

Under the Resource Management Act 1991  
In the matter of Notices of Requirement to enable the construction, operation and  
maintenance of the City Rail Link

Between

**Auckland Transport**

Requiring Authority

and

**Auckland Council**

Consent Authority

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**Statement of Evidence of Craig Michael Fitzgerald**

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## **Qualifications and Experience**

1. My full name is Craig Michael Fitzgerald.
2. I graduated in 2004 with a Bachelor of Engineering (Mechanical) from the University of Auckland. I worked as a mechanical engineer in a design and project management capacity prior to joining Marshall Day Acoustics (MDA) as an acoustician in 2007. More recently, I worked as an acoustician for Capita Symonds in the UK, gaining my Chartered Engineer (CEng) status in 2011 through the Engineering Council (UK). Upon returning to New Zealand in 2011, I rejoined MDA as an acoustician. I am a member of the Acoustical Society of New Zealand and Institute of Acoustics (UK).
3. I have experience in environmental acoustics for large rail infrastructure projects, including Crossrail (UK) and the Wellington Regional Rail Programme. Crossrail is a new east-west underground railway line which passes under central London. I prepared environmental impact assessments addressing construction noise for two tunnel portal sites located in London's eastern residential suburbs. Construction noise was also the focus of my assessment for the Wellington Regional Rail Programme, which addressed electrification, track layout and signalling system upgrades between Kaiwharawhara Station and Wellington Station.
4. I have presented expert evidence on the subject of environmental noise for Council Hearings on two previous occasions. I also have experience in architectural acoustics, providing advice on sound insulation, room acoustics and mechanical services noise control.

## **Background and role**

5. The City Rail Link (CRL) project is a 3.4km underground passenger railway (including two tracks and three underground stations) running between Britomart Station and the North Auckland Line (NAL) in the vicinity of the existing Mount Eden Station. CRL also requires an additional 850m of track modifications within the NAL. The stations included in the CRL Notices of Requirement (NoR) have been

temporarily named Aotea Station, Karangahape Station and Newton Station.

6. MDA was engaged by Auckland Transport's Principal Advisor (PA) team in support of the NoR work stream. The PA is led by Aurecon NZ Ltd and comprises the principal partners of Aurecon NZ Ltd, Mott MacDonald, Jasmax and Grimshaw. The PA reports directly to Auckland Transport's Infrastructure Delivery work stream which is responsible for delivery of the CRL project. The PA is also supporting the NoR and Property work streams.
7. MDA was specifically engaged to provide an independent assessment of the noise and vibration effects associated with the proposed CRL. I co-authored the technical expert assessment, which was submitted as part of the NoR application: '*Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report*'.
8. Subsequently, I co-authored a letter (dated 9 November 2012) in response to a 'pre-notification' request for further information received from Auckland Council (dated 23 October 2012).
9. My evidence focuses on the noise effects of the CRL project. My colleague, Mr James Whitlock, provides separate evidence focused on vibration and subsequent reradiated noise effects of the CRL.
10. I am familiar with the project area and have also undertaken many site visits to measure the existing noise and vibration environment to inform the NoR.
11. I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2011), and I agree to comply with it as if this hearing was before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

## Scope of Evidence

12. My evidence will address the following:
- (a) Assessment of environmental noise effects;
    - (i) Existing noise environment,
    - (ii) Noise performance standards,
    - (iii) Assessment of noise effects for the construction phase,
    - (iv) Assessment of noise effects for the operational phase,
    - (v) Response to 'pre-notification' request for further information,
  - (b) Proposed mitigation;
  - (c) Response to submissions;
  - (d) Response to Planner's Report; and
  - (e) Proposed conditions.

## Summary of Evidence

13. I have undertaken measurements of the existing acoustic environment at key positions along the route. In conjunction with a literature review of relevant noise performance standards and case studies, I have recommended appropriate Project Criteria for the noise effects assessment. For construction noise, the Project Criteria largely reflect the provisions in the Auckland District Plan (Central Area Section)<sup>1</sup>. This is discussed further in paragraph 27.
14. My assessment of noise from the construction phase is based on a review of the typical machinery likely to be utilised, the timeframe it is likely to be used for, an understanding of the existing noise

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<sup>1</sup> Refer Auckland District Plan (Central Area Section) rule 7.6.4 (c)

environment and receivers, predicted construction noise levels, and an overall assessment against the Project Criteria.

15. CRL construction noise emissions are likely to be comparable with those associated with a typical inner city building site or road works activity. Construction is expected to occur in close proximity to the façades of buildings. As a result, in some instances during the daytime, noise emissions are expected to exceed the Project Criteria for short durations. For most large scale construction projects, exceedances of the construction noise limits for short durations are common. Provided these exceedances are of short duration and the 'Best Practicable Option' (BPO) is implemented to avoid, remedy and mitigate construction noise, I consider the construction noise levels would be reasonable and acceptable.
16. Once operational, I expect that the principal noise effects would be caused by mechanical ventilation at each station. The operational noise Project Criteria aligns with the District Plan permitted activity noise limits, except that in accordance with best practice it uses the  $L_{Aeq}$  measurement descriptor in place of  $L_{A10}$ . With appropriate design, I consider that the operational noise effects can be managed to achieve the Project Criteria.
17. Overall, with the incorporation of the recommended mitigation measures, I consider the noise effects of the CRL construction and operational phases can be managed to an acceptable level. In particular, I am satisfied that the proposed noise management measures would require Auckland Transport to implement the BPO to avoid unreasonable noise.
18. Further targeted assessments of both individual and collective noise issues are presented in my response to submissions. My opinions on the changes made by Council as part of the section 42A report are included in my response to the Planner's Report.

## Assessment of environmental noise effects

### Existing noise environment

19. At the start of my involvement in the Project, I identified ten measurement locations which I assessed as being sufficient to ascertain the existing ambient acoustic environment in the Central Area, the Mixed Use Zone in Newton and the Residential area near the NAL. Surveys were undertaken at nine of those sites between March and June 2012, of which I was in attendance at eight (a tenth site at 23 Dundonald Street was approached but access was not obtained). I did not consider that it was necessary to find an alternative location as we had sufficient locations to understand the existing noise environment. The measurements enable the assessment of noise effects by providing a base level with which predicted construction and future operational noise levels can be compared.
20. The overall results of the survey show a high ambient and background acoustic environment. Sky City Grand Hotel on Albert Street was the noisiest survey location, while a residential property at 27 Brentwood Avenue was the quietest.
21. A summary table of noise measurements representing the existing ambient environment is presented below. The full results of the noise survey are presented in the noise and vibration assessment<sup>2</sup>.

Location	Period <sup>3</sup>	Measured Noise Levels <sup>4</sup>	
		dB L <sub>Aeq</sub>	dB L <sub>A90</sub>
DFS Galleria	Day	59-72	55-64
	Night	54-68	53-64
Sky City Grand Hotel	Day	64-80	62-76
	Night	61-77	60-74
Aotea Centre ASB Theatre (Inside)	Day	29	26

<sup>2</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* at Section 5.1 and Appendix E

<sup>3</sup> Proposed Project Criteria Periods (Day: 0700 – 2300 and Night: 2300 – 0700)

<sup>4</sup> 15 minute measurement intervals

Location	Period <sup>3</sup>	Measured Noise Levels <sup>4</sup>	
		dB L <sub>Aeq</sub>	dB L <sub>A90</sub>
	(Outside)		
	Day	57	54
The Beresford (apartments)	Day	54-67	50-58
	Night	48-64	44-56
Mercury Theatre	Day	60-77	53-66
	Night	55-80	46-66
The French Café	Day	65-81	51-70
	Night	54-75	41-64
1 Akiraho Street (apartments)	Day	51-70	40-55
	Night	43-70	35-51
10 Ruru Street (apartments)	Day	50-71	44-55
	Night	43-53	42-44
27 Brentwood Avenue (dwelling)	Day	40-61	40-53
	Night	40-64	40-52

#### Noise performance standards

22. Under the provisions of the Resource Management Act (sections 16 and 17) there is a duty to adopt the ‘Best Practicable Option’ (BPO) to ensure that noise does not exceed a reasonable level, and that any adverse effects shall be avoided, remedied or mitigated. With an understanding of the existing noise environment, relevant noise performance standards<sup>5</sup> and case studies<sup>6</sup> that I consider to be pertinent, I have proposed Project Criteria for the control of noise effects from construction and operational phases, reproduced below in Paragraphs 27 and 29 respectively.
23. Construction Noise Standard NZS 6803: 1999, Section 7 – “*Guidelines for setting Construction Noise Limits*” recommends; “*desirable upper limits for construction noise received by the community for reasonable protection of health and amenity. The desirable limits vary according to*

<sup>5</sup> Resource Management Act, Auckland City District Plan – Isthmus and Central Area Sections, and NZS 6803: 1999 Acoustics – Construction Noise

<sup>6</sup> Auckland Electrification Project, Waterview Connection, and Crossrail UK

*the type of land use, time of day and anticipated duration of the construction work*". It recommends more relaxed noise limits (than would otherwise be permitted) to enable construction activity to take place.

24. The Auckland City District Plan (Central Area Section) references the Construction Noise Standard, but also recognises it is a high noise environment. At night, the primary acoustic objective is to ensure that any noisy activities do not give rise to sleep disturbance. Auckland City District Plan includes minimum sound insulation requirements for new dwellings in the Central Area and Isthmus Mixed Use Zone to alleviate the high noise environment and ensure reasonable amenity is maintained. Consequently, the high noise environment and higher level of sound insulation is reflected in higher District Plan noise limits for Sundays and Public Holidays than are otherwise recommended by NZS 6803:1999.
25. Aligned with this, I consider that construction activities would be deemed acceptable if the noise generated in the bedrooms of dwellings did not exceed 35 dB  $L_{Aeq}$ <sup>7</sup>. Sound insulation studies of facades of New Zealand dwellings has shown that old villa type dwellings with closed wooden sash windows would provide approximately 25 decibels attenuation, whilst modern dwellings/apartments with closed aluminium windows can provide up to 30 decibels attenuation. Construction noise is, therefore, considered acceptable where the noise level at 1m from the façade of a habitable room does not exceed 60 – 65 dB  $L_{Aeq}$ .
26. I consider that in special cases, in order to enable efficient construction, that this limit could be relaxed by 5 decibels where a specific scheduled construction activity would only occur for 1 period of up to 2 consecutive nights in any 10 days. Similarly, in special cases the daytime limit could also be relaxed where a specific scheduled construction activity would only occur for 1 period of up to 2 consecutive weeks in any 2 months. Any such special case would still require the use of noise management techniques as part of the BPO.

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<sup>7</sup> In accordance with Auckland Council District Plan (Central Area Section) Rule 7.6.3 (c), WHO Guidelines For Community Noise and NZS 6802:2008

27. Project Criteria – Construction Noise<sup>8</sup>

Description	All days (dB L <sub>Aeq</sub> ) <sup>1</sup>	
	Day time <sup>2</sup> (0700 to 2300)	Night-time <sup>3</sup> (2300 to 0700)
Commercial and industrial buildings	75	80
Noise sensitive activity (e.g. dwelling)	75	60 <sup>4</sup>

Notes:

1. Construction noise shall be measured and assessed in accordance with the provisions of NZS 6803:1999
2. Noise limit may be relaxed by 5 decibels for 1 period of up to 2 consecutive weeks in any 2 months
3. Noise limit may be relaxed by 5 decibels for 1 period of up to 2 consecutive nights in any 10 days
4. Or 35 dB L<sub>Aeq</sub> measured inside a bedroom

Airblast noise from blasting activities shall comply with 120 dB L<sub>Cpeak</sub>, measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 “Acoustics - Construction Noise”.

28. Operational noise Project Criteria should be adopted for the assessment of mechanical plant and ancillary infrastructure servicing the underground areas of CRL. The Project Criteria essentially align with the District Plan permitted activity noise limits. The only difference is that the proposed criteria use the L<sub>Aeq</sub> descriptor in place of L<sub>A10</sub>. I have recommended the use of the L<sub>eq</sub> noise index as this reflects the approach adopted by the most recent New Zealand Noise Standards<sup>9</sup>. I note that for a continuous noise source such as mechanical services noise, the measurement descriptors can be considered essentially equivalent.

29. Project Criteria – Operational Noise (excluding rail movements)<sup>10</sup>

<sup>8</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Appendix A*

<sup>9</sup> New Zealand Standards NZS 6801:2008 and NZS 6802:2008

<sup>10</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Appendix B*

Location	Period	dB L <sub>Aeq</sub>	dB L <sub>AFmax</sub>
Auckland Central Area	7.00am to 11:00pm	65	
	11:00pm to 7:00am	60 70 @ 63 Hz 65 @ 125 Hz	75
Auckland Isthmus Area	7.00am to 10:00pm	60	
	10:00pm to 7:00am	55	75

30. Above-ground CRL rail movements would be within the existing Auckland Line (NAL) KiwiRail designation that currently provides for rail purposes. As such, District Plan noise rules do not apply for the control of noise emissions within the NAL designation. However I consider it appropriate to assess the indicative change in noise level due to, for example, realigned NAL tracks being moved closer to existing noise sensitive receivers to accommodate CRL. My indicative calculations predict this would result in an increase of less than 1 decibel for nearby noise sensitive receivers. To put this into context, a change in noise level of 1-2 decibels is generally considered to be indiscernible, while 3-4 decibels is considered just noticeable. On this basis, I consider the noise effect arising from realigning the NAL, where this is required, to be negligible.
31. It is important to note that NAL electrification will give rise to a reduction in overall noise from train movements. Even with realignment and an increase in future movements, with electrification future noise levels would be less than existing.
32. Vibration from underground train movements may be received in a building as reradiated noise. This matter is addressed as part of Mr Whitlock's evidence on vibration effects.

#### Assessment of noise effects for the construction phase

33. The most significant construction noise emissions are predicted to be as a result of piling and excavation activities above ground level. As stated in paragraph 15, CRL construction noise emissions are likely to be comparable with activities from a typical inner city building site or road works. I have predicted noise levels from anticipated construction

'activities', comprising grouped machinery noise sources typical of that activity. This provided 'setback distances' at which the Project Criteria is predicted to be achieved.

34. Intensive construction activities (such as D-wall and secant piling, road works and above ground excavation works) are predicted to significantly exceed the night-time Project Criteria. For receivers such as dwellings or hotel accommodation, effects could range from annoyance to sleep disturbance. However I note with reference to Mr Bill News evidence, that indicative scheduling of such noise intensive activities is contained between the hours of 7am and 7pm, Monday to Saturday. In my view, restricting these noise intensive activities during the night-time period represents BPO. Where this approach is not possible and with the agreement of the identified occupants, temporary relocation should be considered for short durations exceeding the Project Criteria. For longer durations, sound insulation and ventilation improvements maybe more appropriate on a case by case basis.
35. During the day, most construction activities are predicted to comply with the Project Criteria. However, some particularly noisy activities<sup>11</sup> (such as piling and surface works) would exceed the criteria when in close proximity to a building during peak construction periods.
36. Short term exceedances of the Construction Noise Standard noise limits are common (and typically unavoidable) for most large scale inner city projects. I therefore consider such exceedances are reasonable if they are of limited duration and BPO measures are implemented to avoid, remedy and mitigate the noise emissions as far as practicable. I discuss a range of mitigation measures that can be employed later in my evidence.
37. I have undertaken noise modeling of 5 proposed construction activities across 4 worksites as part of the AEE, and a further 16 activities across 6 worksites after review of the submissions. 2D and 3D noise contours of these sites are attached to my evidence as Appendix D (modelling assumptions for those activities are included in Appendix A and B).

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<sup>11</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* Table 7.1.3.1, Activities A, B and C

They provide a visual representation of the predicted noise levels during peak construction periods. Please note that each Figure is a snapshot of a construction activity when positioned directly adjacent to a receiver. As the activity progresses geographically, similar results can be expected for other noise sensitive receivers when positioned directly adjacent.

