Before the Board of Inquiry
Waterview Connection Project

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in the matter of: the Resource Management Act 1991

and

in the matter of: a Board of Inquiry appointed under s 149J of the Resource Management Act 1991 to decide notices of requirement and resource consent applications by the NZ Transport Agency for the Waterview Connection Project

Statement of evidence of Siiri Wilkening (Operational Noise) on behalf of the **NZ Transport Agency**

Dated: 11 November 2010

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STATEMENT OF EVIDENCE OF SIIRI WILKENING ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION

1 My full name is Siiri Wilkening.

2 I am an acoustical consultant employed by Marshall Day Acoustics Ltd (MDA). I have had over twelve years experience in acoustic engineering in Germany and New Zealand, specialising in environmental noise control and computer noise modelling. I hold a Masters degree in Environmental Engineering (Land Improvement and Environment Protection) from the University of Rostock, Germany.

3 Over the last twelve years I have been involved in investigating and reporting on traffic noise effects of numerous roading projects, including local roads and State highways. My work has involved all aspects of traffic noise assessments, from route selection and evaluation, through noise level surveys, computer noise modelling, reporting and community consultation.

4 I have given evidence at Council planning hearings and have been involved in Environment Court mediation. Roading projects I have been involved with include the following:

4.1 Victoria Park Tunnel;

4.2 Newmarket Viaduct Improvement Project;

4.3 SH16/18 Realignment;

4.4 SH1 Northern Motorway Extension Orewa to Puhoi;

4.5 SH22 Drury Widening;

4.6 North Shore Busway;

4.7 SH20 to SH1 Manukau Link;

4.8 SH20 Manukau Harbour Crossing;

4.9 SH1 Improvement Projects Warkworth;

4.10 East Taupo Arterial Road; and

4.11 Additional Waitemata Harbour Crossing.

5 My evidence is given in support of notices of requirement and applications for resource consents lodged with the Environmental

Protection Authority (*EPA*) by the NZ Transport Agency (*NZTA*) on 20 August 2010 in relation to the Waterview Connection Project (*Project*). The Project comprises works previously investigated and developed as two separate projects, being:

5.1 The State Highway 16 (*SH16*) Causeway Project; and

5.2 The State Highway 20 (*SH20*) Waterview Connection Project.

6 I am familiar with the area that the Project covers, and the State highway and roading network in the vicinity of the Project.

7 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2006), and agree to comply with it. In preparing my evidence, I have not omitted to consider material facts known to me that might alter or detract from my opinions expressed.

SCOPE OF EVIDENCE

8 My evidence will deal with the following:

8.1 An executive summary of my evidence;

8.2 My background and role;

8.3 A summary of my assessment of operational noise effects;

8.4 Post-lodgement events;

8.5 Comments on submissions; and

8.6 Proposed operational noise conditions.

EXECUTIVE SUMMARY

9 I have assessed the Project's operational noise effects, namely the effects from traffic and mechanical services associated with the ventilation of the tunnel. My assessment is based on relevant New Zealand Standards.

10 I have measured existing noise levels, predicted existing and future noise levels (with and without the Project) and provided mitigation options to the wider Project team. The Project team, with my input, determined the best practicable option (*BPO*) for noise mitigation for the Project. I used the BPO determinations to predict future noise levels and have discussed the potential effects for relevant sections of the Project.

11 Overall, I consider that the implementation of the Project will provide a similar or better noise outcome to that presently experienced for sensitive positions in Sectors 1 to 7. These are positions which currently receive high ambient noise levels from existing roads such as SH16 and Great North Road. The implementation of mitigation measures will result in similar or lower noise levels for most positions.

12 For positions in Sector 9, the implementation of the Project will result in a significant increase in noise level, despite the proposed mitigation measures. This is due to the fact that the current noise environment is very low in this area. It is not possible for the Project alignment to retain these low noise levels. Therefore, the BPO mitigation measures determined by the Project team provide a balance between noise level reduction and other factors, such as visual and urban design implications and cost.

13 Ventilation noise can be controlled to comply with the most stringent night-time noise criterion, and I therefore consider that the effects from ventilation and associated mechanical noise will be no more than minor.

BACKGROUND AND ROLE

14 The NZTA retained MDA as part of a consortia team to assist with the investigation, engineering and planning of the Project. I was asked to prepare an Assessment of Operational Noise Effects Report (*Report*) in relation to the operational noise effects of the Project. The Report was peer reviewed by Stephen Chiles of URS Limited, also retained by the NZTA.

15 My Report was lodged with the EPA in August 2010 as part of the overall Assessment of Environmental Effects (*AEE*) (Part G, Technical Report G.12).

16 I have been involved with the Project in its various forms since 2000. My input involved the evaluation of noise effects of various route options, scheme assessments and the assessment of noise effects for previously considered alignments.

17 The effects of construction noise require separate consideration from the effects of operational noise and I have prepared a separate brief of evidence on the former.

SUMMARY OF ASSESSMENT

18 In this section of my evidence I will describe the methodology and key conclusions of my Report.

Methodology

NZS 6806:2010

19 My assessment of traffic noise effects is based on New Zealand Standard NZS 6806:2010 Acoustics – Road traffic noise - New and Altered Roads (*Standard*). The Standard is the first New Zealand Standard to address road traffic noise and was released on 30 April 2010. The NZTA has adopted the Standard, replacing its implementation of the 'Transit Guidelines for the Management of Road Traffic Noise – State Highway Improvements' (1999) (*Transit Noise Guidelines*).

20 The Standard is an extensive and complex document; therefore, I will only present the key concepts in my evidence. A more comprehensive explanation of the Standard is contained in Section 4.1 of my Report.

21 The Standard includes some of the methodologies used in the Transit Noise Guidelines for the assessment of road traffic noise, such as the noise measurement index ($L_{Aeq(24h)}$) and the concept of a "design year"[1] at least ten years after opening of a project. For this Project, the design year is 2026, based on the assumption that construction may be completed in 2016. I note, however, that the results of my noise level predictions would change insignificantly should the design year change by two years in either direction.

22 The Standard specifies the types of protected premises and facilities (*PPFs*), which are to be assessed in accordance with the provisions of the Standard, including dwellings, educational facilities and playgrounds within 20 metres of educational facilities. In order to be included in the assessment, the Standard requires that PPFs need to exist, or have building consent issued, at the time of assessment and be within 100 metres of the road alignment. The assessment position is at the façade of each PPF.

23 Commercial and business uses are not considered to be noise sensitive and are therefore not considered as PPFs and excluded from the assessment.

24 The noise criteria of the Standard are not based on existing ambient noise levels, but distinguish between new and altered roads, and roads carrying different traffic volumes.

25 The fundamental basis of compliance with the Standard is the application of the best practicable option (*BPO*) to achieve one of three noise criteria categories (A, B and C), which are applied progressively, i.e. with criterion B being met or bettered if criterion A is not practicably achievable, and so on.

[1] The Design Year is the year for which the assessment is undertaken.

26 My Report, in Section 4.2, sets out the Standard categories and related noise criteria in detail. In summary, the applicable Category Criteria for the Project are: the "A" (or primary external) noise criterion 64 dB $L_{Aeq(24h)}$, the "B" (or secondary external) noise criterion 67 dB $L_{Aeq(24h)}$ and the "C" (or internal) noise criterion 40 dB $L_{Aeq(24h)}$.[2]

27 The Standard requires that structural (external) mitigation be implemented in preference to building modification mitigation. However, where habitable rooms would still receive external noise levels of more than 67 dB $L_{Aeq(24h)}$ and internal noise levels greater than 45 dB $L_{Aeq(24h)}$ following the implementation of structural mitigation, the Category C requirements shall be implemented.

28 The category to be used for any given section of an alignment depends on the outcome of the BPO test.

29 As explained at Section 4.1.3 of my Report, the Standard provides for several operational scenarios to be assessed and compared. These include:

29.1 The existing noise environment;

29.2 A future Do-Nothing scenario;

29.3 A future Do-Minimum scenario; and

29.4 Several future mitigation options.

30 In order to ensure that the BPO is identified, the Standard requires that several mitigation options be developed and compared, not only in terms of noise level reductions but also in relation to other considerations such as urban design, safety and cost. For large projects, such as Waterview Connection, the Standard recommends that up to four mitigation options be developed and a preferred option chosen.

31 The process of comparing mitigation options is interactive, and often additional mitigation options are developed from the collaboration of several disciplines. Therefore, the assessment generally consists of a number of options and a preferred option developed by the entire project team. For that reason, the mitigation option chosen as the preferred option may not be the option providing the greatest noise level reduction, but an option which is considered optimal and practicable on balance, when evaluated against all relevant criteria by the wider project team.

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[2] See Table 4.1: Noise Criteria in my Report, page 13.

