MARSHALL DAY Acoustics

# DOMINION AND VALLEY ROAD APARTMENTS

## ASSESSMENT OF ACOUSTIC EFFECTS

Rp 001 20240682 | 25 September 2024

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Project: **DOMINION AND VALLEY ROAD APARTMENTS**

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Cover Photo: ashtonmitchell

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## 1.0 SUMMARY

Barker and Associates, on behalf of Precinct Properties, has asked us to prepare an assessment of acoustic effects from the proposed mixed-use development at the corner of Dominion and Valley Roads, Mt Eden. The development is proposed to accommodate five café and retail units at street level fronting Dominion and Valley Roads, and 135 apartments over five levels in three buildings. The buildings are named based on their location, the Dominion Road building, Valley Road building and Carrick building.

We have assessed acoustic effects from two distinct phases of the Project:

- During construction, noise and vibration will be generated by the excavation of the carpark level and water retention tanks, as well as the construction of the buildings above; and
- During operation, noise will be generated by vehicles entering the site along the eastern boundary before entering the carpark, any heavy vehicles entering the site such as rubbish trucks, and mechanical noise from air conditioning units.

We predict that construction activities will generally comply with the permitted construction noise and vibration rules. However, we predict that rock breaking may infringe these limits at the closest neighbouring buildings. We therefore recommend that a Construction Noise and Vibration Management Plan (CNVMP) be prepared and implemented throughout the construction to ensure the effects are reasonable. The CNVMP would ensure that all best practicable option management and mitigation measures are adopted. We consider engagement to be critical to the success of addressing any noise and vibration effects.

A development on this site was approved previously, but not implemented. The current proposal results in less acoustic effects during the construction period on neighbouring buildings as there will be significantly less excavation, including rock breaking, required for the proposed scheme.

During the operation of the site, noise emissions from on-site vehicle movements can comply with the relevant noise limits, and mechanical plant will be designed to ensure that cumulative site noise emissions comply with the relevant noise limits.

A suitable indoor acoustic environment can be achieved provided that appropriate acoustic design of the façade is undertaken prior to construction and the building is properly built and maintained. This means that habitable spaces need mechanical ventilation and cooling systems so that external doors and windows can remain shut, and that glazing is chosen to provide sufficient noise level reduction.

Mechanical plant and building envelopes will be designed with the relevant noise limits in mind during the building consent stage.

## 2.0 SITE LAYOUT AND PROPOSAL

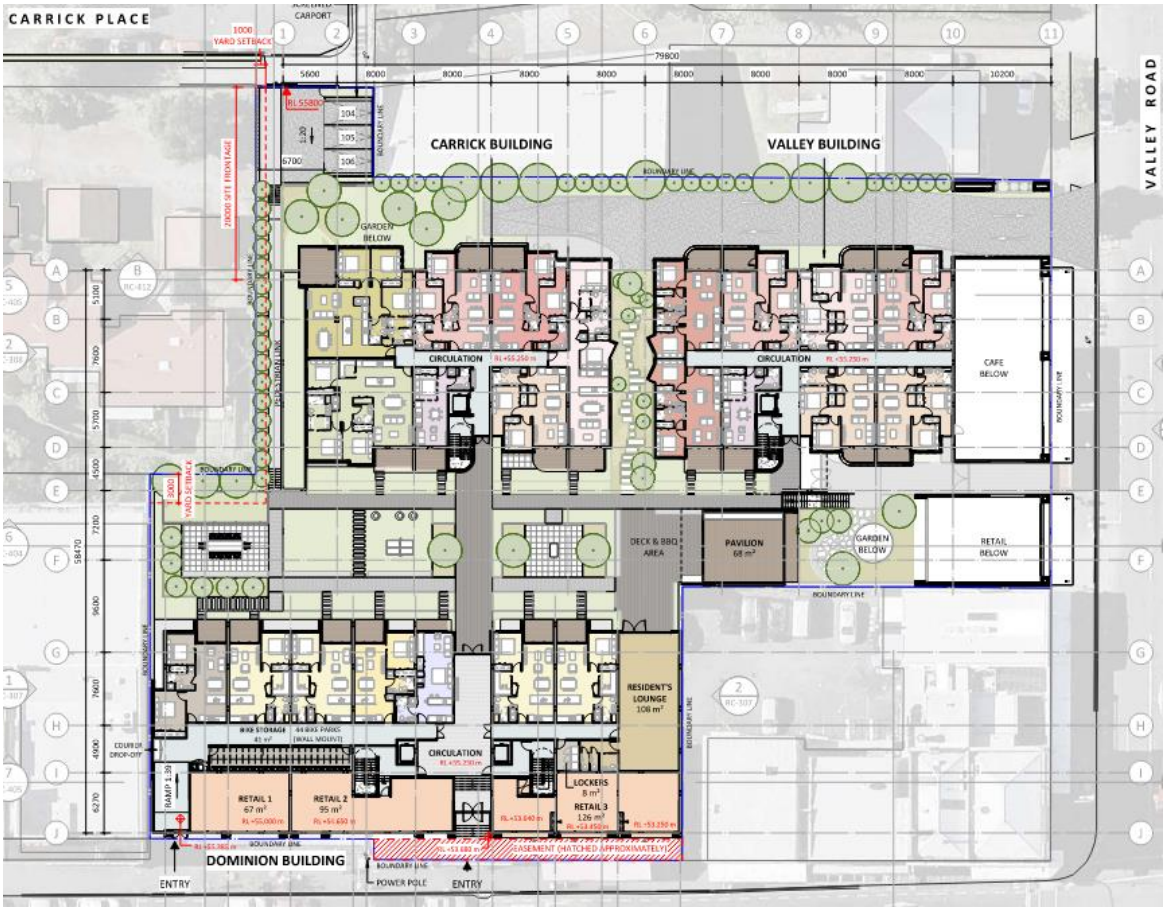
Precinct Properties proposes to redevelop the sites at 198 to 222 Dominion Road and 113 to 117 Valley Road in Mt Eden. The buildings on the corner site of 224 to 234 Dominion Road are not part of the subject site.

