildings in red. Those buildings shown in grey on the figures are outside the assessment area of 200 metres from the road alignment or are not PPFs (refer Section 4.4).

4.5.7 Noise contour plans

Noise contour plans for the entire Project area are included in **Appendix D**. These plans show predicted free-field noise level bands at 5 decibel intervals for the seven sections of the Project with the preferred mitigation options in place.

5.0 DESIGN AND MITIGATION

5.1 Methodology

For each sector, the existing situation has been assessed by means of noise level surveys and computer noise modelling. The Do-Nothing situation is compared with the Do-Minimum scenario to determine the potential noise level change due to the Project implementation. The Do-Minimum scenario serves as the base for the assessment of noise mitigation options.

The modelling process allows noise levels at all PPFs to be predicted and evaluated against the NZS 6806 design criteria. The modelling also permits the effective assessment of noise mitigation options which, for this Project, primarily focussed on:

- Noise barriers in the form of earth mounds or noise barriers or a combination of the two. A range of barrier heights have been assessed from 2 to 4.5 metres;
- The use of Open Graded Porous Asphalt (OGPA) surfacing on the approach to overbridges. **OGPA has already been nominated for use on the majority of CSM2 and MSRFL as part of the Do-Minimum Scenario**.

A number of noise mitigation options have been evaluated by the Project team under the BPO guidance provided by the Standard and using an evaluation matrix prepared by NZTA (the matrix template can be downloaded from http://acoustics.nzta.govt.nz/file/nzs-6806-assessment-matrix).

The assessment matters include, but are not limited to, noise reduction, visual impact, safety, planning and cost. For this Project, a workshop was held which was attended by the Project team. Each mitigation option was evaluated in order that the BPO could be determined. Of the noise mitigation options that were presented at the workshop, a number of bunds and barriers were immediately identified as not being necessary owing to the intended Crown purchase of the property they were designed to protect.

Each sector assessment set out below contains a summary of all mitigation options considered and a description of the selected mitigation option.

5.2 Weedons Road Interchange to CSM2/MSRFL Interchange (Section 5, 6 & 7)

Refer to **Appendices C-5, C-6 & C-7**.

The assessment of Sections 5 to 7 is very similar and is therefore presented together.

The noise environment at dwellings in these sections is dominated by Main South Road/SH1 traffic. Accordingly, the Altered Road criteria have been applied. There are a total of 29 dwellings including one that is two-storey. This gives a total of 29 PPFs with 30 assessment positions.

Not included in these totals are the dwellings to be purchased by the Crown. These are identified in Appendix C. We note that four of the Crown purchased properties are to be relocated to the rear of their respective sites. Whilst these dwellings' final locations are uncertain, traffic noise levels are likely to meet the Category A criteria for Altered Roads without any additional specific noise mitigation.

5.2.1 Existing noise environment

The existing noise environment at the 29 PPFs in these sections has been predicted to range between 51 and 71 dB $L_{Aeq(24h)}$, depending on their distance from SH1. For dwellings close to Weedons Road and Weedons-Ross Road, only the contribution from the existing SH1 has been calculated. This has resulted in a conservative estimate (lower) ambient noise level being used in our mitigation options assessment.

5.2.2 Do-Minimum scenario

The Do-Minimum scenario includes low-noise road surface material (OGPA) along the main CSM2/MSRFL alignment. The Do-Minimum scenario shows that the operation of CSM2/MSRFL would have a negligible to slight effect on noise levels at dwellings in these sections.

In these sections, three of the assessment positions would be within Category B (between 64 and 67 dB $L_{Aeq(24h)}$). All of the remaining assessment positions would be Category A (up to 64 dB $L_{Aeq(24h)}$).

5.2.3 Mitigation options

The selection of OGPA as the Do-Minimum surface for the alignment means that traffic noise emissions from the main alignment are much lower than might otherwise be the case if a noisier Do-Minimum surface had been selected (e.g. asphaltic concrete or chip seal).

The noise mitigation options investigated for these sections are summarised in Table 8. The sections for which each option was investigated is outlined in Table 9.

Table 8: Weedons Road to CSM2/MSRFL Interchange (Section 5, 6 & 7) Mitigation Options

Option	Description	Comments
1	Short localised sections of 1.8m high fences	Useful for targeting specific dwellings requiring mitigation, difficult to achieve more than a 3 decibel reduction in noise level except where fences are located very close to houses. The inclusion of gates for access slightly decreases performance. Some benefit found by wrapping fences around the side of properties.

Option	Description	Comments
2	Long sections of 1.8m high fences along the edge of the alignment.	Greater reductions in noise level achieved than short sections (generally above 5 decibels at all target locations), however performance will significantly reduce where access gates are present. Significantly more expensive than short sections due to much greater fence lengths required. Visual impact of long sections of fence was considered.

Table 9: Sections where mitigation options were considered

Option	Description	Applicable Section		
		5	6	7
1	Short localised sections of 1.8m high fences	✓	✓	✓
2	Long sections of 1.8m high fences along the edge of the alignment.	✓	✓	✓

We note that we have not presented the full set of mitigation options that were specifically evaluated for dwellings that were subsequently purchased by the Crown.

5.2.4 Preferred mitigation option

Option 1 was selected as the preferred option. Refer to Appendices C-5, C-6 & C-7 for a more detailed indication of the location of the noise mitigation.

A summary of the noise level categories for the Do-Minimum and selected mitigation option are shown in Table 10:

Table 10: Section 5, 6 & 7 noise level categories

	No. of assessment positions[13]	
Categories	**Do Minimum**	**Selected Mitigation**
A	26	29
B	3	0
C	0	0

5.3 Waterholes & Hamptons Roads (Section 4)

Refer to **Appendix C-4**.

The noise environment at dwellings in this section is dominated by traffic on Waterholes Road and Hamptons Road, and the existing SH1. The relative traffic noise contribution from

[13] For each two-storey PPF there are 2 assessment positions

each road depends on each dwelling's proximity to each respective road. As traffic on the local roads is intermittent and only affects properties within 50m of the road, the more stringent New Road criteria have been applied.

There are a total of four PPFs and six assessment positions in this section.

5.3.1 Existing noise environment

The existing noise environment at the four dwellings has been predicted to be between 51 and 53 dB $L_{Aeq(24h)}$.

5.3.2 Do-Minimum scenario

The Do-Minimum scenario includes low-noise road surface material (OGPA) along the main CSM2 alignment. The Do-Minimum scenario shows that the operation of CSM2 would have a negligible to slight effect on the PPFs in this section. Noise levels will remain similar to existing levels for most dwellings, with changes ranging from a 1 decibel decrease up to an increase of 4 decibels.[14]

All PPFs in this section would be within Category A (up to 57 dB $L_{Aeq(24h)}$).

5.3.3 Mitigation options

All four assessed PPFs in this section are within Category A for the Do-Minimum situation and therefore no mitigation options have been developed.

A summary of the noise level categories for the Do-Minimum are as shown in Table 11:

Table 11: Waterholes & Hamptons Roads (Section 4) noise level categories

	No. of assessment positions[15]	
Categories	**Do Minimum**	**Preferred Mitigation**
A	6	n/a
B	0	n/a
C	0	n/a

5.4 Trents & Blakes Roads (Section 3)

Refer to **Appendix C-3**.

The noise environment at dwellings in this section is affected by traffic on Blakes Road and Trents Road and, to a lesser extent, the existing SH1. Traffic on Blakes and Trents Roads is

[14] Refer Section 6.1 for an explanation of subjective responses to changes in noise level.
[15] For each two-storey PPF there are 2 assessment positions.

intermittent and traffic noise is not considered to not to have a significant effect on existing properties. Therefore the New Road criteria have been applied.

Of the eight dwellings in this section, four are to be purchased by the Crown and have therefore not been assessed further. One of the remaining dwellings is two storey and therefore we have considered a total of four PPFs and five assessment positions in this section.

With the proposed alignment, Blakes Road will not cross CSM2 and therefore will no longer function as a through road. The resulting decrease in traffic along this road will cause a decrease in traffic noise level for properties close to Blakes Road.

Trents Estate Winery lies within this section of the Project and is not considered a PPF as it is a commercial activity. The potential noise effects of the Project on this property have nevertheless been considered under the assessment of effects at the request of NZTA as part of the Project brief (refer Section 6.4).

5.4.1 Existing noise environment

The existing noise environment at the five assessment positions has been predicted to be between 52 and 54 dB $L_{Aeq(24h)}$. The existing noise environment at Trents Estate Winery has been measured to be 47 dB $L_{Aeq(24h)}$.

5.4.2 Do-Minimum scenario

The Do-Minimum scenario includes low-noise road surface material (OGPA) along the main CSM2 alignment. The Do-Minimum scenario shows that the operation of CSM2 would have a negligible effect on dwellings in this section, with noise levels remaining similar to existing levels for most dwellings, with increases in noise levels of up to 2 decibels.[16]

All assessed PPFs in this section would be within Category A (up to 57 dB $L_{Aeq(24h)}$).

5.4.3 Mitigation options

All five assessment positions are within Category A for the Do-Minimum situation. Therefore no mitigation options have been developed for this section.

[16] Refer Section 6.1 for an explanation of subjective responses to changes in noise level.

A summary of the noise level categories for the Do-Minimum scenario are as shown in Table 12:

Table 12: Trents & Blakes Roads (Section 3) noise level categories

	No. of assessment positions	
Categories	**Do Minimum**	**Preferred Mitigation**
A	5	n/a
B	0	n/a
C	0	n/a

5.5 Shands Road (Section 2)

Refer to **Appendix C-2**.

The noise environment at dwellings in this section is dominated by Shands Road traffic and Altered Road criteria have been applied. There are a total of six single-storey dwellings in this section. It is understood that one dwelling is owned by the Crown and two others are to be purchased be the Crown and do not require assessment, for the reasons explained in section 4.4. This gives a total of three PPFs, and correspondingly three assessment positions, in this section.

5.5.1 Existing noise environment

The existing noise environment at the assessment positions has been predicted to be between 54 and 66 dB $L_{Aeq(24h)}$, depending on their distance from Shands Road.

5.5.2 Do-Minimum scenario

The Do-Minimum scenario includes low noise road surface material (OGPA) along the main CSM2 alignment. In addition, Stone Mastic Asphalt (SMA) has been proposed for the overbridge and its approaches. Category A (up to 64 dB $L_{Aeq(24h)}$) would be achieved at all assessment locations.

