

Resonate

North East Link Project

Inquiry and Advisory Committee Hearing

Statement of Evidence – Acoustics

Thomas Ross Evans

Expert of Manningham City Council

Monday, 15 July 2019

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1 Introduction

- 1.1 My name is Thomas Ross Evans. I am a Technical Director of Resonate Consultants Pty Ltd (Resonate) at Level 4, 10 Yarra Street, South Yarra, Victoria 3141.
- 1.2 This Statement of Evidence has been prepared following instruction from Harwood Andrews, who are acting for the Manningham City Council (Council) in relation to the North East Link Project (Project) Environment Effects Statement (EES).
- 1.3 I confirm that I have read the Planning Panels Victoria *Guide to Expert Evidence* dated April 2019.
- 1.4 I have been instructed to review the EES, in particular the Technical Reports relevant to noise and vibration, and other relevant items including the final EES scoping requirements, IAC terms of reference, Council's public submission and IAC preliminary matters and further information requests. Following my review, I have been asked to provide an expert witness statement that:
- Provides my opinion on the capacity of the Project to achieve acceptable noise and vibration outcomes in the City of Manningham with regard to relevant legislation, policy and best practice.
 - Provides any recommendations as to feasible modifications to the alignment or design of the Project that would offer improved outcomes relevant to noise and vibration.
 - Provides any recommendations or specific measures, including any changes to the Environmental Performance Requirements (EPRs) that I consider necessary and appropriate to prevent, mitigate or offset adverse noise and vibration effects.
 - Identifies any areas where I consider there to be insufficient information to make an assessment of the environmental effects of the Project with respect to noise and vibration, having regard to the current stage of the Project as a 'reference design'.
 - Responds appropriately to Planning Panels Victoria's recently updated guide to expert evidence.
- 1.5 In addition, I have been asked to respond to specific queries about:
- The potential for a reduction in the height of the proposed Estelle Street noise wall to reduce non-acoustic impacts.
 - The acoustic impact of the relocation of the southern portal further south towards the Eastern Freeway interchange.
- 1.6 This Statement provides my comments and professional opinions following my review of the documents requested, as well as consideration of:
- My observations during a site visit conducted to relevant areas adjacent to the Project alignment on Wednesday 3 July 2019.

- A meeting with the Project's noise expert, Mr David Lindsey of SLR Consulting, on Monday, 8 July 2019.
 - Consideration of the documents listed in Appendix A of this Statement.
- 1.7 The majority of my comments in this Statement refer to the following EES documents:
- EES Technical Report C *Surface noise and vibration*
 - EES Technical Report D *Tunnel vibration*
 - The proposed EPRs documented in EES Chapter 27 *Environmental Management Framework*.

Qualifications and experience

- 1.8 I hold a Bachelor of Engineering with 1st Class Honours (Mechatronic) from the University of Adelaide and a Bachelor of Economics.
- 1.9 I have worked as a professional acoustic consultant for 13 years. Since commencing my career, I have gained significant experience in the measurement, prediction and assessment of environmental noise. I am a Member of the Australian Acoustical Society (MAAS).
- 1.10 Appendix B contains a statement detailing my qualifications and experience.

Expertise

- 1.11 My area of expertise is acoustics, including environmental noise and vibration assessment. I have significant expertise in the assessment of road traffic noise, and in the area of construction noise and vibration assessment.
- 1.12 The majority of my professional experience relates to the assessment of noise and the specification of mitigation and control strategies for achieving compliance against relevant noise assessment criteria. Key projects are presented in my statement of qualifications and experience in Appendix B.

2 City of Manningham

Sensitive uses

- 2.1 Noise and vibration sensitive uses within the City of Manningham that may potentially be affected by the Project are primarily residential land. Residential land uses include those:
- located near to the Manningham Road interchange
 - located above the tunnelled portion of the road between the Manningham Road interchange and the southern tunnel portal
 - located near the new interchange with the Eastern Freeway
 - located to the north of the Eastern Freeway between Bulleen Road and Springvale Road, adjacent to the upgrade works that will occur along the Eastern Freeway.
- 2.2 The Applewood aged care community at the Tram Road intersection with the Eastern Freeway is also a residential-type sensitive use.
- 2.3 In addition to residential land uses, the following sensitive uses also exist adjacent to the Project within the City of Manningham:
- Educational uses, including Marcellin College, Birralee Primary School and childcare centres.
 - Sporting ovals for Marcellin College, Carey Grammar and Trinity Grammar School near the southern tunnel portal.
 - Open space passive and active recreation areas, such as Bulleen Park and a number of parks along the existing Eastern Freeway. This includes areas of the Koonung Creek Linear Park.
 - Community buildings such as the Heide Museum of Modern Art and the Veneto Club in Bulleen.
- 2.4 Commercial and industrial land uses also exist adjacent to the Project alignment. While these uses are not typically considered overly sensitive to noise, commercial and industrial buildings may be susceptible to damage from construction vibration at very high levels.
- 2.5 In my opinion, the EES has appropriately identified the above sensitive uses within the City of Manningham. The EES area separates the Project area and sensitive uses into Noise Precincts, of which the following are relevant to Council:
- Noise Precinct 2: Lower Plenty Road to Manningham Road interchange.
 - Noise Precinct 3: Manningham Road interchange to Bulleen Road intersection with Eastern Freeway.
 - Noise Precinct 4: Areas adjacent to the existing Eastern Freeway east of Bulleen Road to Springvale Road.

Existing environment

- 2.6 EES Technical Report C details baseline noise and vibration monitoring results at a considerable number of locations across the Project area.
- 2.7 Based on the monitoring results and my own observations, it is clear that road traffic noise is an existing feature of the environment for sensitive uses throughout the area where the Project will add additional road traffic noise in the City of Manningham. However, I believe EES Technical Report C overstates this when it makes general statements about Noise Precinct 3 and 4 such as:
- Ambient noise environment in the areas bordering the Eastern Freeway is dominated by road traffic noise and those residents closest to the Eastern Freeway tend to be above the project's noise criteria.* (EES Technical Report C, Section 6.5.7).
- 2.8 This statement is not supported by the existing measurement data that shows only 4 of 25 residential measurement locations having existing noise levels above 63 dB $L_{A10,18h}$ (the Project's noise criteria) across both Noise Precinct 3 and 4. Similarly, the 'Do Nothing' scenario noise contours in Appendix K of Technical Report C do not indicate many City of Manningham residences adjacent to the Eastern Freeway would be expected to exceed 63 dB $L_{A10,18h}$ even in 2036 if the Project did not proceed.
- 2.9 While this does not necessarily impact on the outcomes of the EES, it supports the adoption of a 63 dB $L_{A10,18h}$ noise objective for road traffic noise.

Potential impacts from the Project

- 2.10 Potential impacts from the Project to sensitive uses in the City of Manningham that have been assessed in the EES and that I have considered are:
- Airborne construction noise from construction works.
 - Ground-borne vibration from construction works and tunnelling activities.
 - Regenerated, or ground-borne, noise from tunnelling activities.
 - Operational noise from road traffic.
 - Operational noise from fixed plant providing tunnel ventilation at the southern tunnel portal and Manningham Road Interchange.
- 2.11 I note that the EES did not assess potential impacts from operational vibration in detail as it was stated that operational vibration generated by smooth roads at grade are unlikely to be perceptible. I consider this a reasonable statement and concur that operational vibration impacts from the Project are unlikely.

