Caversham Valley Improvements

Noise Assessment for Notice of Requirement

June 2011

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Contents

1 Introduction

This report describes the assessment of the noise effects of the Caversham Valley Safety Improvements (the Project), for operational road-traffic noise and construction noise. While the assessment of operational road-traffic noise effects will continue to be updated as the Project design develops, for the Project's current design, this report summarises the operational road-traffic noise effects and likely nature of noise mitigation for practicable mitigation of any of those effects. Construction noise is discussed though construction noise effects will be fully assessed within the Project's Construction Noise Management Plan.

The Caversham Valley Safety Improvements, as shown in Figure 1.1, affect State Highway 1 and associated connections between Lookout Point and Barnes Drive, in Dunedin. The Project proposes to widen the highway, involving the acquisition and removal of some adjacent houses, and at Lookout Point an overbridge is proposed across the highway to link Mornington Road and Riselaw Road.

Figure 1.1 Illustration of the Caversham Valley Safety Improvements

The highway as it currently exists is contained within a designation. To enable the Project to be completed, changes to the existing designation are required. The changes are primarily to widen the existing designation, with no substantial deviation of route.

1.1 Noise assessment

The noise assessment identifies potential operational road-traffic noise effects of the Project on the general surrounding environment. It examines the practicability of mitigating these noise effects with regard to the wider aims and aspects represented by other disciplines involved in the Project. The assessment's primary concern is road-traffic noise effects on existing premises that are located near the Project and may be generally affected by road-traffic noise, and focuses particularly on residences.

The assessment establishes road-traffic noise effects and road-traffic noise mitigation options by following a process regularly adopted and accepted as good practice. This process includes:

- Measure and assess existing ambient noise levels;
- Calculate the road-traffic noise levels expected once the Project is operational, using recognised road-traffic noise prediction methods;
- Determine the impact of the expected road-traffic noise levels, with reference to the New Zealand Standard 6806: 2010 Acoustics - Road-traffic noise - New and altered roads; then
- Develop noise mitigation options to ensure that as far as is practicable the road-traffic noise impacts are mitigated to meet the applicable New Zealand Standards, and thereby ensure that both the noise levels from the Project are reasonable and that the Best Practicable Option (BPO) has been used to mitigate the effects of the noise levels. And,
- Consider and address any further noise impacts that may be not covered by NZS 6806: 2010.

1.2 Report structure

This report has been prepared to inform the preparation of the Project's Notice of Requirement. The report presents prediction and assessment of the operational noise effects of the Project on the study area with development and recommendation of a Best Practicable Option (BPO) for mitigation of operational road-traffic noise effects.

The report begins with an outline of the criteria against which road-traffic noise effects should be assessed, including a review of relevant documents relating to noise assessments.

The report describes the study area applicable to the road-traffic noise assessment and the existing noise environment for the area. Section 3 describes the selection process for determining properties for which noise effects have been specifically assessed. Section 5 and Appendix C include detailed listings of the addresses of those properties.

Section 6 discusses construction noise and outlines how NZS 6803: 1999 Acoustics - Construction noise should be applied for assessing and limiting noise of road construction activity.

2 Operational road-traffic noise criteria

2.1.1 Resource Management Act

The overarching requirement for management of noise is established by the Resource Management Act, 1991 (RMA). Section 16 of the RMA requires of land owners that noise emissions from their property are reasonable. “Reasonable” has no further definition. Section 16 of the RMA also requires land owners should use the Best Practicable Option to limit noise emissions from their property.

Under Section 31 of the RMA, local authorities can set controls on noise levels in District Plans or through Resource Consent Conditions for any land located outside a designated road corridor.

2.1.2 Reasonable noise

The reaction of people to noise is broad. For any particular level of road-traffic noise a portion of the population will find it disturbing and a similar proportion will find that same noise level of little concern. This broad response is explained by various research findings. For example, some research indicates that acceptance of noise is influenced by the extent that the noise is perceived to be necessary or unavoidable. Other research indicates that tolerance of noise depends on the extent that the noise intrudes into the activities that are sought to be undertaken. The impacts of noise on amenity are therefore highly variable. The higher noise levels can also impact on health, perhaps indirectly by causing stress or by reducing the quality of sleep.

In considering whether noise is reasonable, it is necessary to have regard to standards or guidelines in which noise limits are recommended; these limits representing the view of stakeholders as to the acceptable level of community disturbance. In general, these standards and guidelines are targeted at reducing the worst of the noise impacts on amenity and in protecting health.

2.1.3 Noise guidelines and Standards

For a number of years, the NZTA Noise Guidelines[1] have had acceptance by Local Authorities and the Environment Court as a measure of “reasonable” noise. Since 1991 these NZTA Noise Guidelines have been used on most capital projects on the State Highway network and also by many local road controlling authorities. In the main, roading projects made to the NZTA Noise Guidelines have had acceptance by the affected community.

These NZTA Noise Guidelines have now been superseded by the New Zealand Standard NZS 6806: 2010 Acoustics - Road traffic noise - New and altered roads. This Standard was published in April 2010 and immediately adopted by the NZTA. The standard was developed with inputs from a wide range of stakeholders concerned with road traffic noise; including from sectors of public health, local government, road controlling authorities, and acoustic professionals; with stakeholders representing central government or agencies involved in transport; and with public input. The representation of stakeholders involved in its development, the NZS 6806: 2010 can be taken as authoritative guidance as to “reasonable” noise.

[1] Appendix 6 of the 1999 edition of the Planning Policy Manual "Transit New Zealand's Guidelines for the Management of Road Traffic Noise" Under the predecessors to the NZTA, these have also been known as the Transit New Zealand Noise Guidelines or the Transit Noise Guidelines.

An attribute of NZS 6806: 2010 is that it provides a stronger basis for establishing "practicability". While both the NZTA Noise Guidelines and NZS 6806: 2010 limit mitigation to what is practicable, NZS 6806: 2010 offers improved clarity on the process for determining practicability and should allow for better overall outcomes to be achieved in roading projects.

While NZS 6806: 2010 supersedes the NZTA Noise Guidelines, NZS 6806: 2010 does not apply to designations where mitigation of road noise was provided for by a condition or conditions. If a designation exists with conditions that were framed around the NZTA Noise Guidelines, those conditions are expected to remain while the designation is current.

2.1.4 NZTA Environmental Plan

The NZTA has an Environmental Plan[2] that includes investigating situations of high road-traffic noise, and if practicable reducing the noise levels. It is noted that this Environmental Plan is primarily directed at existing roads. However when developing new roads it is preferable to avoid a situation where once the road was operational, it would need to be investigated under the Environmental Plan. There is an alignment between the noise management of NZS 6806: 2010 and the noise management that would be applied under NZTA's Environmental Plan; so in applying NZS 6806: 2010, the NZTA Environmental Plan will also be fulfilled.

2.1.5 Dunedin City District Plan

The Dunedin City District Plan contains "Noise Maps" which describe "Noise Areas" throughout the district. Reading the maps with Rule 21.5.1(i)(a) of the Dunedin City District Plan, any activities which are permitted, controlled or discretionary (restricted) in any section of the District Plan undertaken in the area of the Project must comply with the noise limits shown in Table 2.1.

Table 2.1 Dunedin City District Plan noise limits applicable to the area of the Project

	Monday to Friday	Saturday	Sunday and statutory holidays
Midnight to 7:00 am	L_{A10} 40 dB	L_{A10} 40 dB	L_{A10} 40 dB
7:00 am to 8:00 am	L_{A10} 45 dB	L_{A10} 50 dB	L_{A10} 40 dB
8:00 am to 6:00 pm	L_{A10} 50 dB	L_{A10} 50 dB	L_{A10} 40 dB
6:00 pm to 9:00 pm	L_{A10} 45 dB	L_{A10} 45 dB	L_{A10} 40 dB
9:00 pm to Midnight	L_{A10} 40 dB	L_{A10} 40 dB	L_{A10} 40 dB

In addition to those L_{A10} noise limits shown in Table 2.1, Rule 21.5.1(i)(b) states

> *Between 9.00 pm on any night and 7.00 am the following day no noise shall exceed an L_{max} of 75 dBA measured at the boundary of the site or within any other side.*

Most District Plans in New Zealand do not include operational road-traffic noise. In many instances the District Plans are explicit that operational road-traffic noise is excluded from noise limits. In other instances it is implied by the fact that the noise limits are the same as those in District Plans where operational road-traffic noise is excluded and by the fact that road-traffic noise from nearly all streets would exceed those typical District Plan noise limits. District Plans that do include operational road-traffic noise have a noise limit for that specific noise source which is higher than the typical District Plan noise limits.

[2] The NZTA Environmental Plan establishes an environmental policy for State Highways. The Environmental Plan enables the NZTA to integrate environmental and social considerations, including mitigation of road-traffic noise, into all aspects of State Highway planning, construction, and maintenance. The Environmental Plan version current at this time is Version 2, published in June 2008.

The governing District Plan is the Dunedin City District Plan. This District Plan has no specific requirements relating to operational road-traffic noise. Given the scale of the District Plan's noise limits, as shown in Table 2.1, it can be implied that these noise limits are not intended to be applied to operational road-traffic noise.

The Dunedin City District Plan does include that in assessing Resource Consent Applications, the Council will have regard to the extent of road construction noise effects.

2.1.6 NZS 6806: 2010 noise criteria

Clause 1.1.1 of NZS 6806: 2010 states the Standard:

> *recommends noise criteria to be applied to road-traffic noise from new or altered roads received at the assessment position(s) of protected premises and facilities (PPFs).*

Clause 1.3.1(a) sets that the Standard does not apply to existing roads, and Clause 1.3.1(n) sets that the Standard does not apply to

> *New and altered roads that are designated in the relevant district plan and at the time of designation, mitigation of road noise was provided for by a condition or conditions (other than by any condition requiring this Standard to be applied).*

The Project requires changes to the existing designation so NZS 6806 can be applied to this Project.

The noise criteria of NZS 6806: 2010 have been set to avoid adverse health effects on people and communities associated with noise but also with regard to the potential benefits of new and altered roads. NZS 6806: 2010 identifies premises and facilities to be protected from road-traffic noise (Protected Premises and Facilities, PPFs), and for these the NZS 6806: 2010 noise criteria shown in Table 2.2 are applicable.

Table 2.2 NZS 6806: 2010 Table 2 showing noise criteria, $L_{eq(24h)}$ (dB)

Category	Altered roads	New roads with a predicted traffic volume >75,000 AADT at the design year	New roads with a predicted traffic volume of 2,000 to 75,000 AADT at the design year
A (primary free field external noise criterion)	64	64	57
B (secondary free field external noise criterion)	67	67	64
C (internal noise criterion)	40	40	40

Noise mitigation options are to be assessed, and if practicable, the Category A criterion should be achieved. If this is not practicable then mitigation should be assessed against Category B. However, if it is still not practicable to comply with Categories A or B then mitigation should be implemented to ensure the internal criterion in Category C is achieved. Depending on the specific building, mitigation in Category C could include ventilation and/or noise insulation improvements ranging from upgraded glazing through to new wall and ceiling linings. Category A and Category B achieve internal indoor amenity by means of protecting the external outdoor amenity. In Category C there is no protection of external outdoor amenity.

NZS 6806: 2010 provides a procedure for assessing the benefits and costs of mitigation options to help determine the Best Practicable Option for mitigating the adverse effects of noise.

The criteria apply to a design year 10 to 20 years after the completion of the new of altered road. In this case, the design year has been taken as 2024 and all noise predictions in this report relate to predicted traffic volumes in 2024.

3 Noise study area and protected premises and facilities (PPFs)

3.1 Determining the noise study area

Clause 1.3.1 (d) of NZS 6806: 2010 limits the Standard's application for protection from road-traffic noise to within 100 metres of a new or altered road in an urban environment. This distance then defines the noise study area, as shown in Figure 3.1. A selected range of properties within the noise study area are referred to as protected premises and facilities, PPFs. The PPFs of this Project are identified in Section 3.2.

Figure 3.1 Determination of noise study area

3.1.1 "New roads" and "altered roads"

NZS 6806: 2010 *applies only to limited types of roading projects*.[3] NZS 6806: 2010 uses the terms "new roads" and "altered roads" with meaning specific to that Standard.

NZS 6806: 2010 defines "new roads" as *any road which is to be constructed where no previously formed legal road existed.*[4] The Project has no works that fit this definition.

An "altered road" is *an existing road that is subject to alterations of the horizontal or vertical alignment*.[5]

- NZS 6806: 2010 is applied where the alterations (with no specific noise mitigation) would both create a noise environment of 64 dB $L_{Aeq(24h)}$ or more and increase the road-traffic noise level for a PPF by 3 dB $L_{Aeq(24h)}$ above the noise level the PPF would have if the alterations were not undertaken.[6]

[3] NZS 6806: 2010 1.5.1
[4] NZS 6806: 2010 1.6
[5] NZS 6806: 2010 1.5.2
[6] NZS 6806: 2010 1.5.2 (a)

- Or, NZS 6806: 2010 is applied where the alterations (with no specific noise mitigation) would both create a noise environment of 68 dB $L_{Aeq(24h)}$ or more and increase the road-traffic noise level for a PPF by 1 dB $L_{Aeq(24h)}$ above the noise level the PPF would have if the alterations were not undertaken.[7]

Operational road-traffic noise modelling was used to determine if any PPFs of the Project fulfil these "altered road" criteria. (Details of the operational road-traffic modelling process are discussed in later sections.)

- Road-traffic noise levels for the scenario of the Project without any noise-specific mitigation were modelled for the design year of 2024 for each PPF.
- Road-traffic noise levels for the scenario of that future date (2024) without the Project having been built were modelled for each PPF.
- For each PPF, the road-traffic noise level from the Project without any noise-specific mitigation was inspected with that noise level in relation to the noise level without the Project having been built.

From this, two PPFs were identified for which the road-traffic noise level of the Project without any noise-specific mitigation was 64 dB $L_{Aeq(24h)}$ or more and that noise level was at least 3 dB $L_{Aeq(24h)}$ above the noise level the PPF would have without the Project having been built. Thus, the "altered road" criteria are fulfilled and therefore NZS 6806: 2010 is applied to the Project. There are no "new roads" and all works of the Project are "altered roads".

3.1.2 "Urban environment" and "rural environment"

NZS 6806: 2010 also has specific reference with regard to application of the Standard in urban and rural environments. For example, to the PPFs that must be considered in each environment and the criteria for considering those PPFs.

"Urban environment" and "rural environment" are defined in NZS 6806: 2010 in accordance with Statistics New Zealand definitions of urban zones and rural zones. Statistics New Zealand's census meshblocks are coded according to urban/rural profiling.

According to NZS 6806: 2010 classification of the Statistics New Zealand census meshblocks, the Project is entirely within an "urban environment".

3.1.3 100/200 metres from edgeline

Clause 1.3.1 of NZS 6806: 2010 states its application to PPFs located in urban environments and located within 100 metres from the edge of the closest traffic lane of a "new road" or "altered road" and PPFs located within 200 metres in rural environments.

As the Project is fully within an "urban environment", the 100 metres threshold distance is applied. The 100 metre threshold distance provides practical criteria to ensure the noise assessment is made at the most relevant receivers. Potential noise effects are still indirectly controlled at receivers further away by virtue of noise criteria applying at receivers nearest to the road.

[7] NZS 6806: 2010 1.5.2 (b)

3.1.4 Changing criteria

Comment C1.2.4 of NZS 6806: 2010 states *practical consideration means abrupt changes in noise criteria should be avoided.* In this Project, the same "altered road" noise criteria apply for the full Project so no further consideration need be given to this.

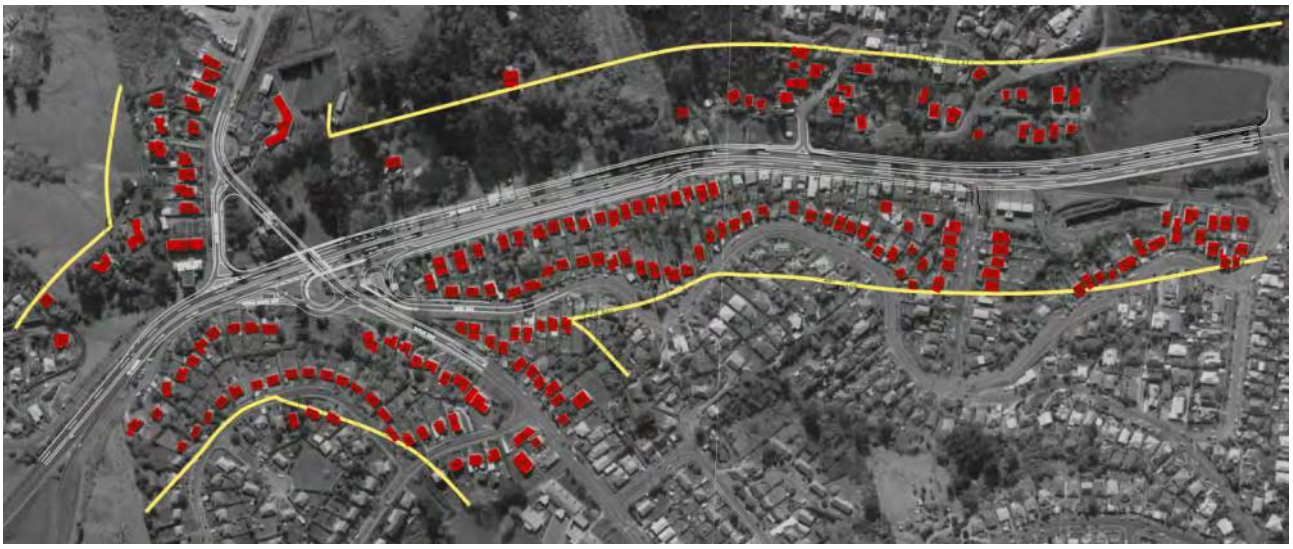
3.2 Determining the protected premises and facilities (PPFs)

Premises within the noise study area are protected based on their usage, including existing houses, schools, marae and various other locations defined in the Standard. These premises are termed Protected Premises and Facilities (PPFs).

In accordance with NZS 6806: 2010, future (not built) PPFs are not considered in the assessment, unless they have a building consent. Premises to be removed by the project are not considered.

From the information in Section 3.1, Figure 3.2 illustrates the Project PPFs.

Figure 3.2 Project PPFs



The Lookout Point Fire Station is within the noise study area. Some spaces of the building, adjacent Caversham Valley Road, are clearly provided for housing the fire engines. It is understood that other spaces in the building, further northward from Caversham Valley Road, may be used for sleeping. Though the Lookout Point Fire Station building is not shaded in Figure 3.2 showing the Project PPFs, modelling and assessment has been undertaken of the operational road-traffic noise effects on the fire station spaces likely to be used for sleeping. These are reported particularly in Section 5.4.1.