The development proposes three five storey buildings on the site. The buildings are named based on their location, the Dominion Road building, Valley Road building and Carrick building.

The Dominion and Valley Road buildings are proposed to accommodate five café and retail units at street level, with apartments above, while the Carrick buildings will only accommodate apartments. In total, 135 apartments ranging from one to three bedrooms, are proposed in the three buildings.

Figure 1 shows the site layout for Level 1.

**Figure 1: Site layout Level 1 (ashtonmitchell)**




(North towards the lefthand side of the figure)

The site allows for 103 car parks in the basement carpark. The carpark would be accessed from Valley Road, along the eastern site boundary. Rubbish trucks will back into the basement carpark door for rubbish collection twice a week during daytime hours. As the basement height will be limited, delivery trucks or vans and moving trucks will use the loading bay adjacent to 109 Valley Road.

At basement level, there is a garden area at the northeastern site corner closest to Carrick Place, and at ground floor level inner courtyard green spaces through the centre of the site and toward the east. External decks for BBQ and similar activities are provided also at ground level.

## 3.0 ZONING

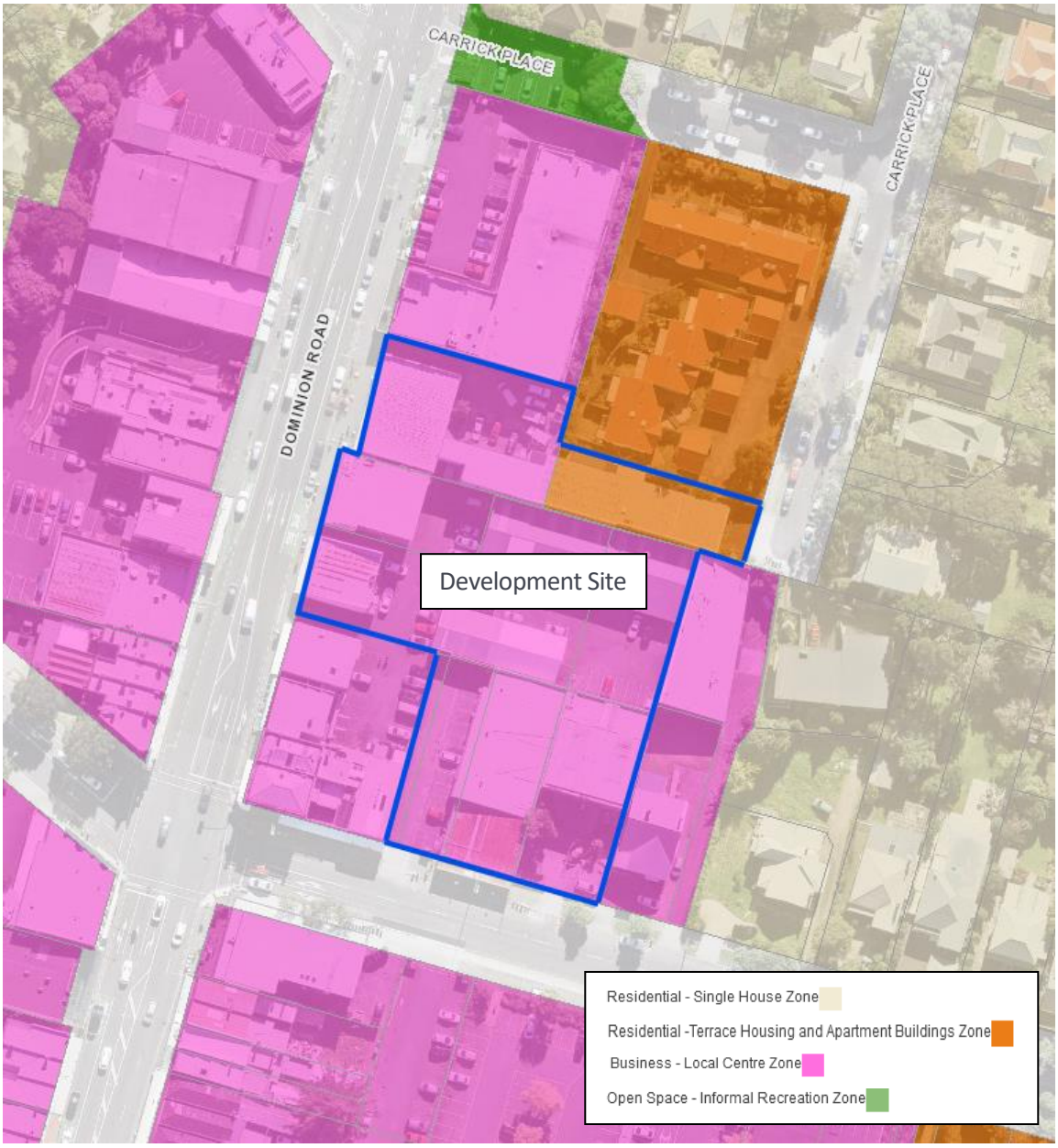
The site zoning of the Auckland Unitary Plan (AUP) is shown in Figure 2.

