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Board of Inquiry**

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Title: **Northern Corridor Improvements
Review of Noise and Vibration Effects
Construction and Operational Phases**

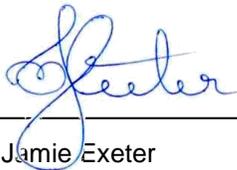
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Executive Summary

Styles Group has been engaged by the Environmental Protection Agency (EPA) on behalf of the Northern Corridor Improvements (NCI) Board of Inquiry (BoI) to prepare a report setting out any issues or gaps arising from a review of the noise and vibration related technical reports, submissions and evidence, and to summarise the issues that require further analysis or resolution.

This report has been prepared only to discuss issues that require resolution and should not be considered to be a report providing a full review of the proposal. There are many aspects of the technical reports and assessments that the author agrees entirely with and which are not challenged, but these are not analysed herein. Notwithstanding, the review undertaken has found that the technical noise level measurement and prediction work has been carried out to a high standard and is able to be relied upon. If the issues could be summarised into a theme, it would be that there is insufficient information available at this time to complete a meaningful assessment of the construction noise and vibration effects, and that the assessment of operational road traffic and vibration effects is incomplete or inconsistent with the requirements of the Resource Management Act (the Act). In particular:

- (1) The CNV Report and technical evidence do not provide sufficient information for a meaningful assessment of the construction noise effects to be undertaken. The reports make it clear that noncompliance with the project standards is likely at almost all parts of the route, but no noise levels or durations for those infringements are provided;
- (2) Similarly, the CNV Report does not provide any assessment of the likely vibration effects, and instead states that a very large number of proximate buildings will be subject to a medium and high risk of noncompliance with the project vibration standards. The reports do not contain any upper limits of vibration, assessments of the effects of damage or the effects on people as a function of vibration level and duration of exposure. These factors are critical in the assessment of effects;
- (3) The proposed project standards for the protection of building damage due to construction vibration are in my opinion too high, being set at a threshold where damage to buildings is already likely. I consider that this is an inappropriate threshold for the onset of additional management measures, and that the threshold should more appropriately be based on the requirements of the more commonly adopted German Standard DIN4150-3:1999. The usefulness of this standard as a guide to when damage might begin to be an issue is reflected in the evidence of Ms Wilkening;

- (4) The Traffic Noise Report is based wholly on NZS6806 but with an assessment of the subjective effects of the change in noise level likely to arise from the project, and also an analysis of the number of people highly annoyed by the traffic noise. I consider that whilst the technical basis of the report is sound, the method of assessment does not fulfil the requirements of s16 of the Act and in a number of cases the effects of the project are understated;

- (5) The Traffic Noise Report also provides an assessment of operational vibration effects which states that there will be no adverse effects generated. I disagree with this statement and it is my view that whilst the vibration effects might indeed be reasonable, they cannot be described as nil as the NZTA have done.

Overall, I consider that further work is required by NZTA to ensure that the effects of the project can be properly understood and evaluated against the requirements of the Act.

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1. Introduction

1.1 Scope of Assessment

Styles Group has been engaged by EPA on behalf of the NCI Bol to prepare a report setting out any issues or gaps arising from a review of the noise and vibration related technical reports, submissions and evidence in relation to the New Zealand Transport Agency's (NZTA) NCI project.

This report has been prepared following the receipt of submissions on the proposal and following the lodgement of the primary statements of evidence of the NZTA technical noise and vibration expert. The principal documents referred to herein include the following:

- (1) *Northern Corridor Improvements – Assessment of Construction Noise and Vibration Effects* Project No: 250310, Document Ref: NCI-3PRE-2ENV-RPT-0021 Revision 2, 2 December 2016 prepared by Marshall Day Acoustics (the CNV Report);
- (2) *Northern Corridor Improvements – Assessment of Operational Noise and Vibration Effects* Project No: 250310, Document Ref: NCI-3PRE-2ENV-RPT-0032 Revision 2, 2 December 2016 prepared by Marshall Day Acoustics (the Traffic Noise Report);
- (3) *Section 92 request for further information – Northern Corridor Improvements Proposal*, File Ref: NSP 39 11, 6th March 2017 Board of Inquiry – Northern Corridor Improvements Proposal (the s92 Request);
- (4) *Northern Corridor Improvements Proposal – Request for Further Information*, 29th March 2017, Aurecon (the 92 Response);
- (5) *Statement of evidence of Siiri Wilkening for the New Zealand Transport Agency (Operational noise and vibration)*, dated 20th April 2017;
- (6) *Statement of evidence of Siiri Wilkening for the New Zealand Transport Agency (Construction noise and vibration)*, dated 20th April 2017;
- (7) Submissions related to noise and vibration.

Other documents referred to are referenced specifically.

This report also follows my involvement in the pre-lodgement phase of the project in 2016 undertaking completeness checks of the two technical reports for the EPA. This process involved a site visit with the project team, a project briefing with NZTA and review of the technical reports prior to lodgement and following lodgement.

The scope of this report is to review the primary documents listed in this section and to set out:

- (1) Any gaps or issues with the CNV Report and Traffic Noise Report;
- (2) Whether the proposed mitigation measures for construction noise and vibration (CNV) and traffic noise are appropriate in terms of their location, nature and effectiveness;
- (3) Whether the standards, guidelines or controls on CNV and traffic noise are appropriate; and
- (4) Whether the evidence of the relevant technical expert(s) closes any of the gaps identified or issues raised in (1) to (3) and submissions.

The overall focus of this report is to summarise, in a concise and reasoned fashion, any outstanding issues with the assessment of CNV and traffic noise and vibration effects provided by NZTA, taking into account submissions, the s92 response and the technical evidence lodged by NZTA experts.