32 The Project is one of the first projects to be assessed in accordance with the Standard. While the Standard provides general guidance as to the methodology that should be followed in determining the BPO, I, and the Project team, developed processes suitable to undertake a robust assessment of noise mitigation measures. This assessment involved the following steps:

32.1 I developed several noise mitigation options for each individual noise receiving environment, e.g. all dwellings north of SH16 in Sector 6, and then provided them to the wider Project team for analysis; members of the Project team provided feedback relating to their area of expertise. All feedback was compiled in matrix form;[3]

32.2 Mitigation options and their implications relating to all relevant Project disciplines were discussed in workshops for each affected Sector. Generally, the workshops resulted in alternative mitigation options being developed based on the feedback received;

32.3 The Project team decided on the BPO for noise mitigation for each noise receiving environment; and

32.4 I recalculated the noise levels using the agreed BPO mitigation measures, which form the 'Preferred Mitigation Options' for the Project[4] for each Sector.

Noise Level Surveys and Modelling

33 I based my assessment on a combination of long and short duration noise level surveys (conducted in 2003, 2006 and 2009)[5] and predictions undertaken by computer noise modelling.

34 From the noise level surveys, ambient noise measurement results ranged from 46 dB to 71 dB $L_{Aeq(24h)}$, demonstrating the varying effect of relative proximity to busy roads, with noise levels at the lower end representing positions located away from the existing roading network and noise levels at the higher end representing positions close to existing major roads and motorways such as SH16 and Great North Road.

35 I have used the results of these surveys to verify the predictions of my computer noise model in accordance with the Standard. The verification shows that the computer noise model predicts noise

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[3] The matrices for each Sector are contained in Appendix F 'BPO Process: Matrices, Individual Assessment Noise levels and Figures' of my Report.

[4] The 'Preferred Mitigation Options' for each Sector are included in my Report as Appendix E, and are attached to this evidence as **Annexure A** for ease of reference.

[5] Noise survey results are reported in Appendix D of my Report.

levels to within two decibels of the measured levels for all survey locations.

36 Computer noise modelling provides valuable information for complex projects such as this. Results can be produced for individual receivers, in this instance all PPFs, and overview purposes, e.g. noise level contour areas. While noise level contours provide a general indication of noise propagation, they are derived by interpolation. Individual receiver noise level predictions are more accurate and I have used them to develop mitigation options for the Project. All calculation results are included in my Report in Appendix F.

Assessing each Project Sector

37 The Project has been divided into manageable Sectors, which have been assessed individually. I have assessed the noise levels, noise effects and required mitigation for each relevant Sector by predicting noise levels at all PPFs for the scenarios listed in paragraph 29 of my evidence. The assessments included the following components:[6]

37.1 **Traffic volumes.** I used the traffic volumes provided by the NZTA's consultant, Beca, for the years 2010 and 2026 (the design year) to predict existing and future noise levels, with and without the Project in place.

37.2 **Road paving.** The selection of road paving has a significant effect on traffic noise generation as road-tyre interaction is the major source of traffic noise at speeds over 40 km/h. I understand that, for non-acoustic reasons, the entire alignment of the Project, where it is above ground, will have an asphalt surface such as open graded porous asphalt (*OGPA*) or stone mastic asphalt. These are low-noise generating road surface materials. Additional noise mitigation can be achieved by using twin layer open graded porous asphalt (*Twin Layer OGPA*), and my assessment identifies where this surface should be used in the Project as part of the BPO to comply with the Standard.

37.3 **Safety barriers.** For safety requirements, any new bridges, including the ramps of the new Great North Road Interchange, will include solid concrete edge barriers of either 820 mm or 1100 mm in height on both sides. I have included these barriers in my assessment as they provide effective shielding to some PPFs.

38 Following calculation of existing, Do-Nothing and Do-Minimum noise levels, I assessed potential mitigation options for each Project

[6] Highway parameters are discussed in Section 6.2 of my Report.

Sector. Traffic noise mitigation can take several forms, including choice of road surface material, traffic noise barriers in the form of solid barrier walls, earth bunds or tunnels, and building modification mitigation.[7]

39 It is preferable that noise mitigation is applied as close to the source as practicable, in order to protect as wide an area as possible. Therefore, I considered road surface material and road edge barriers in the first instance. Only where these options were not practicable, for reasons such as visual impact, safety or ineffectiveness of noise reduction, did I consider alternatives such as barriers at property boundaries or building modification mitigation. Building modification mitigation has been considered only where other methods are impracticable or ineffective.

Assessing Ventilation Systems

40 In addition to traffic noise effects, I have assessed the noise from ventilation systems servicing the tunnel section of the Project. This type of noise source is not addressed in the Standard, therefore I have assessed it against noise limits derived from the underlying District Plan zone. All of the Project's ventilation systems will be located in the Auckland City area. The relevant noise limits derived from the current District Plan are 50 dB $L_{Aeq(15\ min)}$ for daytime and 40 dB $L_{Aeq(15\ min)}$ for night-time.[8]

Assessment of operational noise effects

41 In this section of my evidence I will briefly describe the key points of the assessment of operational noise effects. The full assessment is contained in Sections 7 and 8 of my Report.

42 I have undertaken an extensive and detailed assessment of operational noise effects from traffic and ventilation for the Project by assessing receiver positions affected by each Sector separately. I specifically focussed on Sectors 1, 5, 6 and 9 as PPFs are located in or around these Sectors and will be affected by traffic noise from the Project to varying degrees. I undertook the assessment process in accordance with the requirements of the Standard. As I have noted in my methodology discussion, extensive input from the wider Project team resulted in the development and refinement of mitigation options, and the selection of preferred mitigation options to achieve BPO. These options are presented in Section 8 of my Report.

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[7] Building modification mitigation may include one or a combination of the following: alternative ventilation (thus enabling external windows and doors to remain closed), improvement to glazing, joinery and/or external doors, improvements to walls and/or ceilings (by including insulation in cavities or adding layers of wall linings) and similar measures.

[8] The current District Plan references L_{A10} noise limits. New Zealand Standards have moved away from the use of the L_{A10} descriptor and have instead changed to the use of L_{Aeq} which is in line with international standards and practices. Therefore, I have proposed L_{Aeq} limits.

43 I consider that the BPO principle has been applied consistently throughout my assessment, and has resulted in mitigation options that are practicable and generally achieve appropriate noise level reductions given the balancing required against other considerations, such as urban design, safety and shading, under the BPO approach.

Sector 1

44 Sector 1 includes residential sites within Te Atatu that are currently affected by high traffic noise levels from SH16. Currently, dwellings are generally unshielded, and existing noise levels vary from 52 dB to 75 dB $L_{Aeq(24h)}$, depending on the distance and shielding of dwellings from SH16.

45 The implementation of the Project, i.e. the widening of SH16, will result in a small increase in noise levels of up to 2 decibels for most of the PPFs in this Sector. This change in noise level is not discernible. The exceptions are those dwellings currently shielded by dwellings adjacent to SH16 where the dwellings closer to SH16 will be removed to enable the construction of the Project. Here, without mitigation, noise levels would increase by up to 6 decibels due to loss of shielding.

46 The preferred mitigation option for Sector 1 involves a 2.5 metre high barrier north of SH16, barriers varying in height from 2 metres to 3 metres south east of SH16 and Te Atatu Road and barriers varying in height from 2.5 metres to 3.5 metres south west of SH16 and Te Atatu Road.

47 With the mitigation, four dwellings are still identified as exceeding the Category B criterion, specifically 38, 40A and 42 Alwyn Avenue (where residents had indicated that they preferred to retain the view over the harbour), and 14 Milich Terrace[9]. Building modification mitigation will be considered for these dwellings if required to achieve the Category C criterion.

48 The detailed assessment of Sector 1 is set out in my Report in Section 8.1 and Appendix F(i) and the preferred mitigation option is shown in **Annexure A** of my evidence.

Sector 5

49 Sector 5 will involve new ramps connecting SH16 with SH20 and realignment of existing roads to accommodate the new ramps. This will affect residences and teaching facilities in Waterview and Point

[9] The dwellings at 12 and 14 Milich Terrace are shown as one joined building in the figures in Appendices E, F and G in my Report. However, the individual receiver noise level predictions set out in the spreadsheets in Appendix F of my Report show predicted noise levels for 12 and 14 Milich Terrace individually. These predictions confirm that the dwelling at 12 Milich Terrace falls within Category B and no building modification mitigation will be required.

Chevalier. Existing noise levels vary from 52 dB $L_{Aeq(24h)}$ for dwellings in Waterview distant from SH16 and Great North Road to 70 dB $L_{Aeq(24h)}$ for dwellings in Point Chevalier overlooking SH16 and the Great North Road Interchange.

50 Implementation of the Project will result in a small increase in noise levels by up to 3 decibels for PPFs affected by the Project in this Sector.

51 I developed a large number of mitigation options[10] for each of the receiving environments in Sector 5, as there are a large number of PPFs in the Point Chevalier and Waterview area, and the lay of the land makes it difficult to mitigate noise from the Great North Road Interchange.

52 In my view, the topography of Sector 5 means that the installation of traffic noise barriers would be ineffective. Therefore, I advised the Project team to consider the use of alternative road surface material, such as Twin Layer OGPA. I undertook noise predictions for Twin Layer OGPA based on tests undertaken by Opus Central Laboratories in Wellington, which indicated a noise level reduction of 2 decibels below commonly used (single layer) OGPA.