Most of the site is zoned Business – Local Centre, with only the northeastern corner zoned Residential – Terrace Housing and Apartments.

Surrounding sites are mostly zoned Business – Local Centre. To the northeast, the Residential – Terrace Housing and Apartments extends further and incorporates a retirement village. Across Carrick Place, and apart from the adjacent section on Valley Road, is the Residential – Single House zone.

The corner site of Dominion and Valley Roads (also zoned Business – Local Centre) will be retained unchanged. The site is within the Special Character Overlay, however, the buildings at 224 – 234 Dominion Road are not specifically identified in Schedule 14.1 of the AUP (Schedule of Historic Heritage).

**Figure 2: AUP zones**




## 4.0 AMBIENT NOISE LEVELS

We visited the site and surrounds on 23 July 2024 between 12.30pm and 2.30pm to undertake representative 15-minute attended noise level surveys. We measured noise levels at the residential interface on Carrick Place and Valley Road, and across Dominion Road for the closest business receivers.

Weather was suitable during the environmental noise surveys, with low wind speed. We avoided measuring during intermittent rain periods.

Table 1 overleaf shows the measured noise levels and discusses the main noise sources observed in the environment at each of the survey locations.

**Table 1: Ambient noise level survey results**

| Survey location | dB $L_{Aeq}$ | dB $L_{A90}$ | dB $L_{AFmax}$ | Noise sources* |
|---|---|---|---|---|
| Outside 9 Carrick Place closest to site | 48 | 46 | 58 | Traffic on Dominion and Valley Roads, birds, wind in trees, general residential activity, distant construction |
| Outside 200 Dominion Road | 71 | 63 | 81 | Traffic on Dominion Road, people noise, music from car stereos, car horn |
| Outside 109 Valley Road | 64 | 54 | 82 | Traffic on Valley Road, birds, aircraft, people noise |

* Dominant noise source underlined

Overall, the environment is strongly affected by traffic noise on Dominion and Valley Roads. Particularly, buildings fronting those two roads receive existing high noise levels between mid-60 to low-70 dBA, with background noise levels ($L_{A90}$) showing the strong influence of continuous traffic noise.

While Carrick Place is relatively well shielded from Dominion and Valley Roads, the dominant noise source is still traffic on these two roads. Ambient noise levels are just below 50 dB $L_{Aeq}$ which is expected in an urban environment. The background noise level of 46 dB $L_{A90}$ shows the influence of traffic, albeit at a lower level, at Carrick Place also.

The noise environment of the site and surrounds is reflective of its urban location close to major transport routes and commercial uses.

## 5.0 CONSTRUCTION NOISE AND VIBRATION

### 5.1 Performance standards

#### 5.1.1 Construction noise

AUP Rule E25.6.27 sets long-term duration[1] construction noise limits. Construction noise must be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 "*Acoustics - Construction Noise*". The noise limits apply at 1m from external façades of occupied buildings. The relevant limits are shown in Table 2.

[1] 'Long-term duration' refers to projects with a construction duration exceeding 20 weeks

**Table 2: Recommended upper limits for construction noise received by residential and commercial buildings**

| Time of week | Time period | dB $L_{Aeq}$ | dB $L_{AFmax}$ |
|---|---|---|---|
| **Residential buildings** | | | |
| Weekdays | 0630-0730 | 55 | 75 |
| | 0730-1800 | 70 | 85 |
| | 1800-2000 | 65 | 80 |
| | 2000-0630 | 45 | 75 |
| Saturdays | 0630-0730 | 45 | 75 |
| | 0730-1800 | 70 | 85 |
| | 1800-2000 | 45 | 75 |
| | 2000-0630 | 45 | 75 |
| Sundays and public holidays | 0630-0730 | 45 | 75 |
| | 0730-1800 | 55 | 85 |
| | 1800-2000 | 45 | 75 |
| | 2000-0630 | 45 | 75 |
| **Commercial buildings** | | | |
| All days | 0730-1800 | 70 | n/a |
| | 1800-0730 | 75 | n/a |

In summary, the relevant limits are 70 dB $L_{Aeq}$ and 85 dB $L_{AFmax}$ during the daytime period of 7.30am to 6pm, Monday to Saturday. While some quiet works would be able to comply with the relevant noise limits outside these times (e.g. toolbox meetings, internal works etc), the applicable noise limits preclude noisy works on Sundays and at night on any day unless a consent is obtained.

### 5.1.2 Construction vibration

*Building protection*

AUP OIP rule E25.6.30 (1)(a) requires construction vibration to be measured and assessed in accordance with German Standard DIN 4150-3:1999 "*Structural vibration – Part 3: Effects of vibration on structures*". The short-term (transient)[2] vibration limits in Figure 3 apply at building foundations in any axis. The vibration limits in all other cases are summarised in Table 3.

The limits are designed to avoid building damage, including cosmetic damage such as cracking in paint or plasterwork. Cosmetic building damage effects are deemed 'minor damage' in the Standard and can generally be easily repaired. The building vibration thresholds are much lower those that would result in structural damage. The Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*."

