HEGLEY ACOUSTIC CONSULTANTS

WHAKATU ARTERIAL PROJECT

ASSESSMENT OF NOISE AND VIBRATION EFFECTS

Report No 9462.2

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Prepared for:

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Contents

1. EXECUTIVE SUMMARY

Potential Effects

The Whakatu Arterial Link ('WAL') is a new road project that will pass relatively close to a number of existing dwellings. These dwellings will experience noise from both the construction of the WAL and the subsequent traffic movements. There is the potential for both activities to result in adverse noise and vibration effects, which are the subject of this assessment.

Assessments Undertaken

An assessment of operational road traffic noise was undertaken in accordance with NZS6806:2010 'Acoustics – Road –Traffic Noise – New and Altered Roads'. This document provides operational noise limits for road traffic noise to comply with at a selected future design year. To supplement NZS 6806, the existing ambient sound levels at selected sites were also recorded.

Road traffic noise was predicted for the surrounding noise sensitive activities using the TNM computer prediction software which was specifically developed for the prediction of traffic noise. Using TNM, mitigation methods were developed that achieved the criteria of NZS 6806 and, through consultation with the design team, a preferred choice that represents the best practicable option for the WAL was selected.

The noise from the construction of the WAL was assessed against the criteria of NZS 6803:1999 'Acoustics - Construction Noise'. Given that the construction plant and construction activities are as yet undetermined, the assessment relied upon measurements of typical construction activities to predict the expected noise levels to the surrounding houses.

Construction vibration has been assessed against specific criteria for road construction.

Results of Assessments

The analysis of operational road traffic noise showed that mitigation will be necessary for the most exposed dwellings in order to control road traffic noise levels to within the criteria of NZS 6806. Further analysis developed road surface and barrier mitigation options from which the road surface mitigation option was selected. This option will ensure that the criteria of NZS 6806 will be met at all surrounding noise sensitive properties. Based on this, and with reference to the measurements of the existing ambient sound, it was concluded that the adverse effects of road traffic noise will be acceptable.

Predictions of construction noise showed that, at the closer houses, there is the potential for construction activities to exceed the assessment criteria. This is not unusual for construction activities, which are inherently noisy.

Analysis showed that while vibration from construction activities was likely to be noticeable at the closer houses, it is unlikely to cause annoyance and is not expected to cause cosmetic building damage. Given the proposal will include the resurfacing of roads adjacent to the closest houses the vibration from traffic on the road network is expected to be acceptable.

Suggested approach for effects identified

The design solution put forward to control operational noise is to use an asphalt road surface on the following sections:

- WAL between station 2550 and the SH2 roundabout;
- SH2 between station 125 and the SH2 roundabout; and
- SH2 between the SH2 roundabout and station 800.

The most practicable method of controlling construction noise and vibration is through the preparation of a Construction Noise and Vibration Management Plan. Options available to the contractor include:

- Use smaller, quieter plant;
- Limit the use of some noisier equipment to the most exposed houses;
- The use of screens to control noise.

2. INTRODUCTION

The proposed WAL in Hastings will connect Pakowhai Road in the north to State Highway 2 (‘SH2’) in the south. The WAL will consist of a single lane in either direction with roundabout connections at either end. The existing Whakatu Road will intersect with the WAL at a new roundabout. Appendix A shows the location of the proposed WAL. This report provides an assessment of the noise and vibration effects from the construction of, and subsequent traffic using, the proposed WAL and has been prepared in support of a Notice of Requirement (‘NoR’) for the project.

Appendix B contains a description of acoustic terms used in this report.

3. ASSESSMENT CRITERIA

3.1 Road Traffic Noise Assessment Criteria

The Operative Hastings District Plan (made operative on 10 June 2003) provides no criteria for the assessment of traffic noise. However, rule 25.1.7I of the Proposed District Plan requires the use of NZS6806:2010 'Acoustics – Road –Traffic Noise – New and Altered Roads' ('NZS6806'). This standard has been developed specifically for the assessment of traffic noise and has been used for the assessment of the WAL.

NZS 6806 uses the $L_{Aeq(24\ hour)}$ metric to assess traffic noise at the facade of Protected Premises and Facilities ('PPFs') which, in this case, are the houses and Mangateretere School adjacent to the WAL. The locations of the PPFs are shown in Appendix A and on Figure 1.

The assessment method requires noise from traffic on the road at design year, which is a minimum of 10 years after opening, to be compared against specified criteria to determine where mitigation should be investigated. The criteria of NZS 6806 were developed to control road traffic noise to within a reasonable level when taking into account the adverse effects on people, the effects of relative changes in noise level and the potential benefits of new and altered roads. The criteria that apply to this project are detailed in section 4.3.1 of this report. Where necessary, mitigation has been developed.

3.2 Construction Noise Assessment Criteria

Rule 14.2.8.4 of the Operative Hastings District Plan ('District Plan') relates to construction noise and requires that:

> *Construction noise in any zone shall not exceed the recommended limits in, and shall be measured in accordance with the provisions of NZ Standard 6803:1999 Acoustics - Construction Noise "Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work". Discretionary adjustments within clause 6.1 shall be mandatory within the District.*

The reference to the Construction Standard in the District Plan mixes the titles of the latest 1999 edition with its 1984 predecessor, which was titled

'Construction Noise - Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work. As the later New Zealand Standard, NZS 6803:1999 'Acoustics - Construction Noise' (the 'Construction Noise Standard') is the current version, it has been adopted for the assessment. This is consistent with rule 25.1.6I of the Proposed District Plan, which requires the use of the 1999 version of the standard. The relevant sections of NZS 6803 are provided in Appendix C.

For the purposes of this assessment, it has been assumed that construction of the WAL will exceed 20 weeks thereby attracting the 5dB correction for duration. Based on this, the relevant assessment criteria when measured at 1m from the most exposed facade are 70dBA L_{eq} and 85dBA L_{max} between 0730 and 1800 hours, Monday to Saturday.

4. EXISTING AMBIENT SOUND

NZS 6806 does not rely on the existing noise environment for assessment and therefore does not require the existing ambient sound to be measured. However, when assessing the effects of noise from the proposed WAL, a comparison to the existing noise environment is useful and it has therefore been considered.