53 The preferred mitigation option for Sector 5 therefore consists of Twin Layer OGPA to be used for the entire Great North Road Interchange, SH16 and SH20 in Sector 5. In addition, where the Interchange ramps are on elevated structures, solid concrete edge safety barriers of 1.1 metres in height will be installed.[11]

54 With this mitigation in place, I have identified only one dwelling in Sector 5 that is likely to exceed the Category B criterion, namely 49 Montrose Street. This dwelling overlooks the Great North Road Interchange and is elevated above all roads. The installation of a boundary fence would reduce views, and barriers would need to be excessively high (more than 3 metres), which would be out of context in a residential setting. Building modification mitigation[12] to achieve the Category C criterion will be considered for this dwelling in accordance with the requirements of the Standard.

55 A number of Unitec façades will experience noise levels above the Category B criterion of 67 dB $L_{Aeq(24h)}$. Teaching facilities are not specifically included in relation to the Category C Standard

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10 Refer Section 8.5 and Appendix F(ii) in my Report.

11 The safety requirements for these bridges are edge barriers of 0.8 metres high. However, the increased height would provide a small additional benefit in terms of noise reduction by breaking acoustic line-of-sight from the noise source (the road surface) to the receiver (PPF).

12 Refer Section 6.3.3 of my Report.

requirements of meeting an internal noise level of 40 dB $L_{Aeq(24h)}$ as the Standard relates to habitable rooms only.

56 However, as teaching areas are noise sensitive, the Unitec building is identified as a "Category C" building in my Report. I understand that the Unitec building in question is a historic building, and therefore, consideration will need to be given to suitable mitigation options which would not alter the historic character of the building. The process of determining appropriate mitigation measures is set out in my Report in Section 6.3.3 and in recommended Conditions ON.6 to ON.11 and will be undertaken in the relevant time frames and taking into consideration the heritage status of the Unitec building.

57 The detailed assessment of Sector 5 is set out in my Report in Section 8.5 and Appendix F(ii) and the preferred mitigation option shown in **Annexure A** of my evidence.

Sector 6

58 Sector 6 will involve the widening of the existing SH16. A limited number of dwellings are located north and south of SH16 and are currently affected by high traffic noise levels. Existing noise levels vary from 56 dB $L_{Aeq(24h)}$ for dwellings shielded from SH16 by intervening buildings to 74 dB $L_{Aeq(24h)}$ for dwellings adjacent to SH16.

59 The implementation of the Project will result in a small to moderate increase in traffic noise level of 2 to 6 decibels for affected PPFs.

60 The PPFs north of SH16 are level with, or slightly elevated above, SH16. The dwellings are currently affected by very high noise levels, and shielding by means of traffic noise barriers is problematic due to the lay of the land, which slopes towards SH16. Therefore, with input from the Project team, I have developed a mitigation option which consists of a combination of a bund and barriers along the road side and designation boundary, varying in height from 2 to 6 metres.

61 With this mitigation in place, six dwellings would still receive noise levels above the Category B criterion of 67 dB $L_{Aeq(24h)}$. These are: 10 and 12 Parr Road North, and four dwellings at 1102 Great North Road. These dwellings may require building modification mitigation so as to achieve the Category C criterion.

62 South of SH16, PPFs are located on a ridge above SH16 which slopes down to be level with the State highway. All dwellings in this area currently receive, and without the implementation of the Project would continue to receive, high traffic noise levels. Due to the location of the PPFs above SH16, positioning a barrier along the road edge would be ineffective. Similarly, locating a noise barrier

along the designation boundary would be disadvantageous due to shadowing and visual effects.

63 Therefore, the preferred mitigation option determined by the Project team consists of a barrier varying in height from 2 metres to 4 metres which is offset from the property boundary.

64 With this mitigation in place, I have identified only one dwelling to the south of SH16 in Sector 6 at 26A Carrington Road that is likely to exceed the Category B criterion. Building modification mitigation so as to achieve the Category C criterion will be considered for this dwelling.

65 The detailed assessment of Sector 6 is set out in my Report in Section 8.6 and Appendix F(iii) and details of the preferred mitigation option is shown in **Annexure A** of my evidence.

Sector 7

66 Project Sector 7 will contain the tunnel services building, transformers and ventilation shaft. As discussed in paragraph 40 above, I have assessed noise from the ventilation system against proposed noise limits derived from the District Plan. The majority of the tunnel services buildings, including the transformers, will be underground and therefore will be effectively mitigated. However, the ventilation of the transformers and the ventilation shaft will be located above ground.

67 Transformer ventilation can be treated by means of acoustic louvres. While the exact location of the transformers has not yet been determined, I predict that any associated ventilation requirements can be mitigated by using acoustic louvres to achieve ready compliance with the most stringent 40 dB L_{Aeq} noise limit at the closest residential boundary.

68 The ventilation stack is 25 metres high and located at the northern end of the tunnel services building. The design allows sufficient space for attenuation of fan noise and I predict that noise levels at the closest affected property can meet the most stringent noise limit of 40 dB $L_{Aeq(15\ min)}$.

69 The closest affected position to the tunnel services building is the adjacent Waterview Primary School and Kindergarten. While these buildings are not noise sensitive at night-time, I have based my assessment on the most stringent criterion, i.e. the night-time noise limit of 40 dB $L_{Aeq(15\ min)}$.

70 I consider that compliance with the 40 dB $L_{Aeq(15\ min)}$ limit will ensure that noise effects are no more than minor, and in many instances inaudible, and therefore less than minor.

71 A number of dwellings along Great North Road will be removed to enable the construction of the Project, and Waterview Primary School will consequently be exposed to more traffic noise from Great North Road. The northern Tunnel Services building[13] will extend along Great North Road and be approximately 6 metres high. This building will provide shielding for Waterview Primary School and have a beneficial acoustic effect.

Sector 8

72 Sector 8 consists of the full tunnel, which varies in depth between 20 and 45 metres. Traffic noise will be fully mitigated by the tunnel.

73 A smoke extract system for emergency situations originally proposed to be located at 36 Cradock Street is now no longer included in the Project.

Sector 9

74 Sector 9 is located south of the tunnels and includes parts of Owairaka. The Project comprises a new road in this Sector, which will traverse current open space. The new road will be introduced into a relatively quiet urban area, with residential sites adjacent to most of the alignment.

75 Existing noise levels currently experienced by PPFs in Sector 9 range from 45 dB $L_{Aeq(24h)}$ at dwellings facing the open space to 66 dB $L_{Aeq(24h)}$ at dwellings adjacent to existing major roads such as Richardson Road.

76 The implementation of the Project will result in a significant increase in noise level for PPFs in Sector 9, by more than 15 decibels for some dwellings, particularly for those currently facing open space. The Project introduces a new and major noise source into a low-noise urban environment. Mitigation will achieve noise level reductions of up to 9 decibels, with the highest reductions achieved for dwellings south of the Project in the Methuen Road/Valonia Street area.

77 Mitigation options for Sector 9 involve barriers varying in height from 2 metres to 5 metres. No building modification mitigation will be required for any dwellings in Sector 9 in relation to traffic noise mitigation.

78 Mitigation of the dwellings in Hendon Avenue that will remain post-construction was discussed extensively by the Project team, specifically to determine the BPO in terms of location of the noise barriers north of SH20. Installing a barrier on the Hendon Avenue side of the future rail corridor, abutting the residential properties, would result in that 20 metre corridor becoming a 'no-man's-land'

[13] Based upon the indicative design set out in the evidence of Mr David Gibbs.

until a rail line is established. In addition, there is not yet sufficiently detailed information available relating to future rail use of the proposed line to enable pre-emptive mitigation of rail noise.

79 Therefore, the Project team concluded that the best location of the noise barrier at this point in time would be adjacent to the SH20 alignment. This location enables the most effective shielding of dwellings from traffic noise and protects the largest area of land. In addition, the height of the barrier is suitable for a residential neighbourhood with heights not exceeding 2 to 2.5 metres.

80 The highway moves into a deep cut of more than 8 metres depth by the time it reaches the remaining dwellings in Hendon Avenue (to the north of the area where dwellings are required to be removed for construction). These dwellings will be well shielded from traffic noise from the new road by the deep cut.

81 Residences south of SH20 in Methuen Road and Valonia Street are generally located at greater distances from the road, but are slightly elevated above the alignment.

82 Barriers up to 5 metres in height were determined by the Project team to constitute the BPO noise mitigation. The barrier extends past the Valonia Street wetland and sports fields, and will not only provide shielding for dwellings beyond this open space, but will also provide noise mitigation for users of the open space.

83 With the preferred mitigation option in place, I predict that three dwellings at 180, 182 and 184 Methuen Road, are likely to still receive noise levels marginally above the Category A criterion of 64 dB $L_{Aeq(24h)}$ at their upper floors. These higher noise levels are due to the dwellings' elevation above, and relative proximity to, SH20. These three positions are predicted to receive noise level reductions from the proposed barriers of 4 decibels.

84 The trench leading into the tunnel will provide considerable acoustic shielding for dwellings south of SH20. Therefore, the barrier terminates approximately 350 metres from the southern tunnel portal. Extending the barrier would have little positive acoustic effect for dwellings in the area, and may have adverse visual effects.