1.2 The Author

I am an acoustic consultant and the director and principal of Styles Group Acoustics and Vibration Consultants. I am the president of the Acoustical Society of New Zealand and prior to being elected I was the secretary and on the committee of the Society for 8 years. I lead a team of 6 consultants specialising in the measurement, prediction and assessment of environmental and underwater noise, building acoustics and vibration. I hold a Bachelor of Applied Science majoring in Environmental Health and I have completed the Ministry for the Environment's Making Good Decisions programme.

I have approximately 16 years' experience in the industry, the first 4 as the Auckland City Council's Environmental Health Specialist – Noise, and the latter 12 as the director and principal of Styles Group.

I have worked on a large number of projects around New Zealand involving road traffic noise and the application of New Zealand Standards NZS6806:2010 *Acoustics – Road Traffic Noise – New and Altered Roads* (NZS6806) and NZS6803:1999 *Acoustics – Construction Noise*

(NZS6803) along with numerous standards for the measurement and assessment of vibration from traffic flows and construction. A number of these projects have been Roads of National Significance (RoNS) and include the Southern Corridor Improvements, Te Atatu Road widening, Lincoln Road Corridor Improvements, Ellerslie and Takanini Noise Walls, Mill / Redoubt Road (Manukau), SH1 Whangarei Improvements, SH12 Matakohe Bridges, CSM2 & MSFRL (Christchurch Southern Motorway Stage 2 & Main South Road Four Laning), Mackays to Pekapeka, Waikato Expressway (numerous sections), Southern Links Hamilton, Central Motorway Junction, Victoria Park Tunnel, Waterview, St Lukes, SH16 Causeway, Puhoi to Warkworth, the East West Link and Penlink.

I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this report. Except where I state that I am relying on the evidence of another person, the contents of this report is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed herein.

2. Construction Noise Assessment

2.1 Overview

The CNV Report provides a good description of the relevant noise performance standards and the general method by which these are applied and assessed. The relevance of the ambient noise levels is addressed and unlike some other recent large roading projects, the night time noise limits are not proposed to be increased in this case. I support this approach and I support the use of the standard noise limits from NZS6803 for the project standards.

I generally agree with the noise level predictions and the assumptions they are based on, including the reference source levels, construction equipment and methods to be used and reductions for screening where it is practicable.

2.2 Compliance with Project Standards

Section 2.1.3 of the CNV Report discusses the fact that compliance with the project noise standards may not be achievable at all times, and that provided the Best Practicable Option (BPO) is adopted the works may continue at noise levels higher than the CNV standards.

If the works were required to strictly adhere to the project CNV standards, the project would likely cost more and take significantly longer to construct. I therefore agree that it is sensible to provide for some phases of work to exceed the standard project CNV standards where the BPO

has been adopted. I consider that properly understanding and requiring effective management of the CNV effects which are above the project standards is vital.

The CNV Report provides an overview of the noise levels that are expected for various phases of work and for different sectors of the project with a primary focus on determining which of the receivers will be exposed to noise levels greater than the project standards. The assessment states that for each sector of the project there will be numerous receivers exposed to noise levels above the project standards.

In my opinion the CNV Report does not provide an adequate assessment of the effects arising from works which cannot be practicably made to comply with the project standards. TR8 does not give any indication of the duration of works which may exceed the project standards and it does not give any real indication of how high the CNV levels would be at the receivers where compliance with the project standards cannot be achieved. For example, the tables in Section 6 of the CNV Report set out that during the project approximately 549 dwellings will be exposed to noise levels greater than the proposed night time noise limit of 45dB L_{Aeq} . The duration and degree to which the project standards will be exceeded is not stated, and other than relocation of residents where exceedances occur for more than one or two nights, no other form of mitigation is provided. This does not provide any description of how the effects of that work will be experienced by the receivers, both in terms of the level of noise and / or vibration, the duration of works or the mitigation that will be offered. Similarly, section 6 states that 321 dwellings will be exposed to noise levels above the daytime noise limit of 70dB L_{Aeq} . The duration and degree to which the project standards will be exceeded is not stated.

In paragraph 9.2 of her evidence, Ms Wilkening states that only when a contractor is appointed, “...the details of construction necessary to allow for meaningful assessment of required management and mitigation will be known” (emphasis added). This statement supports my position that a meaningful assessment cannot be undertaken as part of this process. Given that significant short term effects are inevitable yet the degree is not known, I am concerned that the NZTA’s position precludes the Board from undertaking that assessment as part of this decision making process.

I note that the evidence of Mr Hegley (for the Auckland Council) states the same concerns.

This issue has not been resolved in the evidence to-date.

2.3 Description of Effects

Section 6 of the CNV Report provides Table 6 showing the correlation between noise level and the associated subjective noise effects. With respect to the subjective effects of noise, I

consider that the table understates the effects generally, especially regarding the onset of sleep disturbance and the subjective effects of noise levels at 70dB L_{Aeq} and greater. It is my view that the onset of sleep disturbance issues will occur at noise levels lower than 65dB L_{Aeq} when measured externally, and the effects on conversation, office activities and residential amenity will occur at noise levels lower than those stated in the table, in many cases by as much as 10dB. The table also does not state that at levels over 70dB L_{Aeq} , it is likely that disruption to business activities will occur and at levels of 80dB L_{Aeq} it may be impossible for some businesses to continue trading. The significant construction activities could result in noise levels over 70dB L_{Aeq} being received at some houses and businesses for weeks or months.

The table also assumes a noise level reduction of 20dB from outside to inside which is generally unlikely at night in the summer months when people need their bedroom windows open for cooling. I consider that a noise level reduction of 10-15dB is more reasonable to assume, especially in the warmer months and for facades not currently exposed to high levels of traffic noise.

Although not specifically a noise or vibration matter, I understand that temporary relocation is an effect in itself, and in my opinion it is not sufficient to say that if residents are temporarily relocated the CNV effects will be reasonable. Whilst the statement might be true in respect of the CNV effects, the potentially disruptive effect of temporary relocation in itself has not been considered.

For these reasons, and for the reasons stated in 2.2, I consider that the description of construction noise effects requires updating.