5.5.3 Mitigation options

All three assessment positions in this section are within Category A for the Do-Minimum situation. Therefore no mitigation options have been developed.

A summary of the noise level categories for the Do-Minimum situation are provided in Table 13.

Table 13: Shands Road (Section 2) PPF noise level categories

	No. of assessment positions	
Categories	**Do Minimum**	**Preferred Mitigation**
A	3	n/a
B	0	n/a
C	0	n/a

5.6 Springs Road (Section 1)

Refer to **Appendix C-1**.

The noise environment at dwellings in this section is dominated by Springs Road traffic and Altered Road criteria have generally been applied. One two-storey PPF (two assessment positions) is subject to the New Road criterion and the remaining three PPF's have been assessed against the Altered Road criterion.

5.6.1 Existing noise environment

The existing noise environment at the PPF's has been predicted to be between 52 and 69 dB $L_{Aeq(24h)}$, depending on the distance to, and elevation above Springs Road.

5.6.2 Do-Minimum scenario

The Do-Minimum scenario includes low-noise road surface material (OGPA) along the main CSM2 alignment. OGPA is also proposed for the Springs Road overbridge and its approaches. The Do-Minimum scenario shows that the operation of CSM2 would have a negligible to moderate effect on dwellings within 100 metres of Springs Road and noise levels would slightly increase or decrease depending on the proximity to Springs Road.

All PPF's adjacent to Springs Road would be Category A (up to 64 dB $L_{Aeq(24h)}$ under the Altered Road criterion) with the exception of the PPF at 312 Springs Road which would be Category B (between 64 and 67 dB $L_{Aeq(24h)}$).

Both assessment positions associated with the PPF to the south of the CSM2 alignment would be Category A (up to 57 dB $L_{Aeq(24h)}$ under the New Road criteria).

5.6.3 Mitigation options

The selection of OGPA as the Do-Minimum surface means that traffic noise emissions from the main alignment are much lower than might otherwise be the case if a noisier Do-Minimum surface had been selected (e.g. asphaltic concrete or chip seal). Noise emissions from Springs Road are the controlling noise source and tend to require more mitigation.

As part of our original assessment, both noise barriers and surfacing options were assessed as part of the mitigation options. The recent provision of OGPA as the Do-Minimum surface means that we have evaluated noise barriers as a mitigation option as summarised in Table 14.

Table 14: Mitigation Options for Springs Road (Section 1)

Option	Description	Comments
1	1.8m high local noise barrier at dwelling at 312 Springs Road	All PPFs within Category A

5.6.4 Selected mitigation option

A 1.8 metre high noise barrier to Springs Rd property boundary of 312 Springs Road was the selected option for this section.

A summary of the PPF noise level categories for the Do-Minimum scenario and selected mitigation option is contained in Table 15.

Table 15: Springs Road (Section 1) PPF noise level categories

	No. of assessment positions[17]	
Categories	**Do Minimum**	**Preferred Mitigation**
A	4	5
B	1	0
C	0	0

The combined use of low-noise road surface and localised fences mean that all dwellings would be within Category A.

5.7 Summary of Preferred Mitigation Options

The following mitigation options have been selected for the Project:

Table 16: Selected Mitigation Option

Section	Description of Mitigation Option
7	1.8m high noise barrier along two boundaries at 1528 Main South Road
6	1.8m high noise barrier at 95 Berketts Road
5	1.8m high noise barrier at 1213 Main South Road
4	None (Do- Minimum Scenario)

[17] For each two-storey PPF there are 2 assessment positions

Section	Description of Mitigation Option
3	None (Do- Minimum Scenario)
2	None (Do- Minimum Scenario)
1	1.8m high noise barrier to road side boundary of 312 Springs Road

We note that the noise barriers will be subject to detailed design. However, barriers should generally be constructed of materials that have a surface mass of at least 10 kg/m² and be built with no gaps. Suitable materials can include concrete, fibre cement board, steel and timber. As far as practicable, barriers will be located either within, or at the edge of the road designation, thereby permitting NZTA to perform ongoing maintenance.

5.8 Traffic noise level generation

Appendix D provides the predicted traffic noise contours the seven sections with for each of the selected mitigation options in place.

6.0 ASSESSMENT OF TRAFFIC NOISE LEVELS

6.1 Subjective perception of noise level changes

Noise is measured on a logarithmic scale and the subjective impression of changes in noise can generally be correlated with the numerical change in noise level. While every individual reacts differently to noise level changes, Land Transport New Zealand Research Report No. 292[18] shows a general correlation between noise level changes and subjective responses. However, we note that this research is based on the resealing of existing roads at urban driving speeds of 50 km/h and therefore may not direct relate to new roading projects with significantly higher speeds. Notwithstanding this comment, our own experience described below is generally supported by the findings of research report No. 292 for moderate noise levels.

Subjective listening tests[19] conducted by Marshall Day Acoustics, in addition to several year's experience assessing noise, has resulted in the development of Table 17 which describes subjective perceptions resulting from a change in noise level. The subjective impressions can be considered to apply for positive and negative changes in noise level.

Table 17: Noise level change compared with subjective perception

Noise Level Change	General Subjective Perception	Impact/RMA Effect
1 – 2 decibels	Insignificant change	Negligible/Less than minor
3 – 4 decibels	Perceptible change	Slight/Minor
5 – 8 decibels	Appreciable change	Moderate
9 – 11 decibels	Doubling of loudness	Significant/ Substantial
> 11 decibels	More than doubling of loudness	Severe

The perception of these noise level changes generally applies to immediate changes in noise level, as would be the case for a new road such as CSM2. Therefore, the changes are likely to be perceived by residents adjacent to the CSM2 as set out in the table. Residents adjacent to MSRFL are likely to be less affected by changes in noise level, as the existing environment is already dominated by traffic from the existing SH1, and the increase in noise level as a result of the Project will happen gradually between the opening of the road and the design year as traffic flows increase.

Refer to **Appendix E** for a full list of existing and predicted noise levels at each PPF at design year, including the selected mitigation option.

[18] For instance, LTNZ Research Report No. 292: Road traffic noise: determining the influence of New Zealand Road surfaces on noise levels and community annoyance,.

[19] Tests were conducted using traffic noise samples played at controlled noise levels and respondents were asked to note the subjective change. Respondents included delegates from the Resource Law Management Association, New Zealand Institute of Architects and the Royal Australian Institute of Architects (among others)

6.2 Weedons Road Interchange to CSM2/MSRFL Interchange (Section 5, 6 & 7)

Refer to **Appendices C-5, C-6 & C-7**.

Under the selected mitigation option described in Section 5.3.3, noise levels for the majority PPFs in these sections are predicted to either remain the same or to decrease. The resulting noise effects will therefore be negligible or positive. Only one dwelling in Section 6, at 1300 Main South Road, is predicted to experience an increase in noise level of 2 decibels. The effect at this property is considered to be less than minor.

6.3 Waterholes & Hamptons Roads (Section 4)

Refer to **Appendix C-4.**

Under the proposed Do-minimum scenario the noise level at one PPF in this section is predicted to slightly decrease by up to 1 decibel. Noise levels at the other PPFs in this section are predicted to increase by between 1 and 4 decibels. This increase is considered to be a less than minor to minor effect (refer Table 17). The change in noise level of 4 decibels, and resulting minor noise effect, will occur at 883 and 904 Waterholes Road.

6.4 Trents & Blakes Roads (Section 3)

Refer to **Appendix C-3**.

Under the proposed Do-Minimum scenario noise levels at assessed PPFs in this section are predicted to increase by up to 2 decibels. This is considered to be a less than minor effect (refer Table 17). A 2 decibel increase will occur at 108 Trents Road and 260 Blakes Road.

Trents Estate Winery also lies within t8his section and traffic noise levels from CSM2 in the garden areas outside the winery buildings are predicted to be less than 53 dB $L_{Aeq(24h)}$. This is an increase in noise level of up to 6 decibels. While this is considered to be an appreciable change, this level of background noise should not negatively impact the use of the Winery's buildings and grounds for functions. For example, traffic noise at this level will not affect the ability of patrons to converse at normal levels whilst enjoying the garden areas.

6.5 Shands Road (Section 2)

Refer to **Appendix C-2**.

Under the proposed Do-Minimum scenario PPFs are predicted to decrease by between 1 and 4 decibels which is considered to be a slight positive effect.

6.6 Springs Road (Section 1)

Refer to **Appendix C-1**.

With the preferred mitigation option in place noise levels at all assessed PPFs in this section are predicted to decrease by between 2 and 11 decibels, which is considered to be a slight positive, to substantially positive effect. The large reductions are primarily as a result of the

existing Springs Road surface being replaced with OGPA on the southern approach to the overbridge.

6.7 Summary of potentially adversely affected dwellings

Based on the above, the following dwellings are likely to experience a change in noise level of 3 decibels or more, corresponding in a minor adverse noise effect: 883 Waterholes Road and 904 Waterholes Road (both in Section 4). In both instances, traffic noise levels will achieve the Category A noise criteria of 57 dB $L_{Aeq(24h)}$ for new roads.

7.0 ROAD TRAFFIC VIBRATION

Vibration levels from traffic depend primarily on the roughness of the road surface. A smooth road surface results in low levels of vibration being generated by moving traffic.

Historical measurements conducted during detailed analysis of road traffic vibration on other New Zealand projects has shown that a significant degradation in the surface of a road, or poor maintenance resulting in bumps or dips in the road surface, are required before vibration from road traffic becomes significant enough to cause even superficial building damage. Given the significance of the CSM2/MSRFL route, degradation of this magnitude is highly unlikely to occur.

The operation effects of vibration from the Project are expected to be negligible (i.e. very unlikely to cause annoyance), provided the Project road surface is monitored and maintained in accordance with the NZTA policy for road roughness. This policy is the primary mitigation tool, and the best practicable option for avoiding and mitigating operational vibration effects.

Vibration levels will be acceptable under international standards relating to human response to transit vibration, such as Norwegian Standard NS 8176.E:2005 *Vibration and shock - Measurement of vibration in buildings from land based transport and guidance to evaluation of its effects on human beings.* This does not imply that residents adjacent to the Project will not feel traffic vibration (there is a small likelihood that the closest receivers may be affected), rather the vibrations will be at a level deemed by the most appropriate Standard for human response to traffic vibration to be acceptable. Vibration monitoring may be undertaken on a case-by-case basis if complaints of traffic vibration are received.

In summary, the operation vibration effects are predicted to be negligible provided the road surface of the proposed Project is maintained according to NZTA policy.