38. The Table in Appendix C summarises the construction noise ‘setback distance’ for each modeled activity to comply with the 75 dB  $L_{Aeq}$  daytime and 60 dB  $L_{Aeq}$  night-time construction noise criteria. These setback distances are comparable with those presented in Table 7.1.3.1 of the MDA AEE report. They assume no shielding, so are conservative for a city environment, as intermediate buildings would shield those further away. This is best shown graphically in the supporting noise contour Figures in Appendix D. As the activities progress between Britomart and Aotea Station, similar results can be expected for other noise sensitive receivers.
39. The noise and vibration report<sup>12</sup> includes the following indicative ‘noise effects matrices’ to assist people to estimate the internal noise levels received during construction. This is based on the predicted external noise level (estimated from prediction tables or indicative construction noise contour Figures) and their existing façade glazing (selected from three generic types ).
40. Daytime in commercial & industrial buildings and habitable rooms in dwellings<sup>13</sup>

External Noise Level (dB $L_{Aeq}$ )	Estimated Internal Noise Level (dB $L_{Aeq}$ )		
	Sealed glazing ( $D_w$ 30 dB)	Operable windows ( $D_w$ 25 dB)	Open windows ( $D_w$ 15 dB)
90	60	65	75
85	55	60	70
80	50	55	65
75	45	50	60

<sup>12</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Section 7.1.8

<sup>13</sup> NZS 6803:1999 section 7.2.7 to determine acceptable internal noise level thresholds

External Noise Level (dB L <sub>Aeq</sub> )	Estimated Internal Noise Level (dB L <sub>Aeq</sub> )		
	Sealed glazing (D <sub>w</sub> 30 dB)	Operable windows (D <sub>w</sub> 25 dB)	Open windows (D <sub>w</sub> 15 dB)
70	40	45	55
65	35	40	50
60	30	35	45

■ < 50 dB L<sub>Aeq</sub> Typically acceptable  
■ 50 – 60 dB L<sub>Aeq</sub> Annoyance and reduction in work efficiency  
■ > 60 dB L<sub>Aeq</sub> Difficulty holding a normal conversation and reduction in work efficiency

41. Night-time in bedrooms of dwellings<sup>14</sup>

External Noise Level (dB L <sub>Aeq</sub> )	Estimated Internal Noise Level (dB L <sub>Aeq</sub> )		
	Sealed glazing (D <sub>w</sub> 30 dB)	Operable windows (D <sub>w</sub> 25 dB)	Open windows (D <sub>w</sub> 15 dB)
90	60	65	75
85	55	60	70
80	50	55	65
75	45	50	60
70	40	45	55
65	35	40	50
60	30	35	45

■ < 35 dB L<sub>Aeq</sub> Typically acceptable  
■ 35 – 40 dB L<sub>Aeq</sub> Annoyance and sleep disturbance for some noise sensitive receivers  
■ > 40 dB L<sub>Aeq</sub> Annoyance and sleep disturbance for most noise sensitive receivers

42. Applying this to the matrix provides an estimate of the received internal noise level. The noise levels are colour coded to identify the potential risk of effects, with an explanation of the examples of effects which may be experienced inside buildings. This is indicative for NoR purposes

<sup>14</sup> NZS 2107:2000 “Acoustics - Recommended design sound levels and reverberation times for building interiors”, Table 1, part 7, recommended design level for sleeping areas in houses and apartments near major roads: 30 dB L<sub>Aeq</sub> (satisfactory) and 40 dB L<sub>Aeq</sub> (maximum)

only, as I recommend that receivers be assessed on a case by case basis (as appropriate) at a detailed design and / or construction stage. This is reflected in the requirements of the proposed CEMP.

43. The indicative construction worksite activity case studies (refer Appendices A-D) are presented in the following paragraphs with a corresponding noise effects assessment for the noisiest activity at each location.

#### Albert Street Cut and Cover Activities (Figures 1-6).

44. Figure 3 illustrates day time piling activity is predicted to be the noisiest construction activity between Britomart and Aotea Station. At the modelled location, noise levels of 90-95 dB  $L_{Aeq}$  are predicted on parts of the adjacent Stamford Plaza façade, decreasing to 75 dB  $L_{Aeq}$  at 50m. The estimated internal noise level from 90-95 dB  $L_{Aeq}$  on the façade would be 60-65 dB  $L_{Aeq}$  (assuming sealed glazing). This noise level may result in difficulty holding a normal conversation, annoyance and reduction in work efficiency. However during the same piling period, a noise level of 70-75 dB  $L_{Aeq}$  is shown on the façade of the nearby ANZ Tower, resulting in a typically acceptable estimated internal noise level of 40-45 dB  $L_{Aeq}$  (assuming sealed glazing).
45. With reference to Mr Newns evidence, piling is predicted to progress at a rate of 5-6m per day. Therefore, noise emissions are predicted to exceed the 75 dBA  $L_{Aeq}$  day time Project Criteria over a 3 week period at any one receiver position. Provided BPO is implemented to avoid, remedy and mitigate construction noise (discussed in a later section), I consider the construction noise levels would be reasonable.

#### Aotea Station Cut and Cover Construction (Figures 7-8).

46. Figure 8 illustrates day time piling activity is again predicted to be the noisiest construction activity with similar peak period noise levels and effects as described for Albert Street piling in the previous paragraphs. The duration of this activity is predicted to be 24 weeks in total (the station is approximately 200m long). Therefore the period exceeding the day time Project Criteria for any one receiver position is predicted to be in the order of 12 weeks.

Karangahape Road and Newton Station Shafts (Figures 9-12).

47. Figures 9, 10 and 12 illustrate that day time piling is again predicted to be the noisiest construction activity. Noise levels of 80-85 dB  $L_{Aeq}$  are predicted on parts of the closest building façades, decreasing to 75 dB  $L_{Aeq}$  at 37m. The duration of this activity is predicted to be 8-12 weeks at Beresford Street entrance and 6-10 weeks at the Mercury Lane and Dundonald Street shafts. Note the lower noise level of 80-85 dB  $L_{Aeq}$  is due to the piling type and distance to receiver locations. 80-85 dB  $L_{Aeq}$  on the façade of a building is estimated to result in an internal noise level of 55-60 dB  $L_{Aeq}$  (assuming operable windows). This noise level may result in annoyance and reduction in work efficiency in commercial and industrial buildings and habitable rooms in dwellings.
48. There is also a risk that a noise level of 80-85 dB  $L_{Aeq}$  predicted at the façades of the Mercury Theatre and Roundhead Studios would impede stage performances and church services in the Mercury Theatre, and recording quality in Roundhead Studios (depending on the location in the building). I expect that the sound insulation performance of these spaces are of a much higher standard than that described for a typical dwelling in paragraphs 40 and 41.
49. Proposed Condition 11 (Communications – Notable Noise and Vibration Receivers) is specific for activities that are recognised as having a more elevated sensitivity to noise and/or vibration compared with other sensitive receivers (including theatres and recording studios). This will require a site specific construction noise management plan (SSCNMP) to be prepared (refer Condition 21A). I expect this would include on-site sound insulation tests to quantify the sound level difference between predicted construction levels on the façade and the level received in recording studios or performance spaces. Once actual, as opposed to theoretical sound insulation and noise sensitivity is known, it would be important to manage all activities that breach these levels to ensure BPO is adopted.

NAL Cut and Cover Construction (Figure 16):

50. Figure 16 illustrates noise levels up to 75-80 dB  $L_{Aeq}$  on parts of the Ruru Street Apartments façade during day time cut and cover piling activities. The duration of this activity is predicted to be 8 months. This is estimated to result in an internal noise level of 45-50 dB  $L_{Aeq}$  (assuming sealed glazing for apartments in the Mixed Use Zone). This noise level is typically considered to be acceptable. However where a building has operable or open windows, the estimated internal noise level would be higher, potentially resulting in annoyance and a reduction in work efficiency.
51. In addition and as discussed above, there is also a risk that construction activities could result in an internal noise level that reduces recording quality in TV3 Studios. Further investigation of the actual sound insulation and sensitivity is required to determine the actual sensitivity of these Studios to noise effects. Management of all activities that breach these levels would then be required to ensure BPO is adopted.

NAL Tunnelling Support Activities (Figure 13):

52. Figure 13 illustrates the predicted noise environment at night from tunnelling support activities. 60-65 dB  $L_{Aeq}$  is predicted on parts of the closest building façades during peak operation, decreasing to 60 dB  $L_{Aeq}$  at 142m. The duration of this activity is predicted to be 2 years. 60-65 dB  $L_{Aeq}$  on the façade of a building is estimated to result in an internal noise level of 30-35 dB  $L_{Aeq}$  (assuming sealed glazing for apartments in the Mixed Use Zone). This noise level is typically acceptable at night-time in a bedroom.
53. Blasting is proposed as part of construction activities at the Mt Eden Station worksites. Blasting has the potential to generate the highest noise levels of all construction activities.
54. Noise from blasting is referred to as 'airblast' noise in the Construction Noise Standard 6803:1999. Section 8.1.4 of the Standard states that "*Practices should confirm with the provisions of documents such as AS 2187:Part 2, provided that the airblast noise limit shall be a peak sound*

*level of 120 dBC measured at a suitable location as specified in 6.2”.*

This requirement is included in the Project Criteria (refer paragraph 27).

55. With reference to Mr News evidence, I understand that test charges of between 1-3kg would be trialled on-site to develop site specific attenuation constants. The tests are predicted to comply with the 120 dB  $L_{Cpeak}$  limit at a distance of 70m for a 1kg charge and 100m for a 3kg charge (determined using the United States Bureau of Mines calculation method).
56. Airblast noise can cause annoyance or discomfort at low levels, and potentially damage structures or result in personal injury at very high levels. The 6803 limit of 120 dB  $L_{Cpeak}$  is a human comfort noise limit related to annoyance. In terms of human response to the explosive airblast, the primary effect is the ‘startle’ factor. In terms of other physical response, BS5228-1:2009 states that an airblast overpressure of 120 dB  $L_{peak (lin)}$  is perceived “*equivalent to that of a steady wind velocity of 5m/s (Beaufort force 3, gentle breeze)*”. The 120 dB  $L_{Cpeak}$  criterion is slightly less stringent than 120 dB  $L_{peak (lin)}$ , and therefore is a conservative effects description.
57. As per paragraph 43, the following blasting support activities have been modeled for visual representation (attached in Appendix D).
58. Basalt removal works excluding blasting (Figure 14):  
Figure 14 illustrates this is predicted to be the noisiest construction activity at the TBM worksite during the day (excluding blasting). Noise levels of 75-80 dB  $L_{Aeq}$  are predicted on parts the Ruru Street Apartments and TV3 façades, decreasing to 75 dB  $L_{Aeq}$  at 98m as the works progress. The duration of this activity in combination with intermittent blasting is predicted to be 2 months. 75-80 dB  $L_{Aeq}$  on the façade of a building is estimated to result in an internal noise level of 45-50 dB  $L_{Aeq}$  (assuming sealed glazing). This noise level is typically acceptable. However where a building has operable or open windows, the estimated internal noise level would be higher, potentially resulting in annoyance and a reduction in work efficiency. With reference to paragraph 51, further works are required to understand the sound insulation and noise sensitivity of activities at TV3.

59. Basalt removal works excluding blasting (Figure 15):  
Each Figure is a snapshot of the construction scenario when positioned at a particular location. Similar results can be expected for other noise sensitive receivers as activities progress between the tunnel portal and the eastern and western turnouts respectively. To further demonstrate this, Figure 15 represents the same activity at the Ngahura Street pedestrian crossing. From this for example, noise levels of 65-70 dB  $L_{Aeq}$  are predicted on the façade of Bear Park child care centre. This is expected to result in an estimated internal noise level with associated noise effects of annoyance and daytime sleep disturbance for some children. This would depend on the location of sleeping areas in the building, window type and ventilation provisions.

#### Assessment of noise effects for the operational phase

60. I predict that above ground noise emissions from stations would be dominated by mechanical ventilation noise. Based on generic station ventilation layouts and indicative mechanical services plant selections<sup>15</sup>, I have calculated that ventilation noise can comply with the Project Criteria (refer paragraph 29) at full design duty<sup>16</sup> with the inclusion of industry standard proprietary attenuation and noise mitigation techniques (such as positioning ventilation openings to face away from the closest noise sensitive receiver where practicable). Therefore, I consider the noise effects to be acceptable.
61. Operational CRL rail movements (outside NAL designations) would be enclosed within underground tunnels, merging within the NAL corridor at grade. Train noise emissions received by patrons on station platforms or inside trains are not relevant for the NoR. However the current network electrification and rolling stock replacement program is predicted to reduce future noise levels below existing.
62. CRL designation footprint areas are identified adjacent to the NAL designation as a result of new or realigned tracks and other rail

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<sup>15</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* at Section 8.1.2

<sup>16</sup> Full design duty reflects maintenance testing periods and emergency operation.

During normal operation, fan duty would be lower, corresponding to reduced noise emissions

infrastructure. Post electrification, my indicative calculations for a representative noise sensitive receiver predicts a noise level increase of less than 1 decibel with and without CRL. This is based on a combination of the existing nearest track moving slightly closer, and the more distant existing track moving slightly further away. In general, a small and indiscernible local increase in noise emissions is anticipated. On this basis, I consider the noise effects would not be appreciable by those in close proximity. Nonetheless, I have recommended noise mitigation measures including targeted noise barriers, and rolling stock and rail maintenance procedures.

63. Vibration from underground movements received in a building as reradiated noise will be addressed as part of the vibration evidence.

#### Response to 'pre-notification' request for further information

64. A 'pre-notification' request for further information was received from Auckland Council, dated 23 October 2012. The request relating to noise specifically focuses on the assessment of construction noise effects. In response, the revised noise and vibration report<sup>17</sup> included indicative 'noise effects matrices' (discussed in paragraph 39) to assist people to estimate the internal noise levels received during construction.

#### **Proposed mitigation**

65. A CEMP would be prepared to ensure BPO is identified and implemented. The proposed CEMP includes a framework for the implementation of noise management procedures, noise mitigation measures and links to the Communications and Consultation Plan.
66. The noise and vibration report provides options for avoiding, remedying or mitigating adverse construction noise effects<sup>18</sup> and detail on construction noise management techniques<sup>19</sup>. These are captured in the Communications and Consultation Conditions 8 – 10 and

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<sup>17</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* at Section 7.1.8

<sup>18</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* Section 7.3

<sup>19</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* Section 7.4

Construction Environmental Management Plan (CEMP) Conditions 13 – 15 and 21. Condition 21 sets out the specific framework for the implementation of noise management procedures, noise mitigation measures and links to the Communications and Consultation Plan. Mitigation options include, but are not limited to: structural mitigation such as barriers and enclosures, the scheduling of high noise construction, use of low noise machinery and temporary relocation of affected receivers. The specifics would be developed as the construction phase progresses, in accordance with the CEMP. However examples include the following:

- Selecting low noise machinery (where practicable).
- Inclusion of a 2m high noise barrier at the perimeter of the construction site. Note however this typically would not benefit receivers located in the upper levels of the adjacent multi story buildings.
- Utilisation of temporary mobile enclosures where practicable. For example, enclosing the road surface cutting works would likely reduce noise emissions shown in Figure 3.1.1 by 10-15 decibels.
- Stockpiling spoil on-site during the night-time period to avoid noise contributions from front end loader and truck movements.
- Enclosing and/or attenuating pumps, generators, compressors and grouting plant where practicable.
- Maintaining mechanical plant to ensure noise emissions are controlled as far as practicable.
- Avoiding unnecessary use of horns and tonal alarms, especially during the night-time period.
- Communication with stakeholders. This measure is essential. For example, a shorter construction program involving higher noise levels may be preferable to a protracted programme with lower levels.

- Further detailed construction noise assessment on a case by case basis where levels at the façade of a building are predicted to exceed the Project Criteria construction noise limits by more than 5 decibels (refer paragraph 26).
- Temporary relocation of noise sensitive receivers where the night time Project Criteria is exceeded for a short duration.
- Façade sound insulation improvements of affected buildings where the night time Project Criteria is exceeded for an extended duration or temporary relocation is not appropriate. This may include provision of mechanical ventilation to enable windows and doors to be closed that would otherwise be required to be open.

67. Blasting reduces the duration of alternative rock breaking activities. I note that the balance of effects versus timeframe needs to be carefully considered with blasting (and indeed any construction works). The volume of rock fractured by one transient blasting event would require a much longer timeframe using alternative methods such as rock breakers, which also produce significant noise.
68. With reference to blasting noise criteria in paragraph 54, the Construction Noise Standard 6803:1999 states that “*Practices should confirm with the provisions of documents such as AS 2187:Part 2*”. The provisions of AS 2187: Part 2 include recommendations to reduce airblast noise to as low a level as practically possible. It recommends training of blasting operators, the use of test blasts to minimise charge size and review of blasting performance. Blasting must be accompanied by a strictly controlled programme to monitor and manage the effects. The noise level generated by a blast is directly proportional to the amount of explosive used, so smaller blasts equate to lower noise levels. Typical airblast noise can be mitigated through communicating exactly when blasts would occur ahead of time, and having an audible countdown sequence (such as sirens at 5 minutes, 1 minute etc. before the blast).
69. A specific communication and consultation plan should be developed with ‘notable’ noise sensitive receivers to manage the adverse effects

from construction noise (including, but not limited to TV3, Roundhead Studios, Mercury Theatre and Aotea Centre). This would involve on-site sound insulation tests to quantify the sound level difference between predicted construction levels on the façade and the level received in recording studios or performance spaces.

70. I have recommended preliminary mitigation for the operational phase in the vicinity of noise sensitive receivers. This focuses primarily on noise from station and tunnel ventilation and rail movements at the NAL connection:

- Select low-noise ventilation plant and high performance attenuation where practicable;
- Maintain equipment and use in a mode of operation that minimises noise where practicable, especially during noise sensitive periods;
- Manage the occurrence of wheel and track corrugations through implementation of a rolling stock maintenance protocol; and
- Lubricate above ground surface turnouts and junctions connecting CRL to NAL where practicable and employ targeted noise mitigation (such as the erection of noise barriers).