This issue has not been resolved in the evidence to-date.

2.4 Construction Noise and Vibration Management Plan (CNVMP)

Section 8 of the CNV Report provides only a summary of the methods that will be used to manage and mitigate CNV effects and states that the proposed CNVMP will contain the specific details. I consider that NZTA should provide a draft version of the CNVMP at this stage so that the receivers and decision makers can properly understand the methods that the Agency are proposing to manage the effects, and the effects thresholds at which those methods are implemented.

Ms Wilkening states in section 11 of her evidence that a CNVMP will be an important tool for the management of CNV effects, but no CNVMP has been provided. I consider that there is sufficient information available to prepare at least the framework of the CNVMP, including the hierarchy of mitigation options for different activities and the threshold of CNV effects or levels

at which the various mitigation methods will be implemented. I consider that this is an important component which can be produced now to provide a good level of understanding of how the contractor will manage the effects and to set some level of expectation for the receivers.

This issue has not been resolved in evidence to-date.

3. Construction Vibration Assessment

3.1 Overview

The CNV Report provides a good overview of the relevant vibration criteria and sources of vibration for the construction phase, and provides a helpful set of vibration risk contours which show in general terms the receivers which may be exposed to vibration levels exceeding the proposed project vibration standards.

3.2 Compliance with Project Vibration Standards

Section 7 of the CNV Report sets out the methods by which the vibration effects have been assessed for the NCI project. The assessment is focussed on the production of risk contours which provide some guidance on the likelihood of the project criteria being exceeded. Tables 13 and 14 of the CNV Report contain a list of property addresses which are subject to either a medium or high risk of noncompliance with the project vibration standards, including those designed for the avoidance of building damage. However, it is not possible to determine from the CNV Report what levels of vibration the receivers will be exposed to and for how long and what the concomitant effects will be. The assessment anticipates that damage will occur by virtue of the high level of vibration permitted by the project standards, (see next section) but also evidenced by proposed condition CNV.8 which requires NZTA to repair any damage.

Given that noncompliance with the project standards can easily result in damage to property, disruption to businesses, annoyance and sleep disturbance, I consider it crucial that the likelihood and magnitude of these effects are understood as far as possible at this stage.

I note that the evidence of Mr Hegley for the Auckland Council supports this position.

This issue has not been resolved in the evidence to-date.

3.3 Project Vibration Standards and Building Damage

As discussed in section 3.2 of this report, the CNV Report does not provide an indication of the vibration levels likely to be received during the project; only that the project standards are highly likely to be exceeded at a large number of buildings.

The project vibration standards are adopted from NZTA's own guide, as reproduced in Appendix C of the CNV Report. Of note is the Category B criteria for unoccupied buildings in the lower right hand corner of the table, which are based on the British Standard BS5228-2. Those values are 50mm/s for reinforced or framed structures and industrial and commercial buildings, and 15mm/s to 50mm/s (depending on the frequency of movement) for unreinforced or light framed structures and residential or light commercial buildings. These levels are considerably higher than the guidance given in the more commonly used German DIN4150-3:1999 standard, and in my opinion will allow for minor cosmetic damage in lightweight and susceptible structures to occur. Such levels may also result in ornaments falling and loose fixtures failing (for example). Indeed, in paragraph 9.7 of her evidence, Ms Wilkening states:

“In a residential environment, people can usually perceive vibration at a level of 0.3 mm/s, but the risk of building damage only exists above 5 mm/s.”

The risk of damage in Ms Wilkening's opinion is therefore 3 times lower than the proposed construction vibration project standards. The CNV Report does not contain an assessment of the likelihood of damage to residential or commercial structures so no meaningful evaluation of the effects of the project can be undertaken.

Proposed condition CNV.6 contains the following statements:

a. If measured or predicted vibration from construction activities exceeds the Category A criteria, a suitably qualified person must assess and manage construction vibration during those activities.

b. If measured or predicted vibration from construction activities exceeds the Category B criteria, those activities may only proceed if vibration effects on affected buildings are assessed, monitored and mitigated by a suitably qualified person.

I do not consider that these requirements add any certainty for the receiver of vibration on what will actually be done to manage the effects, nor does it actually require NZTA to adopt the BPO or undertake any specific tasks. In my opinion these conditions are uncertain and do not directly require any meaningful action to be taken. I consider that it is possible to continue

works at building-damaging vibration levels whilst complying with the proposed conditions provided that the Consent Holder (see CNV.8) remedies the damage. Fixing the damage requires access to the property in question, disruption and potentially displacement of the occupants.

If the Category B vibration criteria are to be used as the threshold for requiring additional management, I consider that they should be set at a level where the likelihood of damage *begins*, rather than at a point where damage is already anticipated. Accordingly, I recommend that the Category B criteria for unoccupied buildings in CNV.6 is replaced with the DIN4150-3:1999 recommendations.

This issue has not been resolved in the evidence to-date.

3.4 Construction Vibration Effects on Sensitive Activities

Section 7 of the CNV Report provides a brief assessment of construction vibration effects and mitigation methods and is focused only on the effects on buildings and people. The CNV Report does not address the potential for sensitive activities along the route that may be significantly affected by vibration below the project vibration limits. Such activities may include laboratories and businesses operating sensitive equipment such as microscopes, printing facilities, medical equipment and sensitive manufacturing equipment. The construction activities that are proposed could have significant effects on such activities including where the proposed project vibration standards are complied with.

Such an assessment requirement is common and is likely to be adopted for the East West Link proposal and has been required on other projects including the City Rail Link and Watercares' Central Interceptor. I suggest that NZTA undertake a comprehensive assessment of the existing environment to determine the proximity of any such activities and the magnitude of adverse effects that is likely. The CNV assessment should then be updated to provide a comprehensive description of the methods that will be used to determine the nature of the receiving environment again immediately prior to works commencing in each area, and a detailed description of the methods that will be used to minimise the effects as far as practicable.