EES Scoping Requirements

- 2.12 I consider that the EES Scoping Requirements identify the same potential impacts as I have identified above. In my opinion, the EES noise and vibration assessments address the issues raised by the EES Scoping Requirements relevant to those areas.

- 2.13 I note that some aspects of the EES Scoping Requirements require consideration of human health impacts relating to noise and vibration. I am not expert in the field of human health and have therefore not addressed the EES Technical Report J *Human health* in this Statement.

3 Construction noise

- 3.1 Construction noise generated by the Project has the potential to cause disturbance to occupants of sensitive uses. While construction noise is temporary in nature, the extended duration and significant nature of the Project works necessitate assessment, management and mitigation.
- 3.2 I note that, in this Statement, construction noise refers to airborne noise from construction works. Tunnelling works have the potential to generate regenerated noise, which is essentially ground-borne vibration that is re-radiated within buildings as noise. I consider potential regenerated noise impacts in Section 4 of this Statement.

Assessment criteria

- 3.3 EES Technical Report C considers two Environment Protection Authority (EPA) Victoria guidelines with respect to the potential impact of construction noise:
- EPA Publication 1254, *Noise Control Guidelines*
 - EPA Publication 480, *Guidelines for Major Construction Sites*.
- 3.4 The EES correctly identifies gaps in the above publications and therefore also adopts assessment criteria from the NSW *Interim Construction Noise Guideline* to address:
- daytime construction noise targets for residences
 - construction noise targets for non-residential sensitive land uses.
- 3.5 I consider adoption of the above to be appropriate, although note some concerns with how the construction noise targets in the EES Technical Report C have been derived. Specifically:
- Construction noise targets or Noise Management Levels (NMLs) have been established on the basis of background noise measurements averaged across several Noise Catchment Areas (NCAs) in Noise Precinct 3 and Noise Precinct 4. This means the adopted background noise level for a particular NCA can be up to 5 dB higher than the measured background noise level at a particular location within that NCA, and the potential impact of construction noise may be understated in the EES for quieter areas of particular NCAs and Noise Precincts.
 - The night time NML for all Noise Precincts has been set at 5 dB above background noise level in Appendix F of Technical Report C. This is inconsistent with the stated approach for night time works whereby the construction noise levels should not exceed the background noise level (e.g. Table 4-21 of Technical Report C). The potential night-time construction noise impacts will therefore be understated in the EES.

Construction noise assessment

- 3.6 EES Technical Report C presents typical predicted construction noise levels and compares them against the adopted NMLs. The construction noise levels have been predicted using assumed typical construction scenarios and likely works that may need to occur outside of normal working hours.
- 3.7 I consider the methodology to be appropriate for an EES assessment of construction noise, noting that the final construction methodology and schedule will need to be confirmed by the appointed Contractor.
- 3.8 The assessment concludes that the most significant construction noise impacts within the Council area will occur in areas adjacent to the Eastern Freeway in Noise Precinct 4. Up to 410 residences in this Precinct are anticipated to be exposed to night-time construction noise levels exceeding the NML and I note that this may increase should the night time NML decrease as per my comments in 3.5 above. This highlights the need for appropriate controls around works conducted outside of normal working hours.
- 3.9 Lesser impacts are predicted in Noise Precinct 2 and Noise Precinct 3, although a number of daytime and night time NML exceedances are also predicted in these areas due to construction works.
- 3.10 I note that, despite documenting a construction noise target for passive and active recreation areas, it does not appear that the EES has assessed construction noise levels at these uses. However, I note that the proposed EPRs will require assessment at these uses and would expect construction noise impacts to be manageable at passive and active recreation areas.

Summary

- 3.11 Overall, I consider that the EES has adopted construction noise targets based on reasonable guidelines. While I have concerns with the use of the background noise levels to establish the specific NMLs in the EES, I expect that this can be rectified as part of a Construction Noise and Vibration Management Plan (CNVMP) developed in accordance with the EPRs.
- 3.12 The EES highlights the potential for considerable construction noise impacts on sensitive uses in the City of Manningham. In my opinion, the application and enforcement of appropriate EPRs will be critical to controlling and managing these construction noise impacts from the Project works.

4 Construction vibration and regenerated noise

- 4.1 Construction vibration generated by the Project has the potential to cause disturbance to occupants of sensitive uses. At very high levels, vibration generated by construction works could also potentially damage buildings and other infrastructure such as pipelines.
- 4.2 Additionally, ground-borne vibration can also result in regenerated noise inside buildings due to vibration of the building structure. This is typically only a significant concern for works such as tunnelling, where airborne noise from the works is insignificant such that ground-borne noise has greater potential to cause disturbance.

Assessment criteria

- 4.3 In the absence of Victorian vibration assessment criteria, EES Technical Report C and Technical Report D adopt assessment criteria from the following sources:
- NSW Environment Protection Authority (EPA) *Assessing Vibration: A Technical Guideline* for the assessment of human comfort from vibration.
 - Australian Standard AS 2187.2-2006 for the assessment of potential amenity impacts from blasting vibration and airblast overpressure.
 - German Standard DIN 4150-3 for the assessment of potential damage to buildings and buried pipeworks.
 - NSW *Interim Construction Noise Guideline* for the assessment of ground-borne noise.
 - ASHRAE vibration criteria for the assessment of vibration impacts on sensitive equipment, should any such equipment be identified.
- 4.4 I consider adoption of the above to be appropriate, and consistent with current good practice for the assessment of vibration on major projects in Victoria.
- 4.5 I note that an inconsistency can exist between the DIN 4150-3 limits for the prevention of building damage and the amenity limits from blasting from AS 2187.2, in that AS 2187.2 can permit vibration levels that can exceed the DIN 4150-3 limits. Therefore, I would recommend that blasting be required to meet both the DIN 4150-3 limits and AS 2187.2 limits in the event that it is required on the Project.

Construction vibration assessment

- 4.6 EES Technical Report C considers construction vibration from surface works. Significant sources of vibration from surface works will likely include vibratory rollers, rock-breakers and piling. The EES has considered these sources by presenting typical safe working distances and analysing the number of sensitive uses that fall within these distances.

- 4.7 I consider the methodology to be appropriate for an EES assessment of construction vibration, noting that the final construction methodology and schedule will need to be confirmed by the appointed Contractor.
- 4.8 The construction vibration assessment for surface works concludes that a number of sensitive uses will fall within safe working distances for cosmetic damage, with a larger number falling within the safe working distances for human comfort. The most significant impacts are anticipated within Noise Precinct 4 due to vibratory rollers, where up to 37 buildings are within the zone for potential building damage. The assessment highlights the need for appropriate vibration mitigation, management and monitoring practices during construction.
- 4.9 EES Technical Report D considers vibration and regenerated noise from tunnelling works, relevant to Noise Precincts 2 and 3 in the Council area. The assessment concludes that, for the areas relevant to the City of Manningham:
- Other than from blasting, which is not expected but may occur, vibration levels of less than 1 mm/s are expected at all but two residential properties.
 - Vibration levels from tunnelling are below 1.5 mm/s and therefore are not expected to exceed building damage limits.
 - Ground-borne noise levels would exceed 35 dB for the residential areas above the tunnel south of Bulleen Road, meaning that evening and night time tunnelling works may have a noise impact on these uses.
- 4.10 I note that the EES Technical Report D states that a meeting was held with the Heide Museum of Modern Art and that no instances of displays were identified that would require more specific vibration criteria than those proposed by the EPRs. I recommend that this statement be clarified as there are multiple levels of vibration targets/limits in the proposed EPRs, and it is unclear if it is intended that the human comfort targets or building damage limits would apply to the Museum. I would have concern if the higher building damage limits were to be applied to the Museum.