[2] Short-term (transient) vibration is "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*"

**Figure 3: Short-term (transient)[2] vibration at building foundations (DIN 4150-3 1999: Figure 1)**

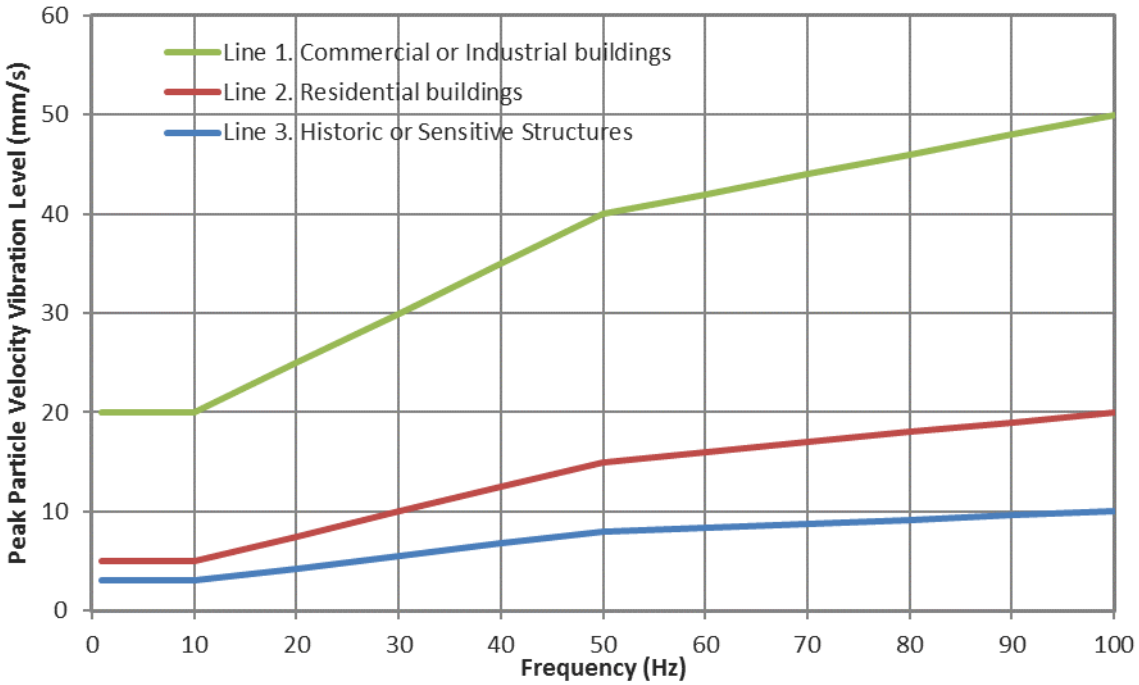



**Table 3: Vibration at horizontal plane of highest floor (DIN 4150-3 1999: Tables 1 and 3)**

| Structure Type | Peak Particle Velocity Vibration Level (mm/s) | |
|---|---|---|
| | Short-term (transient)[2] | Long-term (continuous)[3, 4] |
| Line 1. Commercial or Industrial buildings | 40 | 10 |
| Line 2. Residential buildings | 15 | 5 |
| Line 3. Historic or Sensitive Structures | 8 | 2.5 |

*Amenity*

While the primary vibration concern is building damage, people may be disturbed at levels significantly below the amenity limits. British Standard BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*" provides guidance on the amenity effects of vibration during the day.

- 0.3 mm/s PPV Just perceptible
- 1 mm/s PPV Typically acceptable with prior communication
- 10 mm/s PPV Likely to be intolerable for any more than a very brief period

Therefore, potentially affected parties should be informed about the vibration levels they may experience and should be assured vibration damage could only occur at magnitudes well above the threshold of perception. Residual amenity effects include the potential to startle, cause annoyance and rattle loose fixtures.

AUP rule E25.6.30 (1)(b) requires construction vibration to comply with 2 mm/s PPV in any axis on the floor of interest. Where construction vibration is predicted to exceed this threshold for more

[3] Long-term (continuous) vibration is types not covered by the short-term vibration definition

[4] The long-term (continuous) criteria can apply at all floor levels, but levels are normally highest at the top floor

than three days, the occupants of buildings within 50 m must be advised of the works no less than three days prior to the works commencing and the vibration level must not exceed 5 mm/s whilst occupied.

## 5.2 Overview

While in our experience, conventional construction methods operating within normal operating hours can comply with the construction noise limits for most activities, the Project site provides a specific challenge. We understand that basement excavation works necessitate rock breaking near the boundary with adjacent properties. Therefore, our assessment focuses on the high noise and vibration from rock breaking anticipated, whilst also providing a general overview of the other construction activities. While basalt removal is the challenge highlighted in this assessment, it is not unique in Auckland, and our proposed approach to managing the effects reflects best practice.

## 5.3 Closest receivers

Neighbouring buildings are listed in Table 4 below, together with their use and closest distance to the Project site boundary.

**Table 4: Closest receiver buildings**

| Address | Use | Closest distance to Project excavation (m) |
|---|---|---|
| 9-15 Carrick Place | Residential (retirement village) | 6 |
| 111 Valley Road | Commercial (office) | 7.5 |
| 109 Valley Road | Medical | 9.5 |
| 107 and 107A Valley Road | Residential | 34 |
| 21A, 21B and 21C Carrick Pl | Residential | 37 |
| 18 Carrick Place | Residential | 55 |
| 16 Carrick Place | Residential | 44 |
| 236-238 Dominion Road | Commercial (retail) | 20 |
| 191-217 Dominion Road | Commercial (retail) | 25 |
| 219-225 Dominion Road | Commercial (retail) | 32 |
| 224-234 Dominion Road | Commercial (retail, hospitality) | 1 – 17 |
| 184-196 Dominion Road | Commercial (office) | 0.3 |

We note that the residents of the retirement village at 9-15 Carrick Place may be at home at all times and may not be able to leave during the day to avoid exposure to construction noise and/or vibration. Therefore, we recommend that engagement with the residents is undertaken to gain an understanding of their sensitivity to respond appropriately with construction noise and vibration management.