This issue has not been resolved in the evidence to-date.

4. Traffic Noise Assessment

4.1 Overview

The Traffic Noise Report provides an assessment of the proposal primarily against the requirements of NZS6806, along with an assessment of the subjective assessment of effects to accompany the determination of the BPO. I note that the use of NZS6806 is not mandated by any relevant rules or statute and is adopted here on a voluntary basis.

I agree with the use of NZS6806 for the determination of the BPO for the minimization of road traffic noise for the project and I consider that in general terms adherence to the standards guidance should result in the BPO being adopted. However, it is important to note that NZS6806 does not require any assessment of the effects of road traffic noise to be undertaken for a project. The Traffic Noise Report does however include an assessment of the subjective effects.

Overall, I agree with much of the Traffic Noise Report including the noise modeling methods, ambient noise measurement methods, the application of NZS6806 and the determination of the BPO for Protected Premises and Facilities (PPFs) as defined in the standard itself.

4.2 Section 16 of the Resource Management Act

The noise arising from the NCI proposal must be considered against Section 16 (1) of the Act, which states:

Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.

What is a reasonable level is not defined and any determination would be specific to each particular case, often involving a broad judgement taking into account matters such as relevant guidance and standards, the existing noise environment, the nature and level of the noise of interest, the adverse effects associated with the noise of interest and potentially any other positive effects arising from the project giving rise to the noise effects.

Indeed, if the noise levels associated with a major roading project such as the NCI were to be deemed reasonable, then the adverse effects of the relatively high levels of noise would need to be balanced with some positive effects or the necessity of the project, because the noise levels

themselves cannot be regarded as reasonable when having regard only to the criteria for the protection of health and amenity.

The BPO is defined by the Act as:

best practicable option, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to -

- a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and*
- b) the financial implications, and the effects on the environment, of that option when compared with other options; and*
- c) the current state of technical knowledge and the likelihood that the option can be successfully applied.*

Given that it is unlikely that adverse noise effects of the NCI project cannot be 'prevented', the focus of the BPO in this case then shifts to the minimisation of the adverse effects.

4.3 Assessment of Subjective Effects

Section 3 of the Traffic Noise Report sets out the background to the method used for the assessment of noise effects on the people exposed to traffic noise from the project. Whilst there are numerous ways in which the effects of noise could be quantified, evaluated or expressed, the report draws on the work of Miedema & Oudshoorn and adopts the correlation of noise exposure to the percentage of persons highly annoyed from their synthesis of a large number of other studies. In my opinion the inclusion of an assessment of effects in the Traffic Noise Report is a welcome addition to the objective assessment required by NZS6806. I note that the absence of an assessment of the subjective noise effects arising from the implementation of a roading project has been criticised in the past on other projects.

However, the assessment of effects in the Traffic Noise Report is limited to the assessment of the proportion of the population who would be "highly annoyed" by the traffic noise. The Miedema & Oudshoorn work provided data and methods for determining the number of 'Little Annoyed' (%LA), "Annoyed" (%A) and Highly Annoyed (%HA) for road traffic noise which provides a much more detailed insight into the likely response to noise at a given level of noise.

The Traffic Noise Report does not provide any reasoning for not including the full findings of the Miedema & Oudshoorn work and why the additional response categories of %LA and %A have not been included. In my opinion the inclusion of all other categories of annoyance, (including

therefore the number of people not annoyed) is vital to provide a fair and fully informed understanding of the subjective response to traffic noise that the community is likely to have. Without additional information, it is impossible to tell how the other (generally larger) percentage of the population will react to the noise effects, and is likely to lead to the reader misunderstanding or underestimating the likely noise effects. Of particular concern is that the reader may assume that the proportion of the population that is not in the %HA category are accepting of the effects or are not affected.

There are a number of PPFs which will be exposed to noise levels that are higher than they are currently exposed to as a result of the completion of the Preferred Option for the NCI proposal. I therefore consider that using only the %HA category to demonstrate an overall reduction in noise effects is an incomplete assessment. I consider that if the Miedema and Oudshoorn work is to be used for the assessment of traffic noise effects, the effects should be described in the context of the complete set of findings from the Miedema and Oudshoorn work so that a full understanding is possible.

Figure 1 below sets out the three response curves for traffic noise (with the curves for aircraft and rail noise faded out) for the %LA, %A and %HA categories and their 95% confidence intervals from Miedema and Oudshoorn.