8.0 SUMMARY

An assessment of noise effects associated with the proposed Christchurch Southern Motorway Stage 2 and Main South Road four-laning has been conducted.

The assessment has followed the procedures set out in NZS 6806 *"Acoustics - Road-traffic noise - New and altered roads"* which provides noise level criteria for noise sensitive locations.

A noise model has been developed to predict traffic noise levels and to evaluate the reduction in noise provided by various noise mitigation options. NZS 6806 provides a framework by which each of these noise mitigation measures is assessed in line with the best practicable option (BPO) approach of the Resource Management Act.

This BPO approach has resulted in a number of selected noise mitigation measures for each of the route sections (1 to 7) which include low noise road surface and noise barriers. Comprehensive design of the noise mitigation will occur during the detailed design stage of the Project.

The existing ambient noise environment for dwellings adjacent to existing busy roads (Main South Road, Springs and Shands Roads) is such that the Project will not result in any appreciable change in noise environment for the majority of residents. Dwellings adjacent to less busy roads, or set back a significant distance from the carriageway edge, will mostly be subject to noise levels below the Category A noise level criteria category of NZS 6806.

At Trents Estate Winery, a noise level below 53 dB L_{Aeq} is predicted, which is considered appropriate for normal use of the Winery's buildings and grounds for functions.

While no detailed assessment of potential operational vibration effects has been conducted, experience shows that vibration levels generated by traffic are low, and will be sufficiently well managed as a result of the NTZA's ongoing maintenance requirements for a road.

Overall, the Christchurch Southern Motorway and Main South Road four-laning Project can be operated such that adverse noise effects from traffic will, at worst, be no more than minor. In general, noise effects will be slightly positive or less than minor for the majority of PPFs. These effects have been achieved through the utilisation of the best practicable option approach to noise mitigation. Our assessment has shown that significant noise effects can be avoided, remedied or mitigated by utilising the best practicable mitigation option approach and the achievement of compliance with the relevant criteria of NZS 6806.

9.0 CONDITIONS

The assessment method from NZS 6806, which has been used in this Project, has fundamentally changed the way in which noise mitigation measures are designed. Rather than rigid adherence to a specific noise limit, regardless of practicality or adverse effects such as shading by barriers, NZS 6806 promotes an integrated design process to establish the best practicable option for mitigation.

NZS 6806 requires significantly more design work during the noise assessment, and consequently the noise mitigation is more refined at this stage in the Project.

It is not possible to assign a simplistic performance standard such as a noise limit to the NZS 6806 process or the results of the process. The BPO is determined by following the correct process and not by achieving an absolute limit.

To support the introduction of NZS 6806, the NZTA has commissioned its legal panel to prepare designation conditions that encapsulate the NZS 6806 process. The conditions provide certainty in the noise mitigation outcome to be provided, while allowing for development during normal detailed design processes. It is recommended that this form of noise conditions should be used for the Project.

Examples of designation conditions are found in Section 18 of the NZTA *Guide to Assessing Road Traffic Noise*[20]. The proposed designation conditions for the Project are attached to the Assessment of Environmental Effects.

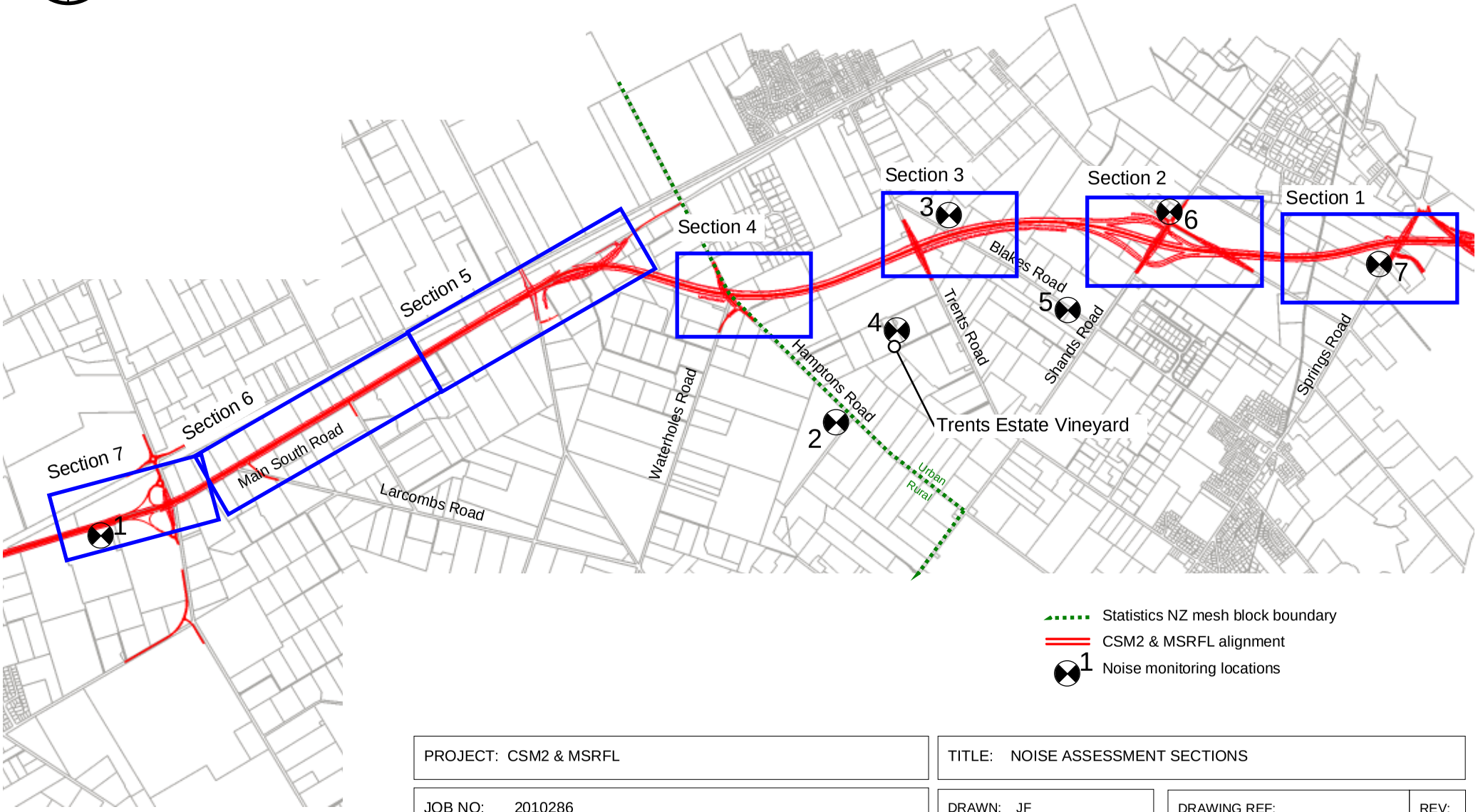
[20] Available online at http://www.nzta.govt.nz/resources/guide-to-assessing-road-traffic-noise/docs/guide-to-assessing-road-traffic-noise.pdf

APPENDIX A GLOSSARY OF TERMINOLOGY

"Do-Minimum" noise environment	The predicted noise level at the design year with the Project implemented, including safety barriers and other structures, which may provide incidental noise mitigation. It does not include any mitigation that would be undertaken for the sole purposes of reducing noise effects.
"Do-Nothing" noise environment	The predicted noise level at the design year assuming no alterations are made to the existing road.
Ambient	The noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"*
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
NZS 6806	New Zealand Standard NZS 6806:2010 *"Acoustics - Road-traffic noise - New and altered roads"*
dBA	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted relative to a sound pressure of $2x10^{-5}$Pa
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates
$L_{A10\,(t)}$	The A-weighted noise level equalled or exceeded for 10% of the measurement period. This is commonly referred to as the average maximum noise level. The suffix "t" represents the time period to which the noise level relates.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX B ROUTE PLAN & NOISE MEASUREMENT LOCATIONS

(following page)



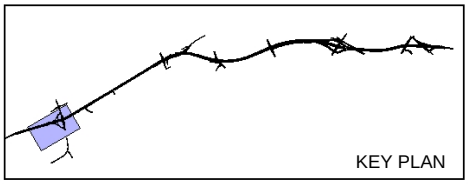
PROJECT: CSM2 & MSRFL	TITLE: NOISE ASSESSMENT SECTIONS		
JOB NO: 2010286	DRAWN: JF	DRAWING REF: Appendix B	REV: 00
	DATE: Sept 11		
	SCALE: NTS		

MARSHALL DAY Acoustics

APPENDIX C NOISE MITIGATION OPTIONS

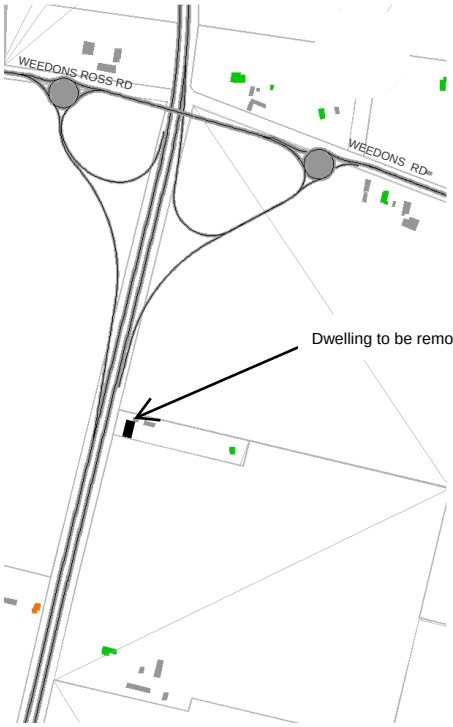
(following pages)

Section 7 - MSRFL: Weedons Rd



Do Minimum

Ground Floor



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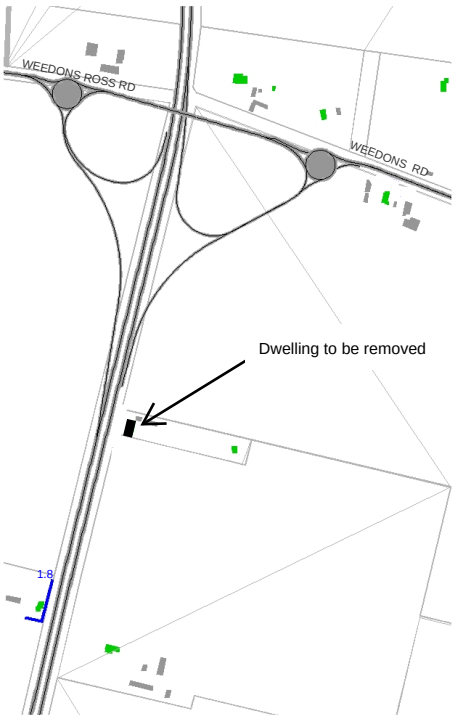


KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional OGPA-14 surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

Altered Road criteria (64/67 dB L_{Aeq}) apply at all PPFs shown

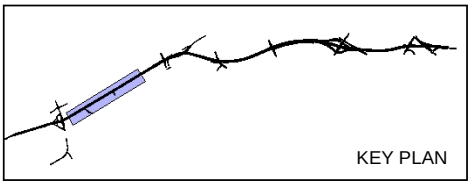
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 7 - PREFERRRED MITIGATION OPTION
JOB NO: 2010286	DRAWN: JF
	DATE: Sept 11
	SCALE: NTS
DRAWING REF: Appendix C-7	REV: 02

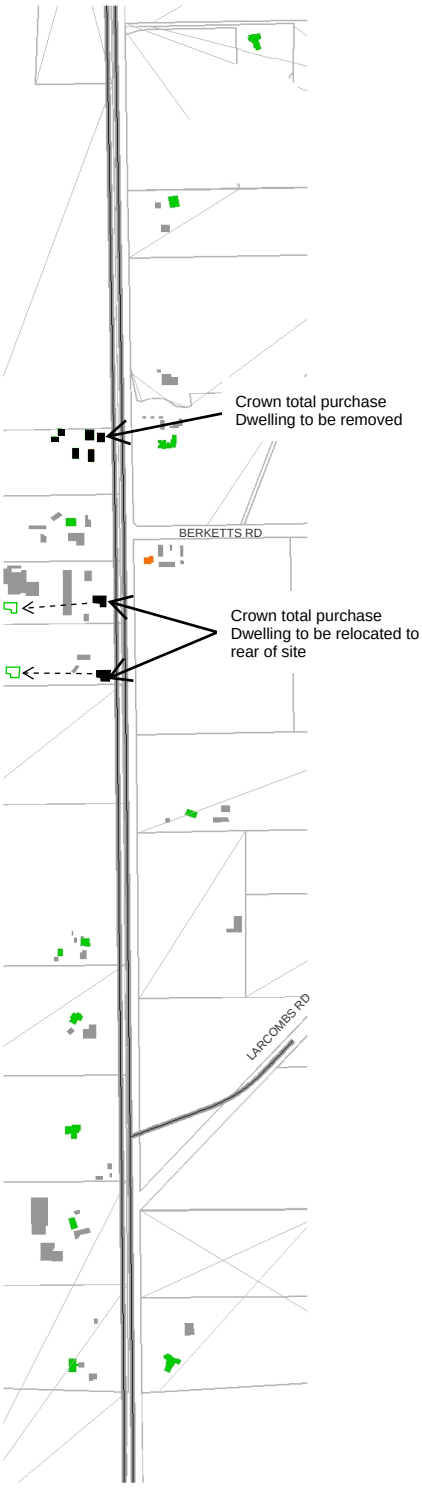
MARSHALL DAY Acoustics

Section 6 - MSRFL: Larcombs Rd

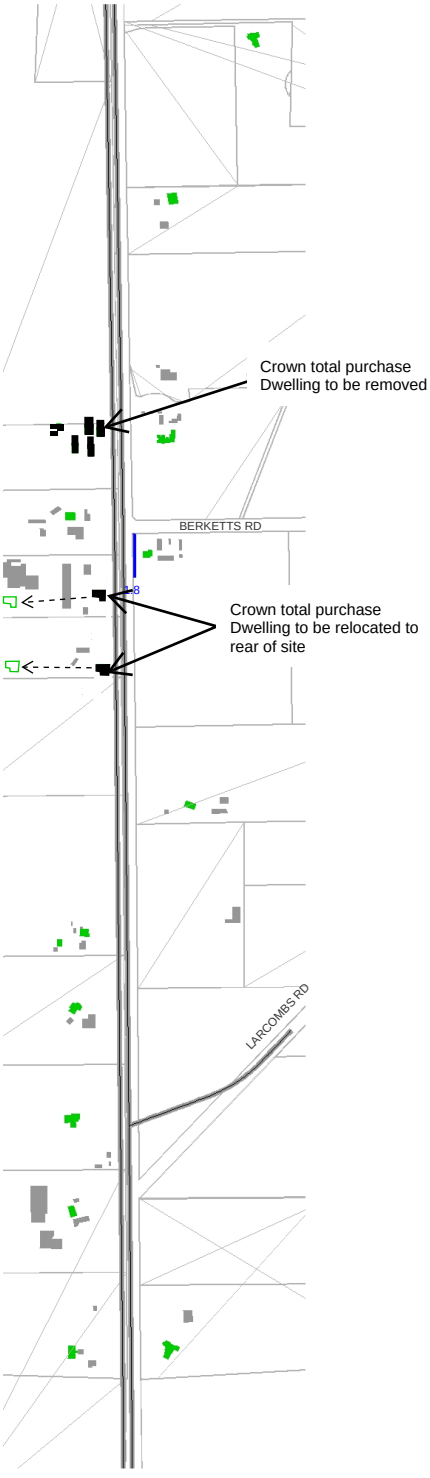


Do Minimum

Ground Floor



Preferred Mitigation Option



KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional OGPA-14 surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

Altered Road criteria (64/67 dB L_{Aeq}) apply at all PPFs shown

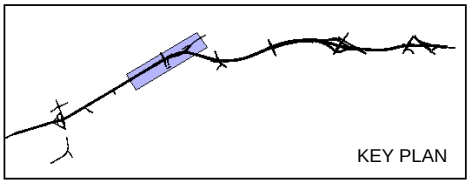
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 6 - PREFERRRED MITIGATION OPTION
JOB NO: 2010286	DRAWN: JF
	DATE: Sept 11
	SCALE: NTS
DRAWING REF: Appendix C-6	REV: 02

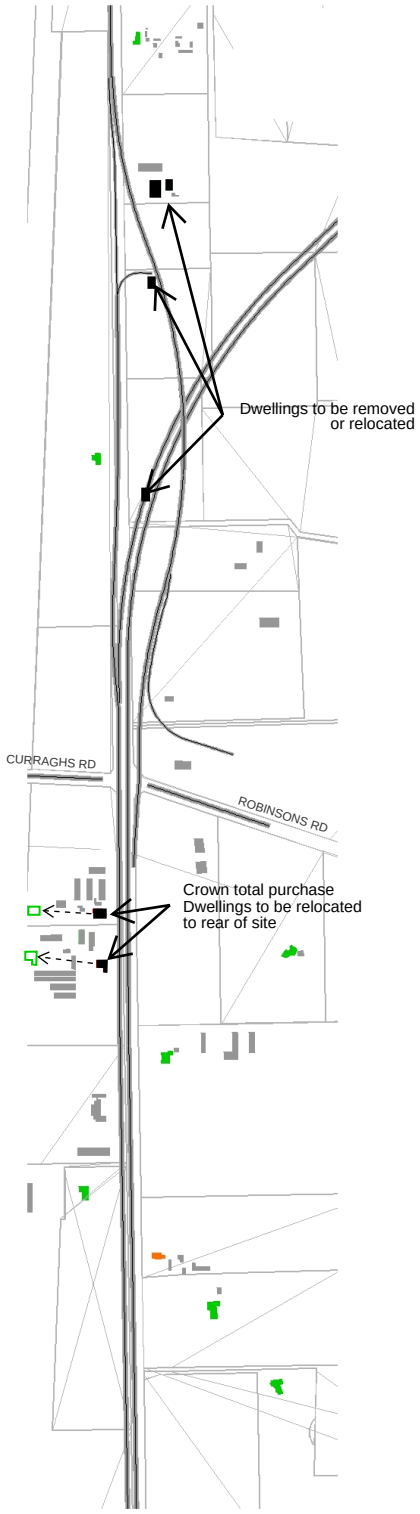
MARSHALL DAY Acoustics

Section 5 - MSRFL:CSM2 Interchange

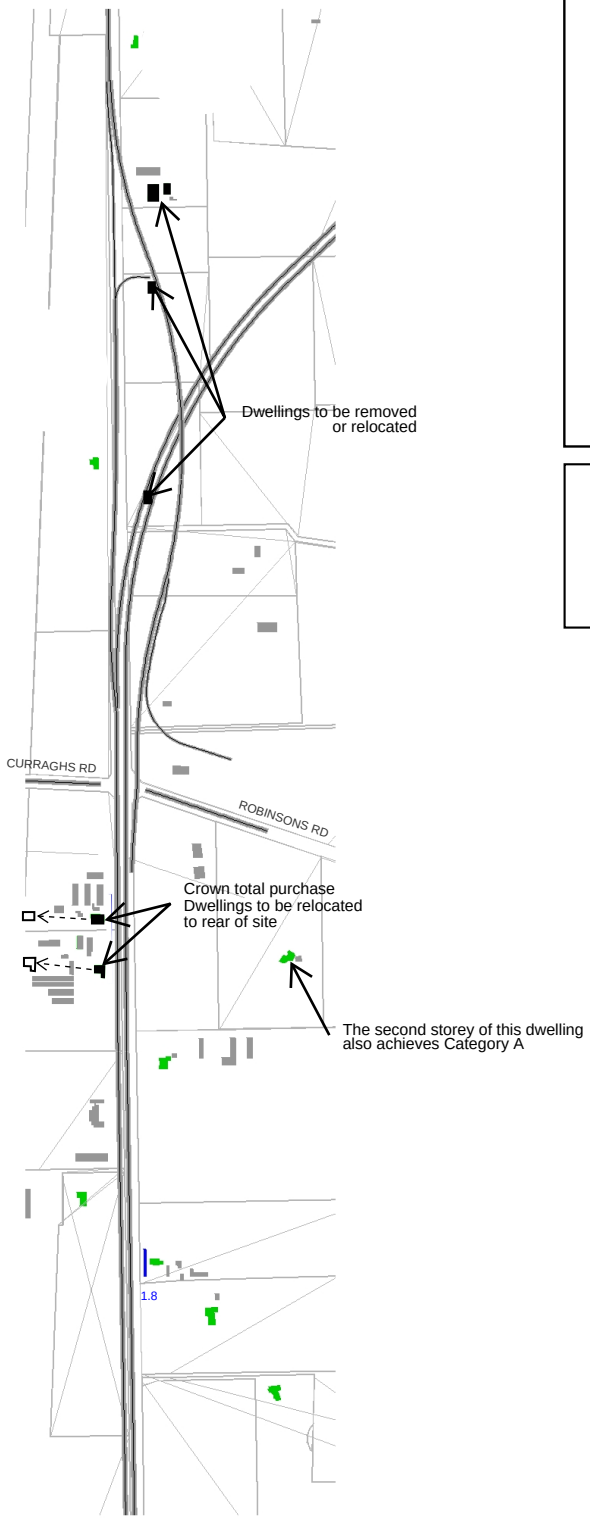


Do Minimum

Ground Floor



Preferred Mitigation Option



KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional OGPA-14 surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