## 5.4 Construction activities

The works involve excavation of the basement (typically up to 1 m across the site) and construction of the mixed-use buildings. Stormwater retention tanks will also be excavated. The building at 198 Dominion Road already has a basement which means that excavation of the new basement level will be significantly reduced.

Construction works causing high noise levels or vibration beyond the site will be undertaken between 7.30am and 6pm, Monday to Friday, and 7.30am and 1pm Saturdays, to take account of the residential neighbourhood towards Carrick Place.

No noisy construction works would generally be carried out on any Sunday, at night-time, or public holidays. An exception may be the delivery and removal of oversized plant, equipment (such as cranes and large machinery) and building elements (such as precast steel or panels) which may occur outside the above times to avoid traffic interruptions. However, such activities would be at a significantly lesser intensity than actual construction activities and would generally involve truck engines and similar broadband noise sources.

The construction programme is likely to be as follows:

- Excavation and foundations

  Excavation and retention of basement and general site preparation works.

  Rock breaking will be required for some of the basement and retention tank excavation. Retention tanks are proposed at the northeastern corner at Carrick Place (about 2.4m deep) and the southwestern corner at Dominion Road (about 1m deep).

  Excavation of the basement and retention tanks would include the removal of fill (including basalt at varying depths) across the site. If the excavated material is generally highly fractured basalt or loose scoria gravels it can be removed by an excavator without the need for rock breaking on site. Where practicable, small rocks will be excavated directly, and larger basalt boulders will be removed by truck for breaking offsite.

  The buildings would be supported on shallow footings constructed directly onto the basalt rock.

- Building Construction

  Erection of the building and fit-out. The new buildings would be erected using mobile and/or tower cranes and hand-tools and will likely consist of concrete elements.

## 5.5 Construction noise

### 5.5.1 Rock excavation

The site contains basalt seams that will need to be excavated for the basement level and retention tanks. There is an existing basement under the existing building at 198 Dominion Road, which significantly reduces the need for rock fracturing and excavation. In addition, based on the geotechnical information available, most of the basalt is located in the northwestern and northeastern corners of the site. This means that rock breaking is not required across the entire site.

The design purposely avoids deep excavations over large areas:

- The carparking basement level requires excavation up to 2.5 m in some areas, but typically 1 m across the site. The buildings will be founded on strip foundations below a series of columns.
- Watercare requires the relocation of a wastewater pipe that currently dissects the site. The new wastewater pipe and associated manholes is proposed to run around the northern and eastern boundaries. Excavation of the required trench will be combined with the excavation of the basement and strip foundations, to a depth of about 1 to 2 m below the existing ground level and will not have a significant impact on the overall excavation period.
- The retention tank requires excavation up to 2.4 m at the northeastern corner. The large retention tank has been placed in the centre of the site, away from sensitive boundaries. The tank requires only minimal excavation and will be placed below the basement floor slab. The chosen location means that excavation into basalt can be minimised and distances to the boundary maximised.

Where basalt is located close to the boundary and requires excavation, to reduce vibration, 100 mm diameter percussion drills may be used to predrill the basalt at 200 to 250 mm centres. We understand that up to 30 holes may be installed. Drilling can be shielded by barriers; however, the drills are high noise generators. They would only be used for limited periods and reduce vibration effects on neighbouring buildings. Overall, the current proposal results in significantly less rock excavation than had been required in the previously consented proposal, and generally further away from the eastern boundary. This means that the duration during which rock breaking is required within 25 m to the closest neighbouring dwellings in 9-15 Carrick Place, will likely be less than 1 week.[5] Rock breaking across the entire site (as needed) may take around 3 weeks, depending on the equipment to be used.

Some of the basalt is understood to be already fractured. If this is the case, a large excavator can be used to rip the fractured rock, which results in lower noise levels than using a rock breaker.

The activities in Table 5 are representative of rock breaking works.

**Table 5: Rock breaking noise levels at 1m from a building façade (with shroud[6] and effective screening)**

| Equipment | Sound Power Level (dB $L_{Aeq}$) | Noise Level (dB $L_{Aeq}$)[7] | | | Setback (m) |
|---|---|---|---|---|---|
| | | 10 m | 20 m | 50 m | 70 dB $L_{Aeq}$ |
| Large excavator (20-30t) mounted rock breaker[6] | 114[6] | 79 | 73 | 64 | 28 |
| Large excavator (8-10t) mounted rock breaker[6] | 109[6] | 74 | 68 | 59 | 16 |
| Small excavator (2t) mounted rock breaker[6] | 104[6] | 69 | 63 | 54 | 9 |
| Large excavator (35-50t) rock ripping | 105 | 70 | 64 | 55 | 10 |
| Percussion rock drill | 124 | 89 | 83 | 74 | 69 |

Even with best practice noise mitigation employed (e.g. using shrouds around the rock breakers and putting substantial noise barriers of around 3.6 m height around the boundary), rock breaking noise is predicted to infringe the 70 dB $L_{Aeq}$ noise limit at the façade of the closest buildings. Indicative predicted noise levels are set out in Table 6 below. We have adjusted the rock breaker size depending on the distance from the boundary and neighbouring buildings, with smaller equipment used closer to the boundary to limit noise levels. However, we note that if a smaller excavator mounted rock breaker is used to control noise and/or vibration levels, the duration of breaking and the associated disturbance would increase. In general, we consider that higher noise levels for a shorter duration are preferable from a noise effects perspective.