Summary

- 4.11 Overall, I consider that the EES has adopted construction vibration and regenerated noise targets based on reasonable guidelines. Mitigation and management of Project works to achieve these targets will be necessary to minimise potential impacts on sensitive uses within the City of Manningham.
- 4.12 In my opinion, and as for construction noise, the application and enforcement of appropriate EPRs will be critical to controlling and managing construction vibration and regenerated noise impacts from the Project works.

5 Operational road traffic noise

5.1 The major potential noise impact associated with the Project is that of operational road traffic noise. The Project will introduce new roads as sources of road traffic noise, as well as upgrading the Eastern Freeway through Noise Precinct 4.

Assessment criteria

- 5.2 Based on VicRoads *Traffic Noise Reduction Policy 2005*, EES Technical Report C has adopted a road traffic noise criterion of 63 dB $L_{A10,18h}$ for residential type Category A buildings and 63 dB $L_{A10,12h}$ for community-type Category B buildings. The criterion is to be achieved 1 m from a building facade 10 years after Project opening (2036) and is relevant to Project roads only.
- 5.3 For other local roads, the same criteria apply with the additional requirement that the noise level increase resulting from the Project must also exceed 2 dB for the criteria to be exceeded.
- 5.4 I consider the adopted operational criteria to be appropriate for the Project area and consistent with current practice in Victoria.
- 5.5 I note that the EES Scoping Requirements also required consideration of the World Health Organization (WHO) *Night Noise Guidelines for Europe 2009*. I agree with the statement in EES Technical Report C that the interim criterion in the 2009 WHO guidelines (55 dB L_{night} free-field) is consistent with the adopted 63 dB criterion adopted from the VicRoads Policy. As identified in the EES, up to 211 unique buildings will exceed the 2009 WHO guideline criterion, predominantly upper floor receivers that are not assessed under the VicRoads Policy.
- 5.6 EES Technical Report C also notes that, in 2018, the WHO released a new publication titled *Environmental Noise Guidelines for the European Region*. The 2018 guidelines recommend adoption of a markedly more stringent 45 dB L_{night} free-field level than the 2009 guidelines. I concur with EES Technical Report C that these 2018 guidelines should be viewed as long-term, aspirational guidelines, noting that:
- Existing noise levels in the environment already markedly exceed the 2018 WHO guidelines recommendations.
 - To my knowledge, no regulatory authority in Australia has yet recommended adoption of the recommendation of the 2018 guidelines or has indicated that they will do so. The adoption of these guidelines would require significantly more stringent noise assessment criteria than has been previously applied in Australia on comparable projects to this Project.

Road traffic noise prediction methodology

- 5.7 I consider the road traffic noise prediction methodology in the EES to be appropriate for assessment of road traffic noise levels against the adopted criteria. Predictions of existing road traffic noise levels have been suitably benchmarked against road traffic noise measurements.
- 5.8 I understand that a detailed review of house locations has not been conducted such that the assessment in EES Technical Report C has not considered locations where the lowest habitable level of houses may be elevated above ground level. Based on my inspection, this does occur at locations adjacent to the Eastern Freeway in Noise Precinct 4 (see Figure 1) and this will need to be reviewed as part of the detailed design process. However, I would not expect significant changes to assessment outcomes as part of this review.



Figure 1 Example of elevated house location on Estelle Street, Bulleen

Road traffic noise mitigation

- 5.9 EES Technical Report C identifies a noise mitigation scheme for the reference design that involves:
- Use of a lower noise open graded asphalt surface on the main road carriageway and potentially some ramps. Dense graded asphalt would be used on the majority of ramps and viaducts.

- Use of new noise barriers, as well as replacement noise barriers along the Eastern Freeway.
 - Consideration of additional at-property treatments where the above is not able to achieve the noise assessment criteria.
- 5.10 I consider the use of an open graded asphalt surface on the main carriageway to be beneficial for noise control. While the performance of the surface will degrade over time, this will be able to be assessed through the proposed EPR that requires noise monitoring to be repeated 10 years after Project opening. Where possible, I encourage the use of open graded asphalt on viaducts as well but understand this may be subject to other design constraints.
- 5.11 The proposed noise barriers have been capped at a height of 10 m. Based on my meeting with Mr Lindsey, I understand this was a Project decision following consideration of concerns around practicality, visual impact and overshadowing. While I note that other projects have considered barriers higher than 10 m previously in Victoria, I consider that the adoption of a 10 m height limit is reasonable. Generally, the cost associated with installing barriers above 10 m in height will outweigh the marginal noise reduction benefits obtained with the increased height.
- 5.12 My primary concern with the EES reference design is the statement that a total of 13 properties are eligible for additional at-property treatments in Noise Precinct 3 and approximately 128 properties eligible in Noise Precinct 4 as the road surface and noise wall treatments are not sufficient to meet the assessment criterion in these areas. From my meeting with Mr Lindsey, I have been advised that these additional at-property treatments are required for a combination of one or more of the following reasons:
- The maximum noise wall height of 10 m was insufficient.
 - Access was required and a noise wall was not possible or could not be constructed to a sufficient length.
 - It was not considered reasonable to replace an existing concrete barrier on the Eastern Freeway with a newer, higher barrier to achieve a marginal reduction.
- 5.13 While I agree that the reasons above may be appropriate depending on the situation, the EES does not provide sufficient information to accurately identify these properties. Mr Lindsey has advised that the Project has not specified the properties requiring additional at-property treatments as this information is likely to change during detailed design. Given this lack of information, it is difficult to interrogate the reasonableness of the number of additional at-property treatments required.

- 5.14 I was also advised by Mr Lindsey that the noise contour maps in Appendix J of EES Technical Report C were sufficient to identify the properties but note that this does not appear to be the case. For example, Figure J4 in Appendix J shows 2036 predicted noise contours for Noise Precinct 2, with road traffic noise levels below 63 dB shown for all residential properties despite 13 properties being identified for additional at-property treatment in this area in Section 9.5.3.3 of the Technical Report. I consider that this matter requires clarification generally throughout Noise Precinct 3 and Noise Precinct 4.
- 5.15 Overall, I understand that opportunities to reduce the number of at-property treatments will be reassessed during detailed design. Under the currently proposed EPRs, I have concerns that there are no specific constraints that would prevent the appointed Contractor increasing the number of at-property treatments to reduce the extent of noise wall works required.
- 5.16 Therefore, I recommend modifications to the EPRs to require submission of an Operational Noise Assessment Report for consultation with EPA and relevant Councils that:
- Is submitted based on the detailed design and prior to major construction works commencing.
 - Identifies the properties requiring at-property treatments.
 - Details the justification behind these selections including the investigation of alternative options and reasons for which they were discounted.