4 Current existing noise environment

NZS 6806: 2010 compares future road-traffic noise levels predicted for the scenario of the project (without any noise-specific mitigation) operational with road-traffic noise levels that would have occurred with the scenario of that future date without the project having been built. This comparison enables the change in road-traffic noise level due to the Project to be established. The road-traffic noise levels of these two scenarios have been modelled and are reported in Section 5.

The criteria in NZS 6806: 2010 for assessing road-traffic noise are not dependent on the current (2010/2011) existing road-traffic noise levels. Monitoring of existing noise levels is therefore not required for the main part of this noise assessment. However, understanding the existing noise environment provides context for understanding the scale and likely effects of changes to that noise environment. As such, an existing noise survey was undertaken for the Project.

Appendix A provides explanation on interpretation of data from noise monitoring and also describes the setup of noise monitoring instruments.

4.1 Noise monitoring

Noise monitoring sites were established as illustrated in Figure 4.1 and shown in Table 4.1. Measurements of existing noise levels were undertaken at eight sites, with each measurement being continuous monitoring over 24 hours.

Figure 4.1 Approximate locations of noise monitoring sites

Table 4.1 Addresses and descriptions of noise monitoring sites

Monitoring site[8]		
08	4 Ballance Street	The Caversham Highway Improvements is expected to have little effect on this site.
09	15 Lindsay Street	The Caversham Highway Improvements is expected to have little effect on this site.
10	5 Aberfeldy Street	The Caversham Highway Improvements will move the highway towards this site.
11	172 Caversham Valley Road	The Caversham Highway Improvements will move the highway towards this site.
12	111 Caversham Valley Road	The Caversham Highway Improvements will require the removal of houses (61 to 107 Caversham Valley Road) that are currently between this site and the highway; thus potentially increasing the noise exposure of this site.
13	486 South Road	The Caversham Highway Improvements will require the removal of houses (61 to 107 Caversham Valley Road) that are currently between this site and the highway; thus potentially increasing the noise exposure of this site.
14	472 South Road	The Caversham Highway Improvements will require the removal of houses (61 to 107 Caversham Valley Road) that are currently between this site and the highway; thus potentially increasing the noise exposure of this site.
15	557 South Road	The noise exposure of this site will potentially increase when the Caversham Highway Improvements create an overbridge crossing the highway.

Noise measurements were conducted in general accordance with NZS 6801: 2008 Acoustics - Measurement of environmental sound.

Traffic on roads, which could affect noise monitoring sites, was considered to be normal during the noise measurements with no roadworks in the immediate vicinity of noise monitoring sites.

During the noise measurements, weather conditions were stable and within the meteorological restrictions of NZS 6801.

The results of the noise measurements are listed in Table 4.2 in terms of the $L_{Aeq(24h)}$ values. Figure 4.2 and Figure 4.3 show records from 24 hours of monitoring at 111 Caversham Valley Road. The nature of the monitoring records shown in the figures are representative of the records from the other monitoring sites and show:

- Over short periods of time, noise fluctuates depending on the presence of traffic;
- Noise is relatively steady throughout the day; and
- The noise levels of the quietest night time hours are generally about 10 dB lower than the noise levels of the noisiest day time hours.

Table 4.2 Summary table of noise monitoring

Monitoring site		Monitoring period	Measured level, L_{Aeq} dB
08	4 Ballance Street	24 hours from 22.10.2010 at 8:15am	60.7
09	15 Lindsay Street	24 hours from 22.10.2010 at 8:15am	60.2
10	5 Aberfeldy Street	24 hours from 26.10.2010 at 9:30am	63.2
11	172 Caversham Valley Road	24 hours from 10.11.2010 at 10:00am	60.9
12	111 Caversham Valley Road	24 hours from 27.10.2010 at 9:30am	70.5
13	486 South Road	24 hours from 27.10.2010 at 9:30am	53.6
14	472 South Road	24 hours from 01.11.2010 at 8:30am	60.4
15	557 South Road	24 hours from 01.11.2010 at 8:30am	66.1

[8] Monitoring sites numbering has been adopted from previous reporting of the noise monitoring

Figure 4.2 Records of one-minute-average noise levels from 24 hours of monitoring at 111 Caversham Valley Road, microphone towards State Highway 1

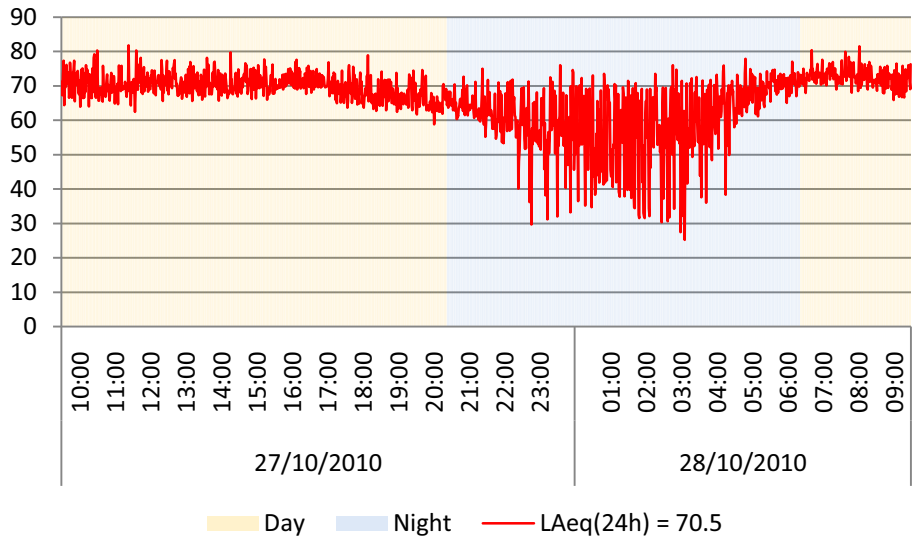
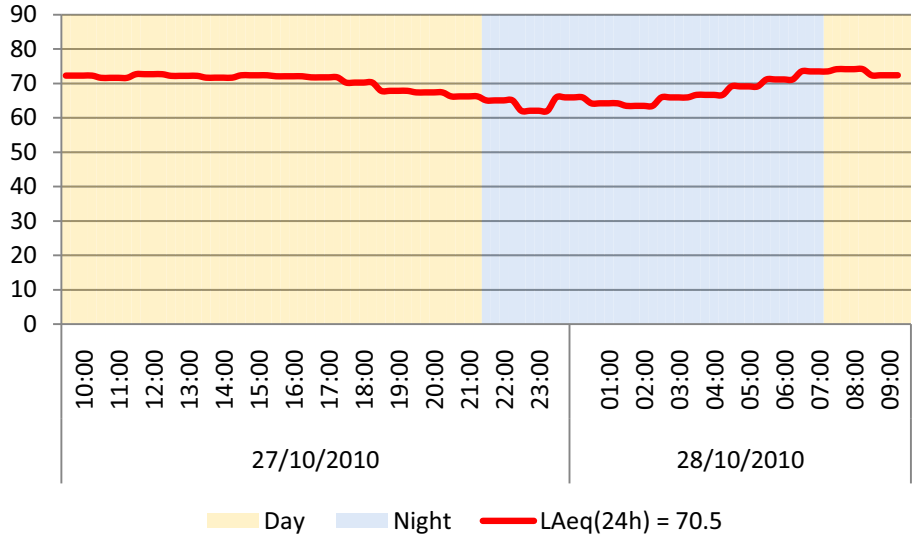


Figure 4.3 Records of one-hour-average noise levels from 24 hours of monitoring at 111 Caversham Valley Road, microphone towards State Highway 1



5 Operational road-traffic noise assessment

The cornerstone to assessing operational road-traffic noise is by representative modelling of road-traffic noise. This provides an objective basis to consider future (or altered) activity. The modelling techniques used in this assessment are well established in New Zealand. The operational road-traffic noise predictions are based on the Calculation of Road Traffic Noise (CRTN) model. This model was developed in the United Kingdom more than thirty years ago. Research in New Zealand has also validated the model as appropriate in New Zealand so long as some New Zealand-specific adjustments are applied.

This section describes the modelling process and results, and explains the process used to determine the design features of the Project with the noise mitigation Best Practicable Option.

5.1 Meaning of the do-minimum scenario of NZS 6806: 2010

NZS 6806: 2010 makes a distinction between design features that are deliberately provided to reduce noise effects and those design features included in the Project for other purposes but have also an influence on the noise effect. The design that occurs prior to inclusion of any design features deliberately provided to reduce noise is referred to as the do-minimum design.

NZS 6806: 2010 defines the “do-minimum” noise assessment scenario:

> *The predicted noise levels at the assessment position(s) of [Protected Premises and Facilities] at the design year with the project implemented including safety barriers and other structures (which may have an incidental noise mitigating effect). This assessment is not to include any measures undertaken for the sole purpose of reducing noise.*

This clearly states the do-minimum design is not the design with nothing being done to mitigate noise effects. Rather, the do-minimum design separates out design features provided for another main purpose (but which may have also a noise mitigation effect) from those design features provided which have noise mitigation as their main purpose. The do-minimum design is the Project without any noise-specific mitigation.

In practice, this rigid separation of the noise-specific design features and design features specific to other Project aims can blur as the Project progresses. As input from other specialists is used to develop the noise mitigation features of the Best Practicable Option, then, very often, choosing the noise mitigation design feature takes into account potential other benefits. For example, bunding included to mitigate noise may also improve landscaping, and bunding may assist social outcomes by desirable separation of activities or providing privacy. This encouragement and enhancement of integrated project design is an attribute of NZS 6806: 2010.

It is important to recognise that the Best Practicable Option noise mitigation design features selected under NZS 6806: 2010 are specifically related to the design of the project without any noise-specific mitigation that was used to develop the Best Practicable Option, Therefore, if aspects of the project design change, then the appropriate noise mitigation may also change.

5.2 NZS 6806: 2010 identification of where investigation of noise mitigation is required

All operational road-traffic noise predictions have been modelled in line with NZS 6806: 2010. The noise modelling specifics are contained in Appendix B.

As discussed in Section 3.1.1, modelling of the scenario of the Project without any noise-specific mitigation with modelling of the scenario without the Project having been built identifies that NZS 6806: 2010 does apply.

Appendix C shows the noise levels at the most exposed receiver position for each PPF for the scenario of the Project without any noise-specific mitigation, and illustrative figures of the road-traffic noise spread for this scenario are contained in Appendix E. (For information and comparison, an illustration of the spread of the road-traffic noise for the scenario of the Project having not been built is contained in Appendix D.)

With reference to NZS 6806: 2010 and Appendix C:

- The road-traffic noise level from the Project without any noise-specific mitigation is shaded green if it is in Category A.
- The noise level is shaded yellow if it is in Category B.
- The noise level is shaded red if exceeds Category B.

Clause 8.4(a) of NZS 6806 sets that investigation of noise mitigation measures is not required where

> *The noise is predicted to meet Category A (the relevant primary external noise criterion) set out in table 2 [of NZS 6806 and Table 2.2 in this report] at all assessment position(s) at all PPFs at the design year without any specific noise mitigation being undertaken.*

The reciprocal of this clause applies to the Project. Specific noise mitigation requires investigation at any PPF that does not achieve a Category A noise level.

Appendix C shows that the Project without any noise-specific mitigation has 23 PPFs with Category B road-traffic noise levels and 21 PPFs with noise levels exceeding Category B. For each of these PPFs, specific noise mitigation requires investigation.

The modelling results identify areas or clusters of PPFs with road-traffic noise levels reasonably similarly affected by the Project. These areas or clusters are approximately shown in Figure 5.1 and are used to structure the further investigation required:

- Section 5.4 discusses Design and assessment of the Best Practicable Option to mitigate noise for PPFs near Lookout Point and the overbridge;
- Section 5.5 discusses Design and assessment of the Best Practicable Option to mitigate noise for PPFs adjacent the northern side of State Highway 1; and
- Section 5.6 discusses Design and assessment of the Best Practicable Option to mitigate noise for PPFs adjacent the southern side of State Highway 1.

Figure 5.1 Areas or clusters of PPFs with road-traffic noise levels similarly affected by the Project

5.3 General aspects influencing design and assessment of the NZS 6806: 2010 Best Practicable Option

Typically the main means of structural noise mitigation are barriers or road surface.

Barriers are not viable in many situations through the Project due to the immediate topography. Where the premise to be protected is elevated relative to the road, barriers of reasonable height (up to 2.4 metres) can have little effect or barriers would have to be impractically high to have effect. Also, in this Project, premises to be protected are often positioned very close to the road edge and this together with local access roads or driveways makes the mitigation of noise by barriers impractical in many instances. The east-west orientation of the highway in the Project area also means that higher barriers would shade houses or backyards on the southern side of the barriers.

With the topography of the Project, the selection of road surface is limited to those capable of withstanding relatively high levels of stress. Open graded porous asphalt is known as a lower noise road surface but it is not viable in the situation of the Project. Other discipline objectives outside of the noise objectives dictate that the only viable road surface on State Highway 1 that is also a low-noise road surface is a medium-textured asphaltic concrete-like surface such as stone mastic asphalt. This type of road surface is part of the scenario of the Project without any noise-specific mitigation (the NZS 6806: 2010 do-minimum), and in the modelling it is assigned the noise properties of stone mastic asphalt.

With the topography of this situation, it is noted that some of the very heavy traffic is travelling at 30 km/h. The engine noise of these vehicles is the dominant noise source so that even a low noise road surface would have no effect on the road-traffic noise of these slow heavy vehicles. Relative to travel on a level road, the engine noise of the climbing heavy vehicles will make them about 2 dB noisier. Therefore, for the uphill State Highway 1 section within the Project, a 2 dB addition was made to the effect of heavy vehicles on a stone mastic asphalt road surface to account for the working of heavy vehicle engines.

5.3.1 Noise modelling results

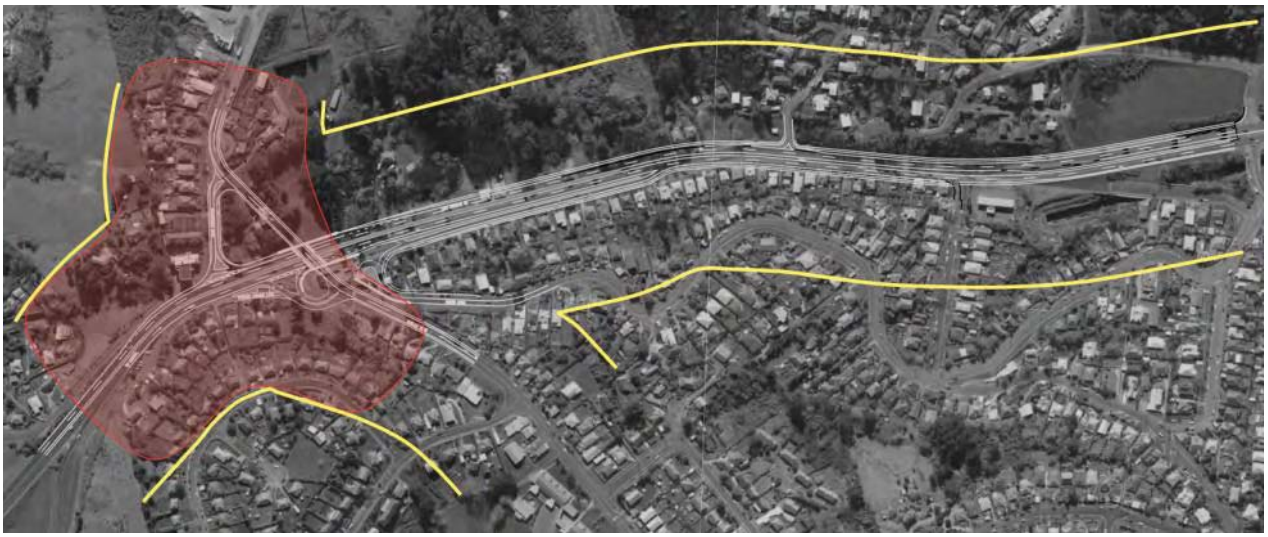
Throughout the noise assessment, noise modelling results are used in the determination and consideration of the noise mitigation Best Practicable Option. The effect of each noise mitigation option is evaluated by comparing the noise level with the mitigation in place to the noise level without the mitigation in place.

Calibration and validation have extensively established the reliability of noise modelling for assessing changes in noise levels. The accuracy of noise models for calculating changes in comparing one situation to another is high, especially if the change is to include or remove barriers to noise, for example. In this process of calculating changes, it is best to retain noise levels with one decimal place as rounding to the nearest whole number can mask or obscure noise level changes and effects, particularly within comparison of potential mitigation options which may have only marginal incremental differences.

Though the noise modelling results are here reported with one decimal place, this accuracy should not necessarily be assumed as the degree of accuracy that could be expected in comparing noise modelling with noise measurements. For any modelled project, the realism of the noise model strongly depends on the completeness and intricacy of its inputs. Notably, noise measurements themselves should be considered not necessarily fully representative of the noise environment but should be used only as a “snapshot” of the noise environment as it specifically occurred during the measurement period. Noise modelling represents a “snapshot” based on annual average daily traffic rates, neutral environmental conditions that neither enhance nor limit propagation of the noise, and usually with no account of extraneous noise sources such as industrial noise or aircraft or residential activity.

5.4 Design and assessment of the Best Practicable Option to mitigate noise for PPFs near Lookout Point and the overbridge

Figure 5.2 PPFs near Lookout Point and the overbridge



Near Lookout Point the Project generally has little effect on the alignment of State Highway 1 but alters connections to local roads and creates an overbridge across the highway to link Mornington Road and Riselaw Road.

Table 5.1 Column D shows the road-traffic noise levels modelled at the most exposed receiver position for PPFs near Lookout Point and the overbridge for the scenario of the Project without any noise-specific mitigation. Column E is the change in road-traffic noise level due to the Project without any noise-specific mitigation: a negative number indicates that the Project decreases noise relative to the scenario without the Project having been built and a positive number indicates that the Project increases noise relative to the scenario without the Project having been built.