Based on the assumption that rock breaking works within 25 m of any one building can be completed within about one week, we consider that the below noise levels would be experienced for about the same duration.

[5] Based on the finding in the Joint Witness Statement (paragraph 11) for the previous consented development that breaking within 25m of 9-15 Carrick Place could be done within 1 week for the previous scheme, for which the extent has now reduced.

[6] Shrouds can achieve an average noise level reduction of approximately 7 dB

[7] Levels are for breaking solid rock. Breaking fractured rock may be up to 10-15 decibels quieter

**Table 6: Predicted rock breaking noise levels (with shroud and barrier mitigation)**

| Address | Indicative predicted noise level (dB $L_{Aeq}$) |
|---|---|
| 109 Valley Rd | 80 |
| 224 – 234 Dominion Road | 80 |
| 184 – 196 Dominion Road | 79 |
| 9 – 15 Carrick Pl | 78 |
| 111 Valley Rd | 74 |
| 236 Dominion Road | 74 |
| 21 Carrick Pl | 72 |
| 107A Valley Rd | 72 |
| 191 – 217 Dominion Road | 71 - 73 |

Some of the neighbouring buildings abut the boundary (109 Valley Road, 184-196 and 224-234 Dominion Road). There, in accordance with the provisions of NZS 6803, we propose to assess the internal noise level of the receiving buildings. Two of these (109 Valley Road and 184-196 Dominion Road) have no openings in the façades facing the site.

We recommend that noise levels be managed through a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP will deal with overall site management as well as individual infringements that will require more intensive mitigation (refer Section 5.7).

### 5.5.2 Typical construction activities

The activities in Table 7 represent conventional commercial construction activities required as part of the removal and general construction phases. These activities would generally comply with the long-term construction noise limit of 70 dB $L_{Aeq}$ with suitable mitigation measures. Most of the construction activities will fall under this category.

Some works will need to be undertaken at height, i.e. above the proposed high noise barrier. These activities will not be able to be shielded by the barrier. These activities may include the use of hand tools such as rattle guns, concrete vibrators for the pouring of high floors or similar.

At times when these activities occur, the 70 dB $L_{Aeq}$ noise limit is likely to be exceeded for brief periods until the building envelopes are installed, which will provide mitigation for neighbouring buildings. For the previous scheme, the time when these exceedances may occur, was indicated to be around 20 weeks, and we consider that the current proposal would have similar effects.

Once buildings have been constructed, internal fitouts, site finishes and similar works will be generally likely less noticeable for neighbours.

**Table 7: General construction noise levels at 1m from a building (10 dB mitigation from effective screening)**

| Equipment | Sound Power Level (dB $L_{Aeq}$) | Noise Level (dB $L_{Aeq}$) | | | Setback (m) |
|---|---|---|---|---|---|
| | | 10 m | 20 m | 50 m | 70 dB $L_{Aeq}$ |
| Rattle gun/hand tools* | 106 | 81 | 75 | 66 | 33 |
| Excavator (20t) | 103 | 68 | 62 | 54 | 8 |
| Concrete truck and pump discharging | 103 | 68 | 62 | 54 | 8 |
| Mobile crane (35t) operating | 98 | 63 | 57 | 49 | 4 |
| Concrete vibratory poker* | 97 | 72 | 66 | 57 | 13 |
| Mobile crane (35t) idling | 88 | 53 | 47 | 39 | 1 |

* No screening assumed

### 5.5.3 Construction noise effects

Infringement of the daytime construction noise limits would typically result in annoyance, difficulty communicating outdoors and potentially influence the loudness of a normal conversation indoors. However, short term infringements of the applicable noise limits are common (and typically unavoidable) for construction activities in densely populated areas. Such exceedances are considered reasonable if they are of a limited duration and Best Practicable Option (BPO) measures are implemented to avoid, remedy and mitigate the noise emissions as far as practicable.

While not strictly applicable, it should be noted that 'short-term' construction works (less than 15 days) have noise limits that are 10 decibels higher than those for 'long-term' construction works. This reflects community response, as neighbours will typically tolerate higher noise levels for short periods, provided they are no louder than necessary.

Table 8 gives examples of the potential effects on receivers at different noise levels based with most exposed façades providing a 20 dB reduction. Depending on the construction of the house, newer facades may provide up to a 25 – 30 dB reduction, however, assumptions and effects provided below are based on a conservative approach of 20 dB reduction only.

**Table 8: Potential construction noise effects on receivers**

| External Noise Level | Potential Daytime Effects Outdoors | Corresponding Internal Noise Level | Potential Daytime Effects Indoors |
|---|---|---|---|
| 65 dB $L_{Aeq}$ | Conversation becomes strained, particularly over longer distances | 45 dB $L_{Aeq}$ | Noise levels would be noticeable but unlikely to interfere with residential or office daily activities. |
| 65 to 70 dB $L_{Aeq}$<br>(The upper end is the relevant daytime criterion) | People would not want to spend any length of time outside, except when unavoidable through workplace requirements. | 45 to 50 dB $L_{Aeq}$ | Concentration would start to be affected. TV and telephone conversations would begin to be affected. |