Parks and open space

- 5.17 While there is no specific requirement under the VicRoads *Traffic Noise Reduction Policy* or otherwise under the Project criteria to assess road traffic noise levels at parks and open space, EES Technical Report C provides assessments of road traffic noise levels throughout Noise Precinct 3 and Noise Precinct 4. Generally, these assessments indicate neutral outcomes for parks and open space in the City of Manningham areas, with the EES stating that:
- Noise levels at sporting ovals in Noise Precinct 3 could increase by up to 5 dB, although it is anticipated that the flood walls, which were not accounted for in the noise assessment, would offset this.
 - Noise levels at parks and open spaces in Noise Precinct 4 would generally remain similar to the expected levels without the Project. In some cases, a decrease is predicted (e.g. Manningham Park Reserve), while in others an increase is predicted (e.g. Koonung Creek Linear Park), although the changes in these cases are relatively limited.

- 5.18 My primary concern is that, while the reference design assessed in the EES is predicted to achieve these outcomes, there is no requirement under the proposed EPRs for an assessment of noise within these spaces. This introduces the risk that a detailed design could change noise levels within the parks and open spaces, resulting in markedly different outcomes to those stated within the EES.
- 5.19 In some cases, such as the new 10 m high noise wall protecting the Bulleen Cricket Club Reserve, the noise contours on Figure J4 (refer extract as Figure 2 below) appear to indicate that the noise wall may not be required to achieve the project noise levels at the residences in the vicinity. This presents a risk that the noise wall could be reduced in size or removed during detailed design unless a formal requirement to provide a noise wall is documented in the EPRs.

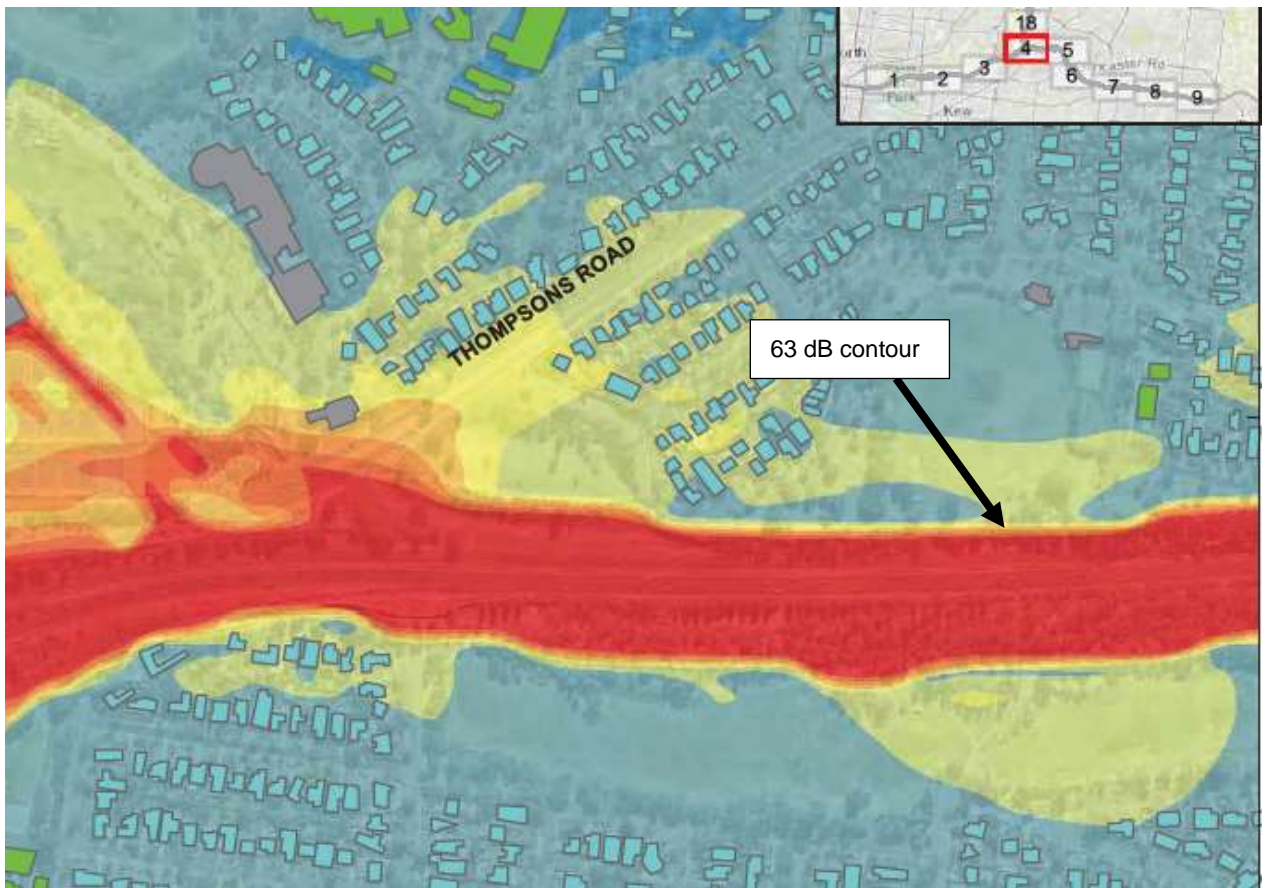


Figure 2 Extract from Figure J4 from Technical Report C

- 5.20 While I acknowledge that there is no requirement under the VicRoads *Traffic Noise Reduction Policy* to provide protection to open space, I note that a comparable recent project (the West Gate Tunnel Project) committed to providing noise walls of a specified height in the EPRs to do just this.

- 5.21 The recently released Minister's Assessment for the Mordialloc Bypass has also recommended that noise attenuation be provided to public open space, primarily to minimise the noise impact on fauna but also giving consideration to passive recreation areas.
- 5.22 Given the above, I recommend adoption of an EPR to address road traffic noise at parks and open spaces that either:
- Commits to the noise wall heights stated in the EES, with the addition of specific information around the flood walls OR
 - Commits to a noise wall design that achieves consistent noise outcomes with the EES at parks and open space (e.g. within 2 dB), to ensure consistency with the EES.

Summary

- 5.23 Overall, I consider that the EES has adopted reasonable road traffic noise assessment criteria and, generally, demonstrated that the reference design can achieve these criteria. However, I consider that further clarification is required around the process for determining residences where additional at-property treatments are required and the reasoning as to why the external noise targets were not able to be achieved through other measures.
- 5.24 Additionally, I note that, while the outcomes for noise levels at open space within the City of Manningham are generally neutral, there does not appear to be any commitment to maintaining this as part of the EPRs.
- 5.25 Therefore, in my opinion, modifications are required to the EPRs addressing operational road traffic noise to address the above shortcomings. I have provided my recommendations on specific EPRs in Section 8.

6 Fixed infrastructure noise

6.1 Fixed infrastructure associated with the Project works refers to those aspects of the proposal that will generate ongoing operational noise other than road traffic noise. Specifically, this refers to the tunnel ventilation systems and substations. Within the City of Manningham, the proposed fixed infrastructure includes emergency smoke discharge and a substation at the Manningham Road interchange, and a tunnel ventilation system at the southern tunnel portal.