71. I consider that the operational noise effects of the Project would be reasonable and acceptable.

### **Response to submissions**

72. I have reviewed all submissions that I am aware of that relate to noise from CRL. I have grouped these submissions according to the concern raised and summarised this grouping in the table overleaf.

Submission Number	Construction Noise						Operational Noise		Designation Conditions
	- Surface works	- Tunnelling	- Road traffic	- Health effects	- Effects on Business	- Ventilation Stacks			
0061									
0121									
0120									
0114									
0122									
0071									
0065									
0186									
0095									
0079									
0221									
0097									
0103									
0139									
0140									
0141									
0142									
0143									
0144									
0245									
0070									
0081									
0246									
0088									
0249									
0236									
0068									
0054									
0074									
0238									
0257									
0240									
0116									
	<b>33</b>	<b>19</b>	<b>7</b>	<b>2</b>	<b>3</b>	<b>26</b>	<b>14</b>	<b>2</b>	<b>11</b>

73. I address each of the collective concerns listed above in the following sub sections. Subsequently, I address specific noise related concerns from the following submissions:

- Auckland Boxing Association (114)

- Ministry of Justice (122)
- Stamford Plaza (71)
- Quay West Suites (95)
- MediaWorks (79)
- Bear Park Mt Eden (221)
- The Roman Catholic Bishop Diocese of Auckland (97)
- Precinct Properties NZ Ltd (81)
- Sky City Entertainment Group (88)
- James Kirkpatrick Group Ltd (236)

#### Construction Noise

74. Construction noise was the most common issue raised, with 33 identified submitters expressing concern. The two general themes related to the suitability of the proposed construction noise Project Criteria (refer Paragraph 27) and the opportunity to engage in the management and communication process for noisy works.
75. With an understanding of the existing noise environment, relevant noise performance standards<sup>20</sup> and case studies<sup>21</sup>, I have proposed Project Criteria for the control of noise effects from construction noise in accordance with the assessment provisions of the Construction Noise Standard (NZS 6803:1999). Where circumstances arise which result in a predicted or actual exceedance of the Project Criteria then consultation with affected parties would be undertaken in accordance with the Communication and Consultation Plan and provisions of the CEMP. I consider this process is appropriate to achieve BPO.

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<sup>20</sup> Resource Management Act, Auckland City District Plan – Isthmus and Central Area sections, and NZS 6803: 1999 Acoustics – Construction Noise

<sup>21</sup> Auckland Electrification Project, Waterview Connection, and Crossrail UK

76. In response to the management and communication process, I emphasise that the CEMP's purpose is to manage the effects of the construction phase, specifically including effects from noise and vibration. The CEMP would put in place a monitoring, mitigation and management framework to deal with actual and potential noise effects. It would also link to the Construction Communication and Consultation Plan to ensure affected parties are kept informed, particularly in advance of noisy construction works, and are aware of the steps to make a complaint and how it is subsequently dealt with.
77. I consider that the CEMP and Communication and Consultation Plan should satisfy submitters' concerns regarding construction noise. Some submitters have included more specific concerns about construction noise. These are detailed in the Table in Paragraph 72, and listed as follows:
- Surface works
  - Tunnelling activities
  - Construction road traffic movements
  - Health effects
  - Effects on business
78. Nineteen submissions relate to construction noise from surface works activities. Four of these submissions<sup>22</sup> express concern that construction noise contours are not provided for all surface works sites, or do not relate to the submitters property. As discussed in paragraph 37, I have undertaken noise modeling of 5 proposed construction activities across 4 worksites as part of the AEE, and a further 16 activities across 6 worksites after review of the submissions. 2D and 3D noise contours of these sites are attached to my evidence as Appendix D (modeling assumptions for those activities are included in Appendix A and B). They provide a visual representation of the predicted noise levels during peak construction periods. Please note that each Figure is

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<sup>22</sup> Submitters 108, 95, 68 and 74

a snapshot of a construction activity when positioned directly adjacent to a receiver. As the activity progresses geographically, similar results can be expected for other noise sensitive receivers when positioned directly adjacent.

79. Concerns about construction noise from underground tunnelling activities were raised in seven submissions. I note that tunnelling vibration maybe received in a building as reradiated noise. This matter is addressed as part of Mr Whitlock’s evidence on vibration effects.
80. Two submitters have expressed concern about noise from heavy vehicles (i.e. trucks using local roads in the vicinity of construction sites). Submission 103 states that this may result in loss of amenity. I consider that the noise effects from individual heavy vehicle movements would be similar to that received from the many major roads in the area. However, the CEMP would address construction traffic movements with management and mitigation methods (e.g. preferential haul routes and restricted periods for spoil removal) as discussed in Mr Clark’s evidence.
81. Three submitters expressed some concern about health effects due to noise. Submission 221 specifies that their concern relates to the construction phase, but Submissions 238 and 257 (which are identical) do not. NZS 6803:1999 Section 7 – “Guidelines for setting Construction Noise Limits” states the following: *“This section specifies desirable upper limits for construction noise received by the community for reasonable protection of health and amenity. The desirable limits vary according to the type of land use, time of day and anticipated duration of the construction work”*. I am not a health expert, but consider that that the proposed Project Criteria (refer paragraph 27) satisfies NZS 6803:1999, and therefore provides a *“reasonable protection of health”*. I anticipate that where specific health concerns are raised by complainants in the consultation process, a health expert could be engaged at that time if appropriate.
82. Twenty six submitters have expressed concern that effects from construction noise may affect their business. These include owners of residential and commercial premises who consider that construction

noise would reduce amenity value, resulting in for example; preference for a competitor's product or service and lower tenant retention rates. Mitigation and management measures such as temporary relocation of sensitive receivers, provision of mechanical ventilation to enable windows to remain closed, or investigation of alternative construction methods/locations may be required. Note that the total construction period of CRL may be between 5 and 6 years, but the period of construction at any one location would be much shorter.

#### Operational Noise

83. Fourteen submitters have expressed concern about noise from train passes once the CRL is operational. Vibration from underground train movements may be received in a building as reradiated noise. This matter is addressed as part of Mr Whitlock's evidence on vibration effects.
84. Two submitters are concerned about the noise from mechanical ventilation servicing Aotea and Karangahape Stations. I have calculated<sup>23</sup> that noise from the ventilation stacks can comply with the Project Criteria (refer Paragraph 60). The Project Criteria essentially align with the permitted activity noise limits contained in the District Plan (refer Paragraph 29). I consider the predicted operational noise effects to be acceptable.

#### Designation Conditions

85. Eleven submitters have emphasised that designation conditions must be included to ensure that noise effects from CRL are avoided, remedied or mitigated.
86. At the time the NoR was submitted, conditions had not yet been drafted (but were indicated), and were therefore not included. Draft conditions have now been developed, and address both construction and operational noise (refer Paragraph 133). In my opinion the proposed conditions are adequate to protect against unreasonable noise.

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<sup>23</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report* at Section 8.1.2

87. Some submitters have requested specific designation conditions that limit the hours of construction activity or mitigate construction noise. These requests are addressed in each of the following individual submission sub sections.

Auckland Boxing Association (114)

88. The Auckland Boxing Association submission notes the Construction Noise Contours<sup>24</sup> incorrectly show their site in the NoR footprint and seek clarification if correcting this is likely to alter the conclusions of the noise assessment. I confirm that the NoR footprint does not include the submitter's site and the conclusions of the assessment are unchanged following this correction.

Ministry of Justice (122)

89. The Ministry of Justice's building at 65-71 Albert Street houses the Auckland Departmental Building and Auckland District Court. The submitter states that noise from the construction phase has the potential to affect noise sensitive recording equipment. I understand that the recordings are made in the courts and hearing rooms.
90. This activity would be captured by Conditions 11 and 21 as a notable receiver, and be subject to noise mitigation and management through the CEMP and an SSCNMP. This process is further explained in response to the MediaWorks submission regarding sound recording (refer paragraph 99).

Stamford Plaza (71)

91. The Stamford Plaza submission is almost identical to those received from The Stamford Residences (Submission 70) and The Grasshopper Bar & Restaurant (Submission 74). They share the same site, and therefore, my comments relate to all three.
92. The Stamford Plaza has specific concerns about construction noise disturbing guest amenity value. With reference to paragraph 44, noise

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<sup>24</sup> Refer *Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report Appendix G*  
Figures 7-10

contours for additional construction activities are provided in Figures 1-6 of Appendix D.

93. I consider it highly likely that there would be periods where construction noise exceeds the day time Project Criteria (refer Paragraph 27), particularly during piling and excavation works directly adjacent to Stamford Plaza. However, as discussed in paragraph 45, provided BPO is implemented to avoid, remedy and mitigate construction noise, I consider the construction noise levels would be reasonable.
94. The submitter suggests that some guests may have to be relocated during particularly noisy works. I agree that this may be a sensible noise management option where appropriate.
95. Stamford Plaza also seeks designation conditions that limit the hours for piling between 10am and 4pm weekdays, general construction periods between 7.30am and 6pm and provide sound insulation improvements. I acknowledge that limiting piling activities to the daytime period is appropriate to achieve BPO. Aligned with this and with reference to paragraph 34, the indicative program schedules this activity between 7am and 7pm, Monday to Saturday. Further mitigation and management measures would be identified through the CEMP . Monitoring and mitigation provisions would include an “adaptive management regime” as suggested by the submitter and outlined in Ms Barwick’s evidence. The same monitoring would also give context to the effects of noise on amenity of the building occupants.

#### Quay West Suites (95)

96. The Quay West Suites’ submission is very similar to that of the Stamford Plaza above. Therefore, I consider that my comments for Stamford Plaza relate to the relevant parts of this submission as well.
97. The main point of difference compared to that of Stamford Plaza, is that they seek a further condition requesting provision for the installation of air conditioning, presumably to enable operable windows to remain closed during construction works. I have included mechanical ventilation as a noise mitigation option to be considered as part of the CEMP framework, on a case by case basis. However with reference to

paragraphs 34 and 66, the indicative construction program does not schedule any noisy construction activities during the night time period. Therefore at this stage, I do not consider this is required for Quay West Suites.

98. The Quay West Suites submission notes that the general 'hours of operation'<sup>25</sup> in the draft construction noise and vibration management plan (CNVMP) are inconsistent with the Project Criteria (refer Paragraph 27). I confirm the hours set out in the CNVMP are a mistake – they should be consistent with the Project Criteria.

#### MediaWorks (79)

99. MediaWorks' TV3 Studios in Flower Street is a notable<sup>26</sup> noise and vibration receiver. As such, this submitter would be addressed using proposed condition 11, which is a specific Communication and Consultation condition for activities that are recognised as having a more elevated sensitivity to noise and/or vibration compared with other sensitive receivers.
100. Their submission expresses concern about reradiated noise from construction vibration disturbing equipment and employees in the studios whilst recording shows and broadcasting live coverage (particularly in the main studios on the ground floor). Reradiated noise from construction and operational vibration is addressed as part of Mr Whitlock and Mr Harrison's evidence on vibration effects.
101. The site is located directly adjacent to the 'NAL connection' construction site. Above ground cut and cover construction activities (such as piling, excavation and basalt blasting) are proposed to create the tunnel portal. With reference to paragraphs 43 and 57, noise contours for additional construction activities are provided in Figures 13-16 of Appendix D.

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<sup>25</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report Appendix J7

<sup>26</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day report at Section 7.2.4.

102. With respect to the construction noise effects assessment<sup>27</sup>, I consider internal levels of up to 50 dB  $L_{Aeq}$  received in commercial office spaces is typically acceptable during the daytime. However in paragraph 4(a) of MediaWorks submission, they state “*the operational requirement for the studio is 25 dB*”. In general, I agree with this statement for some studio types and activities. I also consider that some studio uses would be highly noise sensitive (i.e. during recording sessions and live broadcasts, whereas broadcasting of recorded material would be less so).
103. In my opinion, the actual noise limits suitable for each activity type undertaken by MediaWorks should be determined through the CEMP consultation and monitoring framework. Furthermore, I recommend this include a noise reduction assessment to understand the difference between an external noise level and the level received inside each studio. I expect that the sound insulation performance of each studio is of a much higher standard than that described for a typical dwelling in the noise and vibration assessment<sup>28</sup>. Once actual, as opposed to theoretical sensitivity is known, it would be important to manage all activities that breach these levels, so that the BPO to avoid unreasonable noise is adopted.
104. Once the tunnel portal is constructed, tunnelling support activities would facilitate spoil removal. I predict that construction noise from this stage of the project would comply with the Project Criteria and consider that the noise effects from these activities would be acceptable.
105. To manage the noise effects on the MediaWorks building requires:
- On-going consultation with MediaWorks;
  - Detailed monitoring of the noise effects on the studios and their operations, both before and during construction, to correlate noise levels with real effects; and
  - A commitment by AT to offer reasonable mitigation and/or management strategies (ideally to the satisfaction of both parties).

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<sup>27</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Section 7.1.8

## Bear Park Mt Eden (221)

106. The submitters concerns relate to the noise sensitive nature of their child care business and the noise effects from the NAL construction site activities. They request opportunity to engage in consultation and benefit from acoustic mitigation (including provision of an acoustic fence). They also seek restrictions on works within 500m of Bear Park between 11.30am and 3pm (i.e. when children are typically sleeping).
107. Bear Park is located at the end of Akiraho Street, with pedestrian access to the western end of the Mt Eden Station platform approximately 50m away. The buildings are visually screened by industrial buildings, whereas the external playground has a narrow line of sight to the existing rail corridor and proposed NAL construction site.
108. It is expected that the playground is currently exposed to high noise levels from existing rail movements. Therefore, I feel there is a strong argument for a higher baseline criterion for this outdoor area. With reference to paragraph 59, Figure 15 (Appendix D) illustrates basalt removal works (the noisiest activity in the area excluding blasting) at its closest position to Bear Park. For this example, noise levels of up to 60-65 dB  $L_{Aeq}$  are predicted in the playground. I consider this to be reasonable for temporary construction works.
109. Sleep disturbance during the daytime period is not specifically addressed by the construction noise Project Criteria or taken into account by the Construction Noise Standard NZS 6803. Note that internal noise levels from AS/NZ 2107:2000 have been recommended by the Ministry of Education for other infrastructure projects in the Auckland Region<sup>29</sup> that align with the night-time Project Criterion for bedrooms at night. With respect to Figure 15 in Appendix D, 65-70 dB  $L_{Aeq}$  on the façade of Bear Park child care centre is expected to result in an estimated internal noise level that may result in annoyance and sleep disturbance for some people. This would depend on the location

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<sup>28</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Section 7.1.8

<sup>29</sup> Waterview Connection and Northern Busway projects

of sleeping areas in the building, window type and ventilation provisions.

110. There would be some construction periods when external doors and windows would need to be kept shut in order to reduce internal noise levels to a reasonable level. If this is required for an extended period, I expect the CEMP framework would result in the adoption of noise mitigation. This may include mechanical ventilation in sleeping areas, scheduling of activities outside noise sensitive periods, or relocation of the child care centre (where other measures are not practicable).
111. Ongoing consultation and communication with Bear Park would be important and required throughout the construction period.

The Roman Catholic Bishop Diocese of Auckland (97)

112. The submitter requests that construction noise be minimised during Sunday morning mass. This request would be addressed through consultation using the CEMP and communications framework.

Precinct Properties NZ Ltd (81)

113. The Precinct Properties submission relates to six buildings in the vicinity of the CRL alignment, specifically:
  - Zurich House – 21 Queen St
  - AMP Centre – 29 Customs St West
  - ANZ Centre – 23-29 Albert St
  - PwC Tower – 188 Quay St
  - SAP Tower – 151 Queen St
  - Downtown Shopping Centre – 7 Queen St
114. Precinct Properties primary concern is that there may be no opportunity for their input into developing management plans and mitigation strategies. The submitter also seeks designation conditions to specify

acceptable standards for construction and operational noise. I consider the Project Criteria to be appropriate for this purpose (refer Paragraphs 27 and 29). These Criteria are included in the proposed designation conditions (refer Paragraph 133).

115. The ANZ Centre is on the corner of Custom Street West and Lower Albert Street. It includes the Kindercare child care centre on the ground floor overlooking the intersection where cut and cover works are proposed. Despite the high existing noise environment at this site<sup>30</sup>, and with reference to the discussion regarding Bear Park child care centre (refer Paragraphs 106 – 111), I expect that ongoing consultation and communication with Kindercare would be important and required throughout the construction period.

Sky City Entertainment Group (88)

116. The submitters concern relates to disturbance of hotel, convention centre and restaurant occupancies in its building abutting the proposed Aotea Station beneath Albert Street. The effects on this receiver (as with many in lower Albert Street) are to be addressed through the monitoring and mitigation provisions of the CEMP. With reference to paragraph 43, noise contours for additional construction activities are provided in Figures 7-8 of Appendix D.
117. The submitter specifically comments on the lack of certainty around management and mitigation measures contained in NoR. Like the submission from Precinct Properties NZ Ltd, it is concerned that they would have no input into the development of these tools. I consider that this particular concern has been addressed - refer Paragraph 114.