| External Noise Level | Potential Daytime Effects Outdoors | Corresponding Internal Noise Level | Potential Daytime Effects Indoors |
|---|---|---|---|
| 70 to 75 dB $L_{Aeq}$<br>(The lower end is the relevant daytime criterion) | Businesses that involve substantial outdoor use (for example garden centres) would experience considerable disruption. None of these are present for this Project. | 50 to 55 dB $L_{Aeq}$ | Phone conversations would become difficult. Personal conversations would need slightly raised voices. Office work can generally continue, but 55 dB is considered by the experts to be a tipping point for offices. For residential activity, TV and radio sound levels would need to be raised. |
| 75 to 80 dB $L_{Aeq}$ | Some people may choose protection for long periods of exposure. Conversation would be very difficult, even with raised voices. | 55 to 60 dB $L_{Aeq}$ | Continuing office work would be extremely difficult and become unproductive. In a residential context, people would actively seek respite. Likely acceptable for manufacturing and similar commercial premises. |
| 80 to 90 dB $L_{Aeq}$ | Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss. People passing the site will not require any hearing protection. | 60 to 70 dB $L_{Aeq}$ | Untenable for both office and residential environments. Unlikely to be tolerated for any extent of time. May be acceptable in a factory setting that already provides for such internal noise levels. |

With effective management of construction activities, which includes consultation and communication with affected parties, noise levels can be controlled for the Project so that the effects on the nearest receivers are managed to a reasonable level.

## 5.6 Construction vibration

### 5.6.1 Rock breaking

Table 9 summarises the expected set back distances required for each main vibration generating activity to achieve compliance with the applicable criteria. The predictions are based on regression analysis of available vibration measurements. The amenity setbacks are based on typical levels, whereas the setbacks for cosmetic building damage are more conservative (i.e. addition of a 100% safety factor).

**Table 9: Indicative vibration levels at building foundations**

| | Vibration setback distance (m) | | | |
|---|---|---|---|---|
| **Equipment** | **AUP (2 mm/s PPV)** | **Historic/sensitive (2.5 mm/s PPV)** | **Residential (5 mm/s PPV)** | **Commercial (10 mm/s PPV)** |
| Excavator mounted rock breaker (20-30T) | 12 | 16 | 10 | 7 |
| Excavator mounted rock breaker (8-10T) | 6 | 8 | 5 | 3 |
| Excavator mounted rock breaker (1-5T) | 3 | 4 | 2 | 1 |
| Jackhammer | 2 | 2 | 1 | 1 |

We predict compliance with the building protection criteria for all construction activities. This includes structures that may, following assessment by a building surveyor, fall under the "historic or sensitive buildings" category (refer Section 5.1.2), e.g. based on previous information on this Project, the chimney at the 105 Valley Road (about 55 m from the closest excavation) and the chimney and drystone wall at 16 Carrick Place (about 27 m from the closest excavation).

The buildings in the historic heritage overlay (i.e. 224 – 228 Dominion Road) will need to be assessed by a suitably qualified expert to determine if they fall under the "sensitive" vibration category as set out in DIN 4150-3. Based on that determination, construction activities will need to be managed to achieve compliance with the relevant criterion.

We predict that rock-breaking would infringe the amenity limit at properties within up to 12 m of breaking works. Based on information of the previously consented scheme, we understand that this would take around one week to complete (and likely to be under one week for this proposal as the extent of rock breaking is reduced from that previously consented). There are only few buildings within this distance:

- 109 Valley Road (adjacent to the water retention tank)
- 9 – 15 Carrick Place Unit 1
- 184 – 196 Dominion Road
- 224 – 228 Dominion Road

To enable compliance, if rock breaking is required within 12 m of buildings:

- A smaller breaker should be used close to buildings unless attended vibration monitoring is undertaken
- Building occupants within 50 m of rock breaking should receive timely communication in accordance with the AUP vibration amenity rules (Section 5.1.2).
- Alternatively, rock may be pre-drilled using pneumatic drills. These generate very little vibration (but will need to be mitigated for noise emissions) and enable fractured rock to be dug out using an excavator. Such method may be considered for the excavation closest to 184 – 196 and 224 – 228 Dominion Road.

### 5.6.2 General construction

We predict that general construction including demolition, excavation (excluding rock breaking) and superstructure installation will comply with the amenity vibration criteria. The buildings are proposed to be founded directly on the excavated basalt layer, avoiding the need for piling and fill compaction.

Significant vibration is not expected from other typical construction activities. However, the response of affected parties is expected to vary widely and be influenced by such factors as proximity to the works, the sensitivity of their activities, their attitude to the project and whether they are also impacted by other project-related effects.

### 5.6.3 Construction vibration effects

The vibration effects associated with construction of the Project are considered in terms of human response (amenity) and building effects. However, in our experience the main concern for building occupants during construction is damage to the building itself.

People can generally perceive vibration at a much lower level than when (any) building damage is likely to occur. Adverse effects may range from annoyance to loss of amenity or inability to carry out work. Vibration effects will reduce with distance from the source, and the level of vibration transmission into a building will depend on several factors, such as the foundation type, building construction and height of building.

Potential effects and human perception of the vibration levels are shown in Table 10.