Assessment criteria

6.2 EES Technical Report C has defined assessment criteria for fixed infrastructure on the basis of noise limits determined in accordance with State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No N-1 (SEPP N-1). The adoption of the SEPP N-1 limits is appropriate and consistent with normal practice in Victoria.

6.3 I note that SEPP N-1 only establishes noise limits for residential-type land uses and does not establish noise limits for other sensitive uses around the southern portal, specifically the Veneto Club, Marcellin College and sporting ovals. While I do not expect noise at these uses to control the overall acoustic design of the fixed infrastructure, I consider it prudent that assessment criteria for non-residential type uses be adopted. Such a requirement was included in the Metro Tunnel Project EPRs, where a requirement was included for noise from the ventilation systems to comply with Australian / New Zealand Standard AS/NZS 2107 for other noise-sensitive uses.

Fixed infrastructure noise assessment

6.4 EES Technical Report C presents an assessment of typical tunnel ventilation system against the SEPP N-1 limits and demonstrates that these typical systems would be expected to be able to achieve compliance with these limits. I consider the assessment process reasonable given the current stage of the Project.

Summary

6.5 Overall, I consider that noise from fixed infrastructure would be able to be designed and operated to achieve compliance with reasonable noise limits based on the reference design assessment in the EES.

6.6 During detailed design, it will be necessary for the final fixed infrastructure design to be assessed against the SEPP N-1 noise limits. I would also recommend that noise emissions be assessed to other noise-sensitive uses not covered by SEPP N-1, specifically around the southern tunnel portal.

7 Additional queries

7.1 In addition to my review of the EES and the potential noise and vibration impacts associated with the reference design, Harwood Andrews has also asked that I consider:

- The potential for a reduction in the height of the proposed Estelle Street noise wall to reduce non-acoustic impacts.
- The acoustic impact of the relocation of the southern portal further south towards the Eastern Freeway interchange.

Estelle Street noise barrier

7.2 I understand that Council has concerns that the proposed new 10 m high noise wall along Estelle Street in Bulleen may have amenity impacts on Estelle Street residences. The new 10 m high noise wall is proposed closer to the residences than the current noise mound and timber wall combination to allow for the busway to be constructed where this existing barrier is located.

7.3 Decreasing the height of the wall would result in increased predicted road traffic noise levels behind the wall. However, I note that, based on the noise contours shown in Appendix J of Technical Report C, it appears that a reduction in noise wall height may be possible whilst maintaining compliance with the 63 dB noise criterion, as shown by the extract of Figure J5 included as Figure 3.

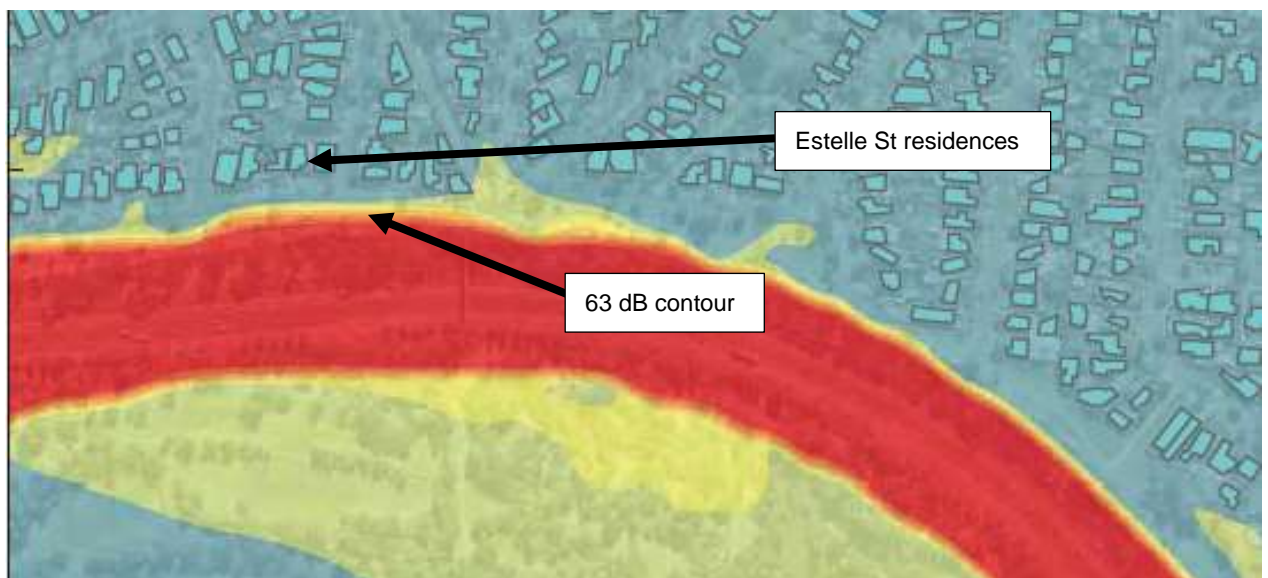


Figure 3 Extract from Figure J5 from Technical Report C

- 7.4 Based on Appendix J of Technical Report C, the predicted road traffic noise levels at the Estelle Street houses appear to be lower than 55 dB $L_{A10,18h}$. It is not possible to give an accurate measure of the reduction in noise wall height that would be possible but, assuming that the contours in Appendix J are correct, it would appear reasonable to me that the barrier height could be reduced by at least 20% and would still achieve compliance with the 63 dB $L_{A10,18h}$ criterion.
- 7.5 Another method that could be used to reduce the height of the barrier, either in combination with the above or not, would be a relocation of the Eastern Freeway and busway further to the south. This would potentially allow for the new barrier to be installed on the existing mound in this area.
- 7.6 I also note that the requirements for noise mitigation must be balanced against other potential amenity impacts. If the Estelle Street barrier were to remain at its current location and a 10 m barrier is required to achieve compliance with the noise criteria, then a reduction in height to reduce overshadowing could be carried out with the provision of supplementary at-property treatments to affected residences. In my opinion, matters such as this can be resolved through my proposed addition to the EPRs requiring submission of an Operational Noise Assessment Report for the detailed design.

Alternative southern portal location

- 7.7 I was asked to consider any potential changes to the noise and vibration impact of the Project if an option to continue the tunnel to the Eastern Freeway was adopted as per Option B outlined in Chapter 6 of the EES.
- 7.8 In my opinion, the adoption of Option B would reduce operational road traffic noise impacts on sensitive uses in Noise Precinct 2 through the removal of new surface roads and viaducts. Consideration would need to be given to additional noise generated by new tunnel openings on the Eastern Freeway, but I would expect that this would be manageable.
- 7.9 There may also be a benefit through the reduction of construction noise impacts on sensitive uses in Noise Precinct 2, although this would depend on the construction methodology as a cut and cover tunnel may have similar construction noise impacts to the reference design assessed in the EES.
- 7.10 The adoption of Option B may introduce some risk of additional construction vibration and regenerated noise at residences along Thompsons Road, but I consider this would be a temporary and manageable impact.
- 7.11 Overall, I would consider that the alternative southern portal location described as Option B in Chapter 6 of the EES would reduce the overall noise impact of the Project in Noise Precinct 2.