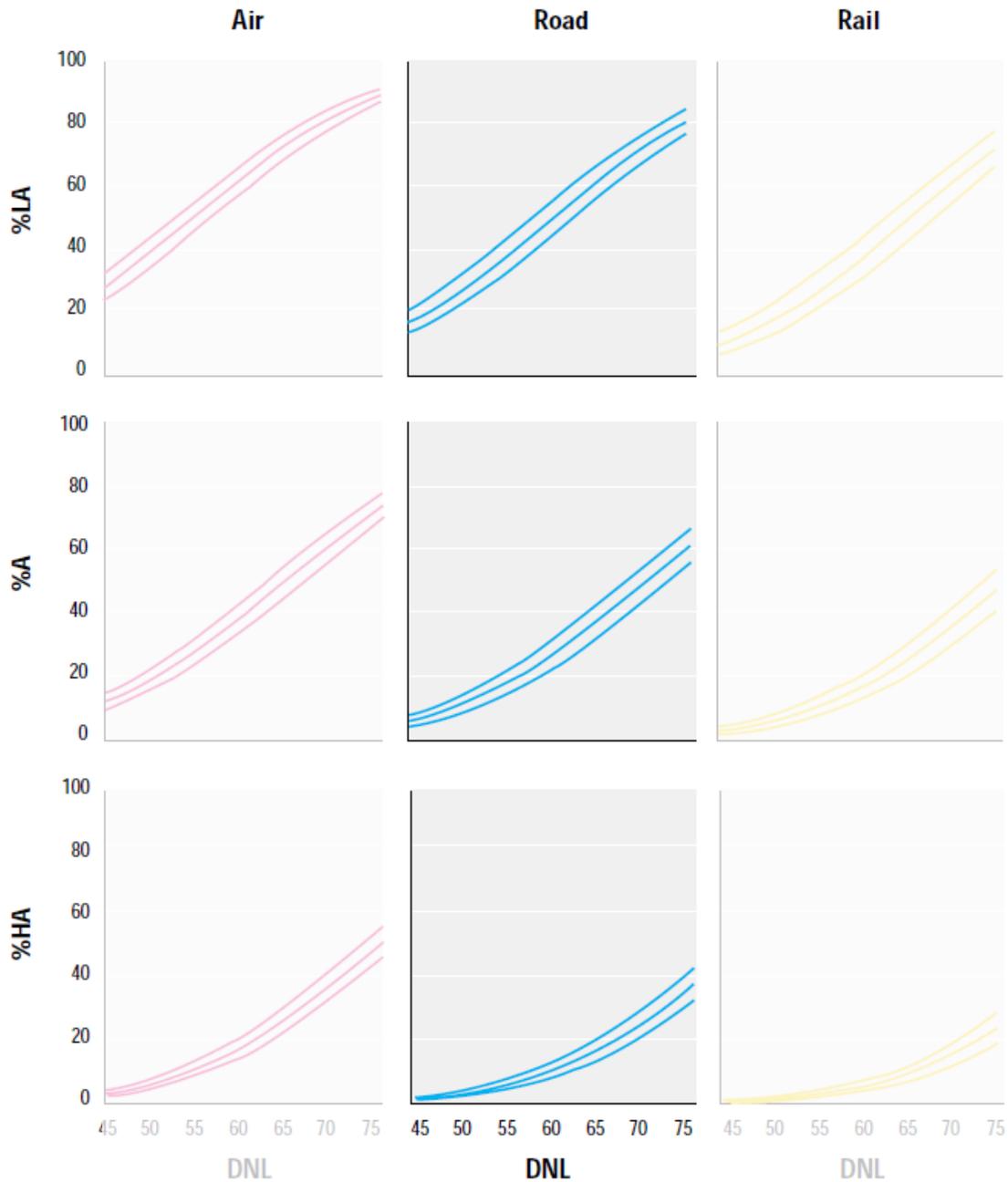


Figure 1. The %LA (top row), %A (middle row), and %HA (bottom row) for aircraft, road traffic, and railways as a function of DNL, together with 95% confidence intervals. The curves were found by fitting Equation 4 to the data from field surveys (see Table 2). The estimates of the parameters are given in Table 3.

Figure 1 – Miedema and Oudshoorn Response Curves

Whilst the DNL metric shown in Figure 1 is not directly applicable to the $L_{Aeq(24hr)}$ metric used for the measurement and assessment of road traffic noise in NZS6806, the curves show that for a given noise level, the number of people in the %HA category is considerably less than the number in the %A category, and less again than the total number of people in the %LA category. For example, for a given level of 67dB $L_{Aeq(24hr)}$, (upper limit of Category B according to NZS6806) approximately 21% of people will be highly annoyed by traffic noise. At the same level, approximately 43-44% of people will be annoyed and highly annoyed, and approximately 67-68% of the population will be little annoyed, annoyed and highly annoyed by traffic noise. From this, it is evident that at the upper level of the Category B criterion in NZS6806 of 67dB $L_{Aeq(24hr)}$, only around 1/3 of the population would be indifferent or accepting of traffic noise.

For the reasons above I consider that if the Miedema and Oudshoorn guidance on the response to noise is to be used, then all three categories should be used to describe the response of the community to the traffic noise effects arising from the proposal, whether they be positive or negative effects.

This issue has not been resolved in evidence to-date.

4.4 Parks and Open Spaces

The Traffic Noise Report is restricted in its scope to assessing the noise effects at Protected Premises and Facilities (PPFs) only. The scope of NZS6806 is limited to assessing the noise effects at noise sensitive locations (PPF's), whereas the Resource Management Act (the Act) requires the assessment of a broader receiving environment. The Auckland Council's submission sought for the assessment to be updated to include an assessment of the likely effects of road traffic noise on parks and reserves. I agree with the Auckland Council's submission.

In paragraph 11.18 of her evidence Ms Wilkening states that the open space areas identified in the Auckland Council's submission are not defined as PPFs by NZS6806. I agree with this, but I do not consider that this absolves NZTA of the need to understand the effects and adopt the BPO to achieve a reasonable level of noise in those areas as is required by s16 of the Act.

I understand that public open space is a valuable resource where residential development is dense, and where private open space may not be available to residents or is restricted in area and quality. The principal areas of accessible private outdoor living spaces are often only the form of balconies which are small, and will often overlook any noise barriers and therefore be noisy spaces.

It is my experience that open spaces, parks, cycle-ways and pedestrian facilities which are screened from high traffic noise levels will have a higher level of amenity and will be used and enjoyed more frequently than a space or facility which is exposed to higher noise levels.

For these reasons I consider that the BPO for the minimisation of road traffic noise from the NCI proposal into these spaces should be investigated and mitigation applied if it is deemed to be practicable.

This issue has not been resolved in evidence to-date.

4.5 *Minimisation of Noise Effects*

The Traffic Noise Report has a clear focus on minimising any upwards 'category shifts' in for the Preferred Design, where the categories are either A, B or C as defined in NZS6806. In summary, for altered roads those categories are:

- Category A Any external noise level up to 64dB $L_{Aeq(24hr)}$
- Category B Any external noise level between 65dB $L_{Aeq(24hr)}$ and 67dB $L_{Aeq(24hr)}$
- Category C Any external noise level above 67dB $L_{Aeq(24hr)}$ provided that the noise level inside a PPF does not exceed 40dB $L_{Aeq(24hr)}$.

A more detailed description of the categories is provided in Table 2 of NZS6806.