Table 5.1 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers near Lookout Point and the overbridge for the scenario of the Project without any noise-specific mitigation (for design year 2024)

Table 5.1: Column A	B	C	D	E
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project
583 South Road	64	67	65.1	-0.1
581 South Road	64	67	62.7	-0.4
579 South Road	64	67	63.87	-0.7
577 South Road	64	67	64.6	-0.4
575 South Road	64	67	64.9	-0.4
569 South Road	64	67	66.8	0.0
567 South Road	64	67	68.2	-0.3
563 South Road	64	67	67.0	-0.6
559 South Road	64	67	66.1	-0.8
557 South Road	64	67	65.2	-0.8
545A South Road	64	67	60.6	-0.7
2 Riselaw Road	64	67	60.1	-0.1
4 Riselaw Road	64	67	61.8	2.5
6 Riselaw Road	64	67	58.9	2.8
8 Riselaw Road	64	67	59.9	2.9
10 Riselaw Road	64	67	58.9	2.8
12 Riselaw Road	64	67	60.0	2.8
6 Columba Avenue	64	67	56.9	2.6
42 Columba Avenue	64	67	55.1	-0.2
40 Columba Avenue	64	67	55.6	-0.3
38 Columba Avenue	64	67	55.7	-0.4
36 Columba Avenue	64	67	55.1	0.1
34 Columba Avenue	64	67	54.7	-0.1
32 Columba Avenue	64	67	54.1	0.3
30 Columba Avenue	64	67	53.3	0.4
28 Columba Avenue	64	67	52.1	0.7
26 Columba Avenue	64	67	51.5	0.7
24 Columba Avenue	64	67	52.7	1.5
22 Columba Avenue	64	67	53.3	1.8

Table 5.1: Column A	B	C	D	E
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project
20 Columba Avenue	64	67	53.2	1.9
18 Columba Avenue	64	67	53.2	2.1
16 Columba Avenue	64	67	51.4	0.2
14 Columba Avenue	64	67	50.5	-0.5
12 Columba Avenue	64	67	50.8	0.5
10 Columba Avenue	64	67	51.0	0.9
8 Columba Avenue	64	67	51.1	-0.5
27 Columba Avenue	64	67	52.8	0.5
25 Columba Avenue	64	67	52.6	0.3
21 Columba Avenue	64	67	52.9	0.2
9 Columba Avenue	64	67	51.6	0.2
7 Columba Avenue	64	67	51.2	0.1
5 Columba Avenue	64	67	53.1	0.7
30 Riselaw Road	64	67	59.5	2.0
34 Riselaw Road	64	67	51.0	1.4
32 Riselaw Road	64	67	58.7	2.0
465 South Road	64	67	55.4	1.5
24 Ensor Street	64	67	57.2	0.3
574 South Road	64	67	56.6	0.0
572 South Road	64	67	62.7	-1.2
182 Mornington Road	64	67	59.7	-1.2
180 Mornington Road	64	67	58.3	-0.9
178 Mornington Road	64	67	58.5	-0.7
176 Mornington Road	64	67	57.2	0.3
174 Mornington Road	64	67	53.1	0.0
172 Mornington Road	64	67	47.5	-0.3
170 Mornington Road	64	67	60.1	1.3
168 Mornington Road	64	67	49.2	-0.2
166 Mornington Road	64	67	56.7	1.3
164 Mornington Road	64	67	63.2	1.0
162 Mornington Road	64	67	61.9	1.0
160 Mornington Road	64	67	59.3	0.8
158 Mornington Road	64	67	59.8	1.4
179 Mornington Road	64	67	55.4	1.5

Table 5.1 Column E shows that for most PPFs in this group, the Project without any noise-specific mitigation changes road-traffic noise levels very little from those that would occur without the Project having been built; with noise level increases and decreases for most PPFs being little more than $L_{Aeq(24h)}$ 1 dB. The change in noise levels for a few PPFs is as much as $L_{Aeq(24h)}$ 2 to 3 dB but even this scale of change is regarded as a minor change in noise effect.

Where the noise level in Table 5.1 Column D is shaded green, investigation of specific noise mitigation is not required for that PPF.

Where the noise level in Table 5.1 Column D is shaded yellow, being a Category B noise level, it is noted that Column E shows that the noise level for the scenario of the Project without any noise-specific mitigation is either unchanged or slightly quieter than the noise level for the scenario without the Project having been built. The topographical constraints on barriers and the engineering constraints on viable road surfaces that could be quieter than the road surface selected, mean that there are no practicable structural mitigation options to further mitigate road-traffic noise.

Table 5.1 Column D shows the road-traffic noise level for the PPF at 567 South Road exceeds Category B for the scenario of the Project without any noise-specific mitigation. Table 5.1 Column E shows that the noise level is a very slightly quieter than that which would occur without the Project having been built. As explained for the PPFs with Category B noise levels, there are no practicable structural mitigation options to further mitigate road-traffic noise. While NZS 6806: 2010 recommends that internal insulation be considered for PPFs with noise levels greater than $L_{Aeq(24h)}$ 68 dB, the PPF at 567 South Road needs to be considered collectively with the cluster of PPFs immediately around it. The immediate cluster of PPFs has very similar noise levels but for these PPFs it is considered that further noise-specific mitigation is not required.

5.4.1 Lookout Point Fire Station

The Lookout Point Fire Station is in this area near Lookout Point and the overbridge. At the most exposed receiver position representing fire station spaces likely to be used for sleeping, the road-traffic noise level from the scenario of the Project without any noise-specific mitigation is $L_{Aeq(24h}$ 64.7 dB. Considered as a PPF, this is a Category B noise level. And, it is noted that this noise level is approximately the same ($L_{Aeq(24h)}$ 0.1 dB less than) the scenario without the Project having been built. As explained for other PPFs in this area with Category B noise levels, there are no practicable structural mitigation options to further mitigate road-traffic noise.

5.5 Design and assessment of the Best Practicable Option to mitigate noise for PPFs adjacent the northern side of State Highway 1

Between Lookout Point and Barnes Drive, the Project widens State Highway 1 effectively moving the highway closer to a group of PPFs adjacent the northern side of the highway, through an area approximately illustrated by Figure 5.3.

Figure 5.3 PPFs adjacent the northern side of State Highway 1

Table 5.2 Column D shows the road-traffic noise levels modelled at the most exposed receiver position for PPFs adjacent the northern side of the highway for the scenario of the Project without any noise-specific mitigation. Column E is the change in noise level due to the Project without any noise-specific mitigation: a negative number indicates that the Project decreases noise relative to the scenario without the Project having been built and a positive number indicates that the Project increases noise relative to the scenario without the Project having been built.

Table 5.2 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers adjacent the northern side of State Highway 1 for the scenario of the Project without any noise-specific mitigation (for design year 2024)

Table 5.2: Column A	B	C	D	E	
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
172 Caversham Valley Road	64	67	64.5	2.1	
5D Aberfeldy Street	64	67	66.3	2.0	*Section 5.5.2*
5B Aberfeldy Street	64	67	61.8	-0.2	
5A Aberfeldy Street	64	67	64.6	0.4	*Section 5.5.2*
5 Aberfeldy Street	64	67	65.2	-0.1	*Section 5.5.2*
7 Aberfeldy Street	64	67	64.1	-0.2	*Section 5.5.2*
9 Aberfeldy Street	64	67	59.9	-0.1	
11 Aberfeldy Street	64	67	56.5	0.7	
19 Aberfeldy Street	64	67	59.1	-0.4	
13 Thompson Street	64	67	55.6	0.1	
1 Lindsay Road	64	67	66.4	-1.2	*Section 5.5.3*
8 Aberfeldy Street	64	67	65.4	-0.6	*Section 5.5.3*
10 Aberfeldy Street	64	67	59.3	-0.4	
16 Aberfeldy Street	64	67	59.2	0.4	
7 Rockyside Terrace	64	67	61.9	-0.3	
11 Rockyside Terrace	64	67	63.5	-0.4	
15 Lindsay Road	64	67	62.9	-0.2	

Table 5.2: Column A	B	C	D	E	
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
25 Lindsay Road	64	67	56.9	-0.1	
14 Ballance Street	64	67	66.5	-1.3	*Section 5.5.3, 5.5.4*
9 Ballance Street	64	67	58.3	0.2	
7 Ballance Street	64	67	57.6	0.3	
8 Ballance Street	64	67	66.4	-0.4	*Section 5.5.4*
6 Ballance Street	64	67	67.3	-0.4	*Section 5.5.4*
4 Ballance Street	64	67	65.6	-0.3	*Section 5.5.4*
2 Ballance Street	64	67	64.9	-0.5	*Section 5.5.4*
3 Ballance Street	64	67	58.5	-0.1	
1 Ballance Street	64	67	59.8	-0.2	
146 South Road	64	67	60.7	1.3	

Where the noise level in Table 5.2 Column D is shaded green, investigation of specific noise mitigation is not required for that PPF.

For those PPFs with Category B noise levels, shaded yellow in Table 5.2 Column D, noise mitigation options require investigation. However, this investigation is within a context of topographical constraints on barriers and engineering constraints on viable road surfaces.

5.5.1 Barrier inside the highway median

A standard-height (1.05 metre high) solid barrier inside the highway median was investigated as a design feature predicated on safety that could also provide noise mitigation for PPFs adjacent the northern side of State Highway 1.

Section 8.2.2 of NZS 6806: 2010 expects that

> *Where the need for noise mitigation measures has been identified, structural mitigation should only be implemented if the combination of the structural mitigation measures used would achieve the following:*
>
> *(a) An average reduction of at least 3 dB $L_{Aeq(24h)}$ at the relevant assessment positions of all PPFs that are part of a cluster.*

Road-traffic noise level results from modelling of a median barrier show that the median barrier does achieve some reduction of road-traffic noise levels relative to the scenario of the Project without any noise-specific mitigation. However the noise reduction is typically only -1 to -2 dB $L_{Aeq(24h)}$. This scale of reduction does not meet the required level of noise mitigation within NZS 6806: 2010 and, in their context, these small noise level reductions may be hardly noticed by residents of the PPFs.

If a median barrier was included to achieve another discipline objective, it could be considered as having some noise benefit, though a median barrier cannot be justified by the noise benefit alone and so it is not a component of the noise mitigation Best Practicable Option.

5.5.2 Barrier adjacent the Aberfeldy Street accessway

For the scenario of the Project without any noise-specific mitigation, Table 5.2 Column D shows four of the five PPFs in the group from 5D to 7 Aberfeldy Street to have Category B noise levels. The general location of these PPFs is shown in Figure 5.4.

Figure 5.4 General location of PPFs 5D, 5B, 5A, 5, and 7 Aberfeldy Street

In this location, the Project is to establish an accessway to Aberfeldy Street approximately adjacent the southern boundary of 5D to 5 Aberfeldy Street. The potential of a barrier along the southern side of this accessway, between the accessway and the highway, was investigated via modelling. Figure 5.5 indicates the location of the barrier modelled.

Figure 5.5 Location of barrier between the Aberfeldy Street accessway and State Highway 1 (in red) modelled for investigating the effect of a barrier adjacent the Aberfeldy Street accessway

Road-traffic noise level results shown in Table 5.3 are for modelling of a barrier adjacent the Aberfeldy Street accessway. Table 5.3 Column E is for road-traffic noise levels modelled with a 1.8 metre high barrier and Column G is for a 2.4 metre high barrier.

Table 5.3 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers of PPFs 5D, 5B, 5A, 5 and 7 Aberfeldy Street for investigating the effect of a barrier adjacent the Aberfeldy Street accessway (for design year 2024)

Table 5.5: Column A	B	C	D	E	F	G	H
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
5D Aberfeldy Street	64	67	66.3	66.3	0.0	66.3	0.0
5B Aberfeldy Street	64	67	61.8	60.6	-1.2	59.3	-2.5
5A Aberfeldy Street	64	67	64.6	64.1	-0.5	62.8	-1.8
5 Aberfeldy Street	64	67	65.2	64.6	-0.6	63.0	-2.2
7 Aberfeldy Street	64	67	64.1	63.8	-0.2	63.0	-1.1

Table 5.3 shows the barrier adjacent the Aberfeldy Street accessway provides some noise reductions; and as would be expected the noise reductions provided by the higher 2.4 metre high barrier are greater than those provided by the 1.8 metre high barrier. However the scale of noise reductions does not meet the required level of noise mitigation within NZS 6806: 2010[9] and, in their context, these small noise level reductions may be hardly noticed by residents of the PPFs.

The most exposed receiver position of the PPF at 5D Aberfeldy Street faces the south direction yet is provided no mitigation by the barrier adjacent the Aberfeldy Street accessway as it is shown in Figure 5.5. If the barrier is extended from its western end to 15 metres northward along the western boundary of the 5D Aberfeldy Street property, then $L_{Aeq(24h)}$ -0.7 dB noise reduction is provided by a 1.8 metre high barrier and $L_{Aeq(24h)}$ -0.9 dB noise reduction is provided by a 2.4 metre high barrier. Even so, the PPF remains with a Category B noise level and the extension of the barrier is not justified by the small noise level reduction.

Input from other Project specialist disciplines advises that a 2.4 metre high barrier height is incompatible with other discipline objectives, particularly landscaping noting the visual and shading effects by barriers of that height. If a barrier adjacent the Aberfeldy Street accessway was predicated to achieve another discipline objective, it could be upgraded to noise-mitigation standard and thus considered as having some noise benefit. However, by the noise benefit alone, a barrier adjacent the Aberfeldy Street accessway cannot be justified and is not a component of the noise mitigation Best Practicable Option.

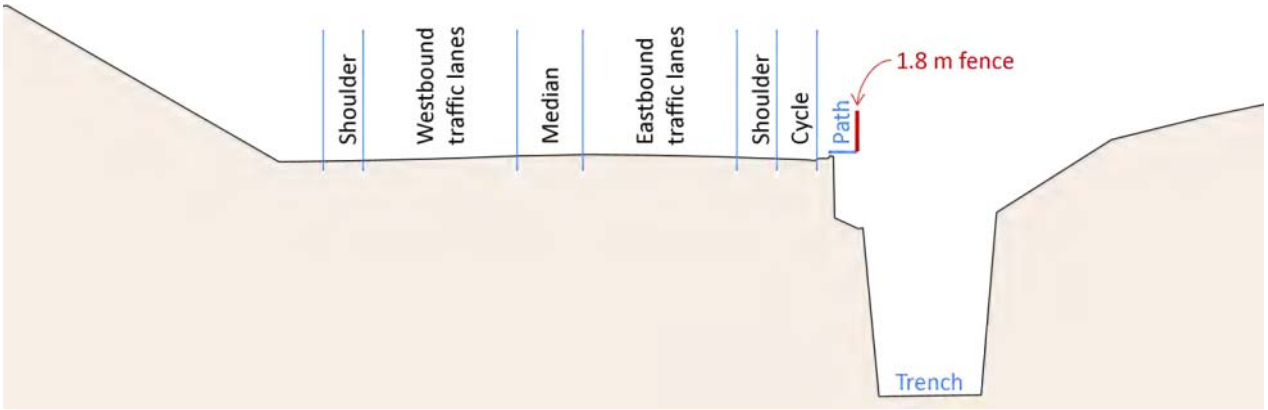
5.5.3 Barrier adjacent the railway trench

For the scenario of the Project without any noise-specific mitigation, Table 5.2 Column D shows PPFs with Category B noise levels at 1 Lindsay Road, 8 Aberfeldy Street and 14 Ballance Street. Between these PPFs and State Highway 1 is a trench for a railway. Figure 5.6 shows the general location of the railway trench and Figure 5.7 shows a typical Project section through this location.

[9] NZS 6806: 2010 Section 8.2.2

Figure 5.6 General location of the railway trench, east of the Aberfeldy Street intersection with State Highway 1

Figure 5.7 Typical Project section through the location of the railway trench (facing west)



For safety, there is a 1.8 metre high barrier alongside the footpath adjacent the railway trench, as shown in Figure 5.7. This barrier is not provided for noise-mitigation purposes and is thus part of the scenario of the Project without any noise-specific mitigation.

For noise-mitigation purposes, the barrier adjacent the railway trench could be upgraded to a standard that provides greater noise mitigation, though selection of the barrier type and material is still constrained by its cantilevered position. Road-traffic noise level results from modelling of a noise-mitigating barrier adjacent the railway trench show that for PPFs adjacent the northern side of the barrier, the upgrade of the barrier provides slight noise reduction additional to that provided by the barrier that would be provided for safety purposes.

However, a noise-mitigating barrier adjacent the railway trench appears to have greater adverse noise effect via increasing the reflection of noise to PPFs adjacent the southern side of State Highway 1. Even if a highly absorbent non-reflective noise-mitigating barrier was technically feasible, still it is not practicable to upgrade the barrier to greater noise-mitigating standard given the scale of noise reductions that offers.

A barrier adjacent the railway trench is not a component of the noise mitigation Best Practicable Option.

5.5.4 Barrier along the Ballance Street boundaries

For the scenario of the Project without any noise-specific mitigation, Table 5.2 Column D shows PPFs with Category B noise levels at Ballance Street properties numbered 14, 8, 6, 4, and 2. Between these properties and the State Highway 1, the terrain is typically sloping upwards from the highway to the property boundaries. Between 14 Ballance Street and the State Highway there is some vegetation and also the railway trench (discussed in Section 5.5.3).

The potential of a barrier along the boundaries of the 14, 8, 6, 4, and 2 Ballance Street properties was investigated via modelling. Figure 5.8 indicates the location of the barrier modelled. This location is noted as outside of the designation and on land not owned by the NZTA.

Figure 5.8 Location of barrier along the boundaries of Ballance Street properties facing State Highway 1 (in red) modelled for investigating the effect of a barrier along the Ballance Street boundaries

Road-traffic noise level results shown in Table 5.4 are for modelling of a barrier along the Ballance Street boundaries. Table 5.4 Column E is for road-traffic noise levels modelled with a 1.5 metre high barrier, Column G is for a 1.8 metre high barrier and Column I is for a 2.4 metre high barrier.

Table 5.4 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers of PPFs 14, 8, 6, 4, and 2 Ballance Street for investigating the effect of a barrier along the Ballance Street boundaries (for design year 2024)

Table 5.5: Column A	B	C	D	E	F	G	H	I	J
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
14 Ballance Street	64	67	66.5	65.4	-1.2	65.2	-1.4	64.5	-2.0
8 Ballance Street	64	67	66.4	65.7	-0.7	65.4	-1.0	64.4	-2.0
6 Ballance Street	64	67	67.3	64.7	-2.7	63.8	-3.6	61.7	-5.7
4 Ballance Street	64	67	65.6	64.0	-1.5	63.4	-2.1	61.9	-3.7
2 Ballance Street	64	67	64.9	63.8	-1.1	63.3	-1.6	61.3	-3.5

Table 5.4 shows the barrier along the Ballance Street boundaries provides some noise reductions; and as would be expected the noise reductions increase as the barrier height increases. The 2.4 metre high barrier provides the scale of noise reductions expected within NZS 6806: 2010[10], however the visual and shading effects of this barrier height conflict with other discipline objectives. Though the 1.5 metre high barrier or the 1.8 metre high barrier do achieve some noise reductions, they do not equate to an average reduction of at least $L_{Aeq(24h)}$ -3 dB per PPF in the cluster and so do not meet the levels of noise mitigation required within NZS 6806: 2010[11].