The ambient sound was measured at the three PPFs described below. These PPFs were selected as between them, they provide an understanding of the ambient sound environment to all PPFs in the vicinity of the WAL. Measurements were undertaken using unattended data loggers that were installed on the morning of Thursday, 1st November 2012 and left for a 24 hour period. During this time, the weather varied, but was generally fine, warm and clear with light winds.

PPF B

PPF B, the location of which is shown in Appendix A and on Figure 1, is accessed from Ruahapia Road. The measured ambient sound level at the assessment point of this PPF was 53dB $L_{Aeq(24hour)}$ and is shown graphically on the Figures of Appendix D.

PPF E

PPF E is located at the southern end of the WAL close to the intersection with SH2. The location of this PPF is also shown in Appendix A and Figure 1. The existing ambient sound at this location was 56dB $L_{Aeq(24hour)}$ as shown in Appendix D.

PPF I

During the measurements at this PPF, a spray irrigator was operating close to the microphone. The noise adversely affected the measurement which has therefore been discarded from the assessment.

4.1 Remaining PPFs

PPFs A and C are in a similar location to, and at a similar distance from Ruahapia Road, as PPF B. Based on this, the ambient sound at A and C have been taken to be the same as at B.

The remaining PPFs are all relatively close to SH2, which will control the ambient sound within the area. Based on this, the existing ambient sound levels have been calculated in the same manner as the proposed future road traffic noise, as discussed in Section 4.1, except that the existing traffic flow of 12,277 vehicles per day with 5% heavy commercial vehicles ('HCV') has been used.

All existing ambient sound levels are summarised in Tables 2 and 3.

5. ROAD TRAFFIC NOISE

5.1 Traffic Noise Prediction Method

Noise from traffic using the alignment has been predicted to the surrounding PPFs using the Traffic Noise Model ('TNM') computer program, which is a three dimensional geometry modelling program that has been developed solely for the prediction of traffic noise by the U.S. Federal Highway Administration ('FHWA'). TNM produces a full scale computer generated model of the alignment that includes all variables that affect traffic noise, which are described in the following sections. TNM includes a barrier design module to optimise the length and height of barriers.

TNM has been calibrated for New Zealand conditions and has proven to predict traffic noise levels to within ±2dBA.

5.2 Data used for Traffic Noise Prediction

Road Alignment

The currently proposed road alignment was provided electronically by the designers in a 3D format that could be imported directly into TNM.

Cuts and Fills

The cuts and fills required for the road alignment were also provided by the designers and imported into TNM.

Surrounding Topography

The topography of the area surrounding the WAL was provided electronically by the designers in a form that could be imported into TNM. The ground contours are at 0.1m intervals.

Protected Premises and Facilities (PPFs)

Statistics New Zealand[1] classifies the area of the proposed WAL as a Main Urban Area. For urban areas, NZS 6806 requires PPFs within 100m of the

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1. Statistics New Zealand. *New Zealand: An urban/rural profile.* Wellington: Statistics New Zealand. 2004.

edge of the closest lane of traffic to be included in the assessment. The 100m boundary is marked on Figure 1.

This assessment deviates from NZS 6806 on this point as it includes PPFs A, B and C, all of which are greater than 100m from the WAL. These PPFs were included when considering other alignment options and were reported upon for public consultation. For completeness, they have been retained for this assessment.

The PPFs adjacent to the proposal were imported into the noise model with the aid of aerial photographs and a topographical survey of the area and are shown on Figure 1 as well as Appendix A.

In accordance with NZS 6802, road traffic noise has been assessed at the façade of each residential dwelling. At Mangateretere School (PPF G), noise is assessed at both the most exposed school façade and at the playground facing SH2, as required by NZS 6802.

Design Year Traffic Flow

NZS 6806 requires assessment to be based on traffic flows between 10 and 20 years after the completion of the road. All analysis has been based on the WAL being operational by 2016, which results in a 2026 design year. The traffic flows and average speeds at this time are summarised in Appendix E. Analysis has been based on 8% HCVs on all roads considered in the analysis.

Road Surface

The analysis has been based on medium grade chip seal (such as Grade 3 + Grade 5) over the majority of the alignment with an allowance for asphalt on the roundabouts and their approaches for a distance of 50m. Throughout the remainder of this report this option is referred to as the '3 + 5 chip option'. Where higher performing road surfaces have been investigated for the control of traffic noise, asphalt or Open Graded Porous Asphalt ('OGPA') have been considered. The performance of the various seal types are in accordance with the Land Transport New Zealand Research Report 326[2].

Ground Type

Noise propagation is affected by the absorption of the ground over which the sound is traversing. Noise has been predicted based on a grassed surface between the source and receiver.

Throttle Settings

TNM adjusts the throttle setting of vehicles to maintain the design speed and increases the throttle setting uphill while reducing the throttle setting downhill. The road gradient is derived from the road alignment, which is imported electronically into TNM.

Barriers

Where the use of barriers has been considered a number of locations and barrier lengths were investigated so as to maximise the performance of the barrier. TNM's barrier design module was then used to optimise the location and height of the barrier.

5.3 Road Traffic Noise Assessment

The process followed by NZS 6806 for the assessment of road traffic noise is outlined below.

5.3.1 Assessment Criteria

NZS 6806 provides criteria for both new and altered roads. PPFs A – C have been assessed against the criteria for new roads. However, as the remaining PPFs are within 100m of one of the roads that are to be realigned to join with

2. Dravitzki, V., Kvatch, I. 2007. Road surface effects on traffic noise: stage 3 – selected bituminous mixes. Land Transport New Zealand Research Report 326.

the new SH2 roundabout, PPFs D – I were assessed against the altered road criteria. Figure 1 shows the 100m boundary from the edge of the carriageways.

NZS 6806 provides graduated noise criteria for both new and altered roads and directs that the lowest criteria that represent the Best Practicable Option ('BPO') be adopted. These criteria are shown below and apply externally at the PPF facade.

Table 1 - Noise Criteria of NZS6806

Category		Altered roads $L_{Aeq(24hour)}$	New roads $L_{Aeq(24hour)}$
A	Primary	64	57
B	Secondary	67	64

The criteria specific to each PPF are summarised in Tables 2 and 3.