85 The third area under consideration in Sector 9 is Christ the King School (*CTK School*) and a small number of unrelated dwellings in the vicinity of the school site. CTK School has entered into a private agreement with the NZTA in relation to works undertaken on SH20. This agreement sets out the noise mitigation that is to be provided for CTK School, including the construction of noise barriers along the property boundary adjacent to Maioro Street Interchange and SH20,

and the construction of new school buildings, which incorporate noise mitigation.

86 Dwellings in the vicinity of CTK School, on Richardson Road, require noise mitigation. Therefore, I prepared several mitigation options for the school and dwellings, and in conjunction with the Project team determined that the preferred mitigation option involves extending the barrier agreed with CTK School by 105 metres to the west. This barrier provides not only shielding for the dwellings, but also part of the school property.

87 The detailed assessment of Sector 9 is set out in my Report in Section 8.9 and Appendix F(iv) and the preferred mitigation option is shown in **Annexure A** of my evidence.

88 Sector 9 will also contain the southern ventilation building and stack. As the ventilation building will be above ground, noise mitigation will involve the choice of heavy building materials such as concrete for walls and roof, the treatment of openings with acoustic louvres, the installation of attenuators inside the building and the location of external ventilation openings away from residences where possible. The ventilation stack will be treated similarly to the northern stack.

89 With the use of common engineering solutions, the relevant noise limits recommended in paragraph 40 of my evidence will be achieved at all times.

All Sectors

90 Noise mitigation for all Sectors has included extensive feedback from the entire Project team and the community, and was determined by the team to constitute BPO. This means that some compromises were required where Project disciplines had conflicting views on issues, e.g. noise reduction versus visual impact. The process of working through each mitigation option in each Sector resulted in balanced outcomes which in my opinion are the BPO.

POST-LODGEMENT EVENTS

91 Following lodgement of the application, I observed an error on plan Nos. 20.1.11-3-D-N-918-117 and 20.1.11-3-D-N-918-118 submitted in Appendix F.17 "Noise Walls – Mitigation – 918" to the AEE. These overlapping plans show the height of noise barriers of the preferred mitigation option for Sector 9. The height of the western most section of the noise barrier south of the SH20 alignment should not be 6 metres, as shown in black on the figures, but should be 2 metres and 2.5 metres in near equal parts, as shown in Appendix E of my Report. A barrier height of 6 metres for a short section of barrier would provide no noticeable benefits due

to its limited extent. The intention is for the barrier to taper down from 5 metres to 2 metres before terminating.

92 As of 28 October 2010, the emergency ventilation stack at 36 Cradock Street will no longer be required. Therefore, I have excluded from my evidence my assessment of the noise effects in Sector 8 associated with that stack.

COMMENTS ON SUBMISSIONS

93 I have read submissions lodged on the Project that raise operational noise issues and, in this section of my evidence, I will address these submissions.

Traffic noise effects in general

94 A large number of submitters[14], including Housing New Zealand[15], raised the issue of high traffic noise levels following the opening of the Project.

95 For a large number of the receivers within 100 metres of the Project, noise levels will reduce when compared with current noise levels. This is due to the requirement of the Standard that in high noise areas with noise levels above 67 dB $L_{Aeq(24h)}$ mitigation should be implemented that reduces noise levels to 67 dB or below. This requirement of the Standard is particularly relevant to receivers adjacent to SH16 where ambient noise levels are currently elevated. The Project's mitigation options will result in an overall betterment to most positions, with traffic noise effects for receivers in Sector 9 being the exception.

96 The current ambient noise level in Sector 9 is low due to the lack of noise sources in the area. Although it is not possible to operate a major motorway without generating noise, noise mitigation has been designed for Sector 9 and the other Project Sectors, which will reduce noise levels to a reasonable level while also being practicable in relation to other disciplines such as urban design, safety and constructability.

97 Earlier in my evidence (paragraph 32), I have explained the methodology I, and the Project team, employed when determining the BPO in relation to traffic noise mitigation. I remain of the opinion that the mitigation measures proposed for the Project are BPO.

98 The operational noise impacts of the Project will vary between Sectors, with effects for PPFs in Sectors 1 to 7 being no more than

[14] Including Submitter Nos. 13, 18, 41, 42, 59, 61, 62, 94, 95, 192, 197, 202, 203, 213, 221, 225 and 230.

[15] Submitter No. 197.

minor, and better for some PPFs. For Sector 9, with the implementation of the BPO noise mitigation option, noise effects on PPFs will still be more than minor, but I consider that such effects will not be unreasonable.

Noise from buses on bus lane

99 Denis Ng[16] is concerned about the noise effect from the proposed bus lane adjacent to the submitter's dwelling at 3/34A Parr Road South.

100 The BPO for noise mitigation in the vicinity of the submitter's dwelling has been determined to be a 3 to 3.5 metre high barrier along the bank north of the dwelling. The placement of this barrier is discussed in paragraph 63 above. I predict that, with the widened SH16, the bus lane in place and the increase in traffic volume until 2026, noise levels will be reduced by 8 to 10 decibels at the submitter's dwelling. This change is significant, and traffic noise will sound nearly half as loud as at present.

Form, size and location of noise barriers

Placement of Barriers Close to Motorway

101 Submitters[17] requested the placement of barriers as close as possible to the motorway to minimise the uptake of open space. As discussed earlier in my evidence,[18] if practicable and effective, traffic noise barriers are best placed as close to the motorway as possible (to maximise their mitigation potential). I have applied this general rule throughout my assessment for the Project. Any offsets shown on the mitigation plans[19] are due to requirements for shoulders, safety distances and/or services, such as lighting; or occur where the specific topography of the area renders placement of walls at the motorway edge ineffective.

Particular location of barriers

102 Some submitters[20] request that barriers be constructed in locations specific to them, such as at the bottom of Montrose Street and Parr Road North.

103 As already discussed, the Project team employed a specific methodology (based on the Standard) when determining the BPO for noise mitigation. The Standard requires that noise mitigation is able to perform effectively, i.e. that a benefit can be shown through the installation of a barrier. Accordingly, where my assessment has

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16 Submitter No. 14.

17 Including Submitter Nos. 38, 46, 70, 73, 124, 191 and 229.

18 Refer paragraph 39 above.

19 Refer Plans and Drawing section of the Application: F.17 Noise Walls – Mitigation -918

20 Including Submitter Nos. 14, 23, 143, 193 and 192.

not proposed a barrier, it is likely the topography, location of dwellings and/or the motorway do not provide a suitable layout for barriers to effectively reduce noise levels. Montrose Street and Parr Road North are examples of this circumstance.

104 In developing the mitigation options for Sector 6, I tested placements of reasonable height boundary barriers (up to 2.5 metres high) for both Montrose Street and Parr Road North and concluded that such barriers would not provide any noticeable noise level reduction. Instead, very high barriers would have been required to provide any noticeable noise mitigation and such barriers were not seen as the BPO by the Project team because of other issues, such as visual impact.

Barriers at Great North Road Interchange

105 I have also tested several barrier heights up to 5 metres on the Great North Road Interchange ramps. While the highest barriers (i.e. 5 metres) would result in a noticeable noise level reduction for a number of residents, the visual, structural and safety aspects of high barriers on high ramp structures was determined by the Project team to not constitute the BPO for the Great North Road Interchange mitigation. Barriers of reasonable height (i.e. up to 2.5 metres) would achieve similar, and partially lower, mitigation compared with a Twin Layer OGPA surface. Therefore, the less visually intrusive, but acoustically effective, mitigation measure of Twin Layer OGPA in combination with low height safety barriers was determined to be the BPO.

Barriers in Sector 9

106 Several submissions[21] comment on the scale and length of the noise barriers south of the tunnel, extending through Alan Wood Reserve and Hendon Park. Barriers proposed to be erected south of the motorway alignment are already of considerable height, up to 5 metres in height. Increasing the height of these barriers will achieve only limited additional noise reduction, and the Project team determined that the proposed noise barriers are the BPO for this area, given the potential adverse visual effects of higher walls.

107 North of the motorway in Sector 9, barriers are only up to 2.5 metres in height because a number of dwellings along Hendon Avenue will be removed[22], and the noise effects have only been assessed for the remaining dwellings, which are further from the new carriageway.

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[21] Including Submitter Nos. 28, 70, 151 and 234.

[22] The dwellings are inside the designation and have been identified for removal as they would be affected by significantly adverse construction noise, vibration, air quality and other effects.

108 The new motorway moves into a cutting from approximately adjacent to the bend in Hendon Avenue and is in a very deep cut (approximately 20 metres below ground level) by the time it reaches the tunnel portal. The road will be well shielded from dwellings in Hendon Avenue. Accordingly, the installation of additional or higher barriers in this area would not result in a significant reduction in noise level for the dwellings on Hendon Avenue that are outside the designation, and such barriers do not constitute the BPO in this circumstance.