At any height, the location of the barrier outside of the designation and on land not owned by the NZTA provides further difficulties with respect to other discipline objectives.

A barrier along the Ballance Street boundaries is not a component of the noise mitigation Best Practicable Option.

5.6 Design and assessment of the Best Practicable Option to mitigate noise for PPFs adjacent the southern side of State Highway 1

For the section between Lookout Point and approximately 111 Caversham Valley Road, the Project effectively moves State Highway 1 slightly away from PPFs adjacent the southern side of the highway. From 109 Caversham Valley Road eastwards to Burnett Street, Figure 5.9 shows where the Project will remove a group of buildings (in the area shaded orange) which for another group of buildings (in the area shaded green) increases the exposure to State Highway 1 road-traffic noise.

Figure 5.9 PPFs adjacent the southern side of State Highway 1 and road-traffic noise effects of the scenario of the Project without any noise-specific mitigation

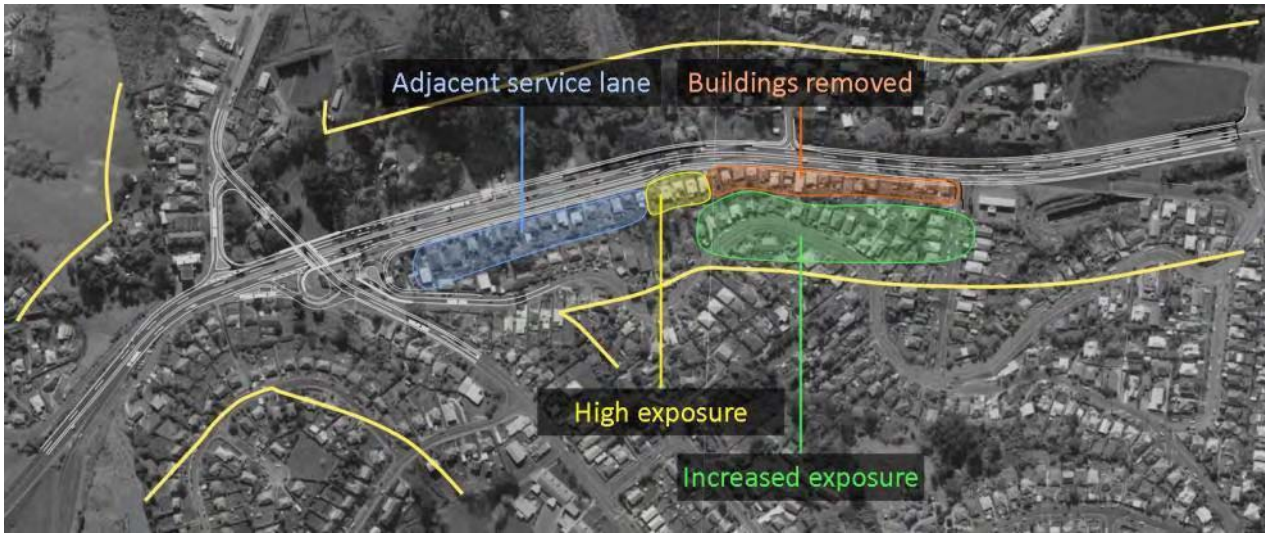


Table 5.5 Column D shows the road-traffic noise levels modelled at the most exposed receiver position for PPFs adjacent the southern side of the highway for the scenario of the Project without any noise-specific mitigation. Column E is the change in noise level due to the Project without any

[10] NZS 6806: 2010 Section 8.2.2
[11] NZS 6806: 2010 Section 8.2.2

noise-specific mitigation: a negative number indicates that the Project decreases noise relative to the scenario without the Project having been built and a positive number indicates that the Project increases noise relative to the scenario without the Project having been built.

Table 5.5 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers adjacent the southern side of State Highway 1 for the scenario of the Project without any noise-specific mitigation (for design year 2024)

Table 5.5: Column A	B	C	D	E	
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
538 South Road	64	67	64.7	0.8	*Section 5.6.1*
163 Caversham Valley Road	64	67	68.6	-3.2	*Section 5.6.1*
161 Caversham Valley Road	64	67	69.1	-3.0	*Section 5.6.1*
159 Caversham Valley Road	64	67	69.8	-3.5	*Section 5.6.1*
155 Caversham Valley Road	64	67	70.5	-4.1	*Section 5.6.1*
153 Caversham Valley Road	64	67	70.6	-4.0	*Section 5.6.1*
147 Caversham Valley Road	64	67	70.7	-3.9	*Section 5.6.1*
145 Caversham Valley Road	64	67	70.6	-3.9	*Section 5.6.1*
143 Caversham Valley Road	64	67	70.4	-3.9	*Section 5.6.1*
141 Caversham Valley Road	64	67	68.8	-2.9	*Section 5.6.1*
139 Caversham Valley Road	64	67	69.9	-2.9	*Section 5.6.1*
127 Caversham Valley Road	64	67	69.3	-2.4	*Section 5.6.1*
125 Caversham Valley Road	64	67	70.9	-2.0	*Section 5.6.1*
123 Caversham Valley Road	64	67	71.1	-0.8	*Section 5.6.1*
121 Caversham Valley Road	64	67	70.6	-1.5	*Section 5.6.1*
119 Caversham Valley Road	64	67	69.9	-2.5	*Section 5.6.1, 5.6.2*
117 Caversham Valley Road	64	67	69.9	-3.1	*Section 5.6.1, 5.6.2*
115 Caversham Valley Road	64	67	70.2	-3.5	*Section 5.6.1, 5.6.2*
113 Caversham Valley Road	64	67	69.5	-3.3	*Section 5.6.1, 5.6.2*
111 Caversham Valley Road	64	67	69.1	-3.3	*Section 5.6.1, 5.6.2*
472 South Road	64	67	66.4	6.1	*Section 5.6.3*
536 South Road	64	67	57.9	0.0	
534 South Road	64	67	57.0	-1.2	
528 South Road	64	67	58.4	0.7	
524 South Road	64	67	57.8	-0.1	
522 South Road	64	67	58.2	-0.2	
520 South Road	64	67	57.8	1.5	
518 South Road	64	67	57.9	1.5	
516 South Road	64	67	57.3	1.3	
514 South Road	64	67	57.2	1.4	
512 South Road	64	67	56.3	-0.7	
510 South Road	64	67	55.5	1.9	
508 South Road	64	67	53.6	0.1	
506 South Road	64	67	53.6	0.9	
504 South Road	64	67	53.2	-2.0	
502 South Road	64	67	53.6	-1.9	

Table 5.5: Column A	B	C	D	E	
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
500 South Road	64	67	55.3	1.9	
498 South Road	64	67	56.5	2.8	
496 South Road	64	67	57.0	4.1	
494 South Road	64	67	59.3	5.0	
492 South Road	64	67	60.7	5.5	
490 South Road	64	67	62.1	7.8	
488 South Road	64	67	63.8	8.7	
486 South Road	64	67	61.2	6.8	
484 South Road	64	67	60.1	6.9	
482 South Road	64	67	59.5	5.9	
480 South Road	64	67	59.6	4.3	
478 South Road	64	67	59.6	3.9	
476 South Road	64	67	55.9	1.6	
474 South Road	64	67	56.5	1.5	
470 South Road	64	67	55.9	0.5	
468 South Road	64	67	62.6	6.0	
67 Caversham Valley Road	64	67	66.3	6.4	*Section 5.6.3*
466 South Road	64	67	57.9	1.4	
464 South Road	64	67	52.8	-0.8	
462 South Road	64	67	57.0	1.4	
460 South Road	64	67	54.1	0.3	
16 Burnett Street	64	67	51.3	-0.9	
14 Burnett Street	64	67	51.0	1.6	
12 Burnett Street	64	67	58.6	0.2	
10 Burnett Street	64	67	59.3	0.2	
8 Burnett Street	64	67	64.4	2.7	*Section 5.6.3*
479 South Road	64	67	50.9	-1.6	
477 South Road	64	67	51.3	0.3	
9 Burnett Street	64	67	64.2	1.3	*Section 5.6.4*
11 Burnett Street	64	67	58.6	-0.1	
13 Burnett Street	64	67	56.8	-0.2	
15 Burnett Street	64	67	55.5	-0.2	
17 Burnett Street	64	67	55.4	0.1	

Where the noise level in Table 5.5 Column D is shaded green, investigation of specific noise mitigation is not required for that PPF.

For those PPFs with Category B noise levels, shaded yellow in Table 5.5 Column D, noise mitigation options require investigation. However, this investigation is within a context of topographical constraints on barriers and engineering constraints on viable road surfaces.

5.6.1 Service lane barrier

For the scenario of the Project without any noise-specific mitigation, Table 5.5 Column D shows the group of PPFs from 163 to 111 Caversham Valley Road to have noise levels exceeding Category B; though it is noted that Column E shows these noise levels are less than or the same as the noise levels for the scenario without the Project having been built. These PPFs are approximately adjacent the service lane, as shown in Figure 5.9 (shaded in blue).

Due to engineering constraints, lower noise road surfaces are excluded as a potential noise mitigation option for the group of PPFs from 163 to 111 Caversham Valley Road. The potential of a barrier inside the island separating the highway and the service lane was investigated.

Road-traffic noise level results shown in Table 5.6 are for modelling of a service lane barrier with ends at approximately 538 Caversham Valley Road to between 119 and 121 Caversham Valley Road (as indicated in Figure 5.10): Table 5.6 Column E is for road-traffic noise levels modelled with a 1.5 metre high service lane barrier; Column G is for 1.8 metres; and Column I for 2.4 metres.

(Relative to the group of PPFs in Table 5.5, the group has been truncated in Table 5.6 to highlight where the service lane barrier has relevance or effect.)

Figure 5.10 Location of service lane barrier (in red) modelled for investigating the effect of a barrier between the service lane and the highway

Table 5.6 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers adjacent the southern side of State Highway 1 for investigating the effect of a barrier between the service lane and the highway (for design year 2024)

Table 5.6: Column A	B	C	D	E	F	G	H	I	J
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
538 South Road	64	67	64.7	64.2	-0.5	64.1	-0.7	63.7	-1.1
163 Caversham Valley Road	64	67	68.6	65.8	-2.8	65.2	-3.4	64.2	-4.4

Table 5.6: Column A	B	C	D	E	F	G	H	I	J
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
161 Caversham Valley Road	64	67	69.1	65.4	-3.8	64.6	-4.5	63.1	-6.0
159 Caversham Valley Road	64	67	69.8	65.5	-4.3	64.5	-5.3	62.7	-7.1
155 Caversham Valley Road	64	67	70.5	65.8	-4.7	64.8	-5.7	62.8	-7.8
153 Caversham Valley Road	64	67	70.6	65.8	-4.8	64.7	-5.9	62.6	-7.9
147 Caversham Valley Road	64	67	70.7	65.8	-4.8	64.7	-6.0	62.7	-8.0
145 Caversham Valley Road	64	67	70.6	65.7	-4.9	64.4	-6.1	62.5	-8.0
143 Caversham Valley Road	64	67	70.4	65.5	-4.9	64.3	-6.1	62.5	-8.0
141 Caversham Valley Road	64	67	68.8	64.6	-4.2	63.4	-5.4	61.5	-7.3
139 Caversham Valley Road	64	67	69.9	65.7	-4.2	64.5	-5.4	62.7	-7.2
127 Caversham Valley Road	64	67	69.3	65.6	-3.8	64.2	-5.2	62.0	-7.3
125 Caversham Valley Road	64	67	70.9	68.0	-2.9	67.1	-3.8	65.3	-5.6
123 Caversham Valley Road	64	67	71.1	68.8	-2.3	68.1	-3.0	66.6	-4.5
121 Caversham Valley Road	64	67	70.6	68.7	-1.9	68.2	-2.4	67.5	-3.1
119 Caversham Valley Road	64	67	69.9	68.7	-1.3	68.5	-1.5	68.2	-1.7
117 Caversham Valley Road	64	67	69.9	69.1	-0.8	69.0	-0.8	68.9	-0.9
115 Caversham Valley Road	64	67	70.2	69.8	-0.4	69.7	-0.5	69.7	-0.5
113 Caversham Valley Road	64	67	69.5	69.2	-0.2	69.2	-0.3	69.2	-0.3
111 Caversham Valley Road	64	67	69.1	68.8	-0.3	68.8	-0.3	68.7	-0.4
536 South Road	64	67	57.9	56.9	-1.0	56.5	-1.4	56.0	-1.9
534 South Road	64	67	57.0	56.6	-0.4	56.1	-0.9	55.5	-1.5
528 South Road	64	67	58.4	57.9	-0.5	57.3	-1.1	56.4	-2.0
524 South Road	64	67	57.8	57.4	-0.4	56.9	-0.9	56.1	-1.8
522 South Road	64	67	58.2	57.7	-0.5	57.3	-0.9	56.3	-1.8
520 South Road	64	67	57.8	57.4	-0.4	57.0	-0.7	56.4	-1.4
518 South Road	64	67	57.9	57.5	-0.4	57.2	-0.7	56.4	-1.5
516 South Road	64	67	57.3	56.8	-0.5	56.5	-0.8	55.8	-1.5
514 South Road	64	67	57.2	56.7	-0.5	56.4	-0.8	55.7	-1.5
512 South Road	64	67	56.3	56.0	-0.3	55.6	-0.7	55.0	-1.3
510 South Road	64	67	55.5	55.3	-0.2	55.2	-0.3	54.8	-0.7
508 South Road	64	67	53.6	53.5	-0.1	53.4	-0.2	53.2	-0.4

Across the range of service lane barrier heights modelled, Table 5.6 Column F, Column H, and Column J show the service lane barrier has less effect, or no effect, for PPFs from 119 to 111 Caversham Valley Road. This is because these PPFs are at the eastern end or slightly east of the end of the service lane barrier so it provides little screening of noise from the road-traffic on State Highway 1.

Table 5.6 Column F, Column H, and Column J also show the service lane barrier achieves noise reductions for PPFs that are uphill of the Project: 536 to 508 South Road. Though these PPFs are well into Category A, still the small effect of the service lane barrier is noted.

At a height of 1.5 metres, the service lane barrier provides noise reductions, as shown by Table 5.6 Column F, of $L_{Aeq(24h)}$ -2 dB to -5 dB for PPFs fully screened by and immediately adjacent the barrier (approximately 163 to 123 Caversham Valley Road); but of these thirteen PPFs, Table 5.6 Column E shows that road-traffic noise levels remain exceeding Category B for two PPFs. Similarly, with a service lane barrier height of 1.8 metres, although Table 5.6 Column H shows noise reductions increase to between $L_{Aeq(24h)}$ -3 dB and -6 dB, of the thirteen PPFs between 163 and 123 Caversham Valley Road, still two PPFs remain exceeding Category B.

At a height of 2.4 metres, the noise mitigation effectiveness of the service lane barrier increases to provide between $L_{Aeq(24h)}$ -4 dB and -8 dB noise reduction. No PPFs between 163 and 123 Caversham Valley Road remain exceeding Category B and ten out of the thirteen PPFs achieve Category A. However, input from other Project specialist disciplines advises that a 2.4 metre high barrier height is incompatible with other discipline objectives, particularly noting the visual and shading effects of that height.

Over the thirteen PPFs primarily affected by the service lane barrier, the 1.5 metre high barrier achieves an average noise reduction of $L_{Aeq(24h)}$ -3.0 dB per PPF and the 1.8 metre high barrier achieves -3.8 dB per PPF.

Providing a 1.8 metre high service lane barrier is compatible with other discipline objectives, this barrier is recommended as a component of the noise mitigation Best Practicable Option.

Figure 5.10 shows the layout and service lane barrier location of the current Project design (May 2011). There is ongoing revision and discussion of the Project design including options which would allow the service lane barrier length to be extended westwards. Indicative modelling of such an extension of the service lane barrier shows it achieves greater noise reductions for PPFs west of 155 Caversham Valley Road. The additional noise reductions are most notable for 538 South Road and 163 Caversham Valley Road: an additional -0.8 or -0.9 dB noise reduction per PPF is achieved by a 1.5 metre high extended service lane barrier and a 1.8 metre high extended service lane barrier achieves an additional -1.2 or -1.4 dB noise reduction per PPF.

5.6.2 Barriers along boundaries at the eastern start of service lane

Table 5.5 Column D shows PPFs 119 to 111 Caversham Valley Road exceeding Category B and Table 5.6 shows the potential noise mitigation option of the service lane barrier does not fully address these PPFs. Figure 5.9 identifies the location of these PPFs in yellow labelled “High exposure”.

Due to engineering constraints, lower noise road surfaces are excluded as a potential noise mitigation option for the group of PPFs from 119 to 111 Caversham Valley Road. The potential noise mitigation of barriers along the property boundaries at the eastern start of the service lane was investigated.

- A barrier has not been placed on the property boundary of 119 Caversham Valley Road. This could be investigated but currently it is perceived that a barrier would be incompatible with the layout of the property.

- One barrier is on the property boundary adjacent to State Highway 1 for PPFs 117 and 115 Caversham Valley Road. 115 Caversham Valley Road is adjacent an alleyway linking to South Road and the barrier is modelled with a return approximately 2 metres along the eastern property boundary alongside the alleyway. A 2.4 metre high barrier is incompatible with the site and so this height was not modelled.
- One barrier is on the property boundary adjacent to State Highway 1 for PPFs 113 and 111 Caversham Valley Road. 113 Caversham Valley Road is adjacent an alleyway linking to South Road and the barrier is modelled with a return approximately 2 metres along the western property boundary alongside the alleyway. 111 Caversham Valley Road is adjacent a property from which the Project removes the building, thus increasing exposure of the eastern face of the 111 Caversham Valley Road property to road-traffic noise. The barrier is modelled with a return approximately 10 metres along the eastern property. A 2.4 metre high barrier is incompatible with the site and so this height was not modelled.

Note that the effectiveness of barriers relies on their continuous length. Gaps for driveways or pathways, for example, must be closed with a solid gate to achieve the potential noise mitigation of the barrier.

Figure 5.11 indicates the location of the barriers and Table 5.7 shows road-traffic noise level results from modelling of those barriers. Table 5.7 Column E is for road-traffic noise levels modelled with a 1.5 metre high barrier and Column G is for a 1.8 metre high barrier.