5.3.2 Assessment of the Do-Minimum Situation

The do-minimum scenario is the noise from traffic on the WAL and associated roads that are to be realigned during design year with the 3 + 5 chip seal and without any specific noise mitigation. The resulting noise levels are summarised in Table 2. Where the do-minimum noise exceeds the Category A criteria of NZS 6806, mitigation has been investigated.

Table 2. Summary of Existing and Do-Minimum Analysis

PPF	New or Altered Road	Road Traffic Noise Levels, dB $L_{Aeq(24\ hour)}$			
		Assessment Criteria		Existing Ambient Sound	Do-Minimum
		Cat A	Cat B		
A	New	57	64	53	50
B	New	57	64	53	55
C	New	57	64	53	54
D	Altered	64	67	65	68
E	Altered	64	67	56	68
F	Altered	64	67	67	69
$G_{(Classroom)}$	Altered	64	67	64	65
$G_{(Playground)}$	Altered	64	67	67	68
H	Altered	64	67	59	62
I	Altered	64	67	57	64

- Complies with Category A and B.
- Complies with Category B criterion but not Category A.
- Exceeds both Category A and B.

5.3.3 Mitigation Options

The do-minimum noise levels of Table 2 indicate that while design year traffic noise levels comply with the Category A criteria to PPFs A, B, C, H and I, it will be necessary to consider mitigation to the remaining PPFs D, E, F, $G_{(Classroom)}$ and $G_{(Playground)}$.

TNM was used to investigate a number of barrier and road surface mitigation options and to develop an optimised solution for each. The resulting barrier and road surface mitigation options were presented to the design team who then assessed the merit of each with respect to their area of expertise. As a result of this collaborative effort, the design team considered that the road surface mitigation option was superior. The deciding factor for selecting this option was that the road surface either side of the roundabouts at either end of the alignment and the intersection with Whakatu Road (which are within the areas where road surface mitigation was identified as necessary), were already being upgraded to deal with the vehicle turning movements. This being the case, it was decided that the best option was simply to extend the upgraded seal slightly further than was necessary to deal with the turning movements at these intersections.

The selected road surface mitigation option consists of replacing sections of the 3 + 5 chip seal with a higher performing road surface. Various lengths and types of upgraded road surface were considered in developing the final option, which is described below for each PPF. Figure 1 shows the extent of the road surface upgrades, while the resulting road traffic levels are given in Table 3.

PPF D

Road traffic noise to PPF D has been controlled to within the Category A criterion by using asphalt on SH2 from the roundabout to station 800, as shown on Figure 1.

PPF E

Road traffic noise to PPF E has been controlled to within the Category A criterion by upgrading the WAL to asphalt from station 2550 to the SH2 roundabout. Figure 1 shows the extent of the asphalt.

PPFs F and $G_{(Playground)}$

Asphalt is proposed on SH2 from station 125 to the new roundabout to control noise to PPF F, PPF $G_{(Playground)}$ and also $G_{(Classroom)}$. Again, Figure 1 shows the extent of this road surface upgrade.

Further Mitigation Options

It is understood that at the Whakatu Community Consultation Meeting on 27 November, 2013, the effects of noise were specifically discussed. Whilst the approach of meeting the criteria of NZS6806 was acknowledged, community members requested that this Standard be treated as a minimum, and an effort was made to exceed the Standard. The surface modification measures proposed in this report will achieve compliance with NZS6806. In order to exceed this, additional measures, such as barriers, would be required at individual PPFs. It is recommended that Hastings District Council investigate the practicability of additional mitigation measures through further consultation with the landowners concerned.