James Kirkpatrick Group Ltd (236)

118. The submitter claims to have a recording studio in their building. This would be captured by Condition 11 and would subject to the same management and mitigation procedures as other studios such as MediaWorks (refer paragraph 99).

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<sup>30</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics report at Appendix E4

## Response to Planner's Report

119. I have reviewed the Auckland Council – Report for Hearing Commissioners ('Planner's Report') dated 11 June 2013. In summary, it recommends amendments to the proposed draft Conditions 21, 38 and 44, as well as the addition of Conditions 21A and 44A. The following sections of the Planner's Report are the most relevant with respect to noise:

- Section 9.2 – Construction Noise and Vibration (P54-75)
- Section 9.3 – Operational Noise and Vibration (P75-86)
- Appendix F – Noise and Vibration Technical Report, Styles Group
- Appendix O – Recommended Conditions

120. The Planner's Report<sup>31</sup> summarises 46 submissions relating to construction noise and 11 submissions relating to operational noise. I consider these matters have been addressed in my response to submissions.

### Construction Noise

121. The Planner's Report<sup>32</sup> quotes the following from the Styles Group report: *"Overall I agree with the approach taken in the MDA report and subject to my comments on the conditions I agree with the overall assessment effects and the proposed management methods in general"*. Thereafter, the Planner's Report continues: *"Further to these conditions, we note the importance of AT relocating those sensitive noise receivers that may be potentially significantly adversely affected at times, and the importance of strong communication links with those parties"*.

122. The addition of Condition 21A requires that further assessment be undertaken as part of a Site Specific Construction Noise and Vibration Management Plan (SSCNVMP) where modelled or measured

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<sup>31</sup> Planner's Report Section 9.2.3 Pages 57 and 77

<sup>32</sup> Planner's Report Section 9.2.5 Page 70

construction noise levels are predicted to exceed a criterion of Condition 38 by 5 decibels.

123. I agree with this Condition, but recommend clarification that it be limited to the activities predicted to exceed the criteria, and, relate to an individual NoR worksite rather than an individual noise sensitive receiver site. This would avoid confusion and/or considerable repetition. For example, the noise effects for piling activities in the NoR 1 worksite between Britomart and Aotea Station are predicted to be largely the same for all buildings adjacent to the worksite. The SSCNVMP for the worksite, would address the buildings individually, but the mitigation and management methods can be captured collectively.

124. Recommended changes to Condition 38 relate to alternative construction noise criteria for night-time, Sunday and Public Holidays, as well the inclusion of noise criteria for child care centres. The key changes are summarised with my comments as follows:

- The night-time period is expanded from 2300-0700 to 2200-0700 to align with that defined for the Mixed Use Zone<sup>33</sup>.

I agree with this change.

- The day time noise limit at noise sensitive receivers is reduced from 75 dB  $L_{Aeq}$  to 60 dB  $L_{Aeq}$  on Sundays and Public Holidays. I accept that a lower limit during this period would offer respite to noise sensitive receivers, but consider the criterion should be set at 65 dB  $L_{Aeq}$  to align with the Central Area permitted activity construction noise limit during the night time period<sup>34</sup>.

- The night-time noise limit at noise sensitive receivers is reduced from 60 dB  $L_{Aeq}$  to 50 dB  $L_{Aeq}$  where windows are required to be open for ventilation.

I disagree with this change. 60 dB  $L_{Aeq}$  aligns with the Central Area Construction Noise limit<sup>35</sup>. Furthermore, for comparison, the

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<sup>33</sup> Section 8.8.10 (b) of the Auckland Council District Plan (Isthmus Section)

<sup>34</sup> Section 7.6.4 (c) of the Auckland Council District Plan (Central Area Section)

<sup>35</sup> Section 7.6.4 (c) of the Auckland Council District Plan (Central Area Section)

permitted activity noise limits are 60 dB  $L_{A10}$  in the Central Area<sup>36</sup> and 55 dB  $L_{A10}$  in the Mixed Use Zone<sup>37</sup>, and both these areas impose minimum sound insulation requirements for residential dwellings based on an external noise level of 60 dB  $L_{A10}$ .

- 55 dB  $L_{Aeq}$  in the outdoor play areas of child care centres. The Auckland Regional Public Health Service document 'Guideline values for noise in early childcare education centres'<sup>38</sup> recommends that outdoor play areas be sited in noise environments below 55 dB  $L_{Aeq}$  to avoid annoyance from external noise sources. However the guidelines are not intended to relate specifically to construction noise. Construction noise is afforded much higher noise limits due to the nature of the activity and its temporary duration. I recommend this restriction be removed as the critical element (sleep disturbance) is adequately dealt with in the following bullet point.
- 35 dB  $L_{Aeq}$  in sleeping areas of child care centres. I agree with this inclusion. While sleep disturbance during the daytime period is not specifically addressed by the noise limits in Condition 38, or taken into account by the Construction Noise Standard NZS 6803, similar conditions have been recommended by the Ministry of Education and adopted for other infrastructure projects in the Auckland Region<sup>39</sup>.
- Criteria shall only be varied by way of an approved SSCNVMP through the provisions of Condition 21A. I agree with this inclusion with reference to my comments in paragraph 122.

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<sup>36</sup> Section 7.6.3 (a) and (c) of the Auckland Council District Plan (Central Area Section)

<sup>37</sup> Section 8.8.10 (b) of the Auckland Council District Plan (Isthmus Section)

<sup>38</sup> Based on 'Guidelines for Community Noise' (World Health Organisation 1999)

<sup>39</sup> Waterview Connection and Northern Busway projects

## Operational Noise

125. The Planner's Report<sup>40</sup> separately addresses operational noise from rail movements and mechanical ventilation.
126. With respect to rail movements, the report acknowledges that "*any effects arising from activity on the NAL are outside the scope of what we may consider here*". However, the addition of Condition 44A requires an Operational Noise Management Plan (ONMP) be implemented to ensure infrastructure is maintained and operated such that noise and vibration is controlled to a reasonable level. I agree with this Condition.
127. With respect to mechanical ventilation, the Planner's Report acknowledges that the proposed noise limits in Condition 44 are essentially aligned with the permitted activity noise limits<sup>41</sup> with the modified descriptor ( $L_{Aeq}$ ).
128. The Planner's Report accepts these limits for the Central Area, provided the specified 63 Hz and 125 Hz controls are discarded in favour of the special audible character provisions of NZS 6802:2008. I agree with this recommended amendment.
129. However, an alternative methodology is proposed by Styles Group for establishing the night-time noise limit for the mechanical ventilation in the Mixed Use Zone (Isthmus Area). Note the proposed mechanical ventilation stacks in the Mixed Use Area are located at each end of Newton Station.
130. The Styles Group report identifies that the background noise level in some parts of Newton drop as low as 40 dB  $L_{A10}$  in the middle of the night. Styles Group therefore suggest an appropriate noise limit (in terms of dB  $L_{Aeq}$ ) would be set at a level 5 decibels above the 90<sup>th</sup> percentile of the measured night-time background noise level ( $L_{A90,15min}$ ). Furthermore, the measurements to determine the background

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<sup>40</sup> Planners Report Section 9.3.5 Page 82

<sup>41</sup> Section 7.6.3 (a) of the Auckland Council District Plan (Central Area Section) and Section 8.8.10 (b) of the Auckland Council District Plan (Isthmus Section)

noise level would be undertaken 1 year prior to the construction of the station ventilation. This is to ensure the proposed limit is linked to the noise environment prior to the time of construction.

131. The proposed amendment to draft Condition 44 provisionally adopts the permitted activity noise limit with the modified descriptor ( $L_{Aeq}$ ) unless the methodology recommended by Styles Group above results in a lower noise limit at the time of construction. Using the Styles Group methodology and noise measurements at the nearby French Café<sup>42</sup>, the night-time noise limit would be 48 dB  $L_{Aeq}$ .
132. I agree with the use of the permitted activity noise limit with the modified descriptor ( $L_{Aeq}$ ), but disagree with the inclusion of the Styles Group methodology option. It seeks to provide additional amenity protection in the Mixed Use Zone that in my opinion is not required (it is not addressing a sleep disturbance issue), does not provide certainty of the noise limits for the Condition, and seeks to restrict noise to levels below those permitted in the District Plan.

### **Proposed conditions**

133. The proposed designation conditions (taken from the Council planners report) relating to my evidence are listed as follows:
- 8: Communication and Consultation Plan  
This condition sets out the methods and framework for what shall be included in the Communication and Consultation Plan, including the monitoring of adverse noise effects and linkages and cross references to the CEMP (refer Condition 13).
  - 9: Concerns and Complaints Management  
This condition details the process for recording and responding to concerns and complaints, including those regarding noise.
  - 11: Communications – Notable Noise and Vibration Receivers  
This is a specific Communication and Consultation condition for activities that are recognised as having a more elevated

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<sup>42</sup> Refer Volume 3, Part 1, Appendix 2 – Marshall Day Acoustics Appendix E7

sensitivity to noise and/or vibration compared with other sensitive receivers. This includes theatres and recording studios.

- 13 – 15: Construction Environmental Management Plan (CEMP)  
The CEMP is the main mechanism for managing adverse effects during the construction period. These conditions provide the general framework and content of the CEMP.
- 21: Construction Noise and Vibration Management Plan (CNVMP)  
Sets out the specific framework for the implementation of noise management procedures, noise mitigation measures and links to the Communications and Consultation Plan. Mitigation options include, but are not limited to: structural mitigation such as barriers and enclosures, the scheduling of high noise construction, use of low noise machinery and temporary relocation of affected receivers.
- 21A: Site Specific Construction Noise and Vibration Management Plan (SSCNVMP)  
This condition requires that further assessment be undertaken as part of a SSCNVMP where modeled or measured construction noise levels are predicted to exceed a criterion of Condition 38 by more than 5 decibels.
- 38: Project Criteria – Construction Noise  
This condition presents the Project Criteria relating to construction noise which shall be met as far as practicable. It states that noise shall be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 “Acoustics - Construction Noise”.
- 44: Project Criteria – Operational Noise  
This condition presents the Project Criteria relating to operational noise from mechanical ventilation plant servicing the underground rail sections of the City Rail Link. It states that measurements shall be undertaken in accordance with New Zealand Standard NZS 6801:2008 “Acoustics – Measurement of environmental

sound” and assessed in accordance with New Zealand Standard NZS 6802:2008 “Acoustics - Environmental Noise”.

- 44A: Operational Noise and Vibration Management Requires an Operational Noise Management Plan be implemented to ensure infrastructure is maintained and operated such that noise and vibration is controlled to a reasonable level.

134. I agree with the proposed conditions as they are currently drafted, subject to my comments to the Planner’s Report. In addition, I recommend an amendment to Condition 38 in accordance with my proposed criteria in Paragraph 27 regarding noise from blasting.

- Airblast noise from blasting activities shall comply with 120 dB  $L_{Cpeak}$ , measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 “Acoustics - Construction Noise”.

135. I also recommend that Condition 21 include a framework for managing airblast noise. I recommend that it include the following:

- All receivers within 200m of a blast site must be notified at least 24 hours in advance
- Blasts must be performed at set times during the daytime only, between 8am and 6pm, Monday to Saturday only
- Comprehensive airblast noise level calculations must be performed prior to any explosives being used
- Blasting will not be performed where overpressure levels are predicted to be above the Project Criteria at an occupied site
- Blasting will not be performed where overpressure levels are predicted to be above 150 dB  $L_{Zpeak}$  at the façade of a building and a building condition survey has not been undertaken prior.

**Craig Michael Fitzgerald**

**2 July 2013**

## Appendix A – Selected Representative Machinery Items

Item	Description	BS 5228 ref	BS 5228 Activity Description	Power Rating (kW)	Equipment size/weight/capacity
1	Mobile Crane	C4.43	Wheeled mobile crane	275	35T
2	Diaphragm wall rig	D4.101	Crane mounted diaphragm wall rig	90	-
3	Secant piling rig	D4.93	Crane Mounted Auger	104	1.05m dia
4	Bentonite / grouting plant	D6.9	Batching plant	-	19m <sup>3</sup> /hr
5	Concrete truck	C4.18	Cement mixer truck (discharging)	-	-
6	Excavator	C4.64	Tracked excavator (trenching)	107	22T
7	Road truck (idling)	C4.8	Dumper (idling)	56	5T
8	Road truck movements	C4.7	Dumper (travel and emptying)	56	5T
9	Dewatering	C2.45	Water pump	20	6in
10	Front End Loader	C2.28	Wheeled loader	170	-
11	Grader	D3.75	Grader	168	-
12	Vibratory Roller	C5.25	Vibratory Roller	32	4.5T
13	Excavator with pulveriser attachment	C1.4	Pulverizer mounted on excavator	147	30T
14	Spoil Conveyor	C10.20	Conveyer drive unit	42	-
15	Power Supply	C4.87	Diesel Generator	7.5	6kVA / 3000rpm
16	Air compressor	C5.5	Compressor for hand-held pneumatic breaker	-	1t
17	Petrol circular saw	C5.36	Hand-held circular saw (petrol)	3	300mm diameter / 9.2kg
18	Drilling blast holes	C9.1	Tracked mobile drilling rig	317	20t/ 125mm dia.
19	Excavator with rock breaker	C9.11	Excavator mounted rock breaker	125	29t

Item	Description	BS 5228 ref	BS 5228 Activity Description	Power Rating (kW)	Equipment size/weight/capacity
20	Concrete truck and pump	C4.28	Concrete mixer truck (discharging) & concrete pump (pumping)	-	26t (capacity)/ 7m3 + 22m boom
21	Skid loader	C2.8	Wheeled backhoe loader	62	8t
21	TBM (underground - vibration only)				
22	Road Header (underground - vibration only)				

## Appendix B – Construction Scenarios

Scenario	Construction Scenario	Memo Description	Machinery Items	Hours	Duration	Appendix D
<b>3</b>	<b>Albert Street Cut and Cover Running Tunnels (Location: Stamford Plaza)</b>					
3.1.1	Enabling works A	Road surface cutting	17	7am-7pm Mon-Sat	3 weeks	Figure 1
3.1.1	Enabling works B	Trenching and backfilling	6, 7	7am-7pm Mon-Sat		Figure 2
3.1.2	Piling	Soldier piles	3, 6, 7	7am-7pm Mon-Sat	3 weeks	Figure 3
3.1.3	Excavation propping and waling	Excavation until road reinstatement + props	1, 6, 7	7am-7pm Mon-Sat	3 x 1 week per level	Figure 4
3.1.4	Permanent works and backfilling A	Concrete works	20	7am-7pm Mon-Sat	8-10 weeks	Figure 5
3.1.4	Permanent works and backfilling B	Backfilling and compaction	6, 7, 12	7am-7pm Mon-Sat	3 x 1 week per level	Figure 6
<b>4</b>	<b>Aotea Station</b>					
4.1.1	Enabling works A	Building demolition	7, 13	7am-7pm Mon-Sat	2 weeks	Figure 7
4.1.1	Enabling works B	Road cutting, trenching and backfilling	Refer 3.1.1	7am-7pm Mon-Sat	12 weeks each side of road	Refer Figures 1/2
4.1.2	Piling	Contiguous piles	Refer 3.1.2	7am-7pm Mon-Sat	12 weeks each side of road	Figure 8
4.1.3	Excavation propping and waling	Excavate, concrete, backfill and compact	Refer 3.1.3/4	7am-7pm Mon-Sat	3 months	Refer Figures 4/5/6
<b>5</b>	<b>TBM Construction (Location: Aotea Centre)</b>					
5.1	Tunnelling	100m of tunnel	-	6am-2am Mon-Sat	2 weeks	-
<b>6.1</b>	<b>Karangahape Road Station (Location: Beresford St Entrance)</b>					
6.2.1	Enabling works	Building demolition	Refer 4.1.1 A.	7am-7pm Mon-Sat	2 weeks	Refer Figure 7
6.2.2	Piling	Contiguous piles or Diaphragm wall	2, 4, 7	7am-7pm Mon-Sat	8-12 weeks	Figure 9
6.2.3	Excavation and primary support	Excavate and concrete	Refer 3.1.3/4	7am-7pm Mon-Sat	10 weeks	Refer Figures 4/5/6
6.2.4	Permanent works	Concrete works	Refer 3.1.4 A.	7am-7pm Mon-Sat	6 months	Refer Figure 5