In very simple terms the standard states that the category of a PPF is determined by the noise level outside the dwelling once the BPO has been adopted. The exception to this is that the BPO need not be adopted if the noise levels will be below 64dB L_{Aeq} in the 'do-minimum' scenario. That is, if all the dwellings were in Category A without any specification noise mitigation measures being applied, then no further mitigation is required by the standard. This approach has been described as 'do the best you can' in other cases.

The Category A criteria of up to 64dB $L_{Aeq(24hr)}$ is not described or justified in NZS6806, and it is not possible to understand the rationale for the development of any of the noise level thresholds for the categories in the standard. This poses some difficulty for readers of reports which are prepared according to the standard.

Under any other circumstance involving noise from industry, recreation activity or other transport infrastructure including airports and ports the starting point for assessing the adverse effects of noise is generally derived from national and international guidance on the effects of noise on the

population. In most cases the guidance of the World Health Organisation (WHO) is adopted, which generally states that noise external levels of 45dB L_{Aeq} should not be exceeded at night and 55dB L_{Aeq} should not be exceeded during the day (equivalent to approximately 53dB $L_{Aeq(24hr)}$). These thresholds are generally accepted to be the upper level of noise that residential activity should be exposed to and are adopted in New Zealand standard NZS6802:2008 *Acoustics – Environmental Noise*.

The WHO have published many policies and studies documenting extensive investigations into the effects of noise exposure on people, estimating the burden of disease from environmental noise and quantification of healthy life years lost as a result of exposure to environmental noise.

The WHO Community Noise Guidelines from 1999 was the first major large scale authority on the effects of noise on large populations. The WHO Guidelines (the Guidelines) provide detailed guideline noise levels that should be achieved on the basis of the effects of the most exposed receiver in the environment. For habitable rooms in dwellings, a level of 35dB L_{Aeq} during the day and evening (56dB $L_{Aeq(24hr)}$ outside) should not be exceeded for the avoidance of speech intelligibility and moderate annoyance. For bedrooms in dwellings, a level of 30dB L_{Aeq} at night (51dB $L_{Aeq(24hr)}$ outside) should not be exceeded to prevent sleep disturbance effects. The Guidelines go on to suggest values of between 30 and 35dB L_{Aeq} (51-56dB $L_{Aeq(24hr)}$ outside) are desirable for classrooms, preschool sleeping areas and hospital wards.

These guideline values are commonly considered quite conservative and are often impracticable to achieve in the real world when balancing the cost of mitigation and the sometimes very high outdoor noise levels that are present in some of our living environments.

More recently, the World Health Organisation has published the Night Noise Guidelines for Europe. The Night Noise Guidelines provide recommendations based on contemporary research and using updated noise level descriptors. The Night Noise Guidelines use the $L_{night,outside}$ descriptor, which is the L_{Aeq} noise level outside a bedroom between the hours of 11pm and 7am averaged over a year. The Night Noise Guidelines assume a reduction of 21 decibels from outside the room to inside. I note that although the predicted noise levels for road traffic noise in New Zealand are not described as a year-long average, they are based on average annual daily traffic flows or on measurements of traffic that might vary only +/- 1-3dB on any typical day of the year, they can be considered approximately equivalent.

The Night Noise Guidelines state that at noise levels above 34dB inside a bedroom at night, (approximately equivalent to 60dB $L_{Aeq(24hr)}$ outside):

“The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.”

The relationship between the noise level and the description of the adverse effects is variable, and none of the guidance relates directly to the metric used in NZS6806 of $L_{Aeq(24hr)}$. Notwithstanding, the guidance in NZS6802:2008 (based on WHO guidance) suggests an equivalent level of 53dB $L_{Aeq(24hr)}$ and the Night Noise Guidelines express some concern at levels of 60dB $L_{Aeq(24hr)}$. For the purpose of this report I consider that a noise level of 55dB $L_{Aeq(24hr)}$ from road traffic is a practical starting point for the consideration of adverse noise effects.

The critical issue then becomes the difference between the level of 55dB $L_{Aeq(24hr)}$ as a starting point for the consideration of adverse effects, and the very lowest threshold for the consideration of noise mitigation given in NZS6806 of 64dB $L_{Aeq(24hr)}$.

NZS6806 has been developed with the stated intention of providing:

“...reasonable criteria for the road-traffic noise from new or altered roads taking into account adverse health effects associated with noise, the effects of relative changes in noise levels on people and communities; and the potential benefits of new and altered roads to people and communities” (emphasis added).

Starting from a reasonable level of noise based only on adverse health and annoyance effects, the jump from this to the guidance in NZS6806 appears to only be justified therein by the potential benefits of new roads to people and communities. Even if all PPFs were predicted to receive noise levels no greater than 64dB L_{Aeq} , in subjective terms this margin would be 9dB: more-or-less double what is otherwise a reasonable level of noise.

The Traffic Noise Report has been prepared on the basis that if the noise level arising from the ‘do-minimum’ scenario is no greater than 64dB $L_{Aeq(24hr)}$ (i.e. the PPFs are in Category A) then no effort to adopt the BPO need be applied. This is precisely the approach adopted in section 5.5 of the Traffic Noise Report for Area 4 (SH18 Cabello Place).

The Auckland Council’s submission states concern that no mitigation has been considered for PPFs where the assessment method adopted in the Traffic Noise Report does not require it. For the reasons set out above, I support the Auckland Council’s submission and recommend

that mitigation be considered for all PPFs where noise levels are higher than a reasonable level without having regard to any positive effects of the project.

An associated issue is the proposed condition ON.2 which controls the final design to ensure that no PPF is subject to an upwards change in noise level category compared to the Preferred Design considered in this process. Because of the relatively arbitrary starting point for Category A being double what an otherwise reasonable level of noise would be, and given that Category C has no upper limit on noise levels, I consider that a condition requiring no upwards Category change is too coarse and should be refined.

This issue has not been resolved in evidence to-date.