Noise from above ground motorway alignment

109 Where the motorway is above ground, traffic noise will affect residents in the vicinity. Extending the tunnel towards Maioro Street, as requested by some submitters,[23] would mitigate the noise effects from the road. However, this lowering of noise levels would be offset to some degree by the introduction of other noise sources, such as larger and more powerful ventilation systems required to service the longer tunnel. The reason for the surface option of the motorway is explained in more detail in Mr Walter's evidence.

110 Given that the Project involves a surface motorway through Sector 9, the noise barriers in that sector have been designed to balance noise, visual, structural and other effects and achieve a suitable outcome. In my opinion, the mitigation measures proposed for Sector 9 are the BPO.

Noise effects in Te Atatu

111 Several submissions[24] refer to noise effects on Alwyn Avenue and request that noise mitigation be implemented closer to the source, i.e. between the motorway and the cycleway. I agree that the implementation of mitigation close to the source is generally most effective. However, in this situation the bund proposed to be installed north of Alwyn Avenue provides effective noise mitigation for residences in Alwyn Avenue. Placement of additional noise barriers between the cycleway and SH16 would not achieve any additional mitigation for residences in the vicinity. The submitters seek to reverse the shape of the bund so that the highest point is closest to the cycleway rather than Alwyn Avenue. I consider that this would make no noticeable difference to the predicted noise levels.

112 The submissions further request that double glazing be installed for dwellings in Alwyn Avenue to reduce noise effects. I identified only three dwellings in Alwyn Avenue[25] where the traffic noise level from the Project will exceed the Category B noise criterion. These three dwellings will be assessed to determine whether building

[23] Including Submitter Nos. 195 and 218.

[24] Including Submitter Nos. 38, 46, 73, 124 and 212.

[25] Namely 38, 40A and 42 Alwyn Avenue.

modification mitigation is required to achieve the internal Category C criterion.[26]

Noise from ventilation stack and buildings

113 Submissions[27] relating to potential noise effects from the ventilation buildings and stacks in Sectors 7 and 9 raise concerns about potential noise breakout from the tunnel services buildings and stacks.

114 As discussed in paragraph 40, the mechanical services associated with the tunnel ventilation will be designed so that they achieve compliance with suitable District Plan night-time noise criteria at all times.[28]

115 The buildings will be constructed of heavy material such as concrete, which will result in effective noise mitigation for any noise generated inside the buildings. Building and equipment design has not been finalised, therefore, my calculations are based on preliminary information. However, as noted in paragraphs 66 to 70 above, noise from the ventilation systems can be mitigated using common engineering methods, such as attenuators and sizing the openings correctly. The size of the ventilation buildings currently proposed allows sufficient space for the installation of attenuators to achieve the recommended noise criteria.

Noise effects on and mitigation for St Francis School, Waterview Primary School and Kindergarten

116 Several submitters[29] are concerned about potential noise effects on the schools adjacent to the Great North Road Interchange, including the respective school boards, the Auckland Kindergarten Association and the Ministry of Education. Mitigation measures requested by these submitters range from the provision of fences to the installation of improved glazing and ventilation for all classrooms.

117 Following a post-lodgement discussion with the Principal of St Francis School, the NZTA is proposing to install a solid boundary fence along the southern school boundary abutting the playing fields. This fence will achieve visual screening and improve safety for the playing fields. In addition, it would provide incidental acoustical shielding for the playing fields and school buildings.

118 Following construction of the Project, Waterview Primary School will be well shielded from traffic on Great North Road by the proposed ventilation building. The school will receive noise levels similar to,

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26 Refer paragraph 47 above.

27 Including Submitter Nos. 62, 134, 151, 172, 191, 205 and 218.

28 Refer paragraph 40 for recommended ventilation system criteria.

29 Including Submitter Nos. 93, 136, 153, 175, 176, 191 and 221.

or slightly less than, those it currently experiences. However, during construction, mitigation in addition to the installation of temporary construction noise barriers may be required, such as the installation of improved glazing and ventilation for the most affected classrooms. I have discussed these measures for mitigating construction noise in a separate brief of evidence.[30]

119 I consider that effects from the Project's operational noise on the schools will be no more than minor, and potentially provide betterment over existing circumstances due to mitigation implemented as part of the Project.

Noise level monitoring pre- and post-construction

120 Some submitters[31] requested that monitoring of operational noise effects be required, both prior to construction (to establish a baseline noise level) and following commencement of operations (for comparison with pre-construction noise levels).

121 Existing noise levels have been measured extensively along the proposed alignment.[32] Noise levels in areas of similar exposure to the same noise sources, e.g. SH16, receive similar noise levels. Therefore, measurement does not need to be undertaken at each individual dwelling, instead I have chosen representative positions that provide an overview of the existing ambient noise environment in the vicinity of the Project.

122 In response to the submissions, I have recommended that the designation include a condition requiring post-construction noise level monitoring.[33] Such monitoring can be undertaken at the same positions where pre-construction monitoring was carried out, and the results compared to gain an understanding of how the Project has affected the noise environment.

Sound proofing of dwellings

123 Several submitters[34] have sought that double glazing or other building modifications be considered for their dwellings.

124 The Standard requires that PPFs, which have been identified as being in Category C, i.e. where future noise levels are predicted to exceed 67 dB $L_{Aeq(24h)}$, be further assessed to determine if building modification mitigation will be required to achieve compliance with the internal noise criterion of 40 dB $L_{Aeq(24h)}$. In my assessment, I have identified a number of dwellings which are likely to fall within

30 Refer my construction noise evidence.

31 Including Submitter Nos. 21, 44 and 84.

32 Refer Section 5 and Appendix D of my Report.

33 Refer Recommended Condition ON.14 in Annexure B.

34 Including Submitter Nos. 23, 61, 94, 95, 151 and 197.

Category C, and they are noted in my evidence above and listed in Table 9.1 in Section 9 of my Report.

125 Some of the dwellings I have identified as likely to fall within Category C will be of interest to the submitters noted above, including Housing New Zealand, which manages properties in Great North Road in Sector 6.

126 Recommended conditions ON.6 to ON.11 set out the process as to how these, and other, Category C buildings will be assessed further. I consider the proposed process to be robust, allowing sufficient time for the assessment of building modification mitigation requirements and dialogue between the NZTA and affected parties.

Loss of shielding from buildings to be removed

127 A number of buildings will need to be removed to allow for the construction and operation of the Project. The removal of these buildings may leave the next closest buildings exposed to noise from the motorways and Great North Road, a point which is raised in a number of submissions.[35]

128 As discussed in my Report and earlier in my evidence, I have modelled the noise effects of the existing road layouts and the noise emissions from the Project. Generally, following construction of the Project, noise levels will remain similar, or reduce, for dwellings in Sectors 1 to 7.

129 Dwellings in Waterbank Crescent and surrounding streets will be shielded from traffic on the new Great North Road Interchange ramps by the proposed 1.1 metre high edge safety barriers, and dwellings in Great North Road will be shielded by the replacement boundary fences, which will be installed during construction of the Project.

130 The removal of dwellings in Hendon Avenue will lead to a number of dwellings on the northern side of Hendon Avenue being exposed to operational noise from the Project. However, these dwellings are a considerable distance from the road (approximately 90 metres), and that distance, in conjunction with the proposed 2.5 metre noise barrier and the fact that the new motorway near Hendon Avenue, is moving into a trench (which will provide additional acoustical shielding) means that noise levels within the Category A criterion can be achieved at all dwellings.

131 In my assessment of operational noise effects, I have taken into consideration the loss of shielding for dwellings and allowed for mitigation where this is required to achieve compliance with the Standard's Category A or B noise criteria.

[35] Including Submitter Nos. 59, 65 and 148.

Noise effects from Great North Road Interchange and widened SH16

132 A large number of submitters[36] are concerned about the traffic noise effects from the Great North Road Interchange and widened SH16. The area is currently affected by high noise levels from SH16, and the introduction of additional ramps and more traffic lanes creates the perception that the alignment will result in higher noise levels than existing.

133 The main mitigation measures for the Great North Road Interchange is the use of low noise generating road surface Twin Layer OGPA in combination with the use of higher than required edge safety barriers. These measures will be applied not only to the new ramps and SH20, but also to the section of SH16 within the Interchange[37]. The overall effect of these mitigation measures will be that the noise level in the area will reduce, despite the increase in traffic volume.

134 Some submitters are concerned that they have not been identified as a Category C dwelling and will therefore not be considered for building modification mitigation. The model I used for my assessment of operational noise takes into consideration several factors (as described in Section 6.4 of my Report), including height of the dwelling, angle of view, shielding and distance from the road. Therefore, while some dwellings appear to be in a similar position compared with neighbouring dwellings, any changes in one or several of the factors affecting noise propagation will result in a difference in predicted noise level.

135 During the development of a large number of mitigation options for the Great North Road Interchange, I tested several options of placing barriers along the road way, including onto part of the causeway. The results showed that barriers as high as 4 metres had no appreciable effect in further reducing noise levels. Therefore, these options were not developed further.

136 Some of the submitters are concerned about noise effects on St Francis School and request that the edge safety barrier on the northern edge of the SH20 to SH16 eastbound ramp be extended. The extent of the barrier is determined by the length of the bridge. Additionally, the ramp will be at a low grade and the edge barrier, if extended, would have no beneficial acoustic effect.