Scenario	Construction Scenario	Memo Description	Machinery Items	Hours	Duration	Appendix D
<b>6.3</b>	<b>Karangahape Road Station (Location: Mercury Lane Shaft)</b>					
6.4.1	Enabling works	Building demolition	Refer 4.1.1 A.	7am-7pm Mon-Sat	2 weeks	Refer Figure 7
6.4.2	Piling	Contiguous piles or Diaphragm wall	Refer 6.2.2	7am-7pm Mon-Sat	6-10 weeks	Refer Figure 10
6.4.3	Excavation and primary support	A. Station excavation	1, 7, 10	7am-7pm Mon-Sat	8 weeks	Figure 11
6.4.3	Excavation and primary support	B. Shotcrete works	Refer 3.1.4 A.	7am-7pm Mon-Sat		Refer Figure 5
6.4.4	Permanent works	Concrete works	Refer 3.1.4 A.	7am-7pm Mon-Sat	4 months	Refer Figure 5
<b>7</b>	<b>Newton Station (Location: Dundonald Street Shaft)</b>					
7.2.1	Enabling works	Building demolition	Refer 4.1.1 A.	7am-7pm Mon-Sat	2 weeks	Refer Figure 7
7.2.2	Piling	Contiguous piles or Diaphragm wall	Refer 6.2.2	7am-7pm Mon-Sat	6-10 weeks	Refer Figure 12
7.2.3	Excavation and primary support	Shaft excavation and shotcrete	Refer 6.4.3	7am-7pm Mon-Sat	8 weeks	Refer Figures 5/11
7.2.4	Permanent works	Concrete works	Refer 3.1.4 A.	7am-7pm Mon-Sat	4 months	Refer Figure 5
<b>8</b>	<b>TBM Worksite</b>					
8.1	Construction role	NAL site tunnelling services (5 trucks/hour)	4, 7, 8, 9, 10, 14, 15, 16	6am-2am Mon-Sat	2 years	Figure 13
8.2	Potential blasting A	Drilling rigs, rock breakers excavators, trucks	6, 7, 18, 19	7am-7pm Mon-Sat	2 months	Figure 14
8.2	Potential blasting B	Blasting	N/A			N/A
8.3	Cut and cover works	Contiguous piles or Diaphragm wall	Refer 6.2.2	7am-7pm Mon-Sat	8 months	Figure 15

### Appendix C – Construction Noise Setback Distance

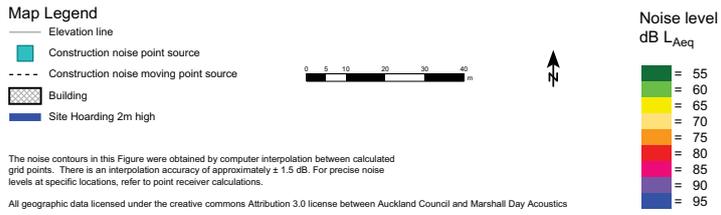
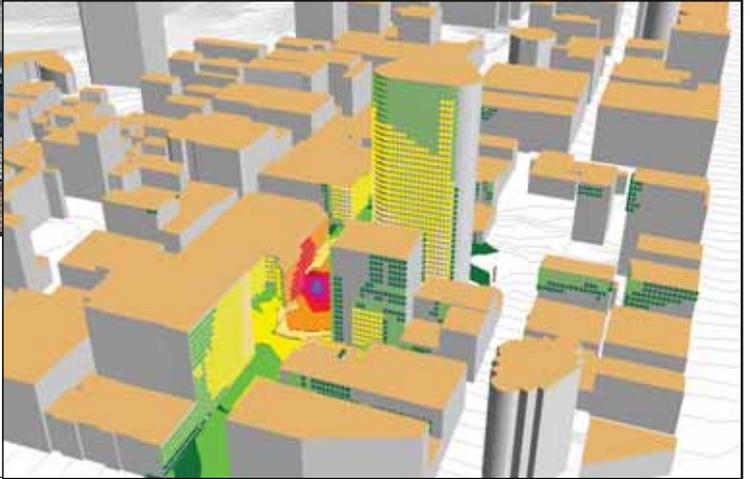
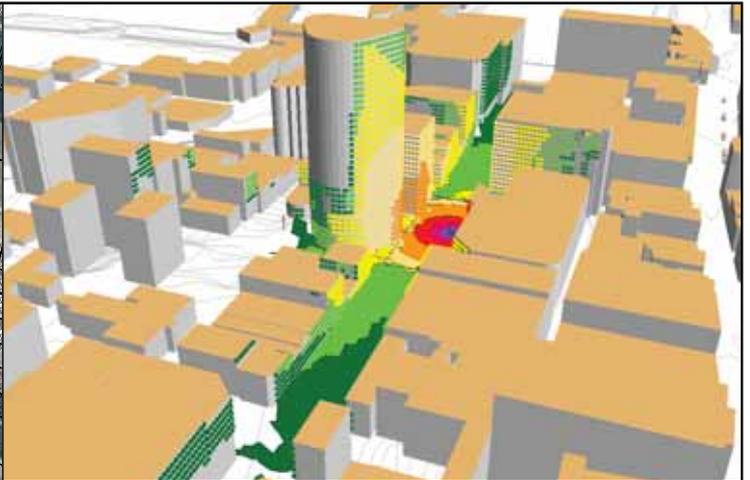
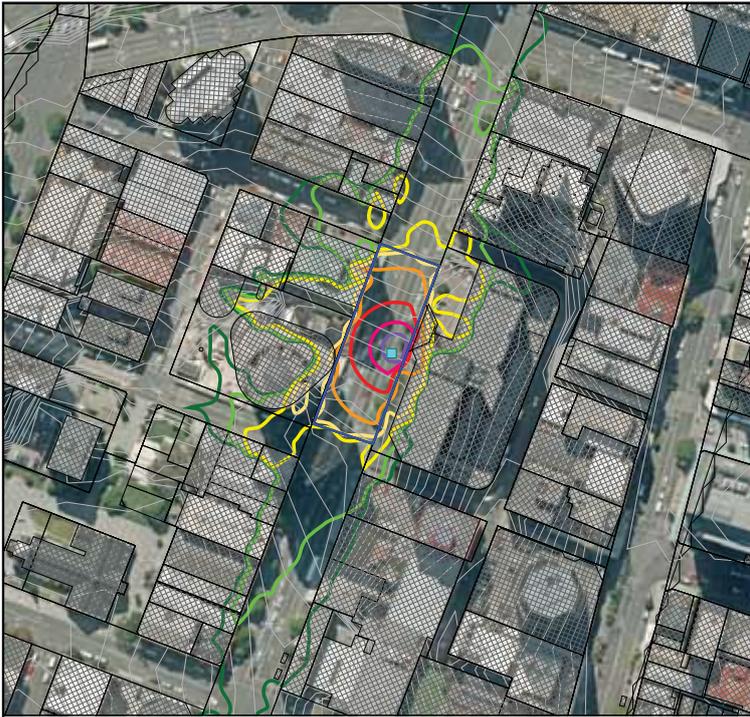
The following Table summarises the setback distance for each scenario to comply with the 75 dB L<sub>Aeq</sub> daytime and 60 dB L<sub>Aeq</sub> night-time construction noise criteria from Condition 38 (only tunnelling services are proposed during the night-time period).

Scenario (Appendix B)	Construction Scenario	Description	60 dB L <sub>Aeq</sub> Setback Distance (m)	75 dB L <sub>Aeq</sub> Setback Distance (m)	Noise Contours (Appendix D)
3.1.1	Enabling works A	Road surface cutting	N/A	40	Figure 1
3.1.1*	Enabling works B	Trenching and backfilling	N/A	10	Figure 2
3.1.2*	Piling	Soldier piles	N/A	50	Figure 3
3.1.3*	Excavation propping and waling	Excavation and propping	N/A	12	Figure 4
4.1.1	Enabling works A	Building demolition	N/A	11	Figure 7
4.1.1*	Enabling works B	Road cutting, trenching and backfilling	N/A	10	Refer Figures 1, 2
4.1.2*	Piling	Contiguous piles	N/A	50	Figure 8
4.1.3*	Excavation propping and waling	Excavate, concrete, backfill and compact	N/A	14	Refer Figures 4, 5, 6
6.2.1	Enabling works	Building demolition	N/A	11	Refer Figure 7
6.2.2*	Piling	Contiguous piles or diaphragm wall	N/A	37	Figure 9
6.2.3*	Excavation and primary support	Excavate, concrete	N/A	14	Refer Figures 4, 5, 6
6.2.4	Permanent works	Concrete works	N/A	10	Refer Figure 5
6.4.1	Enabling works	Building demolition	N/A	11	Refer Figure 7
6.4.2*	Piling	Contiguous piles or diaphragm wall	N/A	37	Figure 10
6.4.3*	Excavation and primary support A	Station excavation	N/A	13	Figure 11
6.4.3	Excavation and primary support B	Shotcrete works	N/A	10	Refer Figure 5

Scenario (Appendix B)	Construction Scenario	Description	60 dB L <sub>Aeq</sub> Setback Distance (m)	75 dB L <sub>Aeq</sub> Setback Distance (m)	Noise Contours (Appendix D)
6.4.4	Permanent works	Concrete works	N/A	10	Refer Figure 5
7.2.1	Enabling works	Building demolition	N/A	11	Refer Figure 7
7.2.2*	Piling	Contiguous piles or diaphragm wall	N/A	37	Figure 12
7.2.3*	Excavation and primary support	Station excavation and shotcrete	N/A	13	Refer Figures 5, 11
7.2.4	Permanent works	Concrete works	N/A	10	Refer Figure 5
8.1	Construction role	NAL site tunnelling services (5 trucks/hour)	142	25	Figure 13
8.2*	Potential blasting A	Drilling rigs, rock breakers excavators, trucks	N/A	98	Figure 14
8.2*	Potential blasting B	Blasting	N/A	N/A	N/A
8.3*	Cut and cover works	Contiguous piles or Diaphragm wall	N/A	37	Figure 15

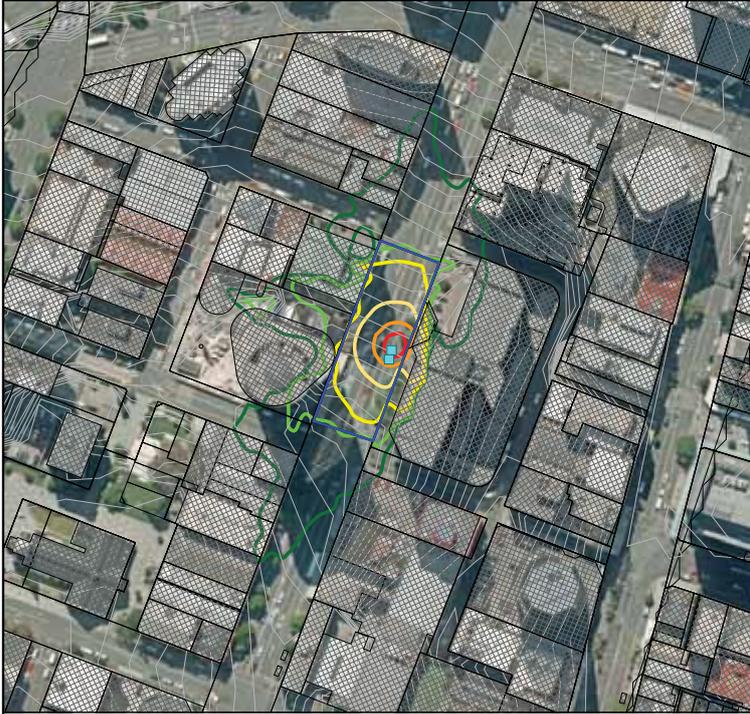
## **Appendix D – Additional Construction Noise Contour Figures:**

1. Albert Street Scenario 3.1.1 – Enabling works (Predicted ‘road surface cutting’ noise levels)
2. Albert Street Scenario 3.1.1 – Enabling works (Predicted ‘trenching and backfilling’ noise levels)
3. Albert Street Scenario 3.1.2 – Piling (Predicted ‘piling’ noise levels)
4. Albert Street Scenario 3.1.3 – Excavation propping and waling (Predicted ‘excavation’ noise levels)
5. Albert Street Scenario 3.1.4 – Permanent works and backfilling (Predicted ‘concrete works’ noise levels)
6. Albert Street Scenario 3.1.4 – Permanent works and backfilling (Predicted ‘backfilling and compaction’ noise levels)
7. Aotea Station Scenario 4.1.1 – Enabling works (Predicted ‘building demolition’ noise levels)
8. Aotea Station Scenario 4.1.2 – Piling (Predicted ‘piling’ noise levels)
9. Karangahape Road Station Scenario 6.2.2 – Piling (Predicted ‘piling’ noise levels at Beresford Street entrance)
10. Karangahape Road Station Scenario 6.4.2 – Piling (Predicted ‘piling’ noise levels at Mercury Lane shaft)
11. Karangahape Road Station Scenario 6.4.3 – Excavation and primary support (Predicted ‘excavation’ noise levels at Mercury Lane shaft)
12. Newton Station Scenario 7.2.2 – Piling (Predicted ‘piling’ noise levels at Dundonald Street shaft)
13. TBM Worksite Scenario 8.1 – Construction role (Predicted ‘tunnelling support activities’ noise levels)
14. TBM Worksite Scenario 8.2 – Potential blasting (Predicted ‘drilling, rock breaking and excavation’ noise levels)
15. TBM Worksite Scenario 8.2 – Potential blasting (Blasting)
16. TBM Worksite Scenario 8.3 – Piling (Predicted ‘piling’ noise levels)



**MARSHALL DAY Acoustics** Figure 1: Albert Street Scenario 3.1.1 - Enabling works  
Predicted 'road surface cutting' noise levels

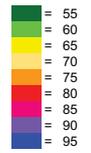
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 Prepared by: CMF Date: 05/06/13



- Map Legend**
- Elevation line
  - Construction noise point source
  - - - Construction noise moving point source
  - ▨ Building
  - ▬ Site Hoarding 2m high



Noise level  
dB L<sub>Aeq</sub>



The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

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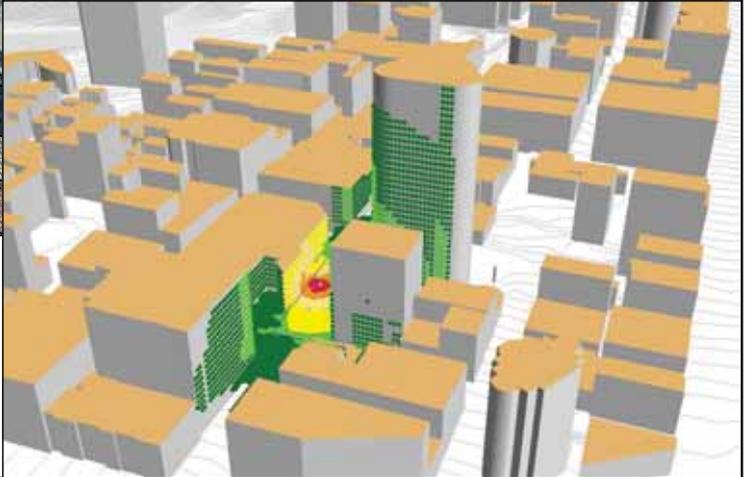
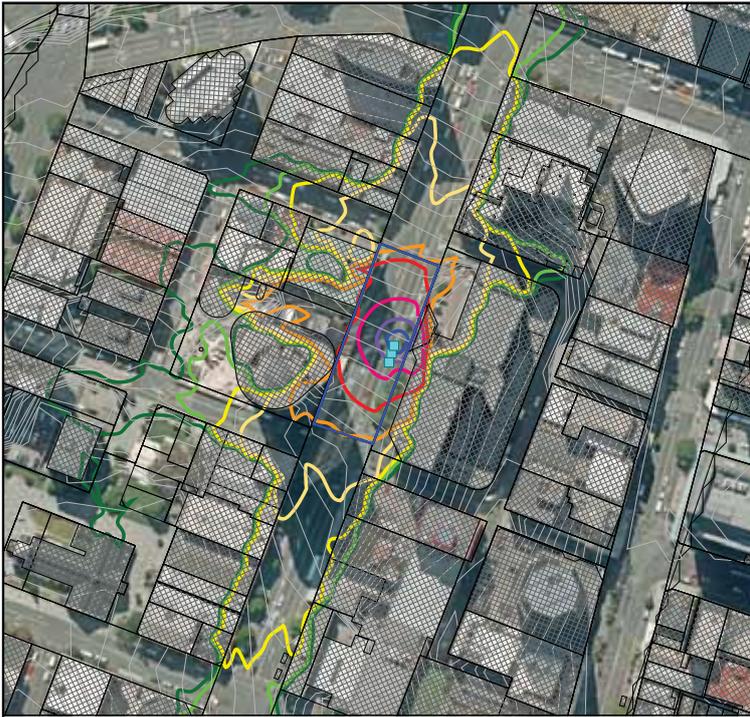


Figure 2: Albert Street Scenario 3.1.1 - Enabling works  
Predicted 'trenching and backfilling' noise levels

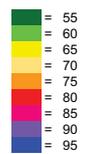
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 Prepared by: CMF Date: 05/06/13



- Map Legend**
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  - ▨ Building
  - Site Hoarding 2m high