4.6 Assessment of Noise Level Changes

The Traffic Noise Report concludes that:

The noise level change due to the Project for dwellings will generally be small (less than 4 decibels). For most areas, noise levels would change by no more than 2 decibels. This change would be imperceptible, particularly as the noise source (i.e. traffic) does not change.

However, I have tallied the noise level changes in the Traffic Noise Report for the Preferred Mitigation Option for each area of the project as follows:

Noise Level Change	PPFs								Total
	1	2	2A	3	4	5	6	7	
5-8 dB Reduction	-	-	-	-	-	5	-	-	5
3-4 dB Reduction	2	0	1	0	0	2	0	0	5
1-2 dB Reduction	7	0	3	0	8	5	0	1	24
<1 dB Change	8	0	4	3	6	7	0	1	29
1-2 dB Increase	6	0	19	35	14	39	3	1	117
3-4 dB Increase	16	22	19	0	2	28	10	6	103
5-8 dB Increase	0	2	3	0	0	0	10	4	19
9-11 dB Increase	-	-	-	-	-	0	0	-	

Table 1 – Tally of Noise Level Changes

If a change of less than 1dB is taken to be no change, then with the Preferred Mitigation Option, there will be a total of 63 PPFs experiencing either no change or a reduction of up to 8 dB, compared to a total of 239 PPFs experiencing an increase greater than 1 dB and up to 8 dB.

The conclusion of the Traffic Noise Report appears to be inconsistent with the tabulated data within the Traffic Noise Report, with the tabulated data showing a considerably higher level of effect than the text of the report.

In her evidence, Ms Wilkening concludes that:

14.3 The noise level change due to the Project for dwellings will generally be small (up to 4 decibels). This change is either unnoticeable or just perceptible.

14.4 Where no noise barriers are proposed, it is not practicable to install barriers because of the height required to achieve sufficient noise level reduction, e.g. where there are multi storey apartment buildings of the buildings are located above the road.

- 14.5 *Dwellings that are predicted to remain within the highest noise criteria Category C, will need to be assessed to determine if and what building modification mitigation should be installed.*
- 14.6 *With the mitigation in place, noise levels are predicted to be generally within the same noise criteria category as would be the case without the Project (do-nothing scenario). I therefore consider both people and amenity values of residential zones will be protected from unreasonable noise arising from the Project.*
- 14.8 *Overall, I predict that this Project will result in similar effects for most people adjacent to the road, compared with current and do-nothing scenarios. While high noise levels cannot be mitigated at all dwellings (usually where the existing noise levels are high), the proposed mitigation will maintain noise levels within the same noise criteria category despite the increase in traffic volume and speed over time.*

I note that the statements in the conclusion of the Traffic Noise Report are inconsistent with the statements in evidence, and both are inconsistent with the tabulated data in the Traffic Noise Report, where in my opinion the tabulated data demonstrates a considerably higher level of effect than the text states.

This issue has not been resolved in evidence to-date.

4.7 Overall Assessment of Noise Effects

- (i) Whilst the Traffic Noise Report and the evidence of Ms Wilkening note that the PPFs in areas 1, 2, 2A and 6 would likely have been constructed subject to the erstwhile North Shore District Plan High Noise Route insulation requirements, the PPFs in areas 3, 4, 5, and 7 were likely constructed before these rules were in place. Those rules do not contain any requirement for bedrooms or habitable rooms to be ventilated or provided with means to ensure adequate cooling whilst the windows are closed to reduce noise levels. Such ventilation and / or thermal cooling is a vital component of the noise mitigation package to allow windows and doors to be kept closed, particularly during the warmer months. I note that there is currently no control in the Auckland Unitary Plan requiring the acoustic insulation of dwellings near to noisy roads. Reliance on dwellings and other PPFs being insulated against high levels of road noise must therefore be with caution.
- (ii) In Table 3 of the Traffic Noise Report, a description of the subjective perception is given for a range of changes in noise level. I consider that these descriptions generally understate the reaction or perception of receivers, particularly for those

experiencing a 3-4 decibel change and a 5-8 decibel change. I consider that the effect could be better described as *perceptible to noticeable* for a 3-4 decibel change and *clear / obvious to substantial* for a 5-8dB change.

- (iii) The final sentence in paragraph 14.8 of Ms Wilkenings evidence states “...*that the proposed mitigation will maintain noise levels within the same noise criteria category*”, whereas in Table 8 of the Traffic Noise Report and in section 9.12 of her evidence, Ms Wilkening states that the project will result in 23 PPFs in Category C compared to only 5 without the project being constructed. I therefore consider that paragraph 14.8 is contrary to the Traffic Noise Report and the earlier statements in Ms Wilkening’s evidence.
- (iv) In paragraph 14.8 Ms Wilkening states, “*Overall, I predict that this Project will result in similar effects for most people adjacent to the road, compared with current and doing nothing scenarios.*” With reference to Table 1 in this report, I disagree with this statement, noting that of the 302 PPFs assessed, a total of 239 PPFs experiencing a increase greater than 1 dB and up to 8 dB. 40% of these PPFs will experience noise level changes of 3dB or more and up to 8dB. In my opinion the effects of the project could be described succinctly as mostly adverse with at least a noticeable increase in noise level for approximately 1/3 of PPFs.
- (v) In paragraph 14.6 Ms Wilkening states that “...*both people and amenity values of residential zones will be protected from unreasonable noise arising from the Project.*” For the reasons set out earlier in this report I disagree with this statement. I do not consider that the amenity of residential zones proximate to the project will be protected from unreasonable noise when the majority of PPFs in those zones will experience a noise level increase and where the amenity levels are already compromised to a significant degree by the high levels of road traffic noise. For that reason, I do not consider that people are protected in the same way. I also consider that the traffic noise levels that the community are being exposed to can in no way be described as reasonable without taking into account the positive benefits of the project.
- (vi) In the case of the NCI, the Traffic Noise Report states that the implementation of the Preferred Options will result in noise levels up to 72dB $L_{Aeq(24hr)}$. Whether the potential benefits of the NCI to people and the communities are sufficient to offset noise levels up to 17dB higher than an otherwise reasonable level of noise is beyond the scope of this report.