(Relative to the group of PPFs in Table 5.5, the group has been truncated in Table 5.7 to highlight where the barriers along boundaries at the eastern start of the service lane has relevance or effect.)

Figure 5.11 Location of a barrier adjacent 117 and 115 Caversham Valley Road and another barrier adjacent 113 and 111 Caversham Valley Road (in red) modelled for investigating the effect of a barriers along boundaries at the eastern start of the service lane

Table 5.7 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers of PPFs 119 to 111 Caversham Valley Road for investigating the effect of a barriers along boundaries at the eastern start of the service lane (for design year 2024)

Table 5.7: Column A	B	C	D	E	F	G	H
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation
119 Caversham Valley Road	64	67	69.9	69.9	0.0	69.8	-0.1
117 Caversham Valley Road	64	67	69.9	69.6	-0.3	68.9	-1.0
115 Caversham Valley Road	64	67	70.2	69.9	-0.3	69.0	-1.2
113 Caversham Valley Road	64	67	69.5	68.8	-0.6	67.6	-1.8
111 Caversham Valley Road	64	67	69.1	68.9	-0.1	68.2	-0.8

Table 5.7 shows a 1.5 metre high barriers along boundaries at the eastern start of the service lane provides only slight noise reductions. Similarly, the noise reductions provided by 1.8 metre high barriers are also only $L_{Aeq(24h)}$ -0.8 to -1.8 dB. Though the barriers do achieve some noise reductions, they do not equate to an average reduction of at least $L_{Aeq(24h)}$ -3 dB per affected PPF and so the barriers do not meet the levels of noise mitigation required within NZS 6806: 2010[12].

Barriers along boundaries at the eastern start of the service lane are not components of the noise mitigation Best Practicable Option.

5.6.3 Barrier adjacent properties of houses removed

For the scenario of the Project having not been built, Figure 5.9 shows there are buildings immediately adjacent State Highway 1 which shield the buildings "behind" (to their south) from road-traffic noise of the highway. The Project removes these "front" buildings, so that road-traffic noise levels increase for the buildings formerly "behind".

Table 5.5 Column E shows these increases to be substantial for a number of PPFs. Notably, 490 to 482 South Road and 468 South Road experience road-traffic noise level increases of $L_{Aeq(24h)}$ 6 dB or more, though the noise level remains within Category A. 472 South Road has a noise level increase of $L_{Aeq(24h)}$ 6 dB and 67 Caversham Valley Road has a noise level increase of $L_{Aeq(24h)}$ 6 dB; with the Project without any noise-specific mitigation creating a Category B noise level for these two PPFs. In the context of these PPFs, noise increases of approximately $L_{Aeq(24h)}$ 4 to5 dB would be noticeable by most residents of the PPFs.

Due to engineering constraints, lower noise road surfaces are excluded as a potential noise mitigation option for this affected group of PPFs.

[12] NZS 6806: 2010 Section 8.2.2

For other discipline objectives, there is to be a barrier located along the northern boundary of 494 to 472 South Road then east across to Burnett Street, approximately as shown in Figure 5.12. This is adjacent the properties from which houses have been removed, between the highway and the PPFs remaining. Upgrading this barrier to noise-mitigating standard could provide a potential road-traffic noise mitigation option. Table 5.8 shows the road-traffic noise levels from modelling of this option. Table 5.8 Column E is for road-traffic noise levels modelled with a 1.5 metre high barrier adjacent properties of house removed, Column G for a 1.8 metre barrier and Column I for a 2.4 metre high barrier.

(Relative to the group of PPFs in Table 5.5, the group has been truncated in Table 5.8 to highlight where the barrier adjacent properties of houses removed has relevance or effect.)

Figure 5.12 Location of barrier along the northern boundary of 494 to 478 to 472 South Road then east to Burnett Street (in red) modelled for investigating the effect of a barrier adjacent properties of houses removed

Table 5.8 Free field $L_{Aeq(24\ hour)}$ (dB) noise levels at 1.5 metre high receivers adjacent the southern side of State Highway 1 for investigating the effect of a barrier adjacent properties of houses removed (for design year 2024)

Table 5.8: Column A	B	C	D	E	F	G	H	I	J
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
472 South Road	64	67	66.4	65.6	-0.8	64.6	-1.8	64.3	-2.1
496 South Road	64	67	57.0	56.4	-0.6	56.1	-0.8	55.7	-1.2
494 South Road	64	67	59.3	58.5	-0.7	58.0	-1.2	57.2	-2.0
492 South Road	64	67	60.7	60.1	-0.6	59.5	-1.2	58.3	-2.4
490 South Road	64	67	62.1	60.6	-1.5	59.8	-2.3	58.5	-3.7
488 South Road	64	67	63.8	63.5	-0.3	61.7	-2.0	58.1	-5.7
486 South Road	64	67	61.2	60.0	-1.1	58.8	-2.4	57.7	-3.4
484 South Road	64	67	60.1	59.3	-0.8	58.2	-1.9	57.3	-2.8
482 South Road	64	67	59.5	59.1	-0.4	58.1	-1.4	57.4	-2.1
480 South Road	64	67	59.6	59.4	-0.2	58.6	-1.0	58.4	-1.2

Table 5.8: Column A	B	C	D	E	F	G	H	I	J
PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Project with 1.5m barrier	Change due to 1.5m barrier relative to without noise-specific mitigation	Project with 1.8m barrier	Change due to 1.8m barrier relative to without noise-specific mitigation	Project with 2.4m barrier	Change due to 2.4m barrier relative to without noise-specific mitigation
478 South Road	64	67	59.6	59.4	-0.2	58.7	-0.9	58.7	-0.9
476 South Road	64	67	55.9	56.1	0.2	55.5	-0.5	55.6	-0.4
474 South Road	64	67	56.5	56.7	0.2	56.1	-0.4	56.3	-0.1
470 South Road	64	67	55.9	56.0	0.1	55.3	-0.7	55.6	-0.4
468 South Road	64	67	62.6	62.9	0.3	62.1	-0.5	61.7	-0.9
67 Caversham Valley Road	64	67	66.3	66.4	0.1	65.5	-0.8	64.9	-1.4
466 South Road	64	67	57.9	58.1	0.2	57.5	-0.5	57.8	-0.1
464 South Road	64	67	52.8	53.0	0.2	52.5	-0.3	52.8	0.0
462 South Road	64	67	57.0	57.2	0.2	56.6	-0.4	56.8	-0.2
460 South Road	64	67	54.1	54.3	0.1	53.9	-0.2	54.3	0.1
16 Burnett Street	64	67	51.3	51.4	0.2	51.1	-0.1	51.4	0.1
14 Burnett Street	64	67	51.0	51.1	0.0	50.3	-0.7	50.5	-0.5
12 Burnett Street	64	67	58.6	58.8	0.2	58.2	-0.4	58.8	0.2
10 Burnett Street	64	67	59.3	59.5	0.2	59.2	-0.1	59.5	0.2
8 Burnett Street	64	67	64.4	64.1	-0.4	63.3	-1.1	63.3	-1.2
479 South Road	64	67	50.9	50.9	0.0	50.8	-0.1	50.9	0.0
477 South Road	64	67	51.3	50.9	-0.3	50.7	-0.6	50.6	-0.6

Table 5.8 shows the barrier adjacent properties of houses removed provides some noise reductions; and as would be expected the noise reductions provided by the higher 2.4 metre high barrier are greater than those provided by the 1.8 metre high barrier which are greater than those provided by the 1.5 metre high barrier. However, the scale of noise reductions does not meet the required levels of noise mitigation NZS 6806: 2010[13]. For example, the 2.4 metre high barrier provides less than $L_{Aeq(24h)}$ -2 dB average noise reduction per PPF when the effect is averaged over just the Table 5.8 truncated set of PPFs.

While a 2.4 metre high barrier does have greatest effect of the three barrier heights modelled, input from other Project specialist disciplines advises that this barrier height is incompatible with other discipline objectives, particularly noting the visual effects of that height and the shading effects from its position on the northern side of the backyards of the South Road properties.

For the three PPFs that achieve Category B for the scenario of the Project without any noise-specification, Table 5.8 shows the 1.5 metre high barrier adjacent properties of houses removed promotes none of these to Category A. The 1.8 metre high barrier does promote one of these three PPFs to Category A.

[13] NZS 6806: 2010 Section 8.2.2

Section 2 discusses sources available for defining “reasonable” noise. NZS 6806: 2010 defines “reasonable” noise via noise limits. If the noise level is less than the applicable noise limit, it is accepted that the effect of the noise level is minor and the noise level is “reasonable”.

For PPFs 494 to 482 South Road, the noise level from the Project without any noise-specific mitigation is a “reasonable” noise level, achieving Category A of NZS 6806: 2010. Still, it is noted that the change of noise due to the Project is $L_{Aeq(24h)}$ 5 to 9 dB. This extent of change could be readily noticed by residents of those PPFs and the effect of any noticeable change in noise level should be verified as minor and “reasonable”; or practicable noise mitigation to achieve a minor effect should be investigated.

Investigation of practicable noise mitigation at the PPF buildings has been already discussed. Practicable noise mitigation to achieve a minor effect on backyard amenity was also investigated. The barrier adjacent properties of houses removed was examined for its effects on backyard amenity of PPFs 494 to 482 South Road. While the 1.5 metre high barrier backyard amenity effectiveness peaks at noise reductions of $L_{Aeq(24h)}$ -2.4 dB for one property, the 1.8 metre high barrier improves backyard amenity by noise reductions of $L_{Aeq(24h)}$ -2.7 to -3.3 dB for four properties. With the 1.8 metre high barrier, though noise level reductions are still small, they could be considered as achieving some worthwhile improvements to the backyard amenity.

If a barrier adjacent properties of houses removed was predicated to achieve discipline objectives outside of the road-traffic noise objectives, it could be upgraded to noise-mitigation standard and thus considered as having some noise benefit. However, by the noise benefit alone, a barrier adjacent properties of houses removed is not a component of the noise mitigation Best Practicable Option.

5.6.4 Barrier adjacent 9 Burnett Street

Table 5.5 Column D shows PPF 9 Burnett Street achieving a Category B noise level. Due to engineering constraints, lower noise road surfaces are excluded as a potential noise mitigation option for this PPF.

The northern face of the 9 Burnett Street building has the greatest exposure to road-traffic noise from the Project. The 9 Burnett Street property is above a steep cut that runs parallel to the northern property boundary of 9 Burnett Street. The potential noise mitigation of a barrier along the top edge of the cut, parallel to the northern property boundary of 9 Burnett Street, was investigated.

- A 1.5 metre barrier provides $L_{Aeq(24h)}$ -0.2 dB noise reduction relative to the scenario of the Project without any noise-specific mitigation. The PPF achieves $L_{Aeq(24h)}$ 63.9 dB.
- A 1.8 metre barrier provides $L_{Aeq(24h)}$ -1.1 dB noise reduction and the PPF achieves Category A with $L_{Aeq(24h)}$ 63.0 dB.
- A 2.4 metre barrier provides $L_{Aeq(24h)}$ -4.1 dB noise reduction and the PPF achieves $L_{Aeq(24h)}$ 60.1 dB.

Of the three heights investigated, the scale of noise reductions from the barrier adjacent 9 Burnett Street does not meet the levels of noise mitigation required within NZS 6806: 2010[14]. At a height

[14] NZS 6806: 2010 Section 8.2.2

where the barrier could be effective, the height would have visual and shading effects incompatible with other discipline objectives.

A barrier adjacent 9 Burnett Street is not a component of the noise mitigation Best Practicable Option.

5.7 Noise mitigation Best Practicable Option

For PPFs with noise levels within or exceeding Category B for the scenario of the Project without any noise-specific mitigation, many potential noise mitigation options have been investigated. Of these, the determined noise mitigation Best Practicable Option is provided by only one noise-specific design feature, a service lane barrier, about 235 metres long and 1.8 metres high, as described in Section 5.6.1. The service lane barrier is the only noise mitigation option investigated that was both compatible with all discipline objectives and achieved noise reductions that meet the levels of noise mitigation required within NZS 6806: 2010[15].

Road-traffic noise levels for the Project with the noise mitigation Best Practicable Option are contained in Appendix G, with noise levels for the Project without any noise-specific mitigation and noise levels without the Project having been built. The spread of noise around the Project with the noise mitigation Best Practicable Option is illustrated in Appendix F.

The noise mitigation Best Practicable Option investigations identified a number of barriers that may be included in the Project for achieving objectives other than noise. For example, a barrier adjacent the railway trench could be included via safety objectives and a barrier adjacent properties of houses removed could be included via a requirement to fence off the road reserve area. For achieving urban design objectives, the preferred height for Project barriers is 1.8 metres high. At this height, upgrade of the barriers to noise-mitigating standard generally provides to any affected PPF buildings only a minimal effect, $L_{Aeq(24h)}$ -1 to -2 dB at most. The barrier upgrades do not meet the levels of noise mitigation required within NZS 6806: 2010. However, if Project barriers were to be provided for other discipline objectives, the additional incremental cost of upgrading to noise-mitigating standard could be considered as having some noise benefit. Noise reduction benefits at the PPF building might be of a scale less noticeable but the amenity of outside areas of the PPF properties may also be improved.

5.8 Further considerations of the Best Practicable Option

5.8.1 The Project design

The noise mitigation Best Practicable Option described in Section 5.7 is specific to the design of the Project without any noise-specific mitigation that was used to develop the Best Practicable Option. Therefore, if aspects of the Project design change, then the appropriate noise mitigation may also change.

[15] NZS 6806: 2010 Section 8.2.2

5.8.2 Building-modification mitigation via acoustic insulation

For several PPFs, it was noted that Best Practicable Option road-traffic noise levels would exceed Category B; in which case, NZS 6806: 2010 expects an investigation of whether a mitigation strategy could improve internal noise levels to achieve the Category C internal criterion.

For residences, the focus of road-traffic noise mitigation is sleep protection at night time. Given the limited scale of effect or availability of structural mitigation options of lower noise road surface or barrier, building-modification mitigation could also be investigated. Building-modification mitigation can be one or a combination of measures ranging from improving seals around windows and doors, through to replacing window units and relining rooms. Acoustic insulation can be targeted to those building faces or rooms most susceptible to effects of road-traffic noise.

Performance potential of any building-modification mitigation must be balanced with the amount of noise that will enter the buildings through other gaps. Many of the houses of these PPFs are quite old and typically noise can enter these houses via poorly fitting windows and doors. Improving these with simple seals can reduce $L_{Aeq(24h)}$ noise levels by -3 to -5 dB and often this would be the practicable scale of improvement.

One possible treatment that improves seals and also reduces noise levels is fitting thermal double-glazing **inserts** into existing window frames. This treatment also retains much of the character of the house. The thermal double glazing has only a small effect 3-4dBA in reducing noise but a further improvement of several dBA could occur because the window will now seal more tightly.

Acoustic double-glazing would require whole new window units. In ideal conditions, this treatment can achieve $L_{Aeq(24h)}$ -10 dB noise reductions, but its effectiveness in old houses is doubtful because, as noted above, noise can be entering the house via many other gaps in eaves and ceiling spaces.

The potential noise reductions of building-modification mitigation via acoustic insulation need to be tempered by the overall condition of the PPF building. Also, setting expectations of the benefits in perceptions and experiences from any noise reductions needs to recognise that in several instances where building-modification mitigation might be considered, noise levels from the Project without any noise-specific mitigation are less than noise levels without the Project having been built.

5.8.3 Providing addition mitigation beyond NZS 6806: 2010 criteria

NZS 6806: 2010 does not preclude achieving noise levels lower than the criteria it recommends, so long as it is practicable and delivers effective noise benefits.

One area that could be considered further in this regard is the group of PPFs on South Road that experience noise increases of $L_{Aeq(24h)}$ 5 to 8 dB. Section 5.6.3 discussed potential improvement to backyard amenity through noise reductions of a barrier adjacent the sections where houses will be removed. While the PPFs in this group are still within Category A the increases in noise will be quite noticeable. Though noise mitigation is not required by NZS6806 it is suggested that some consideration could be given to a low level of building-modification mitigation to improve acoustic insulation, such as improving window seals.

6 Construction noise

6.1 Construction noise criteria

The overarching requirement for noise from construction is established by Section 16 of the RMA, that noise levels shall be reasonable. With respect to construction, reasonable noise levels need to allow construction to occur in an efficient manner but protect the adjacent community from high levels of noise, especially when activities such as sleep are required and expected.

Appropriate noise management and community liaison processes are also important in delivering acceptable construction noise levels. Normally these would be addressed in a Construction Noise Management Plan prepared as part of the construction contract.

Dunedin City District Plan

In the Dunedin City District Plan, Rule 20.5.4 sets road construction as a discretionary activity (unrestricted). Clause 21.5.1(v)(e) of the District Plan makes construction noise exempt to the noise limits that Rules 21.5.1(i) to 21.5.1(iii) apply to other activities.

Rule 20.6.12(a) sets that in the assessment of a Resource Consent application, the Dunedin City Council will have regard to

> *The extent of any positive or adverse effects on the amenity of the surrounding area with regard to, for example, connectivity, noise, vibration, glare and fumes.*

The District Plan Rules do not require that NZS 6803: 1999 be complied with but it is the Standard applied in most NZTA road construction projects throughout the country. NZS 6803: 1999 can be used as part of the guidance in determining whether adverse construction noise effects are likely to occur. Therefore, even if NZS 6803: 1999 is not applied directly but is used only to provide guidance of possible adverse construction noise effects, some discussion of this Standard and the desirable noise limits it contains is warranted.

NZS 6803: 1999

An extensive history of practice has evidenced that construction undertaken within the noise limits set out in NZS 6803: 1999 Acoustics - Construction noise[16] is acceptable to the New Zealand public. NZS 6803: 1999 recognises that construction noise is finite in duration. Established practice is that people will accept construction noise levels, even 25 to 30 dB above normal noise levels set out in the District Plan, so long as that noise level increase is for a finite period and also if good noise management practices are being followed.

However, a proviso on construction noise acceptability relates to the hours of the day during which the construction noise occurs. Usually high levels of construction noise are acceptable only during daytime and only on weekdays, although construction noise on Saturdays can also be accepted. Acceptance of construction noise during the night is particularly dependent on (public perception of) its necessity and dependent on appropriate notification of its occurrence. If the public have a

[16] And also the NZS 6803: 1999 predecessor NZS 6803P: 1984

strong understanding of when the construction noise is going to occur and its likely duration and the purpose of the associated construction activity, there is usually a good acceptance of the construction noise.