137 As noted in paragraph 117 above, following discussions with the Principal of St Francis School, the NZTA is proposing to construct a solid boundary fence along the southern edge of the school playing

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[36] Including Submitter Nos. 94, 95, 100, 104, 136, 148, 179, 191, 192, 221, 222 and 243.

[37] Refer **Annexure A** of my evidence.

fields, which will result in effective acoustic shielding of the school grounds and buildings.

Noise effects on Open Space

138 Several submissions[38] comment on traffic noise effects on open space areas, particularly in Alan Wood Reserve and Hendon Park to the south, and Waterview Park, to the north of the tunnel.

139 Open space in any form, including passive and active recreational space, is not included in my operational noise assessment for the Project. The Standard does not include open space as a PPF, and the Auckland City District Plan does not contain any noise criteria to limit noise from any other zone into the Open Space zone.

140 My assessment focuses on noise effects on locations where people live, learn and sleep. As dwellings and teaching facilities are assessed[39], any noise mitigation implemented for their protection also benefits other sites in the vicinity. For instance, the high noise walls proposed for Sector 9 south of the motorway are intended to mitigate operational noise for dwellings in Methuen Road and Valonia Street will also effectively mitigate noise into the Valonia Street sports fields and wetlands.

141 Noise effects on Eric Armishaw Park in Pt Chevalier are of concern to some submitters. My modelling shows that the park will receive noticeably lower noise levels, with reductions of up to 6 decibels, due to the use of Twin Layer OGPA and higher safety edge barriers on the Great North Road Interchange ramps.

142 Some submitters are concerned about noise levels in the new Waterview Park. Following my assessment, the visual and landscaping design for the new Waterview Park was developed further and a 5 metre visual bund is now proposed between the SH20 to SH16 westbound ramp and the new Park. I had not entered this bund into my model, but have now done so. The bund will provide acoustic screening for the new Park, and noise levels will be similar to those currently experienced in the existing Waterview Park. A figure showing the noise level contours for this area is attached in **Annexure B** of my evidence. That figure should be compared with the figures in Appendix G(iii) of my Report, specifically the figure labelled "Sectors 5 to 7, Existing (2010)".

Maintenance of mitigation measures

143 Heather and Rory Docherty[40] note that mitigation measures, such as road surface material and barriers, will need to be maintained to a

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38 Including Submitter Nos. 12, 70, 136, 178, 179, 191, 192, 205, 211 and 221.

39 A list of PPFs in accordance with NZS6806:2010 is included in Section 4.1.1 of my Report.

40 Submitter No. 209.

high standard in order to achieve the noise level reductions intended. I agree and a maintenance requirement is set out in recommended designation condition ON.12.

Engine braking restriction

144 Noise from "engine braking" is often noted by residents as being annoying as it is prominent above the general hum of traffic. Several submitters,[41] including the Star Mills Preservation Group, note that engine braking on the Great North Road Interchange ramps when approaching the tunnel will be audible, and they seek the installation of "Engine Brake Restriction" signs on the motorways.

145 My assessment of traffic noise effects does not take account of individual noise sources, such as particularly noisy vehicles or noise from engine braking. Therefore, the mitigation measures set out in my Report will not result in effective mitigation of such sources. While overall noise levels from the Project will be mitigated, individual sources will be audible above the general sound. There are very limited mitigation options that would resolve this issue, the most obvious being the installation of "Engine Brake Restriction" signs.

146 In my opinion, these signs would be a suitable and effective mitigation and management measure for dealing with the noise from engine braking. However, I understand from the NZTA that these signs cannot be placed on the motorway for safety reasons[42].

Noise effects on Marine Reserve and on wildlife

147 Noise effects on the Motu Manawa (Pollen Island) Marine Reserve and on wildlife were raised by some submitters,[43] including the Friends of Oakley Creek. These issues are addressed in the evidence of Mr. Graham Don.

David Clendon, Gareth Hughes and Kevin Hague – Green Party

148 The submission[44] addresses a number of issues as follows: the perception that noise mitigation incorporated in the Project is minimal; the requirement to acoustically improve the quality of green spaces and the basis of noise modelling. I address these issues below.

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41 Including Submitter Nos. 191, 199, 225 and 230.

42 As explained by Mr Walter in his evidence.

43 Including Submitter Nos. 136 and 179.

44 Submitter No. 156.

Perception of minimal noise mitigation

149 The Project team, including me, has designed the noise mitigation for the Project based on the BPO principle. In determining the BPO for each Sector, the Project team weighed several factors, including visual impact and urban design. In some areas, therefore, noise mitigation can appear to be minimal. This is particularly noticeable at the Great North Road Interchange, where mitigation will involve the use of low noise road surface and low safety barriers, which will provide the best possible noise reduction without the need for high barriers on high ramp structures, which would have significant adverse visual impacts.

150 Similarly, mitigation in Sector 9 was designed to be unobtrusive, in order to integrate with the residential scale of dwellings adjacent to the alignment. Accordingly, barriers are restricted in height to 2.5 metres in the vicinity of Hendon Avenue.

Noise mitigation for Open Spaces

151 I have addressed this issue in paragraphs 138 to 142 above.

Noise modelling

152 The submission states that traffic volumes for the design year may be higher than those on which my computer models were based. All modelling, e.g. traffic volumes and noise, is based on a number of assumptions. Increased knowledge about factors affecting the assumptions lead to more accurate predictions. My previous experience with noise level modelling has shown that predictions can be made to a reasonable accuracy, generally within 2 decibels of the actual measured noise level.

153 However, as noted in paragraph 21 above and discussed in detail in Section 6.5 of my Report, noise levels are relatively insensitive to changes in traffic volume[45]. Therefore, even with a noticeable change in traffic volume noise levels, would not change considerably, and my predictions will remain unchanged.

Auckland City Council

154 Auckland City Council's (*ACC*) submission[46] addresses a number of issues as follows: mitigation of noise levels for dwellings that will receive noise levels above 64 dB $L_{Aeq(24h)}$, the use of transparent materials for noise barriers and clarification of discrepancies in my Report. I address these below.

Mitigation of noise levels above 64 dB $L_{Aeq(24h)}$

155 ACC's submission relating to the Standard's requirement for traffic noise mitigation appears to misinterpret the Standard. It is correct

[45] An increase in traffic volume of 25% would result in a noise level increase of about 1 decibel.

[46] Submitter No. 111.

that the Standard sets noise criteria categories, which are not dependent on ambient noise levels. Instead, the Standard applies to altered roads, where the noise level difference between the existing and altered road in the future (design) year is 3 decibels or more. Once it has been established that the noise level would change at any one PPF due to the implementation of a project, all PPFs in the vicinity of the project are assessed. This is how I have assessed the Project.

156 The Standard does not require that existing and future noise levels are compared, nor does it require that, following construction of a project, noise level at all PPFs should be 64 dB or less.

157 I have explained that the Standard is based on the concept of the BPO.[47] In accordance with the BPO principle, noise mitigation for the Project has been determined by the Project team. In many instances, noise levels in Category A can be achieved, but some dwellings will receive noise levels in Category B, and I have identified a very small number of PPFs[48] that will need more detailed assessment to determine which, if any, building modification mitigation may be required to achieve the Category C criterion.

158 For the majority of PPFs, noise levels will remain similar to, or be lower than, levels currently experienced. This is particularly the circumstance for dwellings that currently receive high noise levels,[49] and where the Standard requires that noise levels should be reduced if practicable.

159 Where ambient noise levels are low at present[50], the increase in noise level due to the Project will be significant. However, with the implementation of the preferred mitigation option, almost all PPFs in those areas will receive noise levels within Category A (the most stringent category).

Transparent noise barriers

160 In order to be effective, noise barriers need to be constructed of materials that are solid and have a minimum weight of 10 kg/m^2. A list of example materials suitable for the construction of noise barriers is included in Section 6.3.2 of my Report[51].

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47 Refer paragraph 25 above.

48 For the entire Project, only 15 buildings have been identified to be within Category C.

49 This relates to dwellings in Sectors 1 to 7 which are affected by elevated noise levels from traffic on SH16 and Great North Road.

50 This relates to dwellings in Sector 9.

51 Refer also NZTA State Highway Noise Barrier Design Guide, Version 1, August 2010, Section 2.9 'Materials'.

161 Provided the minimum requirements for barrier materials noted above are fulfilled, the recommendation as to what materials should be used is not made by the acoustic consultant, but by others in the Project team, such as the urban designer. Therefore, Ms Hancock in her evidence responds more fully to ACC's request.

Clarification of discrepancies in my Report

162 ACC notes that there are a number of discrepancies in my Report relating to the predicted noise level tables in Appendix F and the wording in the Report.

163 The tables in Appendix F set out each PPF, i.e. each building assessed and each floor of each building. In addition, where there are multiple units in one building, e.g. duplexes or blocks of flats, I have assessed each tenancy separately. Therefore, the table in Appendix F(iii) relating to Sector 6 contains a larger number (14) of PPFs in Category C than there are buildings shown on the figures in Appendix F(iii). The wording in my Report references the six buildings that will require further assessment to determine if building modification mitigation will be required to achieve the Category C criterion.