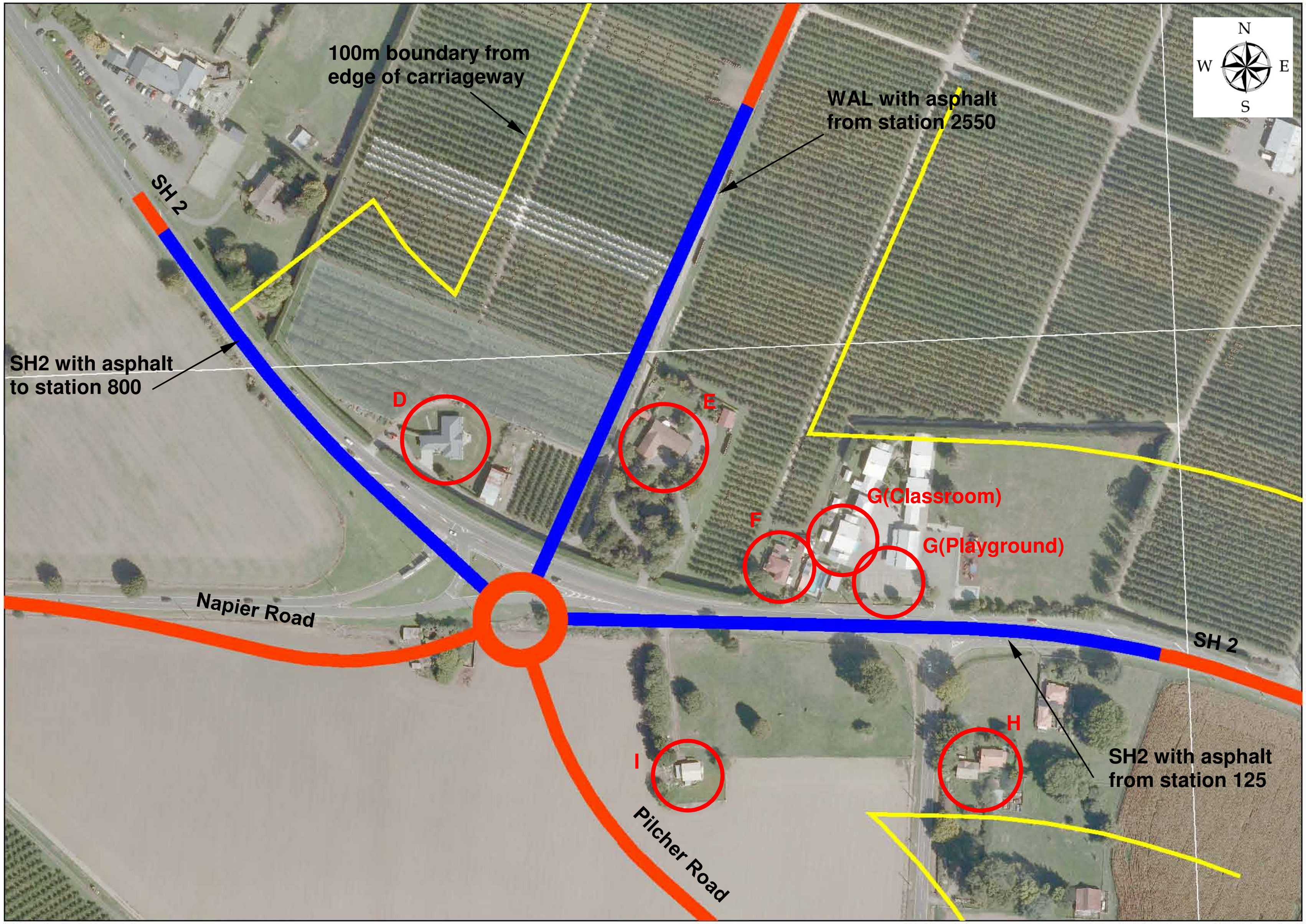


Figure 1. Road Surface Mitigation Option for PPFs D - PPFs D – G

5.3.4 Traffic Noise Levels

The design year road traffic noise levels with the BPO mitigation option are summarised in Table 3 below.

Table 3. Summary of BPO Analysis

PPF	New or Altered Road	Existing Ambient Sound dB $L_{Aeq(24\ hour)}$	Design Year Noise Levels, dB $L_{Aeq(24\ hour)}$		
			Assessment Criteria		BPO Asphalt
			Cat A	Cat B	
A	New	53	57	64	50
B	New	53	57	64	55
C	New	53	57	64	54
D	Altered	65	64	67	64
E	Altered	56	64	67	64
F	Altered	67	64	67	64
$G_{(Class)}$	Altered	64	64	67	61
$G_{(Play)}$	Altered	67	64	67	64
H	Altered	59	64	67	58
I	Altered	57	64	67	63

[green box] - Complies with Category A criterion.

The results reported in Table 3 confirm that the traffic noise levels with road surface mitigation will comply with the Category A criteria of NZS 6806 to all PPFs.

5.3.5 Assessment of Effects

The criteria of NZS 6806 have been considered reasonable when taking into account the adverse health effects associated with noise on people and communities, the effects of relative changes in noise level, and the potential benefits of roads. Therefore, by complying with the criteria of NZS 6806, it can be concluded that the effects of the proposed WAL are reasonable.

A useful method of considering the effects of noise is the magnitude of the change in level compared to the existing situation. As a guide, a 3dB change is the smallest that the average person will detect while a 5dB change is clearly noticeable. A 10dB change is an apparent halving, or doubling, in level.

Considering Table 3, the largest increases in level over the existing ambient sound, as a result of the proposal at design year, will be 8dB and 6dB at PPFs E and I respectively. While these changes could be described as significant, the resulting levels comply with Category A of NZS 6806 and are therefore considered to be reasonable. The only other increases will be at PPFs B and C and the increases will be 2dB and 1dB respectively. These changes in level are too small to be perceived as an increase, although it should be noted that the traffic noise will be audible at these PPFs. To the remaining PPFs, noise levels will reduce by up to 3dB. Again, the changes are small and will not be evident at most PPFs.

When considering the relatively small changes in level as a result of the proposal and the fact that the resulting road traffic noise levels comply with the criteria of NZS 6806, it has been concluded that the effects of noise from the proposal have been adequately mitigated so that they will be reasonable and will not create any adverse effects.

6. CONSTRUCTION NOISE

At the current early stage of the proposal, the contractor and construction methods are unknown making it impracticable to undertake a detailed assessment of construction noise. As a result, a preliminary assessment has been undertaken based on typical construction techniques to demonstrate that it will be practicable to construct the proposed WAL. While the Construction Noise Standard does not refer to the assessment houses as PPFs, this term, which is used in this report for the assessment of operational noise, has been adopted for the assessment of construction noise for consistency.

6.1 Construction Noise from Typical Activities

Plant commonly associated with road construction includes motor scrapers, excavators, graders, rollers and pavers. The noise from this plant has been predicted to each PPF based on measurements of other similar plant. Noise reduces with distance and it is therefore necessary to know how close the plant will come to each PPF. As the detailed construction drawings will be developed at a later stage in project development, the assessment has been based on the construction equipment operating up to 5m from the edge of the carriageway.

The resulting noise levels are reported in Table 4.

Table 4. Construction Noise Levels from Plant at Closest Point to PPF without Specific Mitigation

House	Excavator		Scraper		Grader		Roller		Paver	
	L_{eq}	L_{max}	L_{eq}	L_{Lmax}	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
A	47	61	52	56	49	53	49	58	44	45
B	51	66	56	60	54	58	54	63	49	50
C	54	69	59	63	56	60	57	66	51	52
D	70	85	75	79	72	76	72	82	67	68
E	74	89	79	84	77	81	77	86	72	73
F	73	88	78	82	75	79	75	85	70	71
G(Classroom)	65	80	70	74	67	71	68	77	62	63
H	59	74	64	68	61	65	61	70	56	57
I	64	79	69	74	67	71	67	76	62	63

(green) - Complies with 70dBA L_{eq} and 85dBA L_{max} criteria

(red) - Does not satisfy criterion.

The Table 4 results show that there is the potential for construction noise to exceed the recommended criteria of the Construction Noise Standard and mitigation should therefore be investigated. The most practical approach is to leave the exact form of mitigation to the contractor via a Construction Noise and Vibration Management Plan ('CNVMP') once exact plant and construction techniques are known and it is necessary to demonstrate that there are viable options. Typically, successful mitigation options include:

- Use smaller, quieter plant;
- Limit the use of some noisier equipment to the most exposed houses;
- Use screening. Typically, 5 – 10dB is available from a properly constructed screen, making screening an effective option.

7. VIBRATION

7.1 Construction Vibration

An approach that is currently used in New Zealand for the assessment of vibration from the construction of roads is a two tier system, the criteria of which are shown below.