8 Proposed EPRs

- 8.1 As detailed in my Statement, I consider that the EES demonstrates that the Project can, for the most part, achieve reasonable noise and vibration assessment criteria based on the reference design assessed. While I have identified some concerns in my Statement, I consider that the reference design would be able to address these concerns and be constructed and operated in accordance with the assessment criteria.
- 8.2 Given this, I consider that the development of appropriate noise and vibration EPRs will be the most important outcome from this IAC hearing process with respect to my field of expertise. Suitably enforced EPRs will:
- Ensure appropriate management of construction phase noise and vibration impacts. The construction methodology and program will change from the EES and, therefore, robust EPRs are necessary to manage the potential impacts.
 - Ensure that changes between the detailed design and reference design do not introduce unacceptable noise and vibration impacts.
 - Ensure that post-construction monitoring is undertaken such that compliance with operational noise criteria is verified once the Project commences operation.
- 8.3 The table on the following pages presents my comments on the EPRs proposed in Chapter 27 of the EES. Where I have not commented on an EPR related to noise and vibration, I consider that EPR appropriate.

Code	Environmental Performance Requirement	Comment						
NV1	<p>Achieve traffic noise objectives</p> <p>Design and construct the works to meet the following L_{eq} traffic noise objectives.</p> <table border="1"> <thead> <tr> <th data-bbox="309 427 398 451">Aspect</th> <th data-bbox="409 427 1256 451">External traffic noise levels</th> </tr> </thead> <tbody> <tr> <td data-bbox="309 459 398 730">External traffic noise levels</td> <td data-bbox="409 459 1256 730"> <p>(a) Traffic noise from North East Link Project Roads* must be no greater than:</p> <ul style="list-style-type: none"> - 63 dBA measured between 6 am and midnight at Category A buildings** - 63 dBA measured between 6 am and 6 pm at Category B buildings**. <p>(b) For Category A and Category B buildings on non-Project Roads which:</p> <ul style="list-style-type: none"> - directly intersect with North East Link project roads, and - where total traffic noise for the design year and with Project exceeds the thresholds listed in paragraph (a). <p>The combined noise from North East Link Project Roads and non-Project Roads must not be more than 2 dBA higher than the predicted traffic noise level under the design year 'do nothing' scenario. Non-Project Roads must be modelled for a distance of 100 m from the intersection with North East Link Project Roads or to the first traffic intersection (whichever is the lesser).</p> </td> </tr> <tr> <td data-bbox="309 738 398 922">Applies at</td> <td data-bbox="409 738 1256 922"> <p>The noise criteria in paragraphs (a) and (b) above are to apply to the lowest habitable level of Category A buildings and Category B buildings at both the year of opening and 10 years thereafter (the design year). For the purposes of this EPR, Category A buildings and Category B buildings to be considered are those that are either existing or known to have planning approval prior to exhibition of the North East Link Environment Effects Statement.</p> <p>Where external traffic noise cannot be mitigated through project design solutions to meet the criteria outlined in paragraphs (a) and (b), at-property treatments may be required. At-property treatments would be undertaken with reference to section 7.3 of the NSW Road and Maritime Services document 'Noise Mitigation Guidelines 2015 – Roads and Maritime Services', and in consultation with the owner of the relevant building.</p> </td> </tr> </tbody> </table> <p>* Project Roads are defined to be the M80 Ring Road (east of Plenty Road), the Greensborough Bypass (west of the Plenty River bridge and up to the M80 interchange with North East Link), the upgrade of the Eastern Freeway (between Hoddle Street and Springvale Road) and the new North East Link freeway (connecting the M80 Ring Road to the Eastern Freeway), including all access ramps.</p> <p>** Category A Buildings and Category B Buildings means:</p> <ul style="list-style-type: none"> - Category A Buildings – Residential dwellings, aged persons homes, hospitals, motels, caravan parks and other buildings of a residential nature - Category B Buildings – Schools, kindergartens, libraries and other noise-sensitive community buildings. 	Aspect	External traffic noise levels	External traffic noise levels	<p>(a) Traffic noise from North East Link Project Roads* must be no greater than:</p> <ul style="list-style-type: none"> - 63 dBA measured between 6 am and midnight at Category A buildings** - 63 dBA measured between 6 am and 6 pm at Category B buildings**. <p>(b) For Category A and Category B buildings on non-Project Roads which:</p> <ul style="list-style-type: none"> - directly intersect with North East Link project roads, and - where total traffic noise for the design year and with Project exceeds the thresholds listed in paragraph (a). <p>The combined noise from North East Link Project Roads and non-Project Roads must not be more than 2 dBA higher than the predicted traffic noise level under the design year 'do nothing' scenario. Non-Project Roads must be modelled for a distance of 100 m from the intersection with North East Link Project Roads or to the first traffic intersection (whichever is the lesser).</p>	Applies at	<p>The noise criteria in paragraphs (a) and (b) above are to apply to the lowest habitable level of Category A buildings and Category B buildings at both the year of opening and 10 years thereafter (the design year). For the purposes of this EPR, Category A buildings and Category B buildings to be considered are those that are either existing or known to have planning approval prior to exhibition of the North East Link Environment Effects Statement.</p> <p>Where external traffic noise cannot be mitigated through project design solutions to meet the criteria outlined in paragraphs (a) and (b), at-property treatments may be required. At-property treatments would be undertaken with reference to section 7.3 of the NSW Road and Maritime Services document 'Noise Mitigation Guidelines 2015 – Roads and Maritime Services', and in consultation with the owner of the relevant building.</p>	<p>I consider there are three additional aspects that should be addressed by NV1 or by another EPR.</p> <p>Firstly, a requirement should be included that an Operational Noise Assessment Report be submitted based on the detailed design. The Report should:</p> <ul style="list-style-type: none"> • Detail houses where additional at-property treatment is required. • Provide justification as to why it is not feasible to achieve the criteria at these houses, including details of alternative solutions considered. • Be submitted for consultation with relevant Councils and EPA. <p>Secondly, a requirement should be included to consider the road traffic noise levels at open spaces as this is not currently addressed by the EPRs, but was a significant aspect of the EES. I would consider a requirement for noise levels at open spaces with the Project to remain consistent with those stated in the EES to be a reasonable approach, rather than a specific noise target for open space or specified noise wall heights.</p> <p>Finally, a requirement should be included for noise mitigation measures for road traffic noise to be maintained for at least 20 years as per the West Gate Tunnel Project EPRs.</p>
Aspect	External traffic noise levels							
External traffic noise levels	<p>(a) Traffic noise from North East Link Project Roads* must be no greater than:</p> <ul style="list-style-type: none"> - 63 dBA measured between 6 am and midnight at Category A buildings** - 63 dBA measured between 6 am and 6 pm at Category B buildings**. <p>(b) For Category A and Category B buildings on non-Project Roads which:</p> <ul style="list-style-type: none"> - directly intersect with North East Link project roads, and - where total traffic noise for the design year and with Project exceeds the thresholds listed in paragraph (a). <p>The combined noise from North East Link Project Roads and non-Project Roads must not be more than 2 dBA higher than the predicted traffic noise level under the design year 'do nothing' scenario. Non-Project Roads must be modelled for a distance of 100 m from the intersection with North East Link Project Roads or to the first traffic intersection (whichever is the lesser).</p>							
Applies at	<p>The noise criteria in paragraphs (a) and (b) above are to apply to the lowest habitable level of Category A buildings and Category B buildings at both the year of opening and 10 years thereafter (the design year). For the purposes of this EPR, Category A buildings and Category B buildings to be considered are those that are either existing or known to have planning approval prior to exhibition of the North East Link Environment Effects Statement.</p> <p>Where external traffic noise cannot be mitigated through project design solutions to meet the criteria outlined in paragraphs (a) and (b), at-property treatments may be required. At-property treatments would be undertaken with reference to section 7.3 of the NSW Road and Maritime Services document 'Noise Mitigation Guidelines 2015 – Roads and Maritime Services', and in consultation with the owner of the relevant building.</p>							