NZS 6803: 1999 notes in its foreword that the RMA requires the adaption of the Best Practicable Option to ensure that noise levels are reasonable. This reference to the Best Practicable Option is important because the reasonableness of noise will be context-specific. NZS 6803: 1999 is a guideline for setting noise limits that are specific to a project being undertaken and that are specific to the situation in which the project is located. Current ambient noise levels are an important factor in setting the construction noise limits. The practicability of achieving the work within particular limits is another important factor. NZS 6803: 1999 contains two tables of recommended *desirable* construction noise limits: Table 2 for application in residential areas and Table 3 to apply in commercial areas. However, NZS 6803: 1999 expects these *sample* tables will be modified by using the Standard as guidance to establish a set of recommended noise limits specific to the project.

NZTA Environmental Plan

The NZTA Environmental Plan[17] sets a formal objective to "manage construction and maintenance noise to acceptable levels."[18]

The Environmental Plan states that during construction of a project, potentially unreasonable construction noise effects will be managed and minimised, as far as is practicable, in accordance with NZS 6803: 1999. The preferred mechanism of construction noise management is a Construction Management Plan, or equivalent, which must include a noise management component.

6.2 Desirable noise levels

NZS 6803: 1999 Table 2 (shown in part in Table 6.1) sets out desirable noise limits for construction work of normal duration, and recommends that these noise limits be decreased for work of long duration, that is, more than 18 weeks. However, it is common for those "noise limits for construction work of normal duration" to be applied to road construction projects, even those of two to three years duration because the noise of road construction differs from most other construction in several ways:

- In comparison to sites of building construction, most sites of road construction are long. Long sites may have construction activity occurring simultaneously at numerous areas along the site. Typically only one to four, but sometimes more, items of plant or machinery would be operating at any one area at any time, but many times there may be no activity nearby.
- While the overall duration of a road construction may be long, road construction is notable for its intermittent character. Phases of work will occur in one area, then pause either while

[17] The NZTA Environmental Plan establishes an environmental policy for State Highways. The Environmental Plan enables the NZTA to integrate environmental and social considerations, including mitigation of road-traffic noise, into all aspects of State Highway planning, construction, and maintenance. The Environmental Plan version current at this time is Version 2, published in June 2008.
[18] Objective N3, NZTA Environmental Plan, June 2008

that phase is continued in other sections and/or to allow periods for settling of any fill or underlying materials or for the hardening of structural elements to occur before continuing with the next phase.

- Relative to any fixed (receiver) location, the construction activity centres moves nearer and further away as different works progress. Thus, any one (receiver) location is affected by construction activity for only a portion of the full construction period.

Table 6.1 which is part of Table 2 of NZS 6803

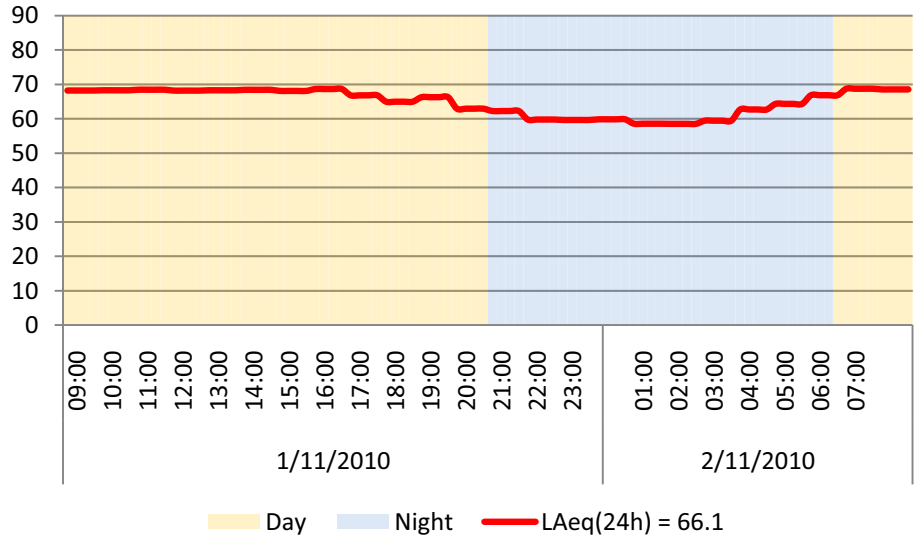
Time	Noise limits (dB)					
	Weekday		Saturday		Sunday/public hol.	
	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
6:30 am through to 7:30 am	60	75	45	75	45	75
7:30 pm through to 6:00 pm	75	90	75	90	55	85
6:00 pm through to 8:00 pm	70	85	45	75	45	75
8:00 pm through to 6:30 am	45	75	45	75	45	75

Table 6.1 is part of NZS 6803: 1999 Table 2. This is the part of the table that is for work of normal duration (as the acceptability of *not* applying the reduction for work of long duration has been identified). These noise limits are, as NZS 6803: 1999 describes, the *desirable* upper limits to construction noise for residential areas. These limits should not be exceeded unless it is not practical to achieve them or unless a higher general ambient noise level means that higher construction noise limits would, if necessary, be acceptable, and as discussed below, ambient noise levels in this area are high.

Existing ambient noise levels

Relevant to these issues and the likely acceptance of construction noise, is the existing noise environment as discussed in Section 4. The sample noise profile given in Figure 4.3 shows that hourly noise levels during the night time are approximately 10 dB below the day time noise levels, but are still high at about $L_{Aeq(1h)}$ 62 dB,. Figure 6.1 also shows the same trait of the night time noise levels, at about $L_{Aeq(1h)}$ 58 dB, being approximately 10 dB below the day peak noise levels.

Figure 6.1 Records of one-hour average noise levels from 24 hours of monitoring at 557 South Road, microphone towards State Highway 1



The measurements of the existing noise environment establish that the day noise levels in the area of the Project are often almost as high as the noise limits desirable for day time contained in NZS 6803: 1999 Table 2 (and shown in part in Table 6.1). The night time noise levels in the area of the Project are well above the noise limits desirable for night time, contained in the same table. These high ambient noise levels should be taken into account when developing the Construction Noise Management Plan and in judging occurrence of adverse construction noise effects.

Existing traffic flows and construction traffic on roads

Understanding characteristics of the traffic flow on State Highway 1 in the area can assist in appropriately managing construction noise effects. Figure 6.2 illustrates traffic data obtained from counts taken on State Highway 1 at Lookout Point. The figure shows how traffic volumes generally fluctuate through the day and night.

Figure 6.2 Hourly traffic at Lookout Point, average of all available counts during 2009 to 2010

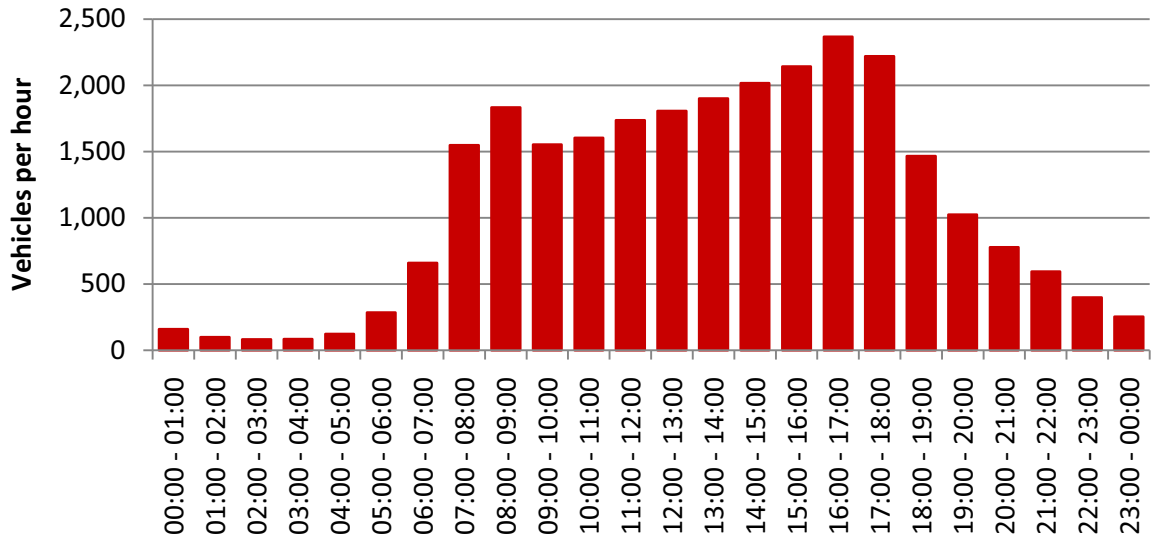


Figure 6.2 represents a total annual average daily traffic flow of 26,700 vehicles per day.

The noise of construction traffic using public roads to access the construction site is not under special control but is generally controlled under the Land Transport: Vehicle Equipment Rules regulation for noise of individual vehicles. Based on the existing traffic flows currently using the nearby road network and given likely construction traffic volumes, the relative noise increases will almost certainly be not at all significant and would be undetected by most people.

6.3 Construction Noise Management Plan

The most effective method to control construction noise is through proactive management. To ensure this occurs, it should be a requirement on the contractor to prepare a Construction Noise Management Plan as part of the Construction Plan. The Construction Noise Management Plan should detail consultant and contractor obligations during the construction, and will include details such as:

- Description of the works, anticipated equipment processes/durations;

- Identification of the most affected houses where noise limits apply;
- Applicable noise limits, including any Consent/designation condition requirements;
- Assessment of construction noise levels;
- Appropriate noise mitigation measures to be implements;
- Establishing a monitoring regime which targets both the more noisy activities and their potential occurrences near noise-sensitive locations;
- Staff training/awareness programme;
- Procedures for maintaining contact with stakeholders, including informing them when noise activities may occur and providing summary reports of monitoring and investigations of any noise complaints;
- Process for managing noise complaints; and
- Contact telephone numbers for key construction staff, staff responsible for noise assessment and Council offices, plus a single point of contact to immediately advise of concerns about noisy activities.

7 Summary and recommendations

Operational road-traffic noise

The Project is to improve the safety of State Highway 1 through Caversham Valley. The Project will be built in an area where road-traffic noise is currently a primary contributor to the noise environment and this situation will remain.

Overall the noise impacts of the project are small, in part because a number of properties that could have experienced large increases in noise levels are in fact removed so as to accommodate the project.

- Noise levels from operation of road-traffic in Caversham Valley will be substantially unchanged for many properties that are near to the Project, relative to the noise levels that would exist without the Project having been built.

- The Project decreases noise levels for properties that will remain on the south side of Caversham Valley Rd as the project moves the main carriageways further away from those houses

- The Project does substantially increase the road-traffic noise levels for some properties through the Project's removal of some buildings that currently provide those properties with screening although the resulting noise levels are reasonable in terms of applicable New Zealand Standards

The operational road-traffic noise of the Project has been assessed using NZS 6806: 2010. The noise mitigation Best Practicable Option currently determined is a service lane barrier, approximately 235 metres long and 1.8 metres high. This barrier further significantly reduces noise for 12 properties on the south side of Caversham Valley Rd, (121 to 163 Caversham valley Road)and provides minor reductions in noise for other houses nearby.

Barriers to further reduce noise in other locations were found to be not practicable.

With the Project operational and the current noise mitigation Best Practicable Option in place, 155 of the 198 premises and facilities to be protected (PPFs) assessed have road-traffic noise levels in the best category of NZS 6806: 2010, Category A. 33 of the PPFs assessed have noise levels in Category B and 10 have noise levels in Category C. The Lookout Point Fire Station has a Category B noise level. For all those 10 houses in category C, the effect of the Project is to decrease their noise levels but further reductions via structural mitigation were found to be not practicable. Because the project has no noise impact for these houses it would be acceptable for no further mitigation to be applied.

For three houses(8 Burnett Street, 67 Caversham Valley Rd, and 472 South Rd) the removal of properties adjacent the southern side of Caversham Valley road causes their noise levels to increase by between 3 to 6dBA, A 1.8 metre barrier has only a small effect so that these houses have noise levels that are still within Category B of NZS6806.These house will be further investigated to identify whether some form of acoustic treatment of the building would be a practicable mitigation of the potential effects of this increased noise.

For eight houses(468, 482, 484, 486, 488, 490, 492, and 494 South Rd) the removal of properties adjacent the southern side of Caversham Valley road causes their noise levels to increase by between 5 and 9 dBA, but noise levels are still within Category A of NZS6806

The current noise mitigation Best Practicable Option is specific to the current design of the Project without noise-specific mitigation, (the “Do Minimum” design.)

Construction noise

NZS 6803: 1999 is the appropriate standard to apply for assessing and limiting noise of construction activity. Following the process and guidance of this Standard, the contractor appointed should prepare and implement a Construction Noise Management Plan for the Project.

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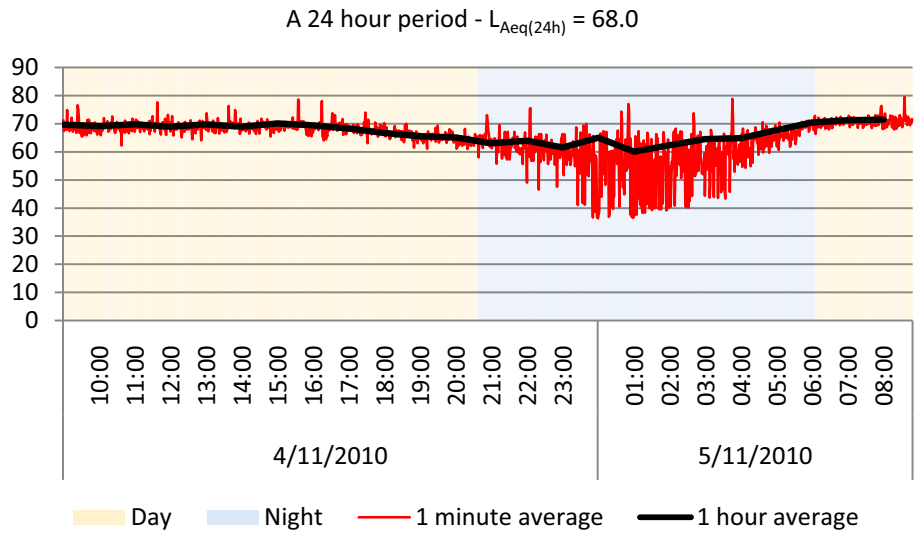
Appendix A Interpreting and using noise monitoring data

A sound level meter measures the noise level every second. Every minute the sound level meter averages the sixty readings and produces a 1 minute average. The noise level readings for a 24 hour period of these 1 minute averages (1,440 minutes) is shown as the red line in the following figure.



The sound level meter will record all noise sources, so it could be that the very high 1 minute average noise levels are due to trains in the area.

The 1 minute averages fluctuate between about 80 dB, possibly when there is a train present, to about 40 dB, during the night when there is probably little traffic nearby and only the general noise of the area is present. This gives an overall picture of the noise and how it varies minute to minute and hour by hour over the day.

Another view of the data is given by averaging over longer periods, such as hourly. 1 hour averages are shown as the black line in the figure. During the main part of the day, 6:00am to about 6:00pm, the noise level does not change much, around 70 dB, but in late night and early morning it decreases to 60 to 63 dB.

Noise monitoring data can be used in the management of road-traffic noise under NZS 6806: 2010. NZS 6806: 2010 uses the 24 hour average noise level measured in a particular technical way, called the 24 hour equivalent noise level. This is not a simple arithmetic average of all the noise levels but a logarithmic average. The effect of this averaging technique can be understood by considering the 1 hour averages shown as the black line in the figure. The 24 hour equivalent noise level is 68.0 dB, demonstrating that the 24 hour equivalent average noise level is about 2 dB less than the noisy day period quite irrespective of how low the noise level falls at night.[19]

The figure also shows that the noise at night time appears far more variable than the noise in day time. This results from there being fewer vehicles at night time. In the minute to minute data, the

[19] The 1 minute average plotted in the figure is calculated logarithmically from sixty 1 second readings. The 1 hour average plotted in the figure is calculated logarithmically from sixty 1 minute averages.

noise when a vehicle is present is about the same in the night time as it is in the daytime. In the day time, it is seldom that a whole minute would pass without any vehicle being recorded. In the night time there are many minute periods in which no vehicle is recorded and so the noise level for that minute is consequently low. The result is the much greater spread of minute to minute noise levels at night time compared to day time, as shown in the figure.

NZS 6806: 2010, and other standards that are used to manage road-traffic noise, use the 24 hour equivalent noise level because research has shown this index closely matches how people feel about noise.

The minute-by-minute data and the hour-by-hour data are used in several ways. Firstly, to check that it fits an expected pattern, to help confirm the reliability of the measurements. The noisy spikes shown in the figure have already been noted as unusual but are explained by the close presence of occasional trains. Where the noise monitoring records show abnormal patterns is taken into account when applying the noise standards.

The noise monitoring data is also used to compare with modelled noise levels. The noise model predicts for only road-traffic noise so modelled noise levels are expected to be a little quieter than the measured noise levels which include the influence of trains. An important caveat in comparing modelled noise levels with measured noise levels is that the noise model represents the noise level in what is known as “neutral” atmospheric conditions and is calculated based on the annual average daily traffic rate on all streets that influence noise levels at that subject receiver location.

Noise monitoring conducted in a residential area is recording propagated noise levels. This propagation is influenced by weather conditions. Wind strength and wind direction influence the noise levels received, as does the extent of cloud cover and sunshine at the time of the noise measurement. The scale of the effect of weather conditions increases with distance further from the noise source. Under NZS 6806: 2010, in an urban area, noise levels will be modelled at 100 metres distant from the road edge. Over this propagation distance, weather conditions that still comply with NZS 6801: 2008 Acoustics - Measurement of Environmental Sound can cause a variation of about ±3 dB.

For monitoring sites with major influence from the highway, traffic flow variations from the annual average daily traffic rate at the time of the monitoring could probably cause a variation less than ±1 dB. Variation form the annual average daily traffic rate in flows on local streets could cause greater variation.

As there are multiple sources of variability in noise measurements, noise modelling is the primary tool used to investigate how a project will change road-traffic noise levels.

Noise monitoring setup

Sound level meters were directed towards State Highway 1. The microphone of the sound level meter was set as high as possible on the tripod, while still being stable, so approximately 1.6 to 1.7 metres above ground level. This is to help match to noise levels modelled for PPFs at 1.5 metres above floor height with recognising the extra height of a building floor above the ground. Where possible, sound level meters were positioned 1 metre in front of the most exposed point on the facade of a selected building (the facade position) to continuously monitor noise levels for 24 hours. In this set of noise monitoring, it was possible for each noise monitoring site to be used

for a continuous 24 hour measurement; however, sometimes it is not practical to monitor noise in the desired facade position for 24 hour duration without constraining use of the building and property. If so and necessary, then the measured noise level is adjusted to represent the 24 hour equivalent noise level at the most exposed position.