Table 5. Vibration Criteria for Construction Activities

Receiver	Details	Category A	Category B
Occupied Dwellings measured inside the building	Night time (2000 – 0630hrs)	0.3mm/s PPV	1mm/s PPV
	Day time (0630 – 2000hrs)	1.0mm/s PPB	5mm/s PPV

The approach used is that construction should be managed to comply with the Category A criteria. If measured or predicted vibration levels exceed the Category A criteria, then vibration should be managed to comply with the Category B criteria as far as practicable. If the construction vibration exceeds the Category B criteria then construction activity shall only proceed if there is continuous monitoring of vibration levels and the effects on those buildings at risk of exceeding the Category B criteria are considered acceptable.

The criteria are largely based on BS 5228-2 ‘Noise and Vibration Control on Construction and Open Sites’, with a reference to the German Standard 4150-3:1999 ‘Structural Vibration - Effects of Vibration on Structures’ for Building Damage Criteria.

As with construction noise the assessment of vibration should be considered preliminary, as the exact construction methods and plant to be used have not yet been determined. Analysis has been based on the use of a vibrating roller, which is expected to be one of the activities that will produce the highest levels of vibration, in order to demonstrate that it will be practicable to complete the project in accordance with the adopted criteria.

Vibration has been predicted in accordance with Appendix E of BS 5228 to the closest house E, which will be closest to the earthworks with the results shown in the Table below.

Table 6. Predicted Vibration Level for Vibrating Roller

House	Exceedance Probability			Comment
	50%	33.3%	5%	
House E	1.2mm/s	2.2mm/s	4.3mm/s	Vibration perceivable but will generally not result in annoyance. Negligible risk of cosmetic building damage.

As a summary, the construction activity that would, if implemented, result in the highest levels of vibration is not expected to cause any cosmetic damage to buildings. While the vibration will likely be perceptible, it is considered that it will generally not be annoying. It should be noted that the predicted vibration levels are for a vibrating roller and, should its use result in an issue, other options could be investigated. The most practical approach is to leave the exact form of mitigation to the contractor via a CNVMP once exact plant and construction techniques are known.

There are a number of industrial uses along the length of the WAL and while they are typically some distance from the proposed carriageway (minimum of 50m), they may have machinery or operating procedures that are particularly susceptible to vibration. Such specific issues require a detailed solution that is based on the vibration tolerances of the particular industry and the plant and operating procedures of the selected contractor. This being the case, the most appropriate method of managing this potential effect is through the CNVMP.

7.2 Operational Vibration

With respect to vibration from vehicles using the WAL, it is noted that with the exception of Houses A – C, which are in excess of 160m from the carriageway, the remaining residences are already relatively close to SH2. Given that the proposal is to resurface all roads about the closest houses, it is expected that there will be an initial improvement in vibration to these houses. Further vibration levels would depend partially on the state of the road surface however assuming proper maintenance, operational vibration effects are expected to be less than minor.

8. CONCLUSIONS

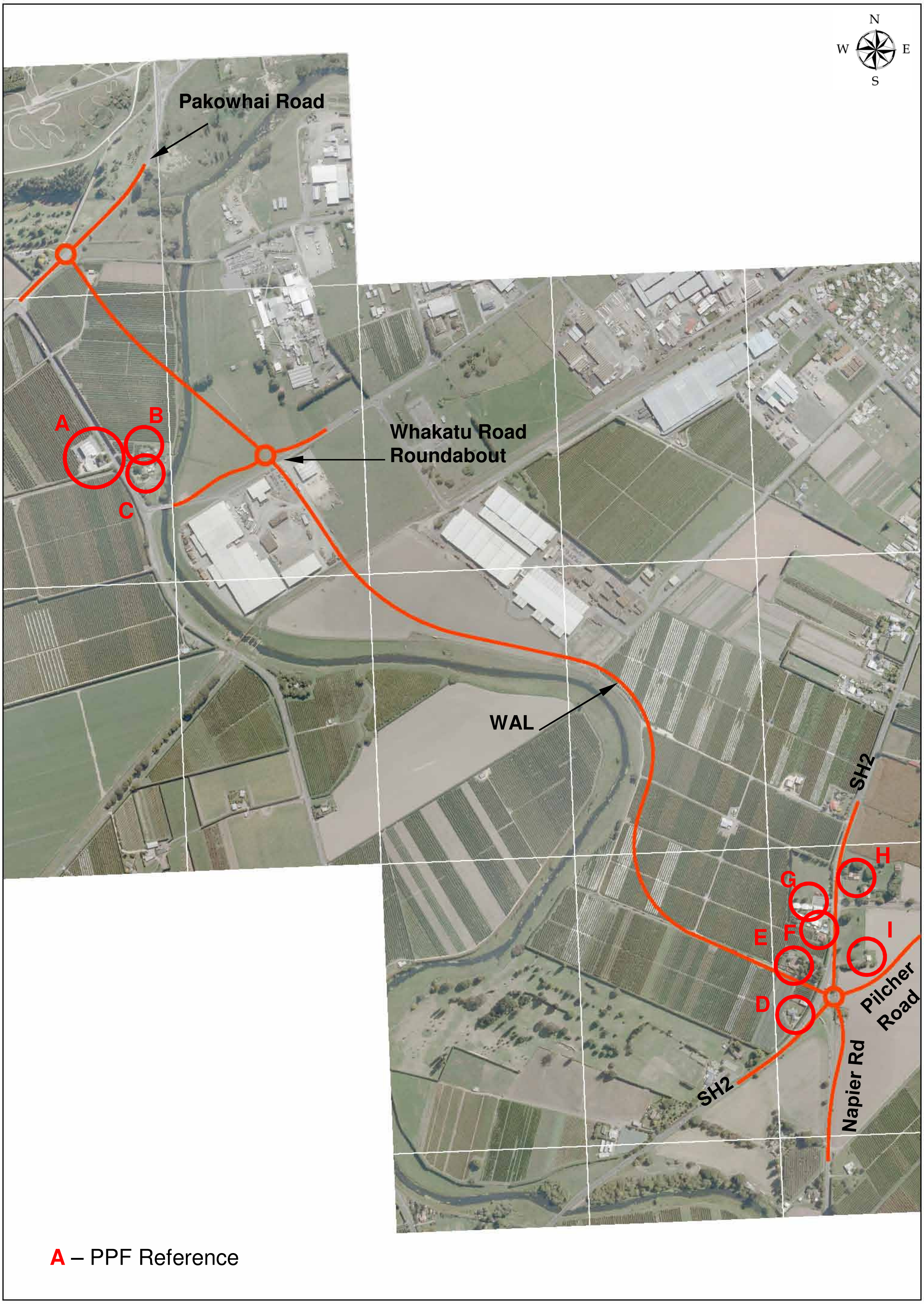
The noise from the proposed WAL has been assessed against the New Zealand Traffic Noise Standard, NZS 6806. Analysis developed options using both road surface and barrier mitigation so that the design year traffic noise levels will comply with the requirements of NZS 6806. The design team considered both options before selecting the road surface mitigation option as the best practicable option for the Whakatu Arterial. Under the selected option, the Category A criterion of NZS 6806 will be met at all PPFs adjacent to the WAL. Based on this, it is concluded that the resulting noise levels to the surrounding PPFs will be reasonable and that any adverse effects have been adequately mitigated.