Code	Environmental Performance Requirement	Comment
NV4	<p>Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts</p> <p>Prepare, implement and maintain a Construction Noise and Vibration Management Plan (CNVMP) in consultation with EPA Victoria and relevant councils. The CNVMP must comply with and address the Noise and Vibration EPRs, be informed by the noise modelling and monitoring results and must include (but not be limited to):</p> <ul style="list-style-type: none"> • Identification of noise and vibration sensitive receptors along the project alignment, including habitat for listed threatened fauna, likely to be impacted by the project • Construction noise and vibration targets as per EPRs NV3, NV5, NV8, NV9, NV10, NV11 and NV12, including any details of conversions between alternative metrics • Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities that have the potential to generate airborne noise and/or surface vibration impacts on surrounding sensitive receivers • How construction noise (including truck haulage) and vibration would be minimised (see EPR T2) • A requirement for preliminary tests using the actual equipment to validate modelling for vibration and regenerated noise and review, with predictions to be remodelled as necessary and confirm prevention/mitigation/remediation measures confirmed • Management actions and notification and mitigation measures to be implemented with reference to the Appendix B and Appendix C of the New South Wales Roads and Maritime Services Construction Noise and Vibration Guideline 2016 (CNVG) • Any processes and measures to be implemented as part of the Communications and Community Engagement Plan including measures concerning complaints management (see EPR SC2) • Requirements to assess and manage vibration impacts to scientific or medical establishments to the higher of ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook), or manufacturers equipment levels (unless by agreement with occupant) • Measures to ensure effective monitoring of noise and vibration associated with construction with consideration to the construction noise and vibration targets • Measures to minimise noise and vibration impacts from temporary traffic diversions and altered access to parking facilities • The Unavoidable Works that would be undertaken, including their location, timing and duration. The CNVMP must either include a clear rationale for defining works or a list of the type of planned works that constitute Unavoidable Works and response strategies to mitigate the impacts of these Unavoidable Works, with reference to EPA Victoria Publication 1254 Noise Control Guidelines and Appendix B and Appendix C of the CNVG. The Independent Environmental Auditor must verify that the proposed Unavoidable Works meet the definition of Unavoidable Works for each instance they are undertaken. Details of Unavoidable Works must be made publicly available. For emergency Unavoidable Work, a rationale must be provided to the satisfaction of the Independent Environmental Auditor as soon as practicable. 	<p>While I consider NV4 to generally be appropriate, I note that it largely addresses the CNVMP as a largely static document developed at the start of construction, with only a short reference to maintenance during the works. However, it is likely that significant aspects of construction, and knowledge of potential or actual impacts, will change during the construction works.</p> <p>Therefore, I recommend that EPR NV4 be modified to include:</p> <ul style="list-style-type: none"> • A process for maintaining the CNVMP such that it be updated, at minimum, every 6 months with external stakeholder review. • Implementation of an Unavoidable Works / Out of Hours Work Approval Process developed in consultation with Councils and EPA. It is unlikely that all Unavoidable Works will be able to be identified in the initial CNVMP as is currently suggested by the proposed EPR. This issue has the potential to cause significant community concerns.

Code	Environmental Performance Requirement	Comment
NV6	<p>Design permanent tunnel ventilation system to meet EPA requirements for noise</p> <p>Design and implement the permanent tunnel ventilation system to achieve compliance with State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 and in accordance with the Works Approval. Provide detailed design to the satisfaction of EPA Victoria prior to commencement of the works permitted by the Works Approval.</p>	<p>This EPR should be broadened to include other fixed infrastructure identified in the EES, such as substations.</p> <p>Additionally, I would consider it beneficial to include a requirement that noise from the fixed infrastructure also be designed to achieve compliance with AS/NZS 2107 at noise-sensitive community and educational uses.</p>
NV7	<p>Monitor noise from tunnel ventilation system</p> <p>Measure noise from the permanent tunnel ventilation system on commencing road operation and monitor noise from the tunnel ventilation system post opening of the North East Lin, as agreed with EPA Victoria, to verify compliance with State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1. Identify and implement contingency measures to be implemented if noise level targets are not met.</p>	<p>As for NV6, this EPR should be broadened to include other fixed infrastructure identified in the EES, such as substations.</p> <p>Additionally, the final sentence of this EPR should be reworded to address grammatical and clarity issues. Notably any contingency measures should be implemented such that compliance is verified with SEPP N-1 limits, which are not targets.</p>