These issues are common between the Traffic Noise Report and the evidence and should be addressed accordingly.

4.8 Appropriateness of Mitigation

The full evaluation of the appropriateness of the Preferred Mitigation design and whether the BPO has been adopted is beyond the scope of this report. An accurate evaluation of these issues requires the input of experts in various disciplines such as urban design, constructability, traffic safety and planning to complete. Following that, the noise level reductions afforded by the mitigation would need to be weighed against the associated adverse effects, possibly requiring a broader judgement to be applied. These considerations are all beyond the scope of this report.

Notwithstanding, this report has highlighted several issues with the approach taken by the Traffic Noise Report and NZS6806 and updating the design to resolve these issues may result in changes to the Preferred Mitigation design.

5. Traffic Vibration Assessment

5.1 Overview

The Traffic Noise Report contains an assessment of traffic-induced vibration and concludes generally that if the roads are well maintained there will be no adverse vibration effects arising. Given that this assessment relies on the roads being maintained in accordance with the standard NZTA requirements which exist now and are presumably being applied to the current alignment, it should stand to reason that if these guidelines are effective then there should also be no adverse vibration effects at the current time.

5.2 Submission 126347 Tzu-Kai Eric Yen

The TK Yen submission raises concern about the level of vibration received in their home primarily from trucks passing on SH18. Ms Wilkening addresses this issue in paragraphs 11.49 to 11.53 of her evidence. In that evidence, she states that based on a very preliminary analysis (and measurements that have not been undertaken in accordance with the appropriate standard), the vibration levels measured in the submitters house will comply with the Class C criterion of Norwegian Standard 8176E of V_{w95} 0.3mm/s. Contrary to the statement in paragraph 11.52, there are no time-averaging provisions in NS8176E that could be used to further reduce the measured levels as suggested. I consider the measurement and assessment procedure used to inform that position is subject to a high degree of uncertainty and requires a more detailed analysis to confirm.

According to NS8176E approximately 1/3rd of the population will be slightly annoyed, annoyed and highly annoyed by vibration at this level. So even if the vibration levels do comply with the criteria of the NZS8176E standard, it is not possible to say that there will be no adverse effect.

Compliance with the Class C criterion appears to be the standard adopted by NZTA to inform their position. If vibration levels approach or meet the Class C criteria, approximately 1/3rd of the population will be annoyed to varying degrees. For the reasons set out above I consider that if the NCI project is designed only to achieve such compliance, it is not correct to state that there will be no adverse effects. The submission of TK Yen supports this.

This issue has not been resolved in evidence to-date.

5.3 Overall assessment

I generally agree that if the road surfaces are maintained in good order the likelihood of vibration issues arising is low, but certainly not completely avoided. Defects in the subgrade construction, pavements joins and wear caused by the braking of heavy vehicles can quickly give rise to deformities which can lead to vibration effects at adjacent sites.

I consider that ensuring compliance with the Class C criterion of NS8176E will ensure that the vibration effects are acceptable for most people. I do not agree with Ms Wilkening that there will be no adverse vibration effects.

This issue has not been resolved in evidence to-date.

6. Proposed Designation Conditions

I have reviewed the proposed designation conditions as they relate to noise and vibration and I consider that a number of revisions and additions are required. I anticipate that many of the issues can be resolved in expert conferencing so a detailed evaluation is not included here.

7. Conclusion

This report has been prepared only to discuss issues that require resolution and should not be considered to be a report providing a full review of the proposal. There are many aspects of the technical reports and assessments that I agree entirely with and which are not challenged, but these are not analysed herein. Notwithstanding, my review has found that the technical noise level measurement and prediction work has been carried out to a high standard and is able to be relied upon. If the issues requiring resolution could be summarised into a theme, it would be that there is insufficient information available at this time to complete a meaningful assessment

of the construction noise and vibration effects, and that the assessment of operational road traffic and vibration effects is incomplete or inconsistent with the requirements of the Resource Management Act (the Act). In particular:

- (1) The CNV Report and technical evidence do not provide sufficient information for a meaningful assessment of the construction noise effects to be undertaken. The reports make it clear that noncompliance with the project standards is likely at almost all parts of the route, but no noise levels or durations for those infringements are provided;
- (2) Similarly, the CNV Report does not provide any assessment of the likely vibration effects, and instead states that a very large number of proximate buildings will be subject to a medium and high risk of noncompliance with the project vibration standards. The reports do not contain any upper limits of vibration, assessments of the effects of damage or the effects on people as a function of vibration level and duration of exposure. These factors are critical in the assessment of effects;
- (3) The proposed project standards for the protection of building damage due to construction vibration are in my opinion too high, being set at a threshold where damage to buildings is already likely. I consider that this is an inappropriate threshold for the onset of additional management measures, and that the threshold should more appropriately be based on the requirements of the more commonly adopted German Standard DIN4150-3:1999. The usefulness of this standard as a guide to when damage might begin to be an issue is reflected in the evidence of Ms Wilkening;
- (4) The Traffic Noise Report is based wholly on NZS6806 but with an assessment of the subjective effects of the change in noise level likely to arise from the project, and also an analysis of the number of people highly annoyed by the traffic noise. I consider that whilst the technical basis of the report is sound, the method of assessment does not fulfil the requirements of s16 of the Act and in a number of cases the effects of the project are understated;
- (5) The Traffic Noise Report also provides an assessment of operational vibration effects which states that there will be no adverse effects generated. I disagree with this statement and it is my view that whilst the vibration effects might indeed be reasonable, they cannot be described as nil as the NZTA have done.

Overall, I consider that further work is required by NZTA to ensure that the effects of the project can be properly understood and evaluated against the requirements of the Act.