Altered Road criteria (64/67 dB L_{Aeq}) apply at all PPFs shown

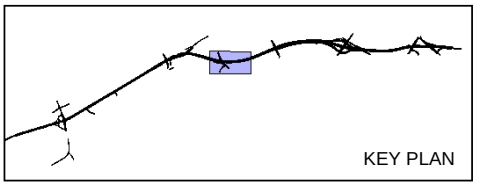
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 5 - PREFERRRED MITIGATION OPTION	
JOB NO: 2010286	DRAWN: JF	DRAWING REF: Appendix C-5 / REV: 02
	DATE: Sept 11	
	SCALE: NTS	

MARSHALL DAY Acoustics

Section 4 - Waterholes and Hamptons Roads



Do Minimum

KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional OGPA-14 surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

"Altered Road" Criteria (64/67 dB L_{Aeq})

New Road criteria (57/54 dB L_{Aeq}) apply at all other other PPFs shown

Ground Floor

1st Floor

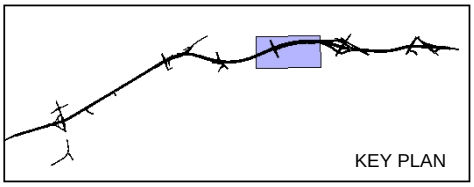
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 4 - PREFERRRED MITIGATION OPTION		
JOB NO: 2010286	DRAWN: JF	DRAWING REF: Appendix C-4	REV: 02
	DATE: Sept 11		
	SCALE: NTS		

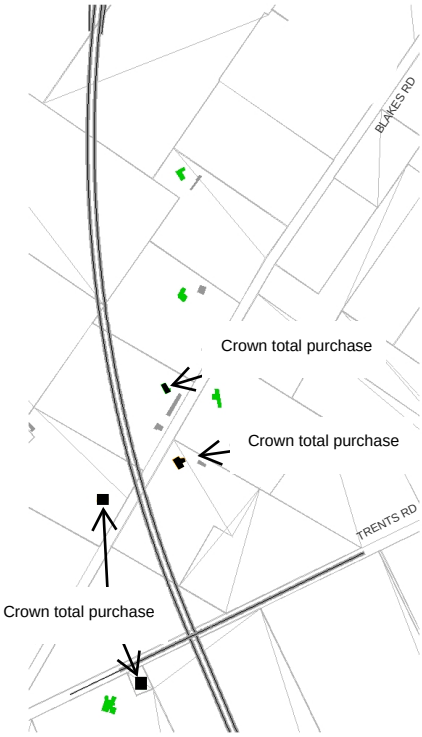
MARSHALL DAY Acoustics

Section 3 - Trents and Blakes Roads

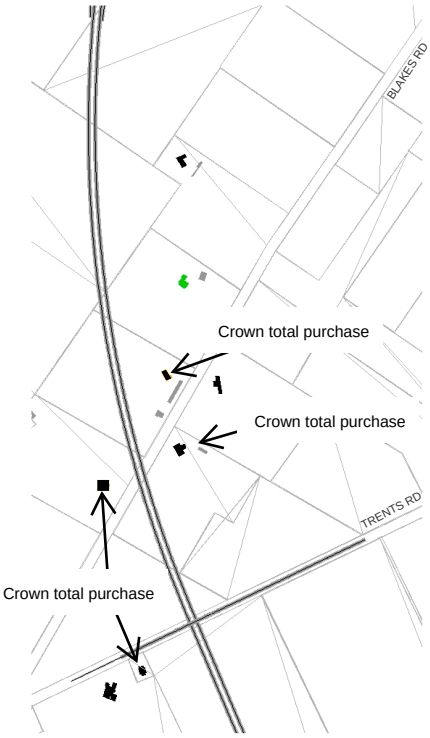


Do Minimum

Ground Floor



1st Floor



KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional OGPA-14 surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

"Altered Road" Criteria (64/67 dB L_{Aeq})

New Road criteria (57/54 dB L_{Aeq}) apply at all other other PPFs shown

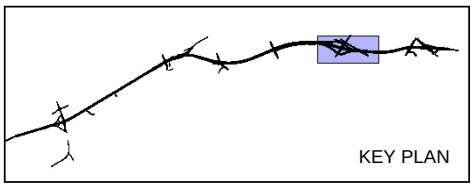
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 3 - PREFERRRED MITIGATION OPTION
JOB NO: 2010286	DRAWN: JF
	DATE: Sept 11
	SCALE: NTS
	DRAWING REF: Appendix C-3
	REV: 02

MARSHALL DAY Acoustics

Section 2 - Shands Rd



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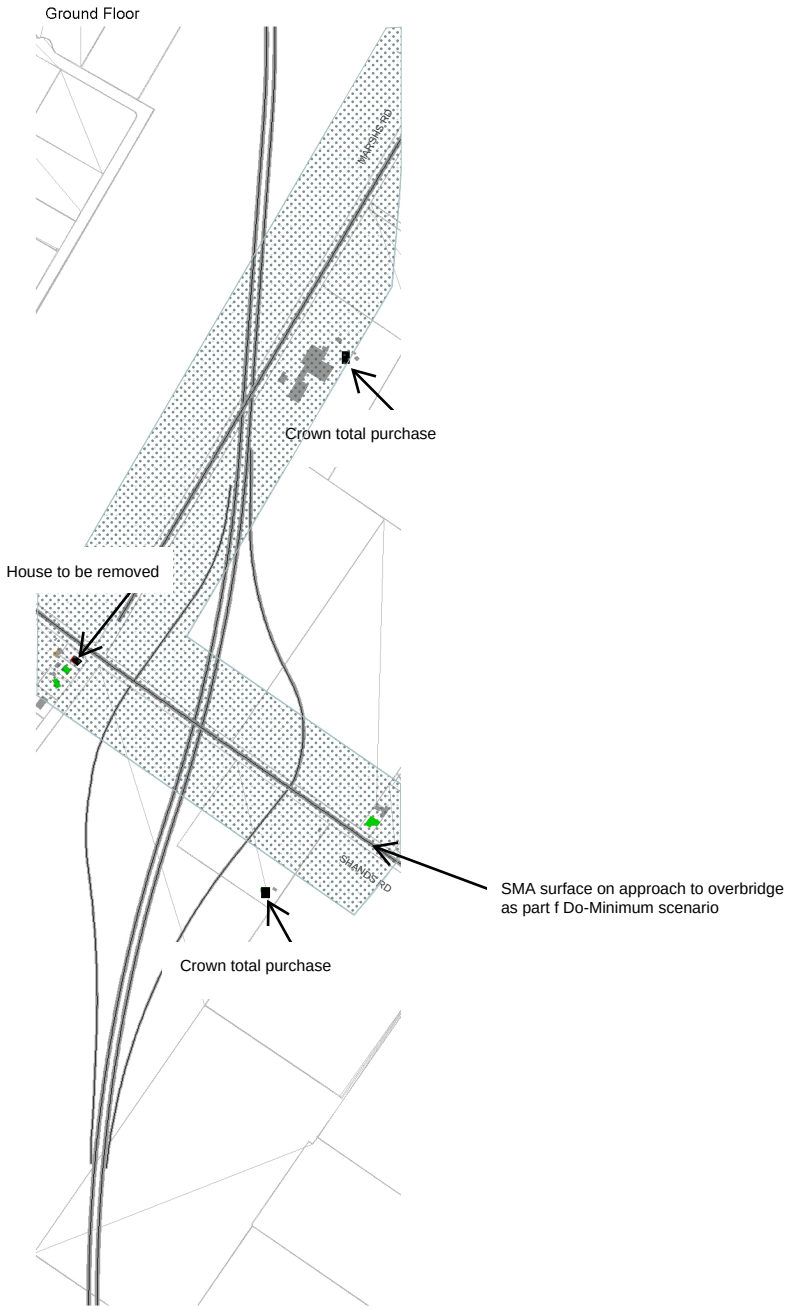


KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional SMA surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

"Altered Road" Criteria (64/67 dB L_{Aeq})

New Road criteria (57/54 dB L_{Aeq}) apply at all other other PPFs shown

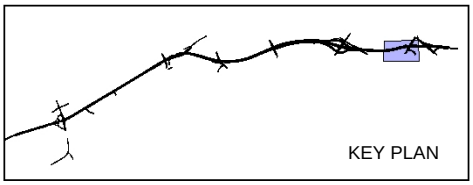
NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 2 - PREFERRRED MITIGATION OPTION
JOB NO: 2010286	DRAWN: JF
	DATE: Sept 11
	SCALE: NTS
	DRAWING REF: Appendix C-2
	REV: 02