Code	Environmental Performance Requirement	Comment																												
NV8	<p>Minimise construction vibration impacts on amenity</p> <p>Implement management actions if the following guideline target levels for continuous vibration from construction activity to protect human comfort of occupied buildings (including heritage buildings) are not achieved (levels are calculated from the British Standard BS6472-1:2008 Guide to evaluation of human exposure to vibration in buildings: Vibration sources other than blasting).</p> <table border="1"> <thead> <tr> <th rowspan="3">Type of space occupancy</th> <th colspan="4">Vibration Dose Values (m/s^{2-7/8})</th> </tr> <tr> <th colspan="2">Day (7am to 10 pm)</th> <th colspan="2">Night (10 pm to 7am)</th> </tr> <tr> <th>Preferred Value</th> <th>Maximum Value</th> <th>Preferred Value</th> <th>Maximum Value</th> </tr> </thead> <tbody> <tr> <td>Residential</td> <td>0.2</td> <td>0.4</td> <td>0.1</td> <td>0.2</td> </tr> <tr> <td>Offices, schools, educational institutions, places of worship</td> <td>0.4</td> <td>0.8</td> <td>0.4</td> <td>0.8</td> </tr> <tr> <td>Workshops</td> <td>0.8</td> <td>1.6</td> <td>0.8</td> <td>1.6</td> </tr> </tbody> </table> <p>Notes</p> <ol style="list-style-type: none"> The Guideline Targets are non-mandatory; they are goals that should be sought to be achieved through the application of practicable mitigation measures. If exceeded then management actions would be required. The Vibration Dose Values may be converted to Peak Particle Velocities within a noise and vibration construction management plan. 	Type of space occupancy	Vibration Dose Values (m/s ^{2-7/8})				Day (7am to 10 pm)		Night (10 pm to 7am)		Preferred Value	Maximum Value	Preferred Value	Maximum Value	Residential	0.2	0.4	0.1	0.2	Offices, schools, educational institutions, places of worship	0.4	0.8	0.4	0.8	Workshops	0.8	1.6	0.8	1.6	<p>I note that EES Technical Report D lacks clarity around the vibration assessment criteria that should apply at the Heide Museum of Modern Art and that this is not clarified by NV8 or NV9.</p> <p>I would consider it appropriate to include a reference to a criterion for this site and would recommend application of the criterion for ‘Offices, schools, educational institutions, places of worship’ in the absence of anything more specific.</p>
Type of space occupancy	Vibration Dose Values (m/s ^{2-7/8})																													
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Workshops	0.8	1.6	0.8	1.6																										
NV11	<p>Minimise amenity impacts from blast vibration</p> <p>Implement management actions if the following vibration values are not achieved. Blasting activities must comply with Australian Standard AS2187.2-2006, Explosives – Storage and use Part 2 – Use of explosives for all blasting.</p> <table border="1"> <thead> <tr> <th>Category (as defined in AS 2187.2-2006)</th> <th>Type of blasting operations</th> <th>Peak component particle velocity (mm/s)</th> </tr> </thead> <tbody> <tr> <td>Sensitive site</td> <td>More than 20 blasts</td> <td>5 mm/s for 95% blasts per year 10 mm/s maximum (unless by agreement with occupier)</td> </tr> <tr> <td>Sensitive site</td> <td>Less than 20 blasts</td> <td>10 mm/s maximum (unless by agreement with occupier)</td> </tr> <tr> <td>Non-sensitive site (with occupants)</td> <td>All blasting</td> <td>25 mm/s maximum value (unless by agreement with occupier).</td> </tr> <tr> <td>Scientific equipment</td> <td>All blasting</td> <td>Existing ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook) (whichever is the higher) or manufacturers equipment levels (unless by agreement with occupier)</td> </tr> </tbody> </table>	Category (as defined in AS 2187.2-2006)	Type of blasting operations	Peak component particle velocity (mm/s)	Sensitive site	More than 20 blasts	5 mm/s for 95% blasts per year 10 mm/s maximum (unless by agreement with occupier)	Sensitive site	Less than 20 blasts	10 mm/s maximum (unless by agreement with occupier)	Non-sensitive site (with occupants)	All blasting	25 mm/s maximum value (unless by agreement with occupier).	Scientific equipment	All blasting	Existing ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook) (whichever is the higher) or manufacturers equipment levels (unless by agreement with occupier)	<p>EPR NV11 should be modified to make clear that blasting vibration levels should also comply with the building damage vibration limits in NV9.</p>													
Category (as defined in AS 2187.2-2006)	Type of blasting operations	Peak component particle velocity (mm/s)																												
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9 Summary and declaration

- 9.1 Having considered the potential noise and vibration impacts of the proposed North East Link Project on sensitive uses in the City of Manningham and the assessment detailed within the EES, I am of the opinion that the Project can be constructed and operated in a manner that results in acceptable noise and vibration outcomes for these uses.
- 9.2 I note that my primary concerns are around potential changes from the EES reference design following approval, in particular:
- How the design of noise mitigation is justified post-approval, given that there is no clear information provided in the EES around those properties in the City of Manningham where additional at-property treatments are required. Justification will need to be provided as to why the noise criteria were not able to be achieved at these locations through other means.
 - How the noise assessment outcomes of the EES will be maintained for parks and open spaces given that there is no formal requirement for these outcomes to be maintained in the currently proposed EPRs.
- 9.3 To address these concerns, and other minor concerns around potential impacts during construction and operation, I have made recommendations as to changes I consider required to the proposed EPRs. With these changes incorporated, I consider that the EPRs will provide a robust and appropriate method of mitigating, managing and monitoring noise and vibration impacts from the Project.
- 9.4 I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.



15 July 2019

Appendix A—Documents reviewed

- Australian / New Zealand Standard AS/NZS 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*
- Australian Standard AS 2187.2:2006 *Explosives – Storage and Use – Use of Explosives*
- British Standard BS 6472-1:2008 *Guide to Evaluation of Human Exposure to Vibration in Buildings*
- City of Manningham, *Submission on the North East Link Project Environment Effects Statement*, 5 June 2019
- DELWP, *Mordialloc Bypass – Minister’s assessment of environmental effects*, June 2019
- EPA Victoria Publication 1254 *Noise Control Guidelines*
- EPA Victoria Publication 480 *Environmental Guidelines for Major Construction Sites*
- German Standard DIN 4150-3:2016 *Structural Vibration – Effects of Vibration on Structures*
- Metro Tunnel Project *Environmental Management Framework*, August 2018
- NSW Department of Environment & Climate Change, *Interim Construction Noise Guidelines*
- NSW Department of Environment & Conservation, *Assessing Vibration: a technical guideline*
- North East Link Project *Environment Effects Statement*, in particular Technical Report C and Technical Report D
- State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No N-1
- VicRoads *Traffic Noise Reduction Policy*
- VicRoads Road Design Note 06-01 *Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005*
- VicRoads *Traffic Noise Measurement Requirements for Acoustic Consultants*
- Victorian Government, *Scoping Requirements for North East Link Project Environment Effects Statement*, June 2018
- West Gate Tunnel Project *Environmental Performance Requirements*, December 2017
- World Health Organization *Night Noise Guidelines for Europe*, 2009
- World Health Organization *Environmental Noise Guidelines for the European Region*, 2018

Appendix B—Qualifications & experience

Qualifications

Bachelor of Engineering (Mechatronic) – 1st Class honours, 2006
Bachelor of Economics, 2005

Professional associations

MAAS – Member of the Australian Acoustical Society
Member of the Victorian Planning and Environmental Law Association

Employment history

June 2019 – ongoing	Technical Director, Resonate Consultants, Melbourne
April 2018 – May 2019	Managing Director, Resonate Consultants, Melbourne
July 2012 – April 2018	Associate Director, Resonate Consultants, Melbourne / Adelaide
January 2012 – July 2012	Senior Acoustic Engineer, AECOM, Adelaide
November 2006 – December 2011	Acoustic Engineer, AECOM (previously Bassett Acoustics), Adelaide
November 2005 – November 2006	Vacation / Part-Time Employment in Acoustics, Bassett Acoustics, Adelaide

Professional experience

Since commencing my career as a professional acoustic consultant, I have gained significant experience in the field of environmental noise, including pre- and post-construction noise monitoring, noise prediction and assessment against relevant guidelines and standards. My experience extends across a wide range of projects including specific experience in transport infrastructure projects and construction phase assessments. Key projects I have been involved in include:

- Melbourne Metro Tunnel Project – advisor on noise and vibration for construction and operation for the University of Melbourne and Peter MacCallum Cancer Centre
- Noise SEPPs Impact Analysis – managed an impact study for EPA Victoria into the EPA Victoria Noise SEPPs and NIRV
- WestGate Tunnel Project Peer Review
- Mordialloc Freeway construction noise and vibration
- Ararat Bypass
- Port of Melbourne Port Capacity Upgrade
- Angas Zinc Mine, Strathalbyn
- Holden Manufacturing Facility, Elizabeth
- Point Wilson Explosives Area Remediation
- Boneo Water Treatment Plant Upgrade