164 The wording in Section 8.9.3.5 of my Report states that all dwellings comply with Category B, while in fact all but one comply with Category A. By definition, each PPF complying with Category A also complies with the less stringent Category B criterion. My intention was to note that no PPF would fall within Category C.

Noise mitigation for Western Springs Garden

165 ACC states in its submission that the Western Springs Gardens, part of which is required for construction purposes, should be provided with noise mitigation, such as noise walls, to improve the Gardens' current "low open space value".[52] Western Springs Gardens is currently affected by traffic noise from Great North Road and SH16 and receives noise levels around 70 dB $L_{Aeq(24h)}$. With the widening of SH16, my predictions show that the noise levels at the Gardens would increase marginally to 72 dB $L_{Aeq(24h)}$, which is generally an unnoticeable difference.[53]

[52] Refer ACC Submission paragraphs 70 and 71.

[53] Refer Section 6.5 of my Report.

166 The Standard sets out a list of PPFs[54] that are to be assessed and protected from traffic noise, if required. PPFs are spaces where people may sleep or be educated. They exclude areas of active and passive recreation, including sports fields, parks, playgrounds (except where these belong to an educational facility) and other public facilities, such as museums or libraries. I undertook my assessment in accordance with the requirements of NZS 6806 and excluded park spaces, such as the Western Springs Gardens.

167 Western Springs Gardens is currently mostly used for car parking and contains a restaurant (Cobb & Co) with associated car parking and a small grassed area, which may be used for passive recreation. I consider that neither use is noise sensitive and are mostly noise generators themselves. As noted in paragraph 139 above, the Auckland City District Plan does not provide noise protection for open space by setting noise limits for intrusive noise into Open Space zones. Therefore, my assessment in accordance with the Standard is similar to that which would be required under the District Plan.

Unitec

168 Unitec[55] raises two operational noise issues; the potential requirement for building modification mitigation to be implemented on a heritage building, and the relationship of future development on the Unitec site.

Building Modification Mitigation of a historic building

169 The old Carrington Hospital (now Building 1 as identified on the figure in Section 8.5.3 of my Report) has a heritage protection order.[56] This building is identified as receiving noise levels in excess of the Category B criterion, and will therefore require further assessment in order to determine if building modification mitigation will be required.

170 I have visited the Unitec site and inspected Building 1 from the outside. I have not yet assessed the internal room layout to determine the use of the rooms where façades were calculated to receive noise levels above 67 dB $L_{Aeq(24h)}$. Therefore, I cannot comment on specific modification requirements at present. However, any building facade improvements required would need to be agreed with Unitec and the Historic Places Trust. Any future determination of modifications required will follow the process set out in recommended conditions ON.6 to ON.11, taking account of the special character of the building.

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54 Refer Section 1.4 of NZS 6806:2010.

55 Submitter No. 244.

56 Refer Mr Clough's evidence.

Future development of the Unitec site

171 The submitter states that the BPO in terms of noise mitigation has not been determined as no allowance has been made for potential future development on the Unitec site, which could involve a multi-storey building on the north eastern corner of the Unitec site, adjacent to Oakley Creek and the Great North Road Interchange.

172 Ms Linzey discusses in her evidence the practicability of the submitted future use. In relation to noise on the site, I have predicted noise level contours covering the part of the Unitec site under discussion.[57] The predictions show that the noise level that will be received at the site with the Project implemented will remain similar to that currently experienced on the site. This outcome is due to the Twin Layer OGPA proposed to be used for the entire Great North Road Interchange as well as SH16 and SH20 in the vicinity of the Interchange. This mitigation, in conjunction with the proposed 1.1 metre high concrete edge barriers on the Interchange ramps, will achieve effective noise mitigation, which will balance the predicted increase in traffic volume and achieve an overall better noise environment for sites in the vicinity of the Interchange.

173 I consider that the Project will have no adverse noise effect on the Unitec site, with noise levels remaining similar to current levels.

PROPOSED OPERATIONAL NOISE CONDITIONS

174 In the documentation lodged with the AEE, the NZTA included a set of Proposed Designation Conditions (see Part E, Appendix E.1). This included proposed operational noise conditions which I recommended would be appropriate to attach as conditions to the designations sought. A copy of the proposed conditions is contained in **Annexure C** to my evidence.

175 As this assessment is based on a detailed process to determine the BPO, it is not possible to then apply a retrospective performance specification, i.e. a numerical limit for each PPF, to define the outcome. I consider that any designation conditions relating to traffic noise generation should instead require the actual physical mitigation measures determined to be the BPO by my assessment to be implemented.

176 The effectiveness of these mitigation measures can be tested following the implementation of the Project, by means of noise level surveys and updated computer noise modelling.

[57] Refer figures in Appendix G(iii) in my Report.

177 I consider that the conditions are still appropriate, with the following recommended alterations:

177.1 I have been advised by NZTA that the deletion of the emergency ventilation stack makes the recommended condition ON.14 obsolete. I have therefore deleted it.

177.2 In response to submitters, I have recommended a new condition ON.14 which deals with pre- and post-construction noise level survey requirements.

Siiri Wilkening
November 2010

Annexure A: Preferred Mitigation Options

Annexure B: Noise Level Contours for Waterview Park (with bund)

Annexure C: Operational Noise Conditions

ANNEXURE A: PREFERRED MITIGATION OPTIONS

Excerpt from Technical Report G.12 "Assessment of Operational Noise Effects"

Appendix E – Preferred Mitigation Options for

- Sector 1
- Sector 5
- Sector 6
- Sector 9

MARSHALL DAY Acoustics

Appendix E
Sector 1
Preferred Mitigation Options (2026)

Noise level
$L_{Aeq\ 24\ h}$
in dB

- <= 64 Category A
- <= 67 Category B
- > 67 Category C

MARSHALL DAY Acoustics

Appendix E
Sector 5
Preferred Mitigation Options (2026) (Twin layer OGPA Surface)

Noise level
$L_{Aeq\ 24\ h}$
in dB

- <= 64 Category A
- <= 67 Category B
- > 67 Category C

MARSHALL DAY Acoustics

Appendix E
Sector 6
Preferred Mitigation Options (2026)

Noise level
$L_{Aeq\ 24\ h}$
in dB

- <= 64 Category A
- <= 67 Category B
- > 67 Category C

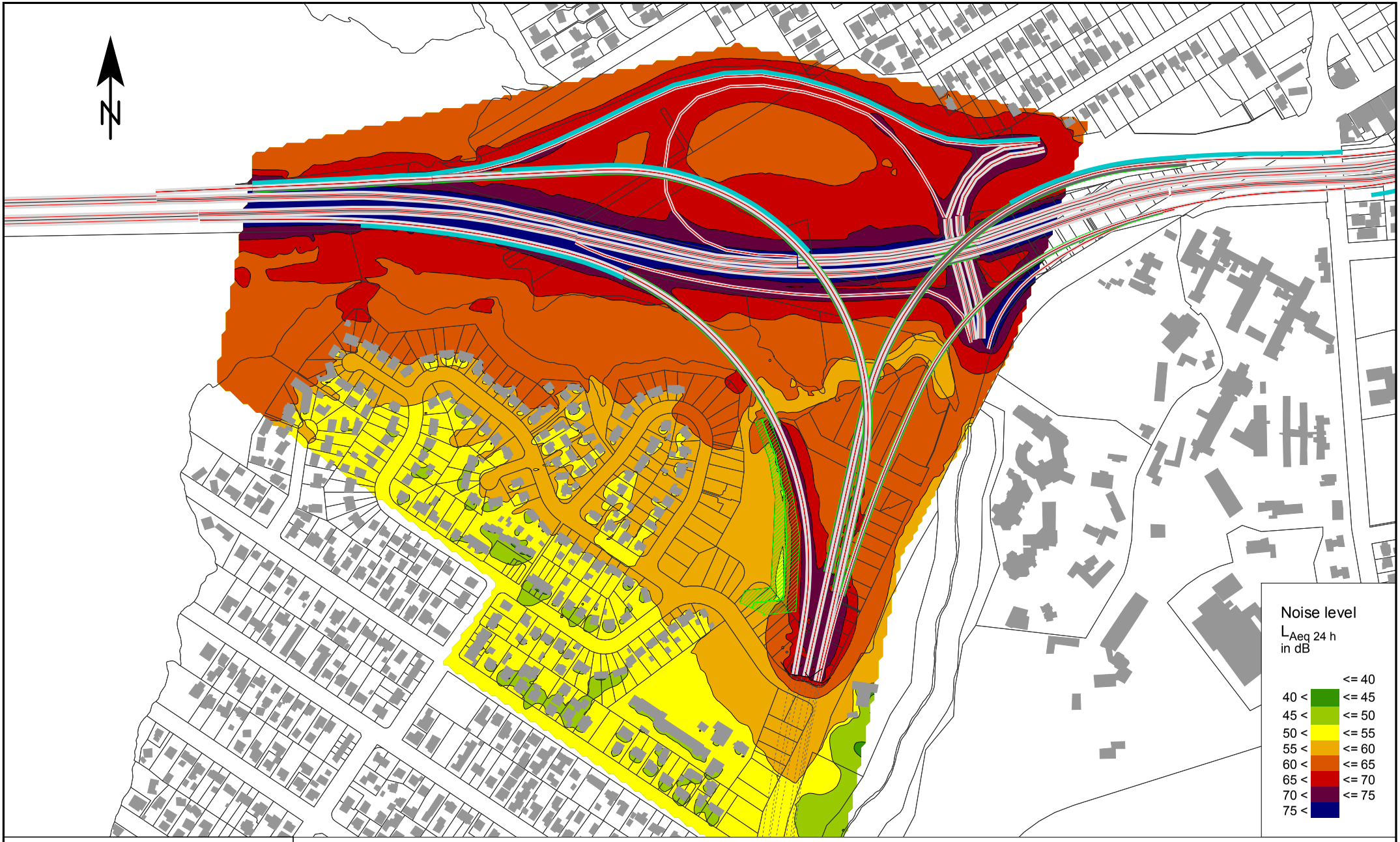
MARSHALL DAY Acoustics

Appendix E
Sector 9
Preferred Mitigation Options (2026)