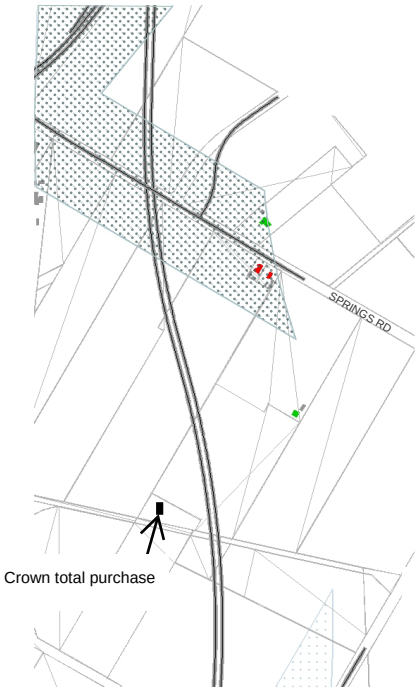
MARSHALL DAY Acoustics

Section 1 - Springs Rd

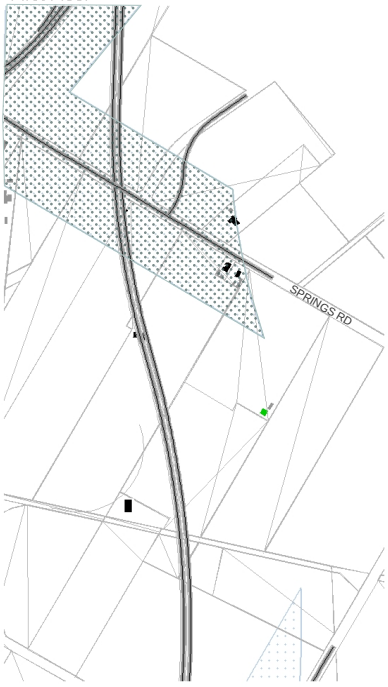


Do Minimum

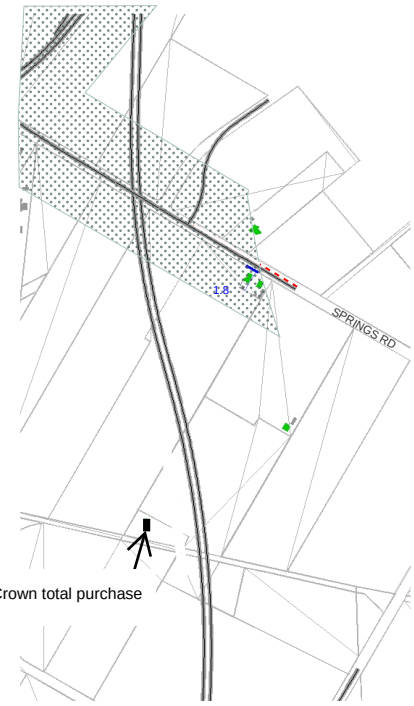
Ground Floor

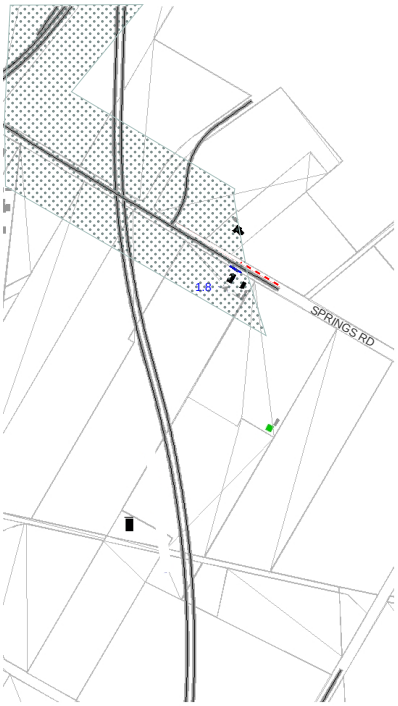


First Floor



Preferred Mitigation Option





KEY

- 1.8 — Noise Control Barrier of Nominated Height
- Region of additional SMA surface treatment
- Road Alignment
- PPF with category A, B or C
- PPF with no assessment required
- Non-PPF building
- Zone Boundary

NZS 6806:2010 Criteria Zones

"Altered Road" Criteria (64/67 dB L_{Aeq})

New Road criteria (57/54 dB L_{Aeq}) apply at all other other PPFs shown

NZS6806:2010 PPF categories

- Category A
- Category B
- Category C

PROJECT: CSM2 & MSRFL	TITLE: SECTION 1 - PREFERRRED MITIGATION OPTION
JOB NO: 2010286	DRAWN: JF
	DATE: Sept 11
	SCALE: NTS
DRAWING REF: Appendix C-1	REV: 02

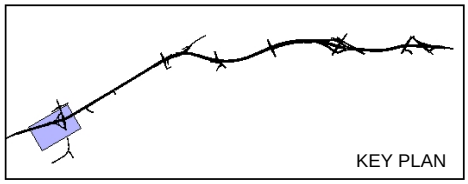
MARSHALL DAY Acoustics

APPENDIX D PREDICTED TRAFFIC NOISE CONTOURS

(following pages)

Section 7 - MSRFL: Weedons Rd

Preferred mitigation option



PROJECT: CSM2 & MSRFL	TITLE: SECTION 7 - PREDICTED NOISE CONTOURS
JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS

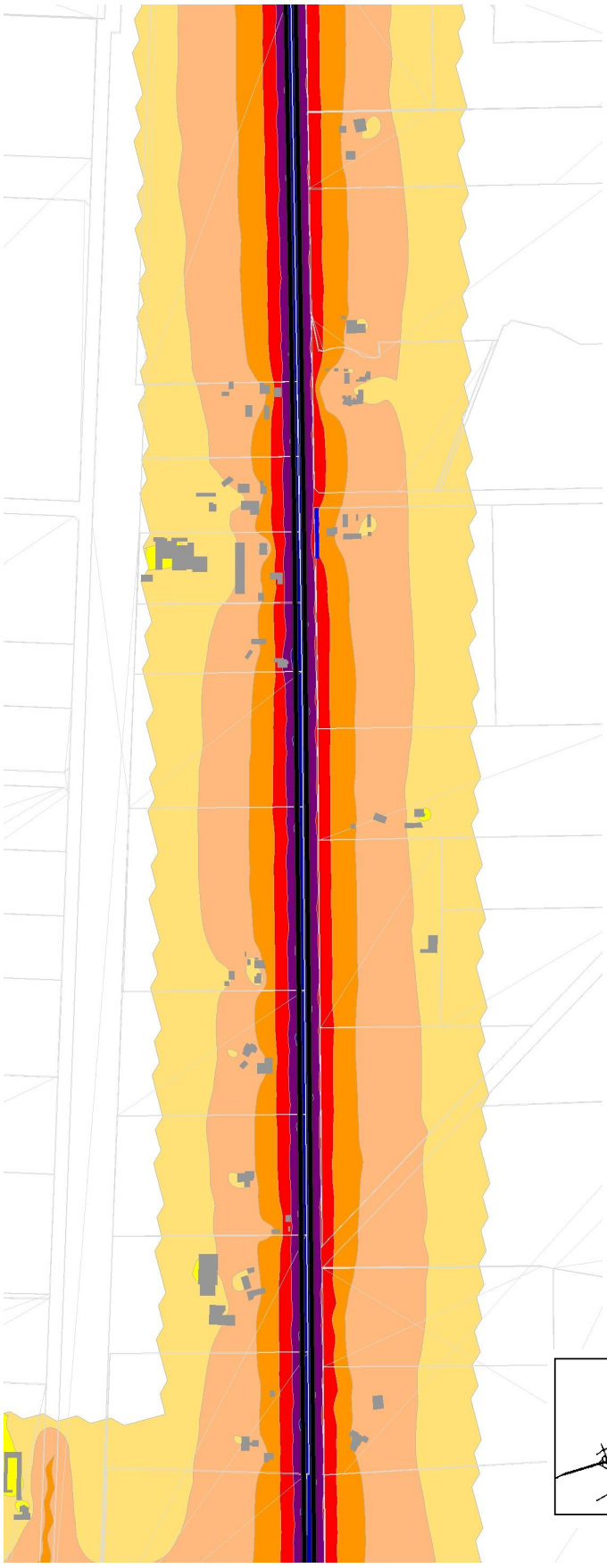
DRAWING REF: Appendix D-7

REV: 00

MARSHALL DAY Acoustics

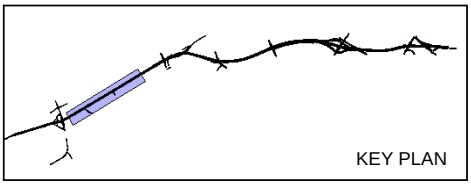
Section 6 - MSRFL: Larcombs Rd

Preferred mitigation option



Noise levels
$L_{Aeq\ (24H)}$

	<= 40
40 <	<= 45
45 <	<= 50
50 <	<= 55
55 <	<= 60
60 <	<= 65
65 <	<= 70
70 <	<= 75
75 <	



PROJECT: CSM2 & MSRFL	TITLE: SECTION 6 - PREDICTED NOISE CONTOURS
JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS

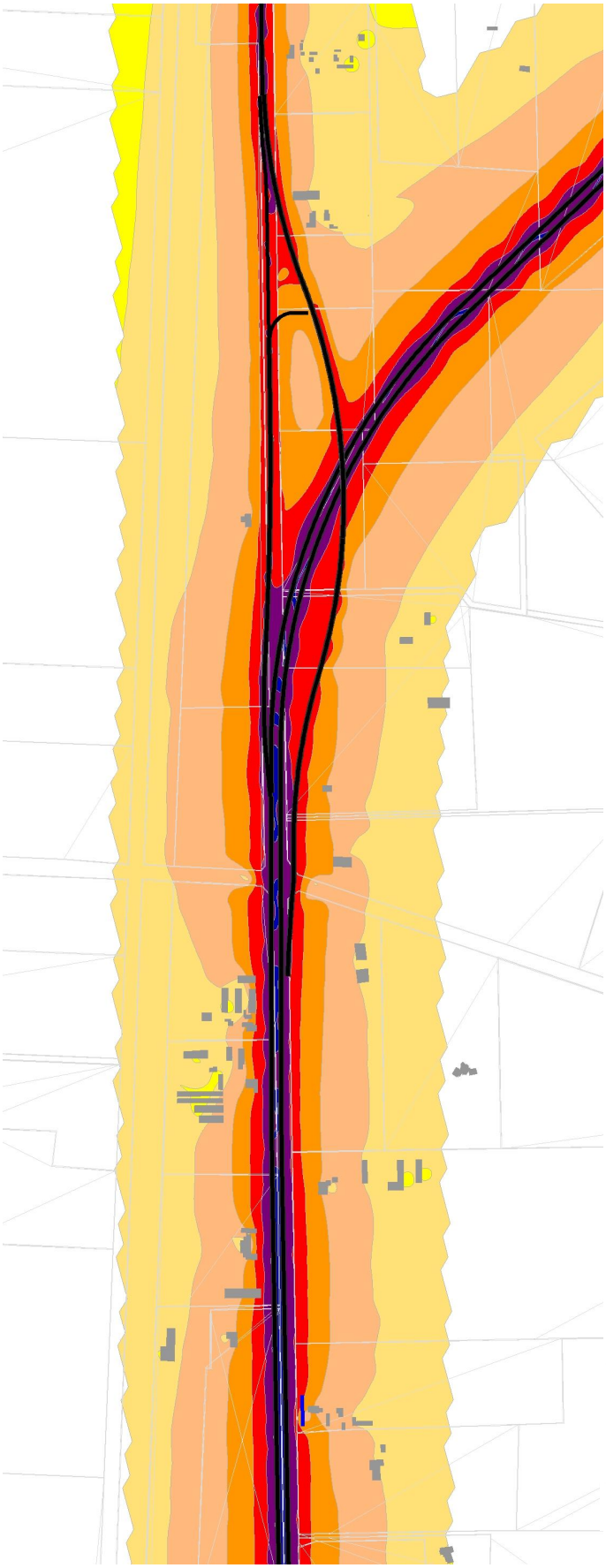
DRAWING REF: Appendix D-6

REV: 00

MARSHALL DAY Acoustics

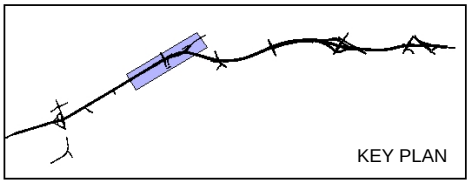
Section 5 - MSRFL:CSM2 Interchange

Preferred mitigation option



Noise levels
$L_{Aeq\ (24H)}$

	<= 40
40 <	<= 45
45 <	<= 50
50 <	<= 55
55 <	<= 60
60 <	<= 65
65 <	<= 70
70 <	<= 75
75 <	