Each monitoring site and microphone position was recorded, including at least two photographs. One photograph shows the positioning of the meter relative to the property and buildings, an example of which follows; the other photograph shows the meter relative to the road. This will ensure that these can be accurately identified, if required say for subsequent noise measurements or post-construction monitoring.

Appendix B Noise assessment specifics

General	
Noise prediction/modelling primary	Tiffany Lester
Noise assessment primary	Tiffany Lester
Noise assessment review primary	Vince Dravitzki

NZS 6806: 2010	The process and particulars of the operational road-traffic noise assessment here reported comply with NZS 6806: 2010.
The design year	2024
Noise model	Calculation of Road Traffic Noise (CRTN) with adjustments to suit New Zealand conditions made in accordance with NZTA research report 326 and using a surface correction of -2 as the base correction for asphaltic concrete. This meets the criteria stated in 5.3.2 of NZS 6806: 2010.
Noise modelling software	SoundPLAN version 7.0 This software meets the criteria stated in 5.3.2 of NZS 6806: 2010.
Assessment date	The operational road-traffic noise assessment for the Notice of Requirement was conducted principally between February 2011 and April 2011.

Specifics of traffic flows
Traffic flow information for the Notice of Requirement was obtained via models prepared by Gabites Porter. The traffic volumes used in the noise model were received in March 2011. The do-minimum scenario uses traffic modelled as "Scenario 6". The do-nothing scenario uses traffic modelled as "Model SC1".
Speeds on local roads are modelled as 50 km/h for both the do-nothing scenario and the do-minimum scenario (and any scenarios of the do-minimum with mitigation).
Speeds on State Highway 1 are modelled as 50 km/h for the do-nothing scenario and 60 km/h for the do-minimum scenario (and any scenarios of the do-minimum with mitigation).
Heavy vehicles are modelled at 3 percent of traffic flow on local roads for both the do-nothing scenario and the do-minimum scenario (and any scenarios of the do-minimum with mitigation).
Heavy vehicles are modelled at 16 percent of traffic flow on State Highway 1 for both the do-nothing scenario and the do-minimum scenario (and any scenarios of the do-minimum with mitigation).

18 hour traffic volumes	2024 do-nothing	2024 do-minimum
SH1 west of Lookout Point	36,700	35,100
SH1 east of Riselaw Road	34,300	33,400
SH1 east of Barnes Drive	32,300	31,000

Road gradient	Road gradient was calculated by the SoundPLAN software based on the imported vertical road alignment
Road surface	The do-minimum SH1 road surface is stone mastic asphalt. For the uphill traffic stream, a 2 dB addition was made to the road surface effect to account for the working of heavy vehicle engines. The do-minimum road surface on the overbridge is asphaltic concrete. The do-minimum road surface on local roads is a medium size chip seal.
Horizontal and vertical alignment	This information for the Notice of Requirement was provided in February 2011 via dxf files that were directly imported into the SoundPLAN software
Terrain data	Topography for the area around the Project was provided as contour

	lines at 1 metre intervals via a dxf file that was directly imported into the SoundPLAN software
Buildings and other structures	Buildings and other structures that may affect propagation of noise were identified via aerial photographs and input into the SoundPLAN software

Landform and development	
Terrain data	As above: Topography for the area around the Project was provided as contour lines at 1 metre intervals via a dxf file that was directly imported into the SoundPLAN software
Road layout	As above: This information for the Notice of Requirement was provided in February 2011 via dxf files that were directly imported into the SoundPLAN software
PPFs affected by noise from an existing road	The SoundPLAN software permits investigation of the noise level at a single receiver, detailing directivity of the noise received or detailing how individual road elements contribute to the total noise level received at a single receiver. In accordance with 6.2.2 of NZS 6806: 2010, this enables that where PPFs are affected by noise from an existing road, mitigation is only required for road-traffic noise generated on the new or altered road.
Assessment positions	Receivers were modelled for all PPFs within the noise study area. Receivers were placed as free field receivers and positioned 1.5 metres above ground level. 1.7.2 of NZS 6806: 2010 states the assessment position should be 1.2 to 1.5 metres above each floor level of interest in the PPF.

Appendix C Noise levels of the Project without any noise-specific mitigation

Free field $L_{Aeq(24h)}$ (dB) noise levels at 1.5 metre high receivers for the scenario of the Project without any noise-specific mitigation (for design year 2024)

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
583 South Road	64	67	65.1	-0.1	*Section 5.4*
581 South Road	64	67	62.7	-0.4	
579 South Road	64	67	63.9	-0.7	
577 South Road	64	67	64.6	-0.4	*Section 5.4*
575 South Road	64	67	64.9	-0.4	*Section 5.4*
569 South Road	64	67	66.8	0.0	*Section 5.4*
567 South Road	64	67	68.2	-0.3	*Section 5.4*
563 South Road	64	67	67.0	-0.6	*Section 5.4*
559 South Road	64	67	66.1	-0.8	*Section 5.4*
557 South Road	64	67	65.2	-0.8	*Section 5.4*
545A South Road	64	67	60.6	-0.7	
2 Riselaw Road	64	67	60.1	-0.1	
4 Riselaw Road	64	67	61.8	2.5	
6 Riselaw Road	64	67	58.9	2.8	
8 Riselaw Road	64	67	59.9	2.9	
10 Riselaw Road	64	67	58.9	2.8	
12 Riselaw Road	64	67	60.0	2.8	
6 Columba Avenue	64	67	56.9	2.6	
42 Columba Avenue	64	67	55.1	-0.2	
40 Columba Avenue	64	67	55.6	-0.3	
38 Columba Avenue	64	67	55.7	-0.4	
36 Columba Avenue	64	67	55.1	0.1	
34 Columba Avenue	64	67	54.7	-0.1	
32 Columba Avenue	64	67	54.1	0.3	
30 Columba Avenue	64	67	53.3	0.4	
28 Columba Avenue	64	67	52.1	0.7	
26 Columba Avenue	64	67	51.5	0.7	
24 Columba Avenue	64	67	52.7	1.5	
22 Columba Avenue	64	67	53.3	1.8	
20 Columba Avenue	64	67	53.2	1.9	
18 Columba Avenue	64	67	53.2	2.1	
16 Columba Avenue	64	67	51.4	0.2	
14 Columba Avenue	64	67	50.5	-0.5	
12 Columba Avenue	64	67	50.8	0.5	
10 Columba Avenue	64	67	51.0	0.9	
8 Columba Avenue	64	67	51.1	-0.5	
27 Columba Avenue	64	67	52.8	0.5	

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
25 Columba Avenue	64	67	52.6	0.3	
21 Columba Avenue	64	67	52.9	0.2	
9 Columba Avenue	64	67	51.6	0.2	
7 Columba Avenue	64	67	51.2	0.1	
5 Columba Avenue	64	67	53.1	0.7	
30 Riselaw Road	64	67	59.5	2.0	
34 Riselaw Road	64	67	51.0	1.4	
32 Riselaw Road	64	67	58.7	2.0	
527 South Road	64	67	57.9	2.3	
525 South Road	64	67	55.7	0.0	
523 South Road	64	67	53.3	1.3	
521 South Road	64	67	51.9	-0.5	
519 South Road	64	67	53.7	-1.5	
517 South Road	64	67	53.0	-1.7	
515 South Road	64	67	53.9	-2.3	
513 South Road	64	67	54.9	-1.7	
511 South Road	64	67	54.6	-0.9	
21 Riselaw Road	64	67	59.8	3.6	
23 Riselaw Road	64	67	58.9	3.1	
25 Riselaw Road	64	67	60.0	3.3	
27 Riselaw Road	64	67	58.4	2.8	
29 Riselaw Road	64	67	57.9	2.5	
31 Riselaw Road	64	67	51.0	1.2	
538 South Road	64	67	64.7	0.8	*Section 5.6*
163 Caversham Valley Road	64	67	68.6	-3.2	*Section 5.6*
161 Caversham Valley Road	64	67	69.1	-3.0	*Section 5.6*
159 Caversham Valley Road	64	67	69.8	-3.5	*Section 5.6*
155 Caversham Valley Road	64	67	70.5	-4.1	*Section 5.6*
153 Caversham Valley Road	64	67	70.6	-4.0	*Section 5.6*
147 Caversham Valley Road	64	67	70.7	-3.9	*Section 5.6*
145 Caversham Valley Road	64	67	70.6	-3.9	*Section 5.6*
143 Caversham Valley Road	64	67	70.4	-3.9	*Section 5.6*
141 Caversham Valley Road	64	67	68.8	-2.9	*Section 5.6*
139 Caversham Valley Road	64	67	69.9	-2.9	*Section 5.6*
127 Caversham Valley Road	64	67	69.3	-2.4	*Section 5.6*
125 Caversham Valley Road	64	67	70.9	-2.0	*Section 5.6*
123 Caversham Valley Road	64	67	71.1	-0.8	*Section 5.6*
121 Caversham Valley Road	64	67	70.6	-1.5	*Section 5.6*
119 Caversham Valley Road	64	67	69.9	-2.5	*Section 5.6*
117 Caversham Valley Road	64	67	69.9	-3.1	*Section 5.6*
115 Caversham Valley Road	64	67	70.2	-3.5	*Section 5.6*
113 Caversham Valley Road	64	67	69.5	-3.3	*Section 5.6*
111 Caversham Valley Road	64	67	69.1	-3.3	*Section 5.6*

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
472 South Road	64	67	66.4	6.1	*Section 5.6*
536 South Road	64	67	57.9	0.0	
534 South Road	64	67	57.0	-1.2	
528 South Road	64	67	58.4	0.7	
524 South Road	64	67	57.8	-0.1	
522 South Road	64	67	58.2	-0.2	
520 South Road	64	67	57.8	1.5	
518 South Road	64	67	57.9	1.5	
516 South Road	64	67	57.3	1.3	
514 South Road	64	67	57.2	1.4	
512 South Road	64	67	56.3	-0.7	
510 South Road	64	67	55.5	1.9	
508 South Road	64	67	53.6	0.1	
506 South Road	64	67	53.6	0.9	
504 South Road	64	67	53.2	-2.0	
502 South Road	64	67	53.6	-1.9	
500 South Road	64	67	55.3	1.9	
498 South Road	64	67	56.5	2.8	
496 South Road	64	67	57.0	4.1	
494 South Road	64	67	59.3	5.0	
492 South Road	64	67	60.7	5.5	
490 South Road	64	67	62.1	7.8	
488 South Road	64	67	63.8	8.7	
486 South Road	64	67	61.2	6.8	
484 South Road	64	67	60.1	6.9	
482 South Road	64	67	59.5	5.9	
480 South Road	64	67	59.6	4.3	
478 South Road	64	67	59.6	3.9	
476 South Road	64	67	55.9	1.6	
474 South Road	64	67	56.5	1.5	
470 South Road	64	67	55.9	0.5	
468 South Road	64	67	62.6	6.0	
67 Caversham Valley Road	64	67	66.3	6.4	*Section 5.6*
466 South Road	64	67	57.9	1.4	
464 South Road	64	67	52.8	-0.8	
462 South Road	64	67	57.0	1.4	
460 South Road	64	67	54.1	0.3	
16 Burnett Street	64	67	51.3	-0.9	
14 Burnett Street	64	67	51.0	1.6	
12 Burnett Street	64	67	58.6	0.2	
10 Burnett Street	64	67	59.3	0.2	
8 Burnett Street	64	67	64.4	2.7	*Section 5.6*
479 South Road	64	67	50.9	-1.6	

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
477 South Road	64	67	51.3	0.3	
465 South Road	64	67	59.8	-0.1	
24 Ensor Street	64	67	55.4	1.5	
574 South Road	64	67	57.2	0.3	
572 South Road	64	67	56.6	0.0	
182 Mornington Road	64	67	62.7	-1.2	
180 Mornington Road	64	67	59.7	-1.2	
178 Mornington Road	64	67	58.3	-0.9	
176 Mornington Road	64	67	58.5	-0.7	
174 Mornington Road	64	67	57.2	0.3	
172 Mornington Road	64	67	53.1	0.0	
170 Mornington Road	64	67	47.5	-0.3	
168 Mornington Road	64	67	60.1	1.3	
166 Mornington Road	64	67	49.2	-0.2	
164 Mornington Road	64	67	56.7	1.3	
162 Mornington Road	64	67	63.2	1.0	
160 Mornington Road	64	67	61.9	1.0	
158 Mornington Road	64	67	59.3	0.8	
179 Mornington Road	64	67	59.8	1.4	
172 Caversham Valley Road	64	67	64.5	2.1	
5D Aberfeldy Street	64	67	66.3	2.0	
5B Aberfeldy Street	64	67	61.8	-0.2	
5A Aberfeldy Street	64	67	64.6	0.4	*Section 5.5*
5 Aberfeldy Street	64	67	65.2	-0.1	*Section 5.5*
7 Aberfeldy Street	64	67	64.1	-0.2	*Section 5.5*
9 Aberfeldy Street	64	67	59.9	-0.1	
11 Aberfeldy Street	64	67	56.5	0.7	
19 Aberfeldy Street	64	67	59.1	-0.4	
13 Thompson Street	64	67	55.6	0.1	
1 Lindsay Road	64	67	66.4	-1.2	*Section 5.5*
8 Aberfeldy Street	64	67	65.4	-0.6	*Section 5.5*
10 Aberfeldy Street	64	67	59.3	-0.4	
16 Aberfeldy Street	64	67	59.2	0.4	
7 Rockyside Terrace	64	67	61.9	-0.3	
11 Rockyside Terrace	64	67	63.5	-0.4	
15 Lindsay Road	64	67	62.9	-0.2	
25 Lindsay Road	64	67	56.9	-0.1	
14 Ballance Street	64	67	66.5	-1.3	*Section 5.5*
9 Ballance Street	64	67	58.3	0.2	
7 Ballance Street	64	67	57.6	0.3	
8 Ballance Street	64	67	66.4	-0.4	*Section 5.5*
6 Ballance Street	64	67	67.3	-0.4	*Section 5.5*
4 Ballance Street	64	67	65.6	-0.3	*Section 5.5*

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Project without any noise-specific mitigation	Change due to the Project relative to without the Project	
2 Ballance Street	64	67	64.9	-0.5	*Section 5.5*
3 Ballance Street	64	67	58.5	-0.1	
1 Ballance Street	64	67	59.8	-0.2	
146 South Road	64	67	60.7	1.3	
9 Burnett Street	64	67	64.2	1.3	*Section 5.5*
11 Burnett Street	64	67	58.6	-0.1	
13 Burnett Street	64	67	56.8	-0.2	
15 Burnett Street	64	67	55.5	-0.2	
17 Burnett Street	64	67	55.4	0.1	
420 South Road	64	67	55.3	0.2	
416 South Road	64	67	57.6	0.3	
414 South Road	64	67	58.1	0.4	
412 South Road	64	67	58.2	0.4	
410 South Road	64	67	58.9	0.4	
408 South Road	64	67	60.7	0.0	
406 South Road	64	67	60.1	0.2	
404 South Road	64	67	62.7	-1.0	
402 South Road	64	67	58.7	-1.8	
21 Caversham Place	64	67	62.1	-1.2	
400 South Road	64	67	56.2	-0.4	
398 South Road	64	67	56.1	0.0	
17 Caversham Place	64	67	61.1	-0.6	
396 South Road	64	67	56.4	0.1	
15 Caversham Place	64	67	61.2	-0.5	
394A South Road	64	67	50.8	0.3	
394 South Road	64	67	58.7	-0.1	
13 Caversham Place	64	67	61.3	-0.3	
378 South Road	64	67	61.4	-0.3	
10 Barnes Drive	64	67	61.3	-0.4	
13 Caversham Place	64	67	61.3	-0.3	
378 South Road	64	67	61.4	-0.3	
10 Barnes Drive	64	67	61.3	-0.4	

184 Mornington Road (Fire station)	64	67	64.7	-0.1	*Section 5.4*

Appendix D Diagrams of road-traffic noise effects of the scenario of the Project having not been built

Spread of road-traffic noise around the scenario of the Project having not been built

PPFs shaded by NZS 6806: 2010 Category for the scenario of the Project without any noise-specific mitigation

$L_{Aeq(24h)}$ noise level exceeds Category B

$L_{Aeq(24h)}$ noise level in Category B

$L_{Aeq(24h)}$ noise level in Category A

Appendix E Diagrams of road-traffic noise effects of the Project without any noise-specific mitigation

Spread of road-traffic noise around the scenario of the Project without any noise-specific mitigation

PPFs shaded by NZS 6806: 2010 Category for the scenario of the Project without any noise-specific mitigation

$L_{Aeq(24h)}$ noise level exceeds Category B

$L_{Aeq(24h)}$ noise level in Category B

$L_{Aeq(24h)}$ noise level in Category A

Appendix F Diagrams of road-traffic noise effects of the Project with the noise mitigation Best Practicable Option

Spread of road-traffic noise around the scenario of the Project with the noise mitigation Best Practicable Option

PPFs shaded by NZS 6806: 2010 Category for the scenario of the Project with the noise mitigation Best Practicable Option

$L_{Aeq(24h)}$ noise level exceeds Category B
$L_{Aeq(24h)}$ noise level in Category B
$L_{Aeq(24h)}$ noise level in Category A

Appendix G Summary of noise levels of the Project

Free field $L_{Aeq(24h)}$ (dB) noise levels at 1.5 metre high receivers for the for design year 2024