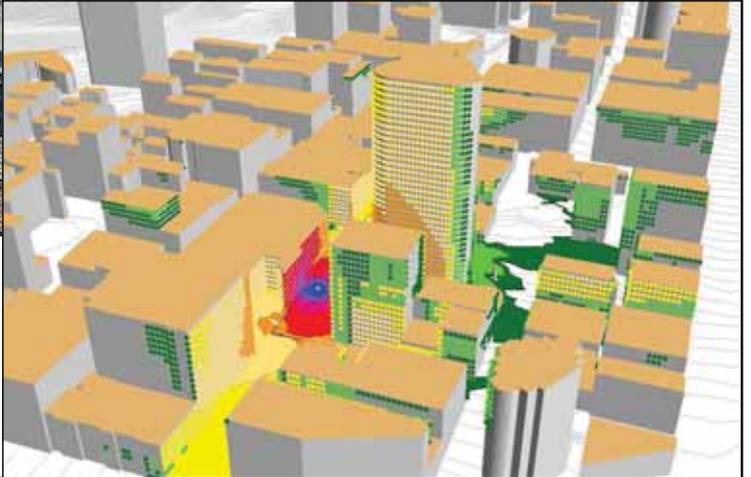
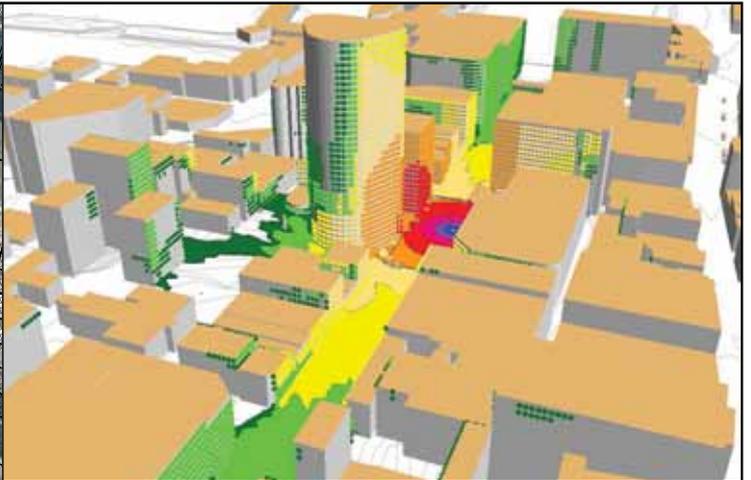


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dB L<sub>Aeq</sub>



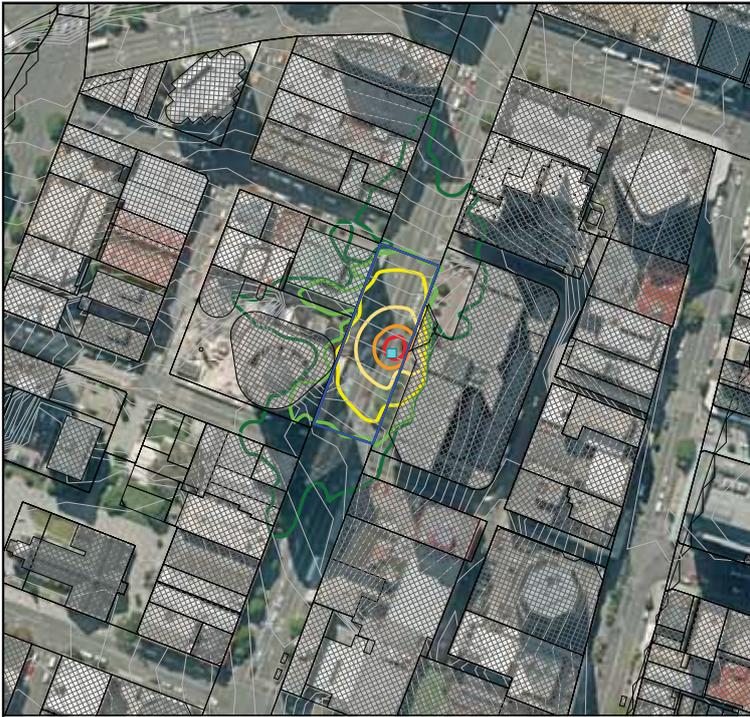
The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

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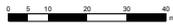
**MARSHALL DAY Acoustics** Figure 3: Albert Street Scenario 3.1.2 - Piling  
Predicted 'piling' noise levels

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Prepared by: CMF Date: 05/06/13

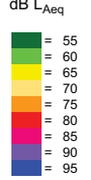


**Map Legend**

- Elevation line
- Construction noise point source
- - - Construction noise moving point source
- ▨ Building
- Site Hoarding 2m high



**Noise level  
dB L<sub>Aeq</sub>**



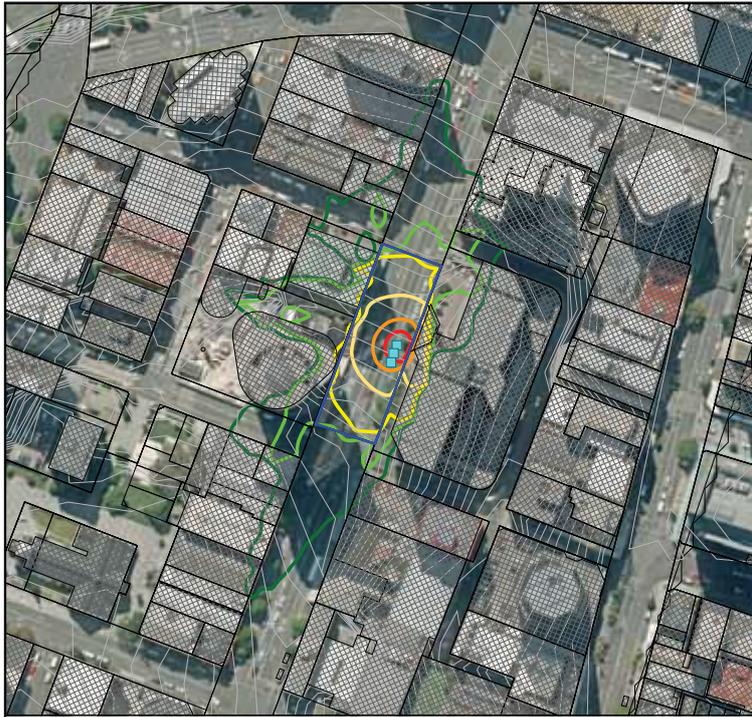
The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

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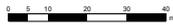


**Figure 5: Albert Street Scenario 3.1.4 - Permanent works and backfilling**  
**Predicted 'concrete works' noise levels**

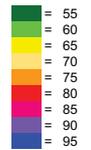
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- Map Legend**
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  - Site Hoarding 2m high



Noise level  
dB L<sub>Aeq</sub>



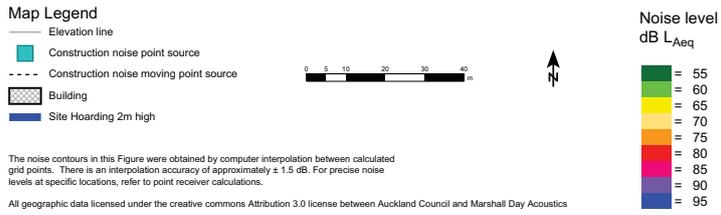
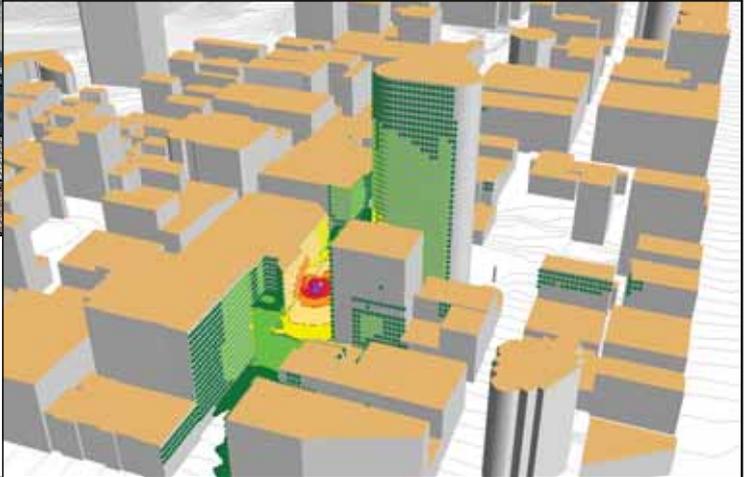
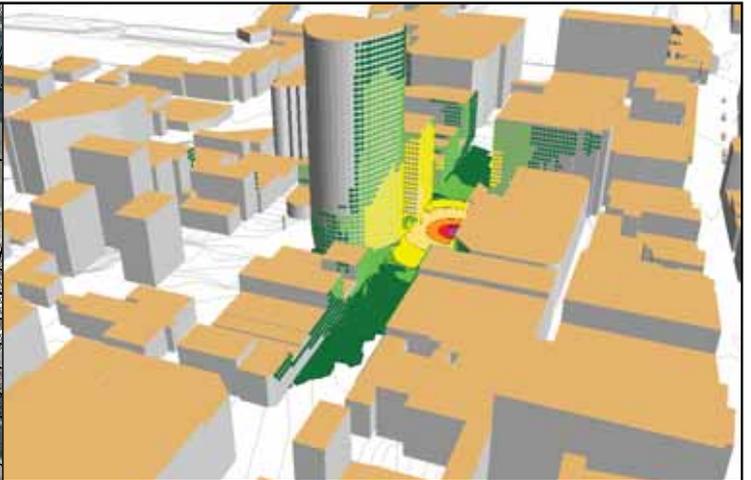
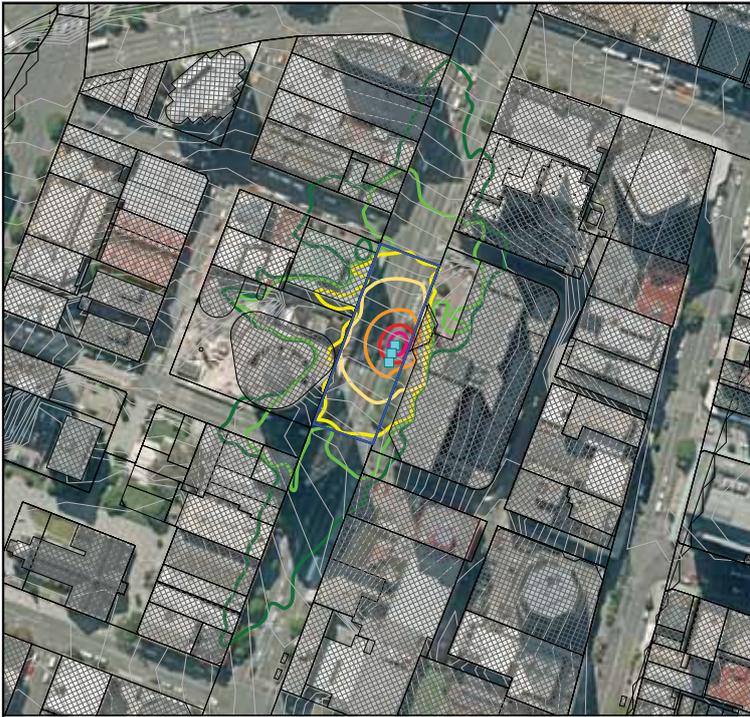
The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

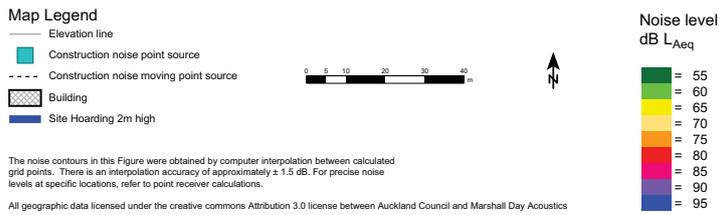
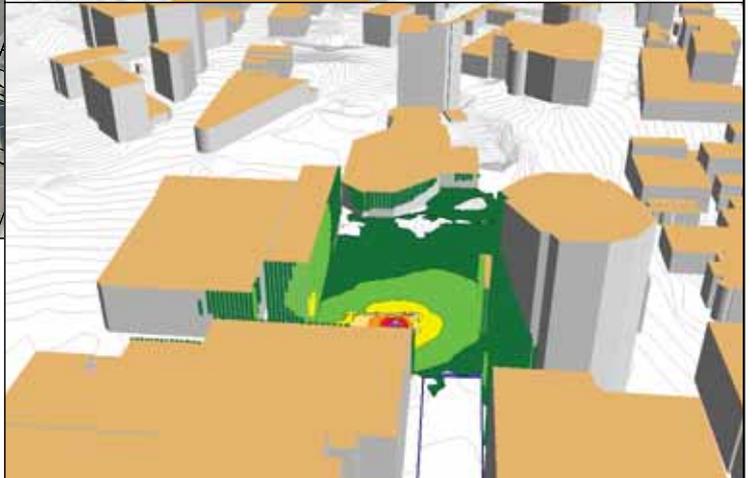
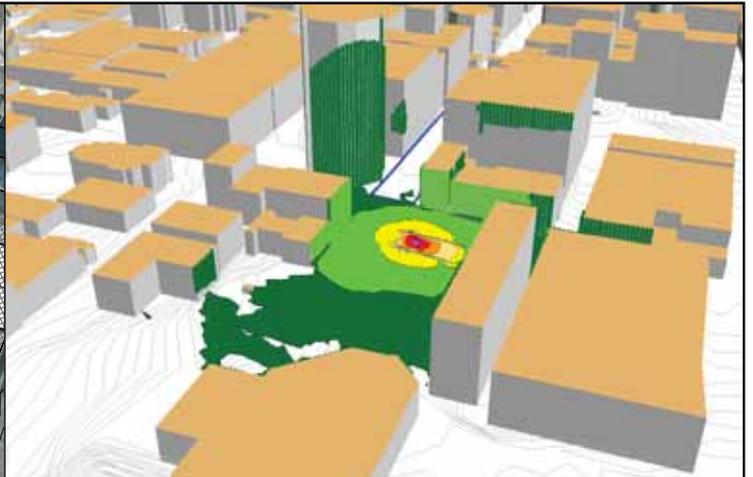
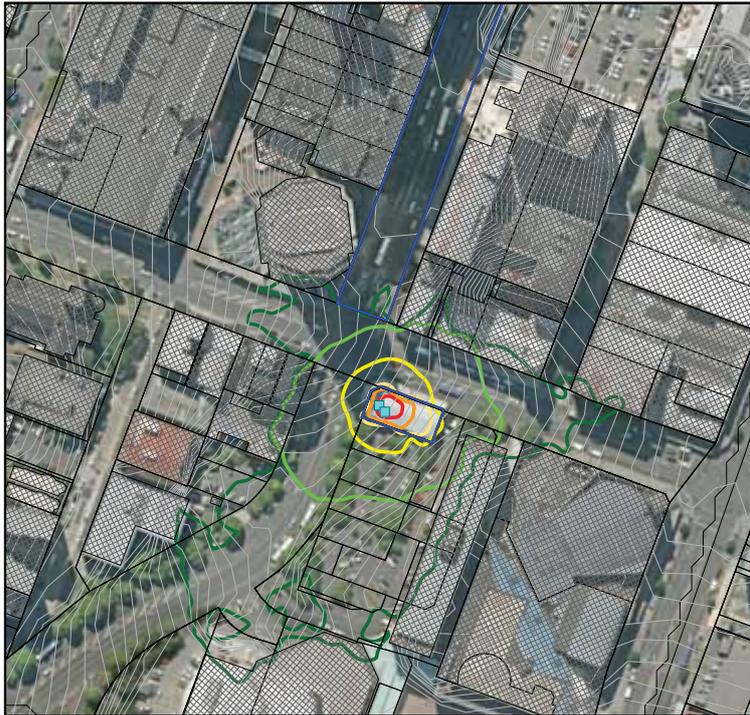
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Figure 4: Albert Street Scenario 3.1.3 - Excavation propping and waling  
Predicted 'excavation' noise levels