A preliminary assessment of noise from typical construction activities has shown that some mitigation to the noisier plant may be necessary when working close to the most exposed houses. There are practicable options for achieving the reductions required. However, due to the large number of variables that affect construction noise, the only practicable method of managing the effects is by the preparation of a Construction Noise and Vibration Management Plan by the successful contractor.

The anticipated construction activities resulting in the highest levels of vibration have been considered and show that vibration is not expected to cause any cosmetic damage to buildings. While the vibration will likely be perceptible at times, it is considered that it will generally not be annoying. It is recommended that any effects are managed through the preparation of a Construction Noise and Vibration Management Plan by the successful contractor.

Given the proposal will include the resurfacing of roads adjacent to the closest houses the vibration from traffic using the new road network is expected to be reasonable.

Appendix A – Schematic Plan of the Proposed Whakatu Link Road



Appendix B – Guide to Noise Terms

The following sets out an explanation of the acoustic terms that are referred to throughout this report. The aim is not to necessarily provide technical definitions, but to enable a basic understanding of what is meant.

The setting of specific noise levels to control any adverse effects does not necessarily mean that noise will not be heard. Audibility depends on the level of a sound, the loudness of the background sound and any special frequency composition or characteristics that a sound may have.

Research suggests that a small number of people (approximately 10%) will find any noise not of their own making unacceptable. Conversely, there are approximately 25% of the population that are essentially immune to any noise. Neither of these two extremes is normally designed for. In establishing the appropriate noise levels the aim is to try and represent the typical expected community reaction, this will generally be approximately 90% of the people.

In order to reflect community response to noise it is necessary to establish a measure that reflects our attitude to the sounds that we hear. Due to the variability of many sounds (level, tone, duration, intrusiveness above the existing sound, etc) no single descriptor will totally describe the potential community reaction to a sound. For this reason there are a number of terms that need to be understood.

dBA

The basic unit to quantify a sound is the decible (dB). The A-weighted sound level, or dBA, is a good environmental noise descriptor because of the similarity between A-weighting and the frequency response of the human ear at moderate sound levels. It can also be measured easily. However, it provides no indication of tonal frequency components or unusual frequency distributions of sound that may be the cause of annoyance. Where appropriate, this must be assessed separately.

We can hear a change in sound pressure that varies from 1 (taken as the threshold of hearing) through to 1,000,000,000,000 (taken as the threshold of pain). In order to bring these numbers to a more manageable size a logarithmic scale is normally adopted. This reduces the above values to 0 and 12 respectively. The decibel is then described as 10 times the logarithm of the ratio of the pressure level of interest, to a reference pressure level. Thus the scale becomes 0 to 120dBA. The following Figure provides a guide as to the perception of different noise levels.
Some typical subjective changes in noise levels are:

A change of 3dBA is just perceptible
A change of 5dBA is clearly perceptible
A change of 10dBA is twice (or half) as loud

Because we use a logarithmic scale care must be taken when adding sound levels. Two equal noise sources raise the level of one source by 3dBA. It takes 10 equal noise sources to raise the level of one source by 10dBA. ie 60dBA + 60dBA = 63dBA and 60dBA x 10 = 70dBA.

Maximum Sound Level (L_{max})

This unit equates to the highest (maximum) sound level for a defined measurement period. It is adopted in NZS6802:1991 Assessment of Environmental Sound, mainly as a method of protecting sleep.

Equivalent Sound Level (L_{eq})