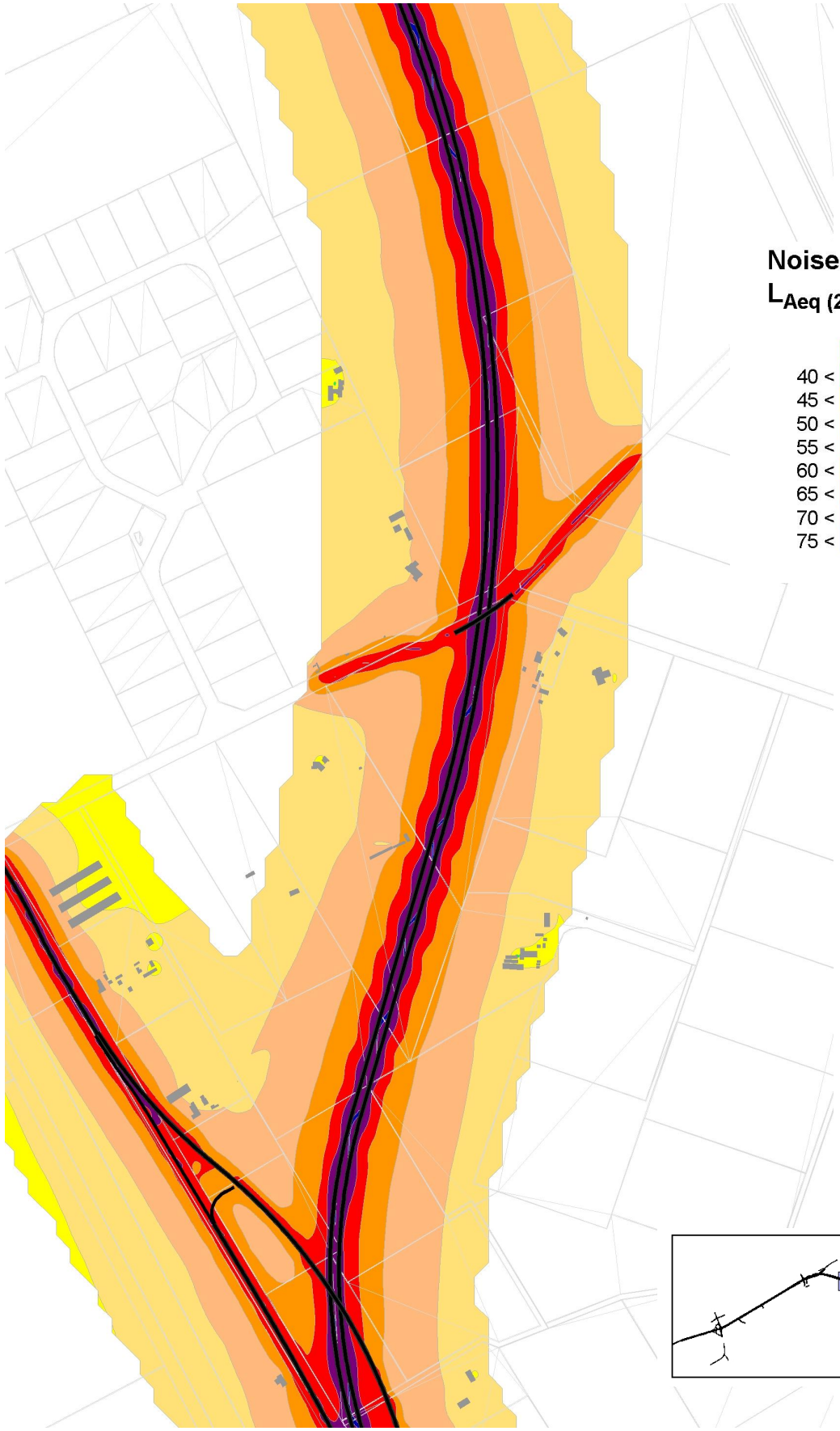


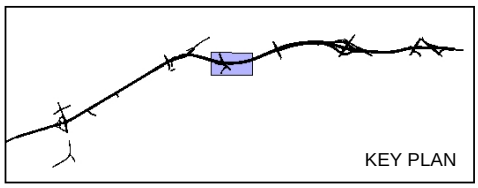
PROJECT: CSM2 & MSRFL	TITLE: SECTION 5 - PREDICTED NOISE CONTOURS
JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS
DRAWING REF: Appendix D-5	REV: 00

MARSHALL DAY Acoustics

Section 4 - Waterholes and Hamptons Roads

Preferred mitigation option





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JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS

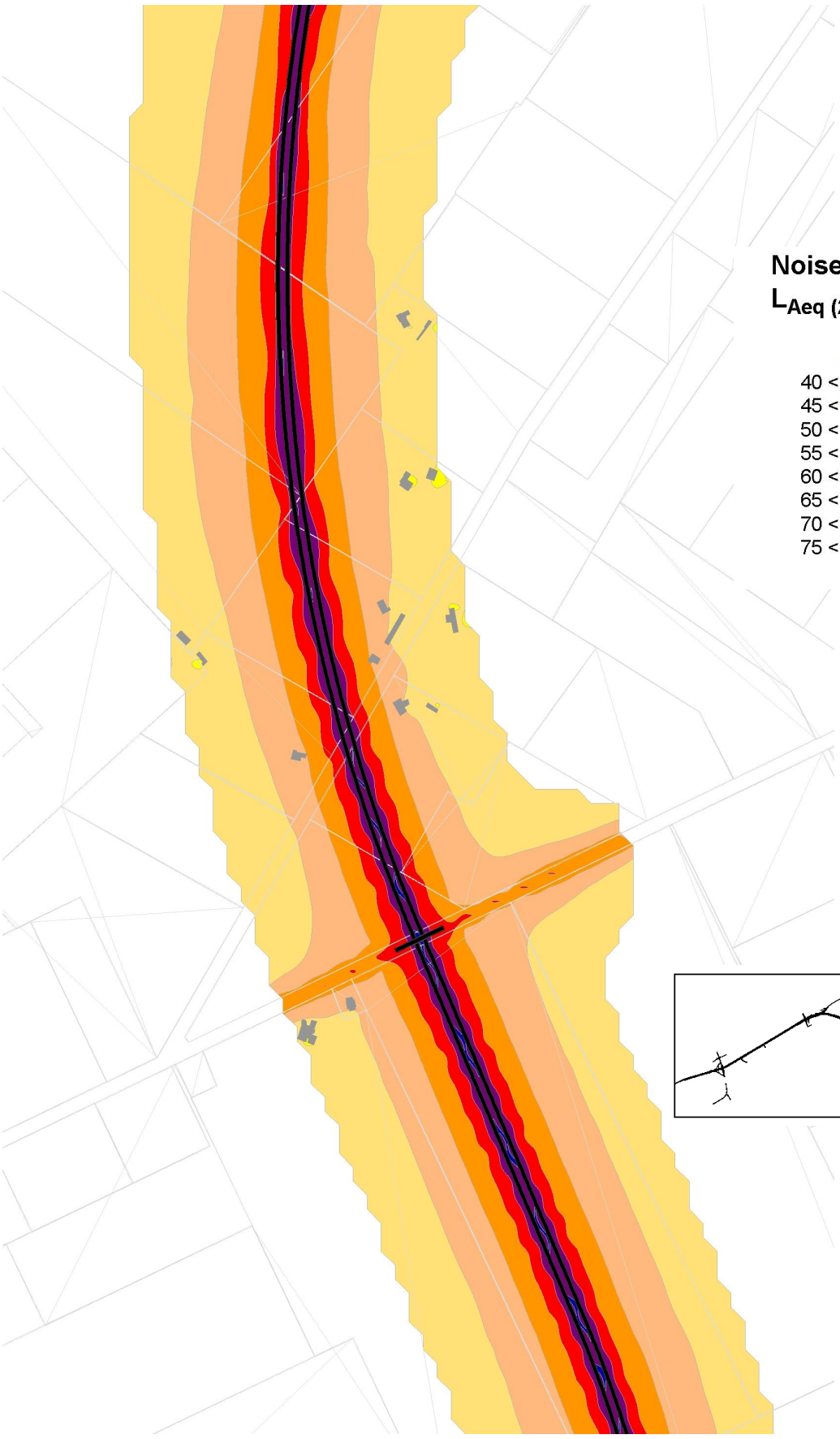
DRAWING REF: Appendix D-4

REV: 00

MARSHALL DAY Acoustics

Section 3 - Trents and Blakes Roads

Preferred mitigation option



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	DATE: Oct 11
	SCALE: NTS

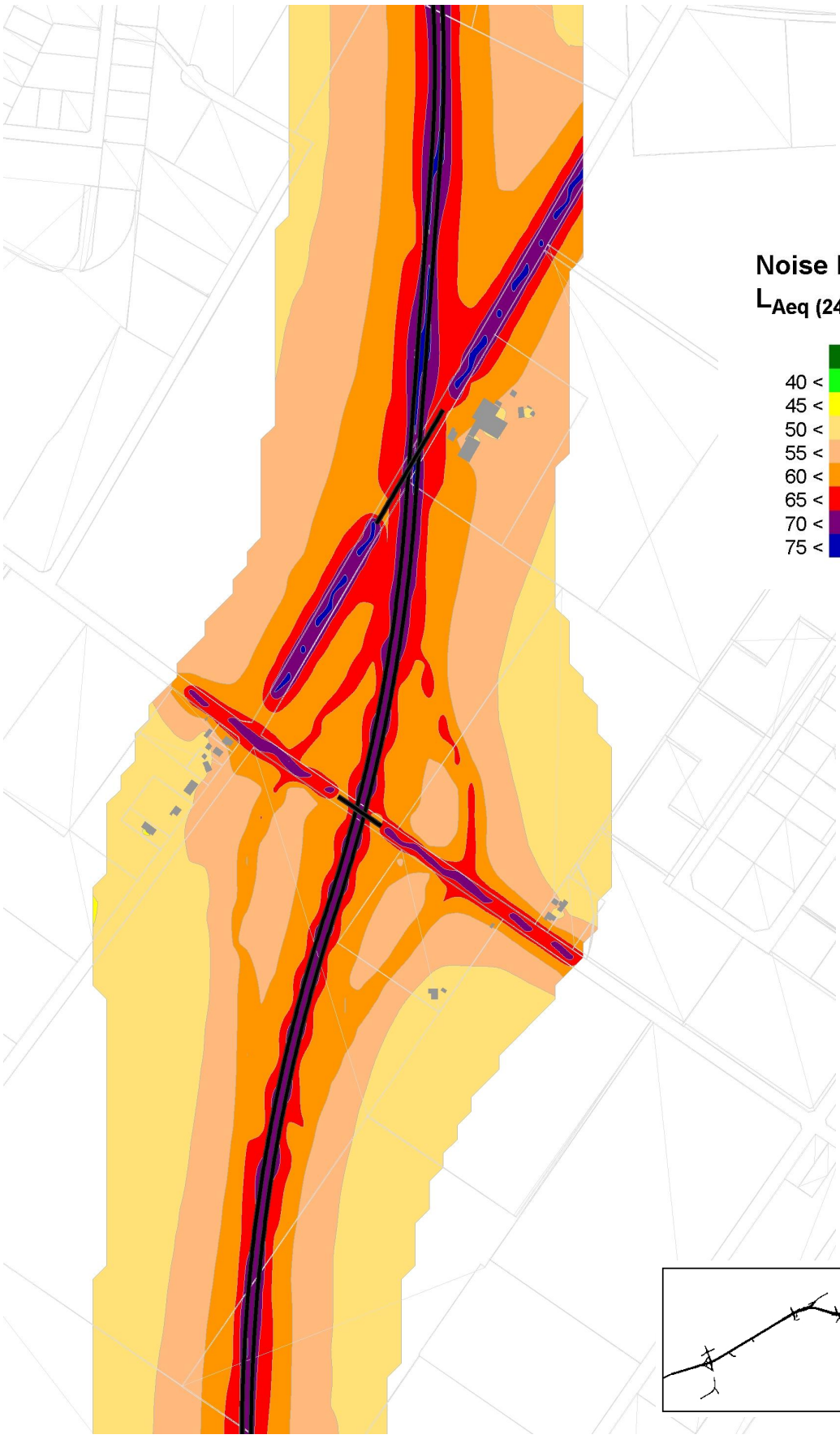
DRAWING REF: Appendix D-3

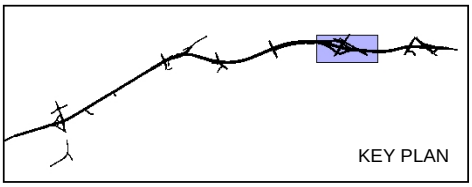
REV: 00

MARSHALL DAY Acoustics

Section 2 - Shands Rd

Preferred mitigation option





PROJECT: CSM2 & MSRFL	TITLE: SECTION 2 - PREDICTED NOISE CONTOURS
JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS

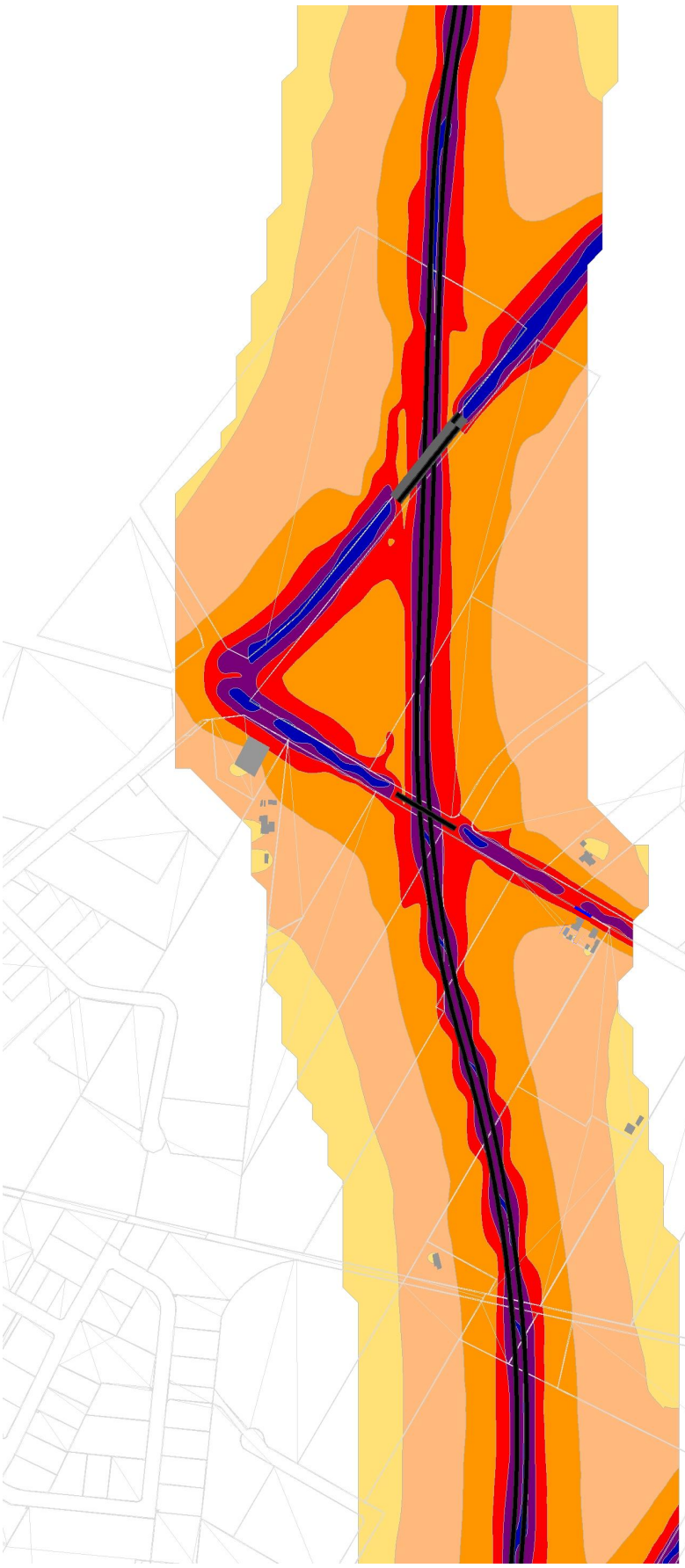
DRAWING REF: Appendix D-2

REV: 01

MARSHALL DAY Acoustics

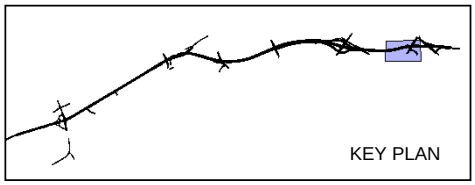
Section 1 - Springs Rd

Preferred mitigation option



Noise levels
$L_{Aeq\ (24H)}$

	<= 40
40 <	<= 45
45 <	<= 50
50 <	<= 55
55 <	<= 60
60 <	<= 65
65 <	<= 70
70 <	<= 75
75 <	



PROJECT: CSM2 & MSRFL	TITLE: SECTION 1 - PREDICTED NOISE CONTOURS
JOB NO: 2010286	DRAWN: RMB
	DATE: Oct 11
	SCALE: NTS

DRAWING REF: Appendix D-1

REV: 01

MARSHALL DAY Acoustics

APPENDIX E EXISTING AND PREDICTED NOISE LEVELS AT DWELLINGS

Address	Traffic Noise Level (dB $L_{Aeq,24h}$)		Change (dBA)
	Existing/Do-Nothing	Selected mitigation option	
Section 7 (MSRFL Weedons Road)			
1528 Main South Road	67	61	-6
1535 Main South Road	58	58	0
750 Weedons Road	53*	52	-1
755 Weedons Road	61*	61	0
768 Weedons Road	58*	58	0
782 Weedons Road	60	60	0
Section 6			
95 Berketts Road	65	62	-3
1257 Main South Road	57	57	0
1285 Main South Road	59	59	0
1300 Main South Road	57	59	2
1335 Main South Road	58	58	0
1354 Main South Road	63	63	0
1366 Main South Road	60	60	0
1386 Main South Road	60	60	0
1394 Main South Road	57	57	0
1414 Main South Road	57	57	0
182 Paige Place	61	61	0
Section 5			
1033 Main South Road	67*	60	-7
1053 Main South Road	66*	58	-8
1090 Main South Road	62	62	0
1181 Main South Road	62	62	0
1200 Main South Road	62	62	0
1213 Main South Road	66	62	-4
1215 Main South Road	53	53	0
979 Robinsons Road	50	50	0
979 Robinsons Road	52	52	0
Section 4			
16 Devine Drive	51	52	1
875 Waterholes Road	53	52	-1
883 Waterholes Road (first floor)	53	57	4
904 Waterholes Road	53	57	4
Section 3			

Address	Traffic Noise Level (dB $L_{Aeq,24h}$)		Change (dBA)
	Existing/Do-Nothing	Selected mitigation option	
240 Blakes Road	52	53	1
260 Blakes Road (ground floor)	52	54	2
260 Blakes Road (first floor)	54	56	2
273 Blakes Road	52	52	0
100 Trents Road	54	55	1
108 Trents Road	55	57	2
Section 2			
191 Marshs Road	60	59	-1
197 Marshs Road	65	62	-3
523 Shands Road	66	62	-4
Section 1			
312 Springs Road	70	59	-11
314 Springs Road	71	62	-9
318 Springs Road (ground floor)	56	54	-2
318 Springs Road (first floor)	58	56	-2
333 Springs Road	63	59	-4

* Best estimate