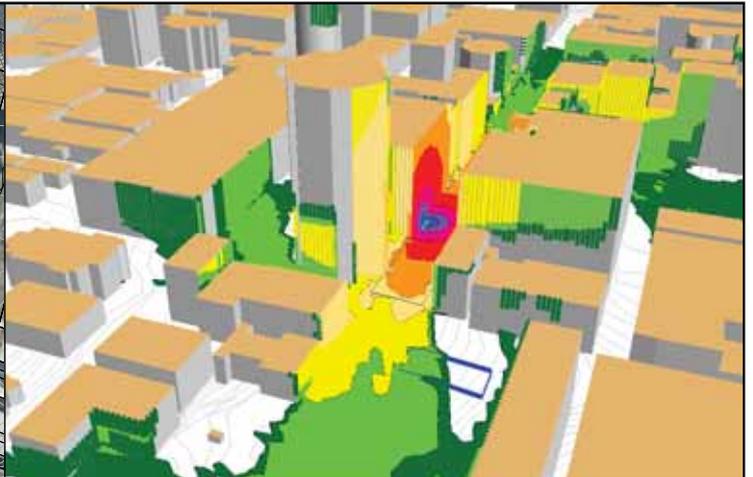
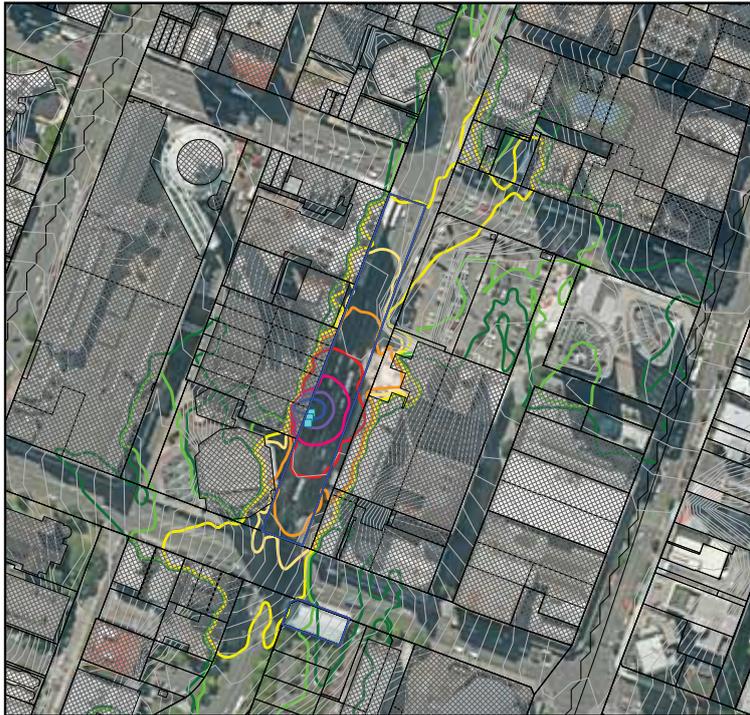
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Prepared by: CMF Date: 05/06/13





**MARSHALL DAY Acoustics** Figure 7: Aotea Station Scenario 4.1.1 - Enabling works  
Predicted 'building demolition' noise levels

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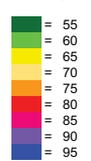


**Map Legend**

- Elevation line
- Construction noise point source
- - - Construction noise moving point source
- ▨ Building
- Site Hoarding 2m high



**Noise level  
dB L<sub>Aeq</sub>**

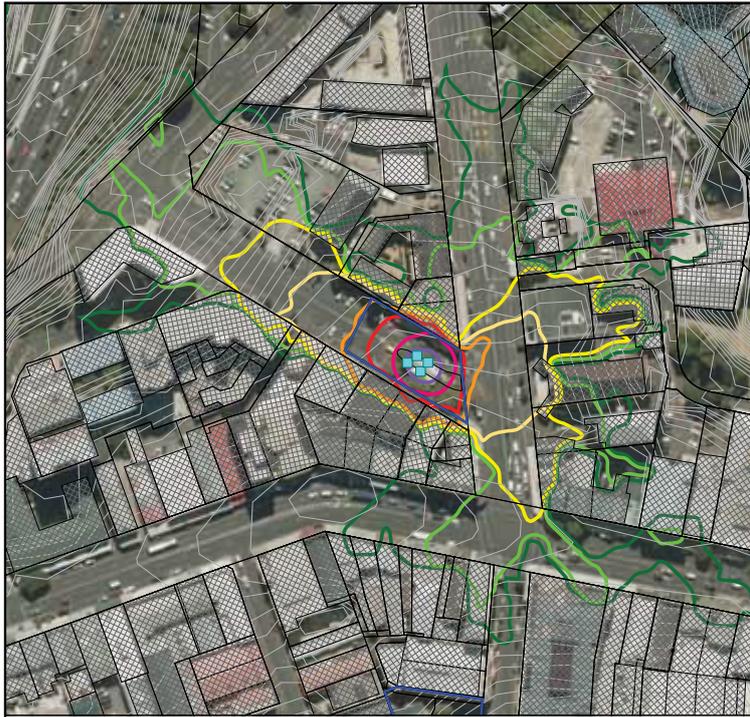


The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

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**MARSHALL DAY Acoustics** Figure 8: Aotea Station Scenario 4.1.2 - Piling  
Predicted 'piling' noise levels

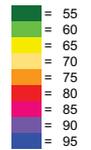
Client: Auckland Transport  
Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
Filename: Figure 8 Scenario 4.1.2 130605.SGS Result: RRLK0421 and RGLK0422.res  
Prepared by: CMF Date: 05/06/13



- Map Legend**
- Elevation line
  - Construction noise point source
  - - - Construction noise moving point source
  - ▨ Building
  - Site Hoarding 2m high

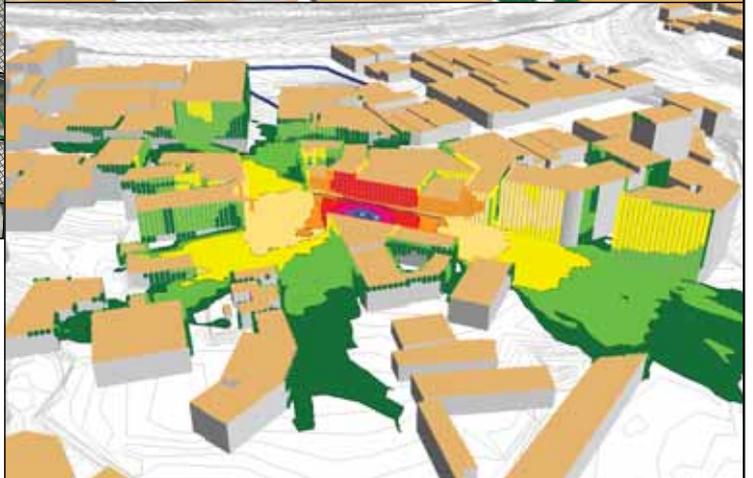
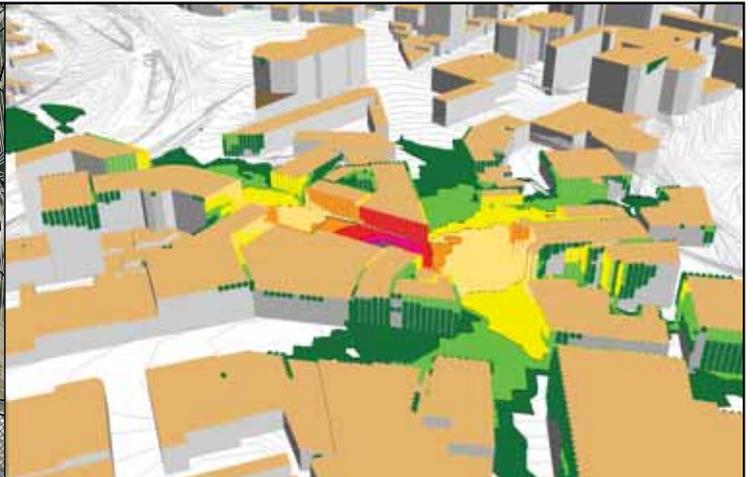


Noise level  
dB  $L_{Aeq}$



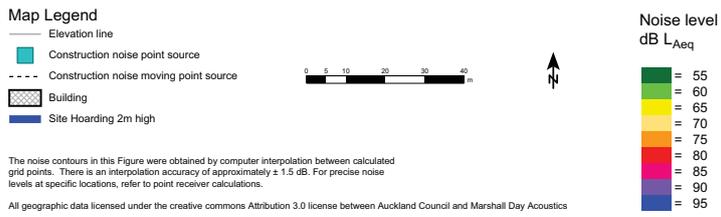
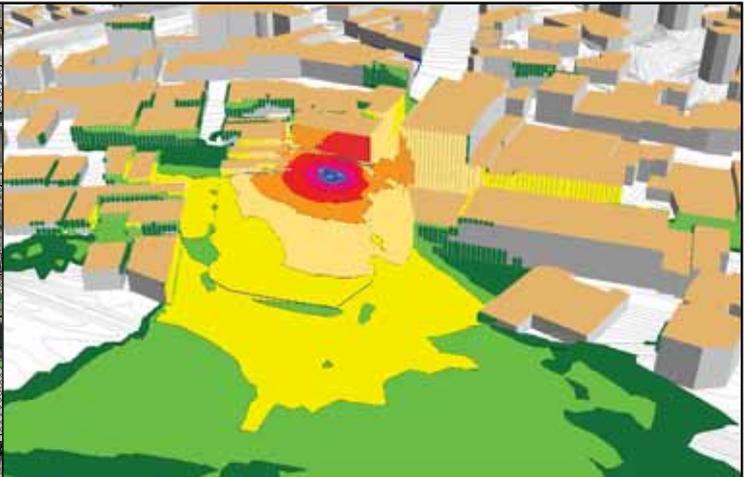
The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately  $\pm 1.5$  dB. For precise noise levels at specific locations, refer to point receiver calculations.

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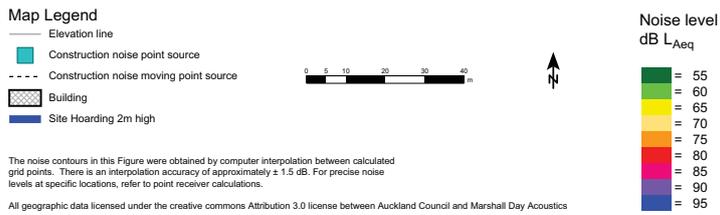
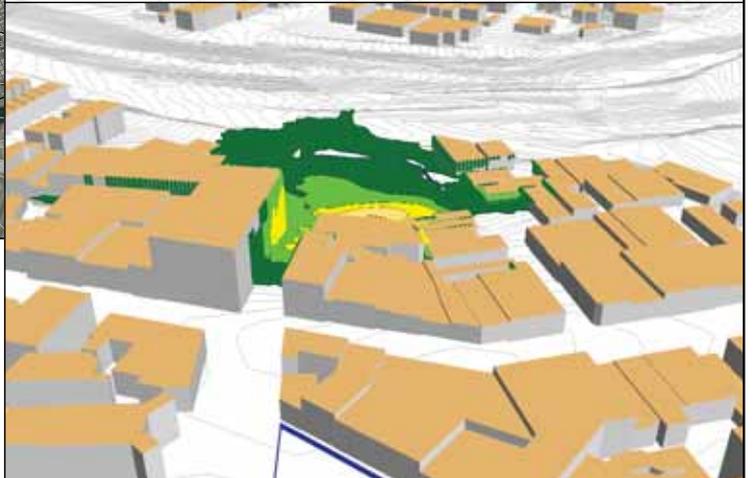
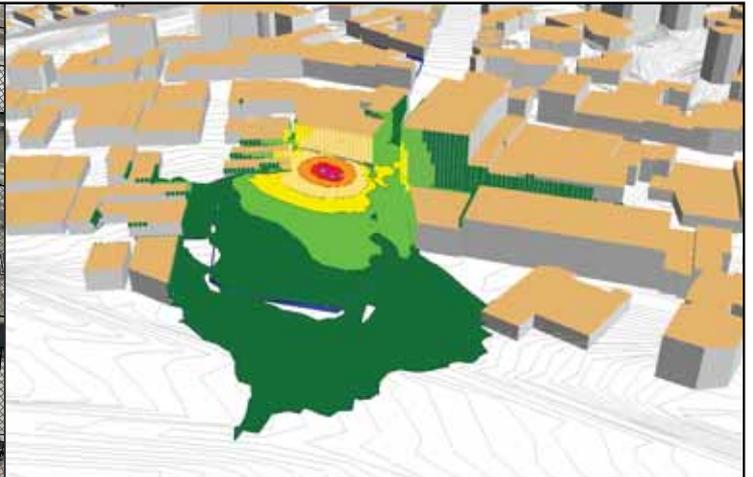
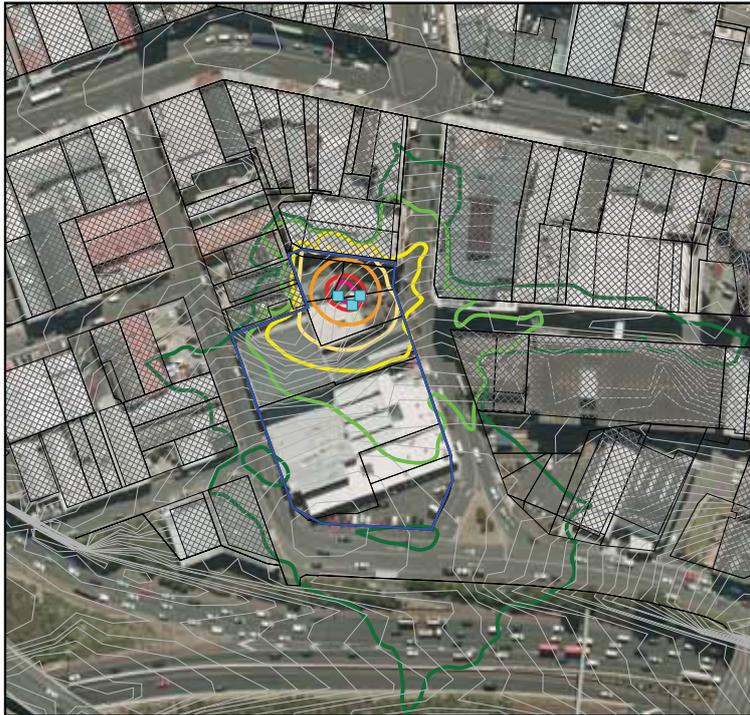
**MARSHALL DAY Acoustics** Figure 9: Karangahape Road Station Scenario 6.2.2 - Piling  
Predicted 'piling' noise levels at Beresford Street entrance

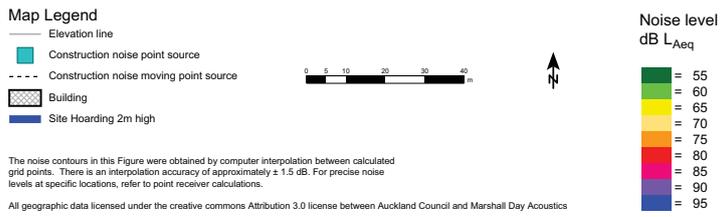
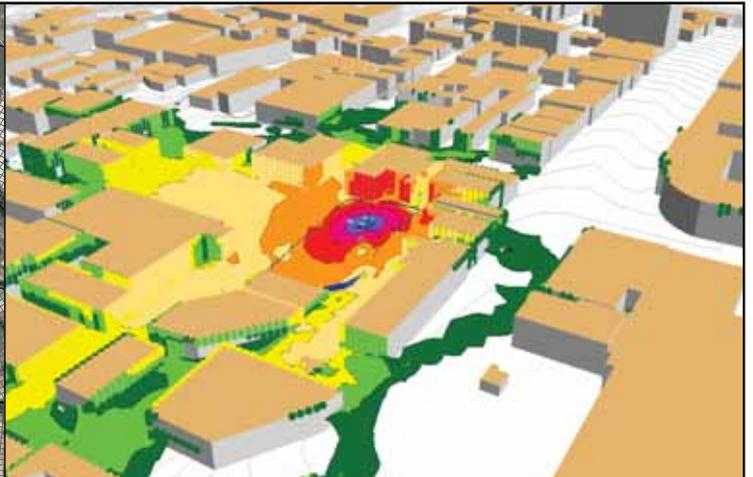
Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 9 Scenario 6.2.2 130605.SGS Result: RRLK0621 and RGLK0622.res  
 Prepared by: CMF Date: 05/06/13



**MARSHALL DAY Acoustics** Figure 10: Karangahape Road Station Scenario 6.4.2 - Piling  
Predicted 'piling' noise levels at Mercury Lane shaft