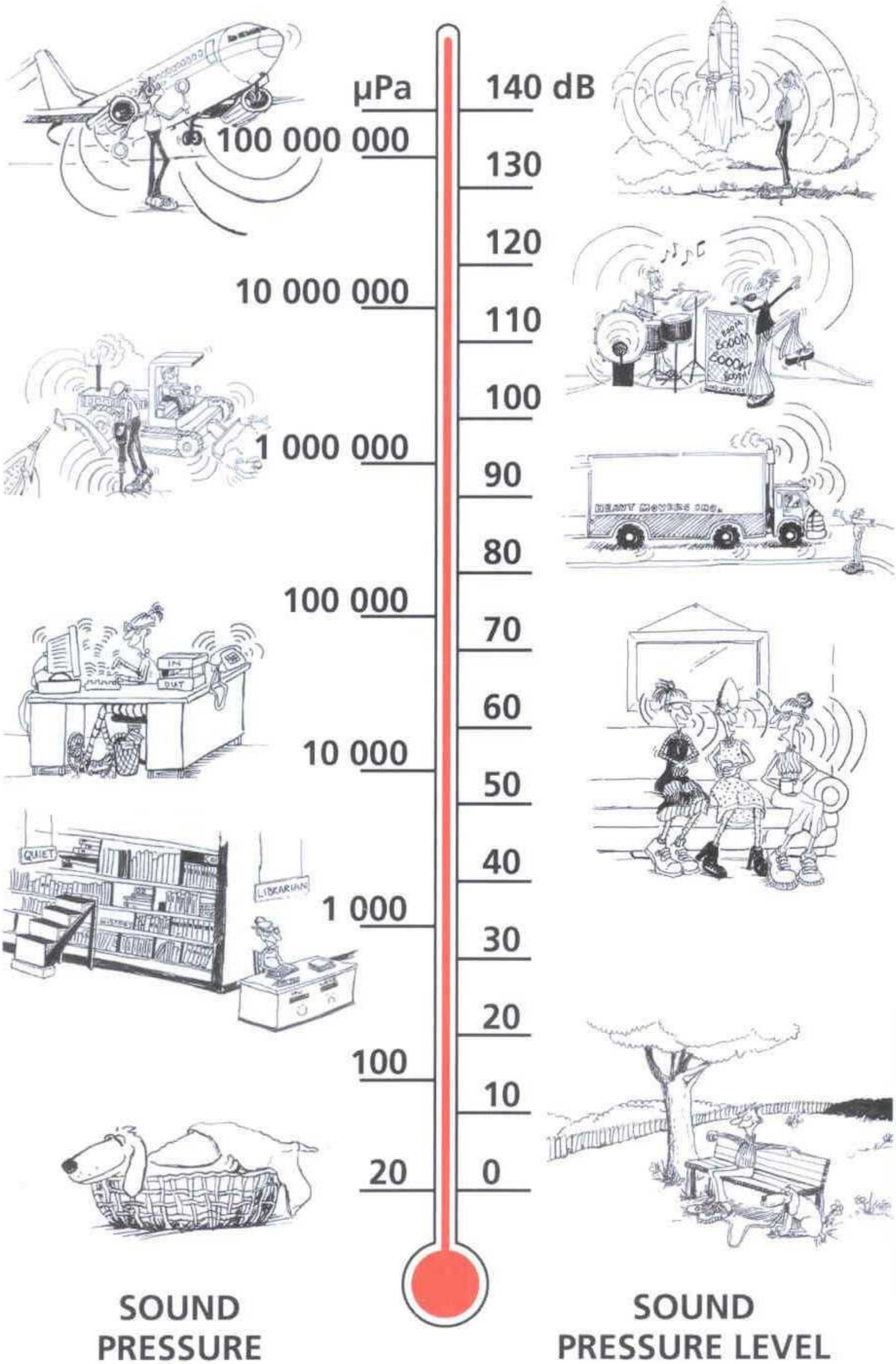
The L_{eq} may be considered as the continuous steady noise level that would have the same total A-weighted acoustic energy as a fluctuating noise over the same time period, which should be stated. Thus the $L_{eq(24hour)}$ is the noise level averaged over a 24 hour period.

Background Sound L_{95}

The sound level which is equalled or exceeded for 95% of the measurement time. This level is adopted in NZS6802:1991 Assessment of Environmental Sound to measure the background sound. This level may be considered as the average minimum sound level and is the component of sound that subjectively is perceived as continuously present.

Ambient Sound

The ambient sound is normally used to describe the total noise environment. The ambient sound is often measured as the 24 hour $L_{eq,}$ which is an average value over the 24 hour period. Shorter times are often used, such as the daytime period



µPa
100 000 000
10 000 000
1 000 000
100 000
10 000
1 000
100
20
140 dB
130
120
110
100
90
80
70
60
50
40
30
20
10
0
QUIET
LIBRARIAN
IN
OUT
SOUND
PRESSURE
SOUND
PRESSURE LEVEL

Appendix C – Construction Noise Rules

District Plan Noise Rule

N2.1 All construction work, including maintenance and demolition work, on any site shall be designed and conducted to ensure that noise from the site does not exceed the noise limits in table 1. Sound levels shall be measured and assessed outside buildings affected by construction noise in accordance with the provisions of NZS6803:1999 Acoustics – Construction Noise.

TABLE 1 of Appendix N

Time period	Weekdays (dBA)		Saturdays (dBA)		Sundays and Public Holidays (dBA)	
	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
06:30 – 07:30	60*	75	45	75	45	75
07:30 – 18:00	75*	90*	75*	90*	55	85
18:00 – 06:30	45	75	45	75	45	75

N2.2 * Where a site is exposed to construction work for a duration exceeding 20 weeks then 5dBA shall be subtracted from the noise limits marked.

N2.3 The air-blast noise limit from the use of explosives shall not exceed a peak sound level of 120dBC measured and assessed outside affected buildings in accordance with the provisions of NZS6803:1999 Acoustics – Construction Noise. Blasting practices shall conform to the provisions of AS2187: Part 2.

N2.4 Construction noise shall be managed using the methods set out in section 8 of NZS6803:1999 Acoustics – Construction Noise.