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Without Project having been built	Project without any noise-specific mitigation	Change due to Project relative to without the Project	Best Practicable Option	Change due to Best Practicable Option relative to Project without any noise-specific mitigation	Change due to Best Practicable Option relative to without the Project
583 South Road	64	67	65.2	65.1	-0.1	65.1	0.0	-0.1
581 South Road	64	67	63.1	62.7	-0.4	62.7	0.0	-0.4
579 South Road	64	67	64.6	63.9	-0.7	63.9	0.0	-0.7
577 South Road	64	67	65.0	64.6	-0.4	64.6	0.0	-0.4
575 South Road	64	67	65.3	64.9	-0.4	64.9	0.0	-0.4
569 South Road	64	67	66.7	66.8	0.0	66.8	0.0	0.0
567 South Road	64	67	68.5	68.2	-0.3	68.2	0.0	-0.3
563 South Road	64	67	67.5	67.0	-0.6	67.0	0.0	-0.6
559 South Road	64	67	66.8	66.1	-0.8	66.1	0.0	-0.8
557 South Road	64	67	66.0	65.2	-0.8	65.2	0.0	-0.8
545A South Road	64	67	61.3	60.6	-0.7	60.6	0.0	-0.7
2 Riselaw Road	64	67	60.3	60.1	-0.1	60.1	0.0	-0.2
4 Riselaw Road	64	67	59.4	61.8	2.5	61.8	0.0	2.4
6 Riselaw Road	64	67	56.1	58.9	2.8	58.8	0.0	2.7
8 Riselaw Road	64	67	56.9	59.9	2.9	59.8	0.0	2.9
10 Riselaw Road	64	67	56.1	58.9	2.8	58.9	0.0	2.8
12 Riselaw Road	64	67	57.2	60.0	2.8	60.0	0.0	2.8
6 Columba Avenue	64	67	54.3	56.9	2.6	56.8	0.0	2.6
42 Columba Avenue	64	67	55.3	55.1	-0.2	55.1	0.0	-0.2
40 Columba Avenue	64	67	55.9	55.6	-0.3	55.6	0.0	-0.3
38 Columba Avenue	64	67	56.0	55.7	-0.4	55.7	0.0	-0.4
36 Columba Avenue	64	67	55.0	55.1	0.1	55.1	0.0	0.1
34 Columba Avenue	64	67	54.8	54.7	-0.1	54.7	0.0	-0.1
32 Columba Avenue	64	67	53.8	54.1	0.3	54.1	0.0	0.3
30 Columba Avenue	64	67	52.8	53.3	0.4	53.3	0.0	0.5
28 Columba Avenue	64	67	51.4	52.1	0.7	52.1	0.0	0.7
26 Columba Avenue	64	67	50.8	51.5	0.7	51.5	0.0	0.7
24 Columba Avenue	64	67	51.2	52.7	1.5	52.7	0.0	1.5
22 Columba Avenue	64	67	51.5	53.3	1.8	53.2	0.0	1.7
20 Columba Avenue	64	67	51.4	53.2	1.9	53.2	-0.1	1.8
18 Columba Avenue	64	67	51.1	53.2	2.1	53.2	0.0	2.0
16 Columba Avenue	64	67	51.3	51.4	0.2	51.4	0.0	0.2
14 Columba Avenue	64	67	50.9	50.5	-0.5	50.5	0.0	-0.5
12 Columba Avenue	64	67	50.3	50.8	0.5	50.8	0.0	0.5
10 Columba Avenue	64	67	50.1	51.0	0.9	51.0	0.0	0.9

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Without Project having been built	Project without any noise-specific mitigation	Change due to Project relative to without the Project	Best Practicable Option	Change due to Best Practicable Option relative to Project without any noise-specific mitigation	Change due to Best Practicable Option relative to without the Project
8 Columba Avenue	64	67	51.5	51.1	-0.5	51.1	0.0	-0.5
27 Columba Avenue	64	67	52.3	52.8	0.5	52.8	0.0	0.5
25 Columba Avenue	64	67	52.3	52.6	0.3	52.6	0.0	0.3
21 Columba Avenue	64	67	52.6	52.9	0.2	52.9	0.0	0.2
9 Columba Avenue	64	67	51.5	51.6	0.2	51.6	0.0	0.2
7 Columba Avenue	64	67	51.0	51.2	0.1	51.2	0.0	0.1
5 Columba Avenue	64	67	52.4	53.1	0.7	53.1	0.0	0.7
30 Riselaw Road	64	67	57.5	59.5	2.0	59.5	0.0	2.0
34 Riselaw Road	64	67	49.6	51.0	1.4	51.0	0.0	1.4
32 Riselaw Road	64	67	56.6	58.7	2.0	58.7	0.0	2.0
527 South Road	64	67	55.6	57.9	2.3	57.8	0.0	2.3
525 South Road	64	67	55.7	55.7	0.0	55.4	-0.3	-0.3
523 South Road	64	67	52.0	53.3	1.3	53.3	0.0	1.3
521 South Road	64	67	52.4	51.9	-0.5	51.6	-0.2	-0.7
519 South Road	64	67	55.1	53.7	-1.5	53.6	-0.1	-1.6
517 South Road	64	67	54.7	53.0	-1.7	53.0	0.0	-1.7
515 South Road	64	67	56.3	53.9	-2.3	53.9	-0.1	-2.4
513 South Road	64	67	56.5	54.9	-1.7	54.7	-0.2	-1.8
511 South Road	64	67	55.4	54.6	-0.9	54.5	-0.1	-0.9
21 Riselaw Road	64	67	56.3	59.8	3.6	59.8	0.0	3.6
23 Riselaw Road	64	67	55.8	58.9	3.1	58.9	0.0	3.1
25 Riselaw Road	64	67	56.7	60.0	3.3	60.0	0.0	3.3
27 Riselaw Road	64	67	55.6	58.4	2.8	58.4	0.0	2.8
29 Riselaw Road	64	67	55.4	57.9	2.5	57.9	0.0	2.5
31 Riselaw Road	64	67	49.8	51.0	1.2	51.0	0.0	1.2
538 South Road	64	67	64.0	64.7	0.8	64.1	-0.7	0.1
163 Caversham Valley Road	64	67	71.8	68.6	-3.2	65.2	-3.4	-6.6
161 Caversham Valley Road	64	67	72.2	69.1	-3.0	64.6	-4.5	-7.6
159 Caversham Valley Road	64	67	73.3	69.8	-3.5	64.5	-5.3	-8.8
155 Caversham Valley Road	64	67	74.6	70.5	-4.1	64.8	-5.7	-9.8
153 Caversham Valley Road	64	67	74.5	70.6	-4.0	64.7	-5.9	-9.8
147 Caversham Valley Road	64	67	74.5	70.7	-3.9	64.7	-6.0	-9.8
145 Caversham Valley Road	64	67	74.5	70.6	-3.9	64.4	-6.1	-10.1
143 Caversham Valley Road	64	67	74.3	70.4	-3.9	64.3	-6.1	-10.0
141 Caversham Valley Road	64	67	71.7	68.8	-2.9	63.4	-5.4	-8.3
139 Caversham Valley Road	64	67	72.8	69.9	-2.9	64.5	-5.4	-8.3
127 Caversham Valley Road	64	67	71.7	69.3	-2.4	64.2	-5.2	-7.5
125 Caversham Valley Road	64	67	72.9	70.9	-2.0	67.1	-3.8	-5.8

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Without Project having been built	Project without any noise-specific mitigation	Change due to Project relative to without the Project	Best Practicable Option	Change due to Best Practicable Option relative to Project without any noise-specific mitigation	Change due to Best Practicable Option relative to without the Project
123 Caversham Valley Road	64	67	71.9	71.1	-0.8	68.1	-3.0	-3.8
121 Caversham Valley Road	64	67	72.1	70.6	-1.5	68.2	-2.4	-3.9
119 Caversham Valley Road	64	67	72.5	69.9	-2.5	68.5	-1.5	-4.0
117 Caversham Valley Road	64	67	73.0	69.9	-3.1	69.0	-0.8	-4.0
115 Caversham Valley Road	64	67	73.7	70.2	-3.5	69.7	-0.5	-4.0
113 Caversham Valley Road	64	67	72.8	69.5	-3.3	69.2	-0.3	-3.6
111 Caversham Valley Road	64	67	72.4	69.1	-3.3	68.8	-0.3	-3.6
472 South Road	64	67	60.2	66.4	6.1	66.4	0.0	6.1
536 South Road	64	67	57.9	57.9	0.0	56.5	-1.4	-1.4
534 South Road	64	67	58.2	57.0	-1.2	56.1	-0.9	-2.0
528 South Road	64	67	57.7	58.4	0.7	57.3	-1.1	-0.4
524 South Road	64	67	57.9	57.8	-0.1	56.9	-0.9	-1.0
522 South Road	64	67	58.4	58.2	-0.2	57.3	-0.9	-1.1
520 South Road	64	67	56.3	57.8	1.5	57.0	-0.7	0.8
518 South Road	64	67	56.4	57.9	1.5	57.2	-0.7	0.8
516 South Road	64	67	56.0	57.3	1.3	56.5	-0.8	0.5
514 South Road	64	67	55.8	57.2	1.4	56.4	-0.8	0.5
512 South Road	64	67	57.0	56.3	-0.7	55.7	-0.7	-1.3
510 South Road	64	67	53.6	55.5	1.9	55.2	-0.3	1.6
508 South Road	64	67	53.4	53.6	0.1	53.5	-0.1	0.0
506 South Road	64	67	52.7	53.6	0.9	53.5	-0.2	0.8
504 South Road	64	67	55.2	53.2	-2.0	53.2	-0.1	-2.0
502 South Road	64	67	55.6	53.6	-1.9	53.6	0.0	-1.9
500 South Road	64	67	53.4	55.3	1.9	55.3	0.0	1.9
498 South Road	64	67	53.8	56.5	2.8	56.5	0.0	2.7
496 South Road	64	67	52.8	57.0	4.1	57.0	0.0	4.1
494 South Road	64	67	54.3	59.3	5.0	59.2	0.0	5.0
492 South Road	64	67	55.3	60.7	5.5	60.7	0.0	5.4
490 South Road	64	67	54.3	62.1	7.8	62.1	-0.1	7.8
488 South Road	64	67	55.1	63.8	8.7	63.8	0.0	8.7
486 South Road	64	67	54.4	61.2	6.8	61.2	0.0	6.8
484 South Road	64	67	53.2	60.1	6.9	60.1	0.0	6.9
482 South Road	64	67	53.6	59.5	5.9	59.5	0.0	5.9
480 South Road	64	67	55.3	59.6	4.3	59.6	0.0	4.3
478 South Road	64	67	55.8	59.6	3.9	59.6	0.0	3.9
476 South Road	64	67	54.4	55.9	1.6	55.9	0.0	1.6
474 South Road	64	67	54.9	56.5	1.5	56.5	0.0	1.5
470 South Road	64	67	55.4	55.9	0.5	55.9	0.0	0.5

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Without Project having been built	Project without any noise-specific mitigation	Change due to Project relative to without the Project	Best Practicable Option	Change due to Best Practicable Option relative to Project without any noise-specific mitigation	Change due to Best Practicable Option relative to without the Project
468 South Road	64	67	56.6	62.6	6.0	62.6	0.0	6.0
67 Caversham Valley Road	64	67	59.9	66.3	6.4	66.3	0.0	6.4
466 South Road	64	67	56.5	57.9	1.4	57.9	0.0	1.4
464 South Road	64	67	53.6	52.8	-0.8	52.8	0.0	-0.8
462 South Road	64	67	55.6	57.0	1.4	57.0	0.0	1.4
460 South Road	64	67	53.8	54.1	0.3	54.1	0.0	0.3
16 Burnett Street	64	67	52.1	51.3	-0.9	51.3	0.0	-0.9
14 Burnett Street	64	67	49.4	51.0	1.6	51.0	0.0	1.6
12 Burnett Street	64	67	58.4	58.6	0.2	58.6	0.0	0.2
10 Burnett Street	64	67	59.2	59.3	0.2	59.3	0.0	0.2
8 Burnett Street	64	67	61.7	64.4	2.7	64.4	0.0	2.7
479 South Road	64	67	52.5	50.9	-1.6	50.8	-0.1	-1.7
477 South Road	64	67	50.9	51.3	0.3	51.3	0.0	0.4
465 South Road	64	67	59.9	59.8	-0.1	59.8	0.0	-0.1
24 Ensor Street	64	67	53.9	55.4	1.5	55.4	0.0	1.5
574 South Road	64	67	57.0	57.2	0.3	57.2	0.0	0.3
572 South Road	64	67	56.6	56.6	0.0	56.6	0.0	0.0
182 Mornington Road	64	67	63.9	62.7	-1.2	62.7	0.0	-1.2
180 Mornington Road	64	67	60.9	59.7	-1.2	59.7	0.0	-1.2
178 Mornington Road	64	67	59.2	58.3	-0.9	58.3	0.0	-0.9
176 Mornington Road	64	67	59.2	58.5	-0.7	58.5	0.0	-0.7
174 Mornington Road	64	67	56.9	57.2	0.3	57.2	0.0	0.3
172 Mornington Road	64	67	53.1	53.1	0.0	53.1	0.0	0.0
170 Mornington Road	64	67	47.8	47.5	-0.3	47.6	0.1	-0.2
168 Mornington Road	64	67	58.8	60.1	1.3	60.1	0.0	1.3
166 Mornington Road	64	67	49.5	49.2	-0.2	49.3	0.0	-0.2
164 Mornington Road	64	67	55.4	56.7	1.3	56.7	0.0	1.3
162 Mornington Road	64	67	62.2	63.2	1.0	63.2	0.0	1.0
160 Mornington Road	64	67	60.8	61.9	1.0	61.9	0.0	1.0
158 Mornington Road	64	67	58.5	59.3	0.8	59.3	0.0	0.8
179 Mornington Road	64	67	58.5	59.8	1.4	60.1	0.2	1.6
172 Caversham Valley Road	64	67	62.5	64.5	2.1	65.0	0.5	2.6
5D Aberfeldy Street	64	67	64.3	66.3	2.0	66.5	0.2	2.2
5B Aberfeldy Street	64	67	62.0	61.8	-0.2	61.8	0.0	-0.2
5A Aberfeldy Street	64	67	64.2	64.6	0.4	64.6	0.0	0.4
5 Aberfeldy Street	64	67	65.3	65.2	-0.1	65.2	0.0	0.0
7 Aberfeldy Street	64	67	64.2	64.1	-0.2	64.1	0.0	-0.1
9 Aberfeldy Street	64	67	60.1	59.9	-0.1	59.9	0.0	-0.1

PPF	NZS 6806: 2010 Category A limit	NZS 6806: 2010 Category B limit	Without Project having been built	Project without any noise-specific mitigation	Change due to Project relative to without the Project	Best Practicable Option	Change due to Best Practicable Option relative to Project without any noise-specific mitigation	Change due to Best Practicable Option relative to without the Project
11 Aberfeldy Street	64	67	55.8	56.5	0.7	56.4	0.0	0.6
19 Aberfeldy Street	64	67	59.4	59.1	-0.4	59.1	0.0	-0.4
13 Thompson Street	64	67	55.5	55.6	0.1	55.7	0.1	0.2
1 Lindsay Road	64	67	67.5	66.4	-1.2	66.4	0.0	-1.2
8 Aberfeldy Street	64	67	66.0	65.4	-0.6	65.4	0.0	-0.6
10 Aberfeldy Street	64	67	59.7	59.3	-0.4	59.3	0.0	-0.4
16 Aberfeldy Street	64	67	58.8	59.2	0.4	59.2	0.0	0.4
7 Rockyside Terrace	64	67	62.2	61.9	-0.3	61.9	0.0	-0.3
11 Rockyside Terrace	64	67	63.8	63.5	-0.4	63.4	-0.1	-0.4
15 Lindsay Road	64	67	63.1	62.9	-0.2	62.9	0.0	-0.2
25 Lindsay Road	64	67	57.0	56.9	-0.1	56.9	0.0	-0.1
14 Ballance Street	64	67	67.9	66.5	-1.3	66.5	0.0	-1.3
9 Ballance Street	64	67	58.2	58.3	0.2	58.3	0.0	0.2
7 Ballance Street	64	67	57.3	57.6	0.3	57.6	0.0	0.3
8 Ballance Street	64	67	66.7	66.4	-0.4	66.3	0.0	-0.4
6 Ballance Street	64	67	67.8	67.3	-0.4	67.3	0.0	-0.4
4 Ballance Street	64	67	65.8	65.6	-0.3	65.6	0.0	-0.3
2 Ballance Street	64	67	65.4	64.9	-0.5	64.9	0.0	-0.5
3 Ballance Street	64	67	58.6	58.5	-0.1	58.5	0.0	-0.1
1 Ballance Street	64	67	60.0	59.8	-0.2	59.8	0.0	-0.2
146 South Road	64	67	59.3	60.7	1.3	61.6	0.9	2.3
9 Burnett Street	64	67	62.9	64.2	1.3	64.2	0.0	1.3
11 Burnett Street	64	67	58.7	58.6	-0.1	58.6	0.0	-0.1
13 Burnett Street	64	67	57.0	56.8	-0.2	56.8	0.0	-0.2
15 Burnett Street	64	67	55.7	55.5	-0.2	55.5	0.0	-0.2
17 Burnett Street	64	67	55.3	55.4	0.1	55.4	0.0	0.1
420 South Road	64	67	55.1	55.3	0.2	55.3	0.0	0.2
416 South Road	64	67	57.3	57.6	0.3	57.6	0.0	0.3
414 South Road	64	67	57.8	58.1	0.4	58.1	0.0	0.4
412 South Road	64	67	57.8	58.2	0.4	58.2	0.0	0.4
410 South Road	64	67	58.5	58.9	0.4	58.9	0.0	0.4
408 South Road	64	67	60.6	60.7	0.0	60.7	0.0	0.0
406 South Road	64	67	59.9	60.1	0.2	60.1	0.0	0.2
404 South Road	64	67	63.7	62.7	-1.0	62.7	0.0	-1.0
402 South Road	64	67	60.5	58.7	-1.8	58.7	0.0	-1.8
21 Caversham Place	64	67	63.3	62.1	-1.2	62.1	0.0	-1.2
400 South Road	64	67	56.7	56.2	-0.4	56.2	0.0	-0.4
398 South Road	64	67	56.0	56.1	0.0	56.1	0.0	0.0

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17 Caversham Place	64	67	61.7	61.1	-0.6	61.1	0.0	-0.6
396 South Road	64	67	56.3	56.4	0.1	56.4	0.0	0.1
15 Caversham Place	64	67	61.7	61.2	-0.5	61.2	0.0	-0.5
394A South Road	64	67	50.5	50.8	0.3	50.8	0.0	0.3
394 South Road	64	67	58.9	58.7	-0.1	58.7	0.0	-0.1
13 Caversham Place	64	67	61.6	61.3	-0.3	61.3	0.0	-0.3
378 South Road	64	67	61.6	61.4	-0.3	61.4	0.0	-0.3
10 Barnes Drive	64	67	61.7	61.3	-0.4	61.3	0.0	-0.4
13 Caversham Place	64	67	61.6	61.3	-0.3	61.3	0.0	-0.3
378 South Road	64	67	61.6	61.4	-0.3	61.4	0.0	-0.3
10 Barnes Drive	64	67	61.7	61.3	-0.4	61.3	0.0	-0.4
184 Mornington Road (Fire station)	64	67	64.8	64.7	-0.1	64.7	0.0	-0.1


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