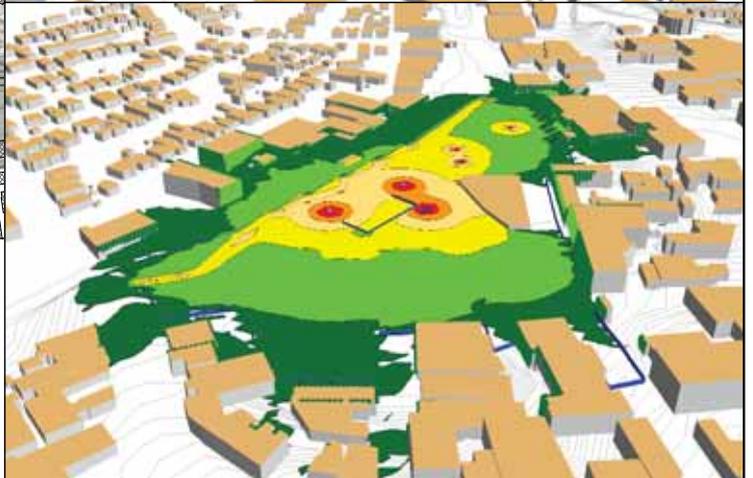
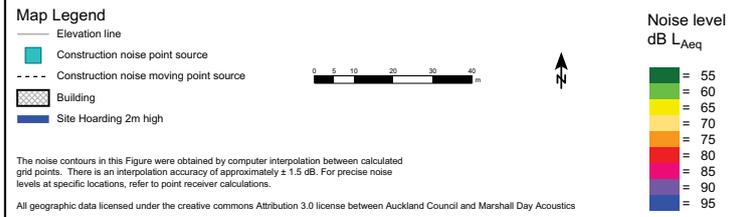
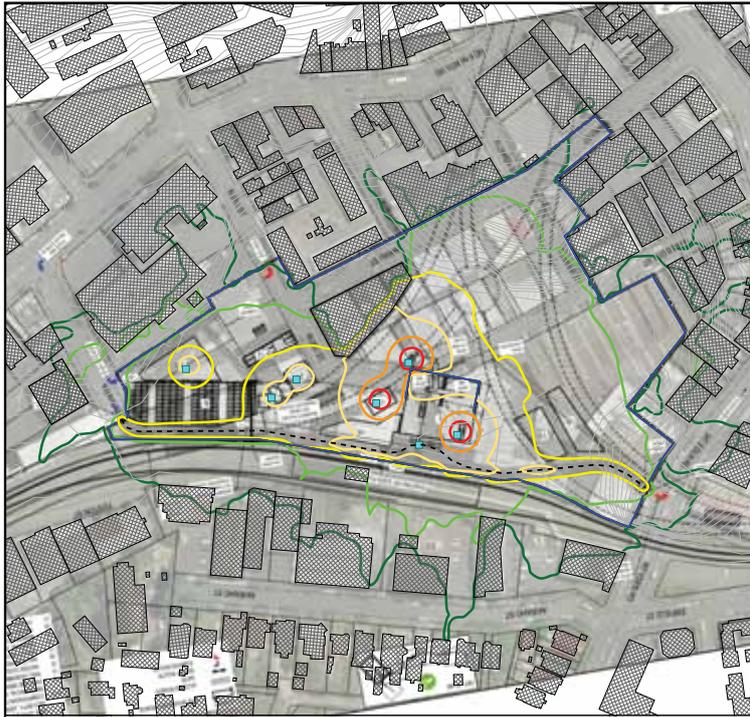
Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 10 Scenario 6.4.2\130605.SGS Result: RRLK0641 and RGLK0642.res  
 Prepared by: CMF Date: 05/06/13





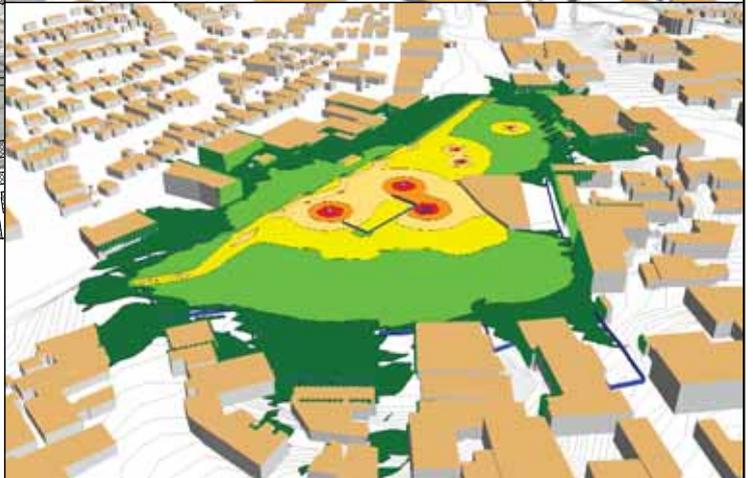
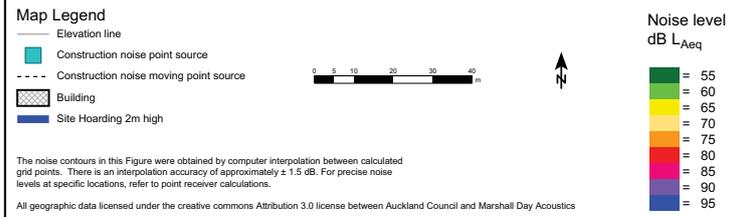
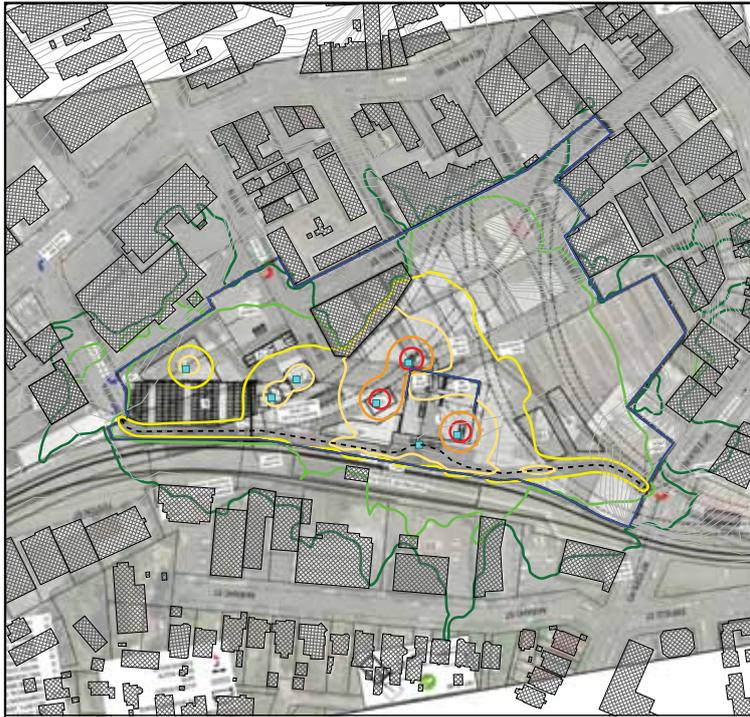
**MARSHALL DAY Acoustics** Figure 12: Newton Station Scenario 7.2.2 - Piling  
Predicted 'piling' noise levels at Dundonald Street shaft

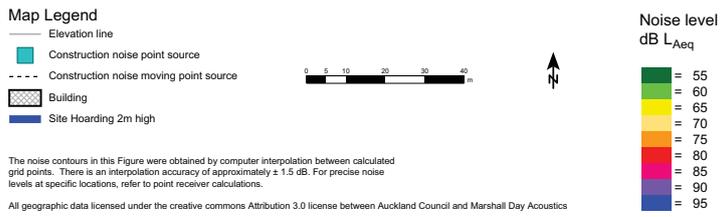
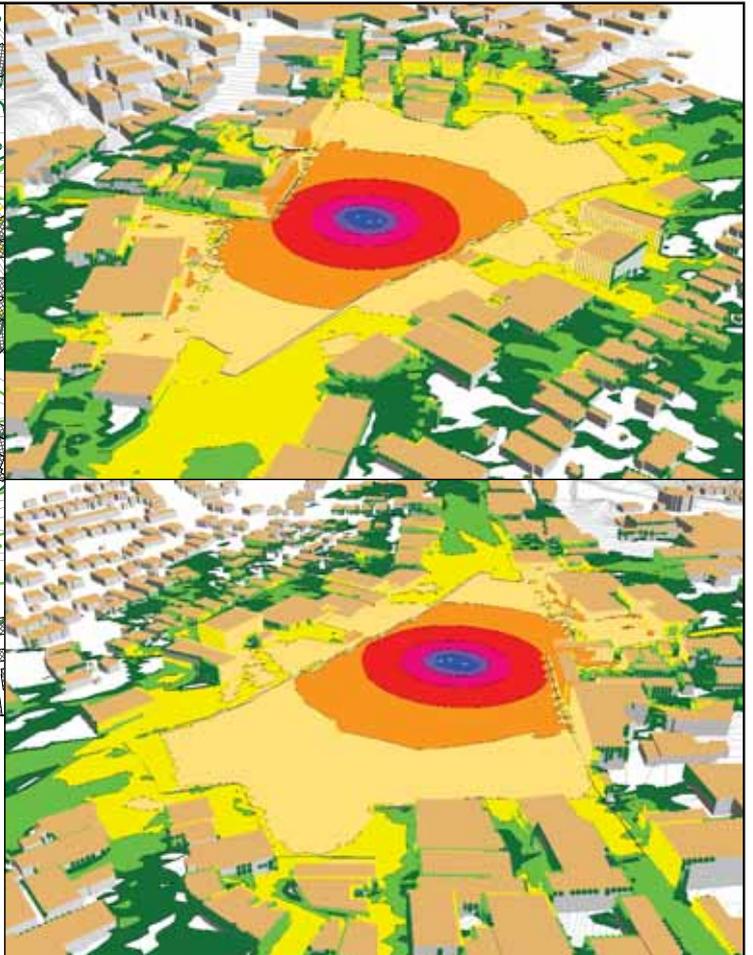
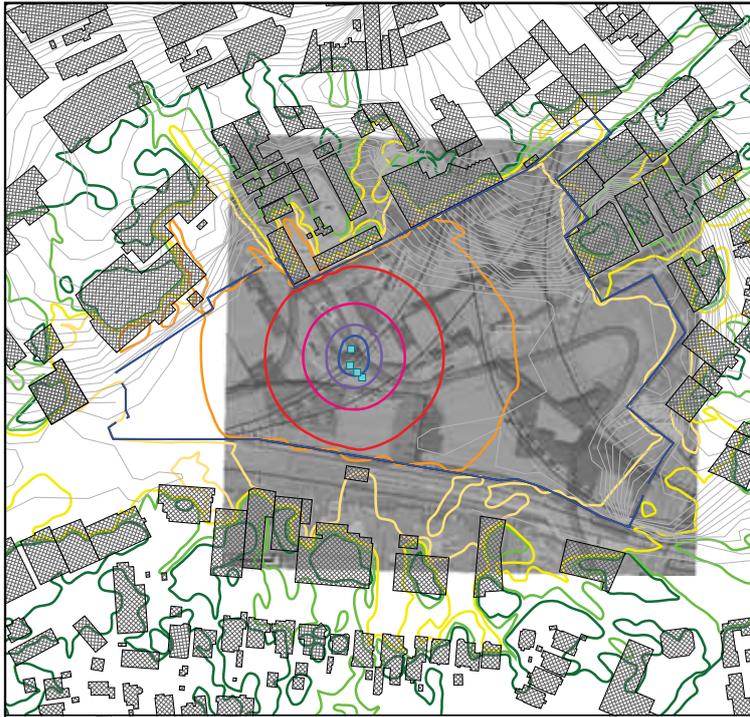
Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 12 Scenario 7.2.2.130605.SGS Result: RRLK0721 and RGLK0722.res  
 Prepared by: CMF Date: 05/06/13

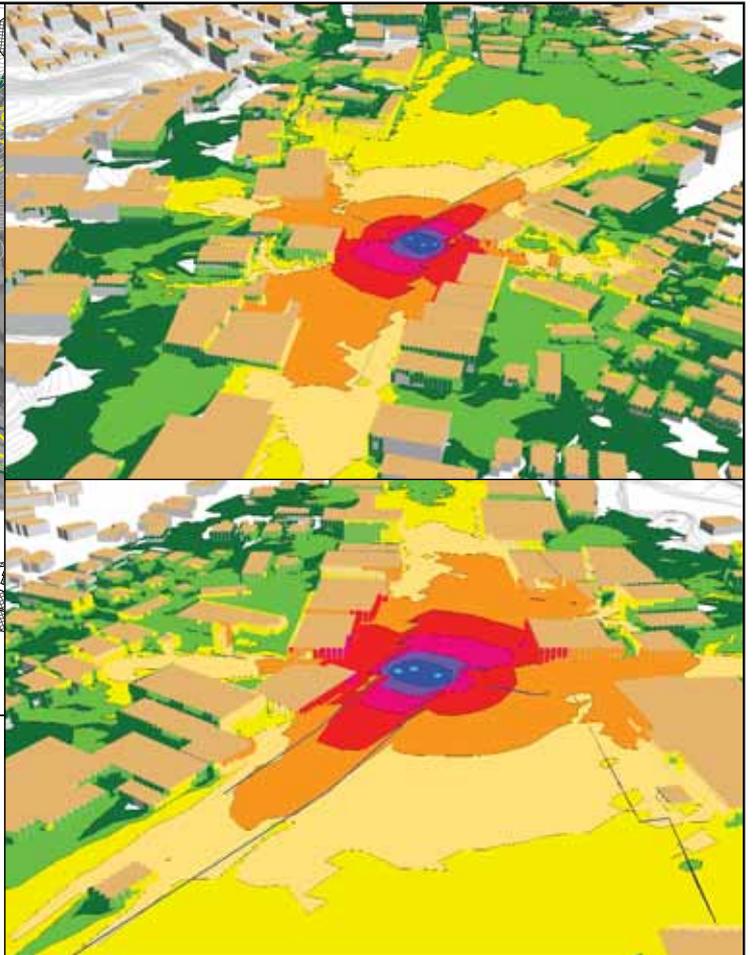
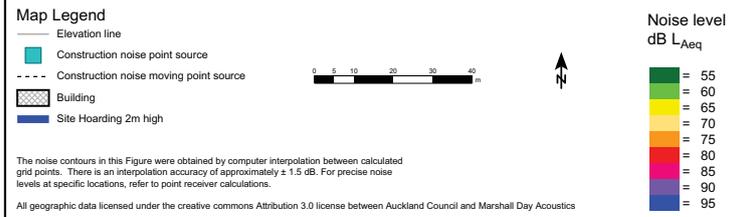


**MARSHALL DAY Acoustics** Figure 13: TBM Worksite Scenario 8.1 - Construction role  
Predicted 'tunnelling support activities' noise levels

Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 13 Scenario 8.1 130605.SGS Result: RRLK0811 and RGLK0812.res  
 Prepared by: CMF Date: 05/06/13

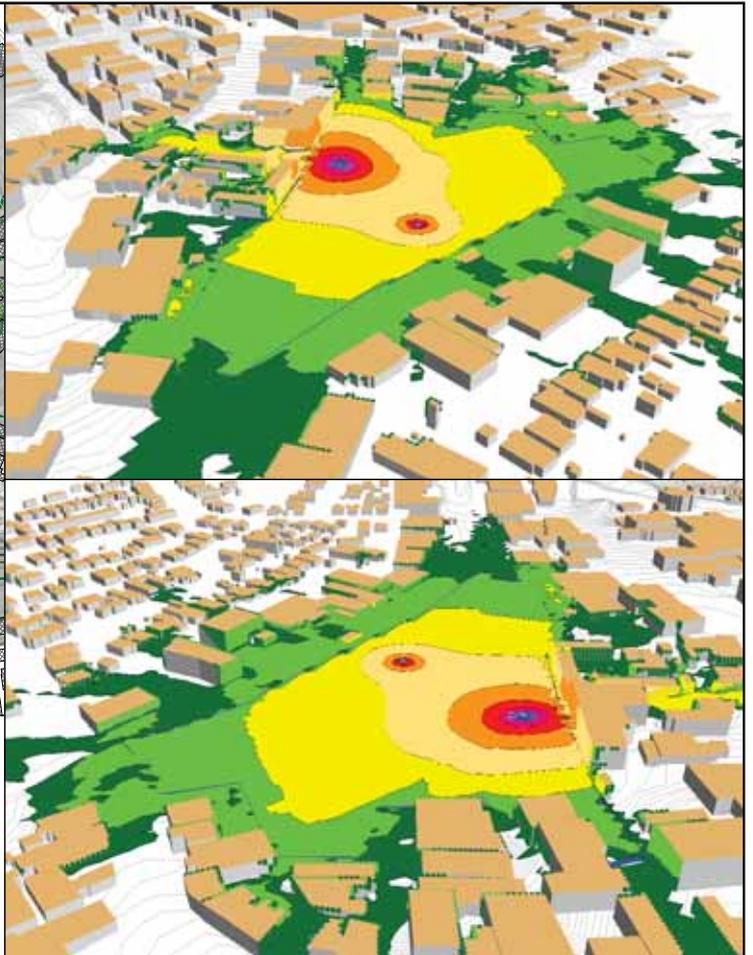
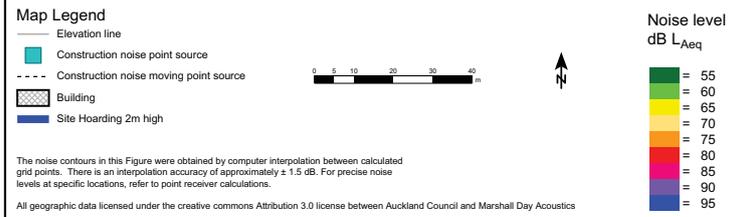






**MARSHALL DAY Acoustics** Figure 15: TBM Worksite Scenario 8.2 - Potential blasting  
Predicted 'drilling, rock breaking and excavation' noise levels

Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 15 Scenario 8.2 130605 Bear Park.SGS Result: RRLK0823 and RGLK0824.res  
 Prepared by: CMF Date: 05/06/13



**MARSHALL DAY Acoustics** Figure 16: TBM Worksite Scenario 8.3 - Piling  
Predicted 'piling' noise levels

Client: Auckland Transport  
 Path: J:\JOBS\2012\2012431A\10 SoundPLAN  
 Filename: Figure 16 Scenario 8.3 130605.SGS Result: RRLK0831 and RGLK0832.res  
 Prepared by: CMF Date: 05/06/13