Noise level
$L_{Aeq\ 24\ h}$
in dB

- <= 64 Category A
- <= 67 Category B
- > 67 Category C

ANNEXURE B: NOISE LEVEL CONTOURS FOR WATERVIEW PARK (WITH BUND)



MARSHALL DAY Acoustics

Sector 5 - Waterview Park with Bund
Preferred Mitigation Options (2026)

ANNEXURE C: PROPOSED NOISE CONDITIONS - OPERATION[58]

ON.1	For the purposes of Conditions [ON.1-14] the following terms will have the following meanings: Appendix E – means Appendix E to the Technical Report G.12 'Assessment of Operational Noise Effects' submitted with this application. BPO – means Best Practicable Option. Building Modification Mitigation – has the same meaning as in NZS 6806:2010. Design Year – means a point in time that is 10 years after the opening of the Project to the public Emergency Mechanical Services – means mechanical services used for emergency situations only. Habitable room – has the same meaning as in NZS 6806:2010. Noise Criteria Categories – means groups of preference for time-averaged sound levels established in accordance with NZS 6806:2010 when determining the BPO mitigation option; i.e. Category A - primary noise criterion, Category B - secondary noise criterion and Category C - internal noise criterion. NZS 6806:2010 – means NZS 6806:2010 Acoustics – Road-traffic Noise – New and altered roads. PPFs – means only the premises and facilities identified in green, yellow or red in Appendix E. Structural mitigation – has the same meaning as in NZS 6806:2010.
ON.2	The NZTA shall implement the traffic noise mitigation measures identified as the "Preferred Mitigation Options" in Appendix E as part of the Project, in order to achieve the Noise Criteria Categories indicated in Appendix E ("Identified Categories"), where practicable and subject to [Conditions 3-11] below.
ON.3	The detailed design of the structural mitigation measures of the "Preferred Mitigation Options" (the Detailed Mitigation Options) shall be undertaken by a suitably qualified acoustics specialist prior to construction of the Project, and, subject to [Condition 4], shall include, as a minimum, the following: (a) Noise barriers with the location, length and height in general accordance with Appendix E; and (b) A requirement that Open Graded Porous Asphalt ("OGPA") or equivalent low-noise generating road surface be used on all surface roads throughout the Project, except at the Great North Road Interchange; and (c) For the Great North Road Interchange, a requirement that Twin Layer Open Graded Porous Asphalt ("Twin Layer OGPA") or equivalent low-noise generating road surface be used as shown in Appendix E.
ON.4	Where the design of the Detailed Mitigation Options identifies that it is not practicable to implement a particular structural mitigation measure in the location or of the length to height included in the "Preferred Mitigation Options", either: (a) If the design of the structural mitigation measures could be changed and would still achieve the same Identified Category at all relevant PPFs, and a suitably qualified planner approved by the [Auckland Council] certifies to the [Auckland Council] that the changed structural mitigation measure would be consistent with adopting BPO in accordance with NZS 6806:2010, the Detailed Mitigation Options may include the changed mitigation measures; or

[58] Contained in Appendix E.1, page **16**.

	(b) If the changed design of the structural mitigation measure would change the Noise Criteria Category at any relevant PPF from Category A or B to Category C but [Auckland Council] confirms that the changed structural mitigation measure would be consistent with adopting BPO in accordance with NZS 6806:2010, the Detailed Mitigation Options may include the changed structural mitigation measures.
ON.5	The Detailed Mitigation Options shall be implemented prior to completion of construction of the Project.
ON.6	Prior to construction of the Project, a suitably qualified acoustics specialist shall identify those PPFs where following implementation of all the structural mitigation measures included in the Detailed Mitigation Options, Building Modification Mitigation in accordance with NZS6806:2010 may be required to achieve 40 dB L_{Aeq} inside habitable rooms (Category C Buildings).
ON.7	(a) Prior to commencement of construction of the Project in the vicinity of a Category C Building, the NZTA shall write to the owner of each Category C Building seeking access to such building for the purpose of measuring internal noise levels and assessing the existing building envelope in relation to noise reduction performance. (b) If the owner(s) of the Category C Building approve the NZTA's access to the property within 12 months of the date of the NZTA's letter (sent pursuant to Condition ON.7(a), then no more than six months prior to commencement of construction of the Project, the NZTA shall instruct a suitably qualified acoustics specialist to visit the building to measure internal noise levels and assess the existing building envelope in relation to noise reduction performance.
ON.8	Where a Category C Building is identified, the NZTA shall be deemed to have complied with [Condition 7] above where: (a) The NZTA (through its acoustics specialist) has visited the building; or (b) The owners) of the Category C building approved the NZTA's access, but the NZTA could not gain entry for some reason (e.g. entry denied by a tenant); or (c) The owner of the Category C Building did not approve the NZTA's access to the property within the time period set out in Condition 7(b) (including where the owner(s) did not respond to the NZTA's letter (sent pursuant to Condition ON.7(a) within that period); or (d) The owner of the Category C Building cannot, after reasonable enquiry, be found prior to completion of construction of the Project. If any of (b) to (d) above apply to a particular Category C Building, the NZTA shall not be required to implement any Building Modification Mitigation at that Category C Building.
ON.9	Subject to Condition ON.8, within 6 months of the assessment required under Condition [7(b)], the NZTA shall give written notice to the owner of each Category C Building: (a) Advising of the options available for Building Modification Mitigation to the building; and (b) Advising that the owner has three months within which to decide whether to accept Building Modification Mitigation for the building, and if the NZTA has advised the owner that more than one options for building modification mitigation is available, to advise which of those options the owner prefers.
ON.10	Once an agreement on Building Modification Mitigation is reached between the NZTA and the owner of an affected building, the mitigation shall be implemented in a reasonable and practical timeframe agreed between the NZTA and the owner.

ON.11	Subject to Condition 8, where Building Modification Mitigation is required, the NZTA shall be deemed to have complied with [Condition 10] above where: (a) The NZTA has completed Building Modification Mitigation to the Category C Building; or (b) The owner(s) of the Category C Building did not accept the NZTA's offer to implement Building Modification Mitigation prior to the expiry of the timeframe stated in [Condition 9(b)] above (including where the owner9s) did not respond to the Requiring Authority within that period); or (c) The owner of the Category C Building cannot, after reasonable enquiry, be found prior to completion of construction of the Project.
ON.12	The NZTA shall manage and maintain the Detailed Mitigation Options to ensure that, to the extent practicable; those mitigation works are maintained to retain their noise attenuation performance until the Design Year.
ON.13	All mechanical services associated with the general operation of the tunnels shall be designed such that noise emissions do not exceed the following noise limits, when measured at or within the boundary of any residential-zoned site: Monday to Saturday 7 am to 10 pm 50 dB $L_{Aeq(15\ min)}$ Sunday & Public Holidays 9 am to 6 pm 50 dB $L_{Aeq(15\ min)}$ At all other times 40 dB $L_{Aeq(15\ min)}$ 75 dB L_{Amax}
~~ON.14~~	~~Emergency mechanical services associated with the operation of the tunnels shall be designed such that noise emissions do not exceed the following noise limits, when measured at or within the boundary of any residential-zoned site:~~ ~~At all times 65 dB $L_{Aeq(15\ min)}$~~ ~~Any testing of these emergency mechanical services shall occur between the weekday hours of 7am to 10am or 4pm to 6pm.~~
ON.14	(a) Prior to construction, the NZTA shall arrange for a suitably qualified acoustics specialist to undertake a minimum of 8 (eight) representative measurements of ambient noise levels. Measurements shall be undertaken in accordance with the requirements of Section 5.2 of NZS6806:2010. (b) Following completion of the work, the NZTA shall arrange for a suitably qualified acoustics specialist to undertake traffic noise monitoring at the same sites surveyed in ON.14(a) above, within 2 to 3 years following completion of construction of the Project. Measurements shall be undertaken in accordance with the requirements of Section 5.2 of NZS6806:2010.