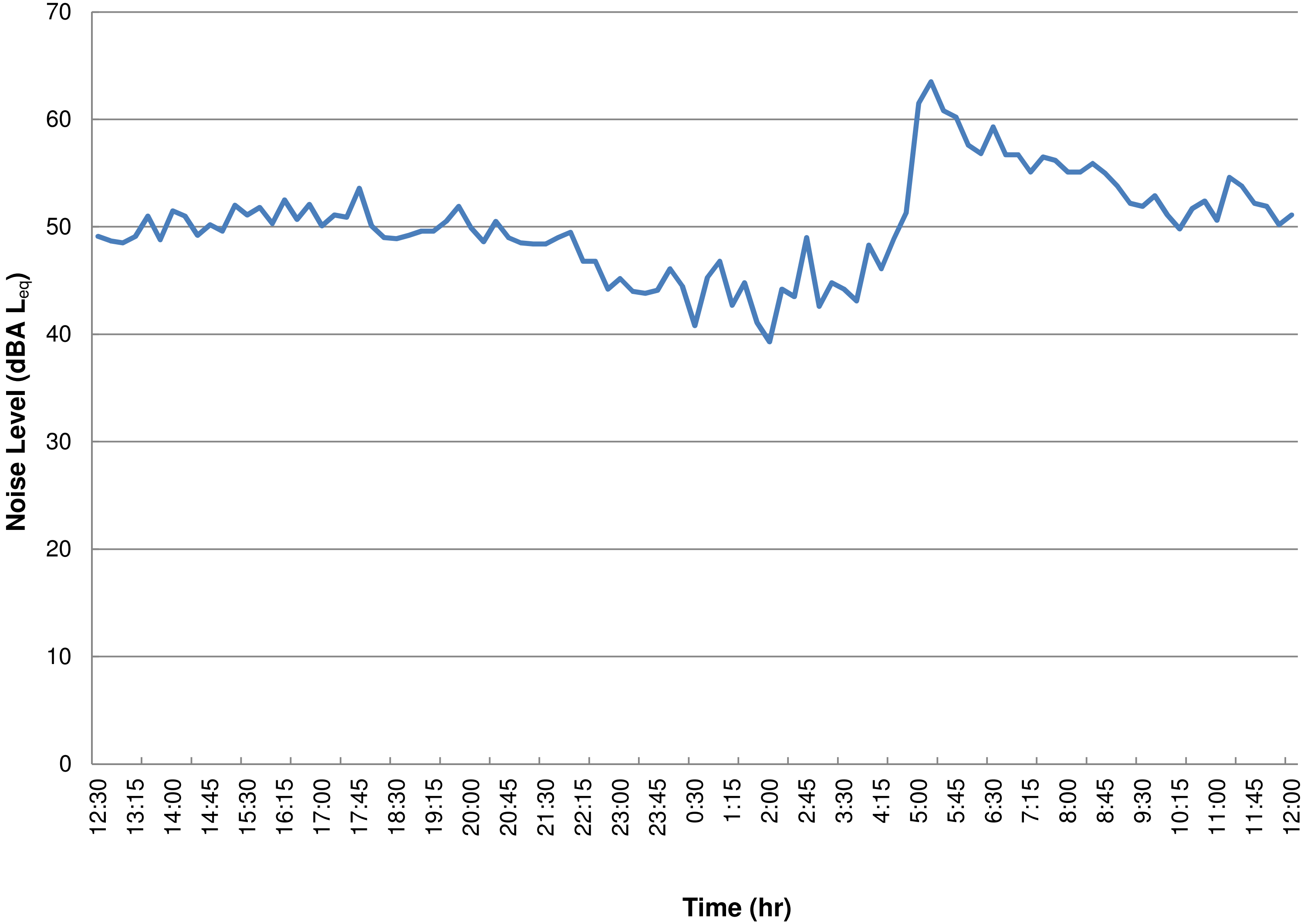
In addition to the above criteria, NZS6803 requires that:

6.2 Measurement Locations

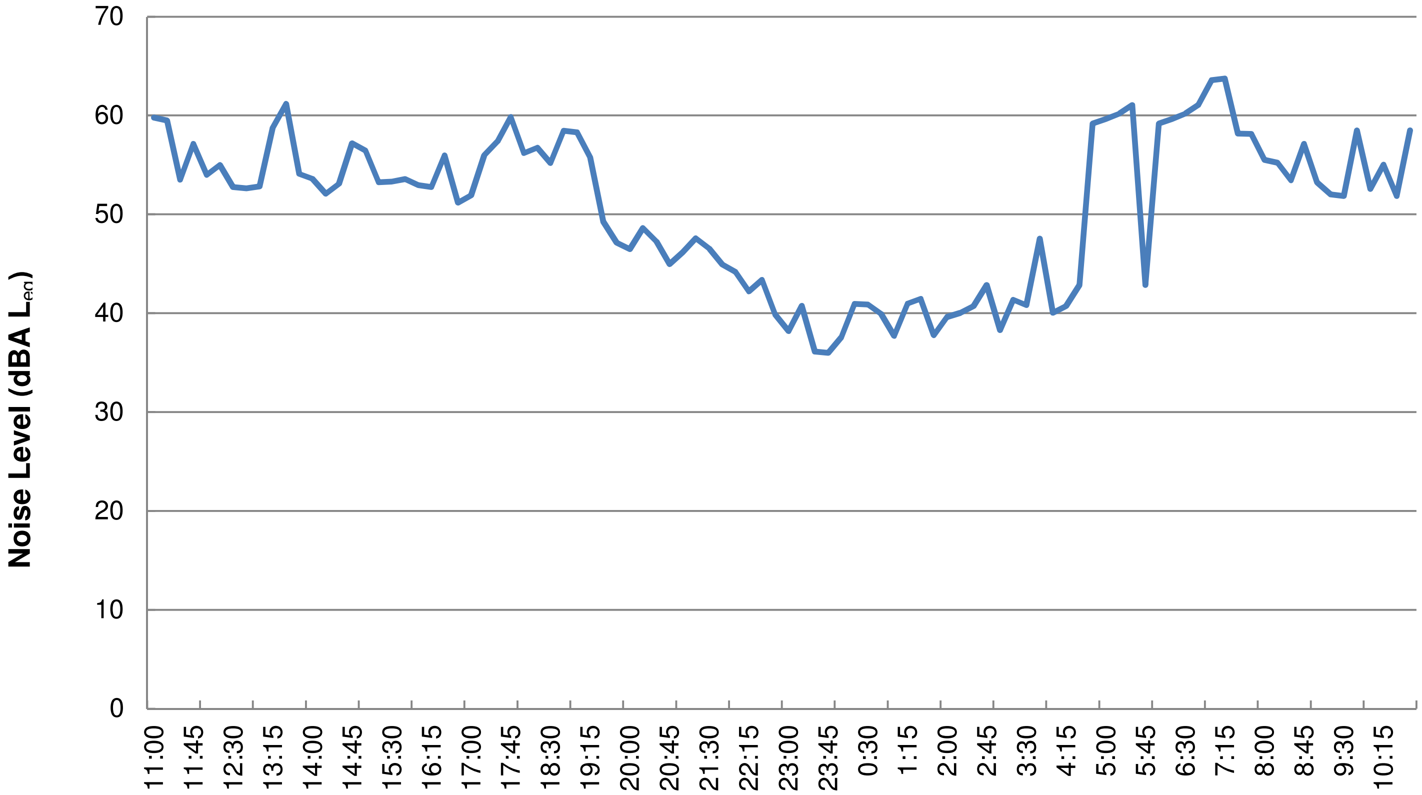
6.2.1 Outside buildings

Measurements outside buildings should be made approximately 1m from the wall most exposed to the sound under investigation, and 1.2m to 1.5m above the relevant floor level. No adjustment to measured sound levels is to be made for facade effects.

Appendix D – Ambient Sound Level at PPF B



Appendix D – Ambient Sound Level at PPF E



Appendix E – Design Year Traffic Flow Information