**Table 10: Potential vibration effects based on people's perception**

| Vibration level (mm/s PPV) | Potential effects Indoors |
|---|---|
| 0.14 mm/s | The threshold of perception for stationary people. Just perceptible in particularly sensitive environments. |
| 0.3 mm/s | Can be just perceptible during normal residential activities, particularly for more sensitive receivers. Levels above may wake most people from their sleep.<br>This is the AUP limit for construction vibration generated at night, but all high vibration activities are proposed during the day. |
| 1 mm/s | Is typically tolerable with prior engagement. Complaints or adverse reaction are likely in office or residential environments, particularly if there is no warning. What people will feel in real life would be subject to the source but could include a steady vibration from sources such as vibratory compaction, or a small jolt such as from the movement of a large digger either of which could rattle crockery and glassware. |
| 2 mm/s | Vibration would clearly be felt. However, it can typically be tolerated in indoor environments such as offices, houses and retail if it occurs intermittently during the day and where there is effective prior engagement.<br>This is the AUP limit for large construction projects generating vibration. |
| 5 mm/s | Unlikely to be tolerable in a workplace. Highly unsettling for both workplaces and dwellings. If exposure is prolonged, some people may want to leave the building. Computer screens would shake, and items could fall off shelves if they are not level.<br>This is the threshold below which no cosmetic damage will occur in the DIN standard and the AUP building vibration limit. |
| 10 mm/s | Likely to be intolerable for anything other than a very brief exposure. |

Construction vibration effects generally have a short timeframe, typically a few hours or days at a time. The use of high vibration generating equipment, such as a rock breaking, should be managed through a CNVMP to minimise potential vibration effects.

## 5.7 Management and mitigation

Good noise and vibration management is essential in reducing adverse noise and vibration effects as far as practicable. Using best practice on site, including proactive communication with affected neighbours, will be paramount to constructing the proposed development. We consider that the best practice approach to construction noise and vibration is the focus on management and mitigation, rather than providing for higher noise limits. In our opinion, the most appropriate response is to retain the AUP noise limits but require the implementation of the BPO for construction noise and vibration management and mitigation through a CNVMP as set out below.

### 5.7.1 Construction Noise and Vibration Management Plan

The most effective way to control construction noise and vibration is through good on-site management and communication between the contractor and neighbouring receivers. Management and mitigation measures are most appropriately set out in a CNVMP. The CNVMP should be used to manage works on site and should set out how the construction contractor interacts with the neighbouring affected parties. The CNVMP would be prepared in conjunction with the contractor and therefore contain detailed information on equipment to be used, timing and staging of the works and similar specific content.

The CNVMP will be a living document that can be updated where new information comes to light during the construction period. Normally, CNVMPs are certified by Council, which enables feedback to be taken into consideration. Any material revisions of the CNVMP would also be recertified by Council.

The CNVMP content will be based on the requirements of Annex E2 of NZS 6803:1999 and include information such as:

- The noise and vibration performance standards
- Predicted noise and vibration levels for relevant equipment and/or activities and, where appropriate, at specific receiver locations
- Mitigation options to identify the BPO with respect to construction noise and vibration
- Noise and vibration management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and any night-time activity (e.g. delivery of large machinery which may have to occur out of hours)
- Noise and vibration monitoring requirements, with triggers and feedback mechanisms
- Procedures for handling complaints; and
- Informative and proactive communication and engagement with receivers in conjunction with noise and/or vibration monitoring is considered the most practicable approach to managing any effects.

### 5.7.2 General measures

Complaints can arise even if the noise and vibration levels comply with the Project limits. To minimise complaints, we recommend the following common mitigation measures:

- Avoid unnecessary noise (e.g. shouting, unnecessary use of horns, loud site radios, rough handling of material and equipment, banging or shaking excavator buckets, unnecessary steel on steel contact and high engine revs)
- Avoid unnecessary vibration (e.g. unnecessary dropping of heavy objects, potholes, bumps or corrugations in site accessways and excavator operators are skilled and use their machine considerately)
- Mitigate track squeal from tracked equipment, such as excavators

- Locate stationary equipment (e.g. generators) away from noise sensitive receivers and/or screen them behind site buildings and material stores
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators)
- Engage with receivers prior to commencing high-noise and vibration activities
- Undertake monitoring
- Train staff to recognise the sensitivities of the surrounding environment and ensure staff is aware of the requirements of the consent and best practice site behaviour

### 5.7.3 Engagement

Engagement with neighbours is the single most important management measure when addressing construction noise and/or vibration effects on neighbours. Engagement can take many forms, and the following are options that may be implemented:

- Written communication (e.g. newsletter) provided to building occupants within a setback distance prior starting construction.
- During construction, occupants of buildings predicted to receive vibration levels infringing the 2 mm/s PPV amenity limit for more than three days will be advised at least 3 days prior to the works commencing as required by the AUP.
- Should night-time activities be required (e.g. delivery of oversized equipment or machinery), occupants of buildings within 100 m of night works should be advised at least 5 days prior to the works commencing.
- Consultation should be offered to the sensitive receivers where noise and/or vibration is predicted to infringe the performance standards by a significant margin or where sensitivity has been established prior to works starting. Receivers that do not want ongoing consultation, should be offered communication.
- Complaints are part of the engagement package. Any complaint should be acknowledged immediately where practicable and responded to within a short period. If a more detailed response is needed, it should be provided within a timeframe agreed with the complainant.

### 5.7.4 Staging and timing

Residents in the area may not leave their homes to go to work, e.g. those in the retirement village at 9-15 Carrick Place. Therefore, in response to information gained during engagement with neighbours, the staging and timing of works may assist in reducing noise and/or vibration effects. This could include the following:

- Avoid evening and night-time works unless absolutely necessary (e.g. delivery of oversized equipment that would cause traffic disruption)
- Limit works on Saturdays to enable a longer weekend rest period (Note: this would increase the overall duration of construction)
- Limit high noise works for rest periods during the day (e.g. include a break from rock breaking to give residents respite) (Note: this would increase the overall duration of rock breaking)
- Construct, where practicable, the building closest to the residential boundaries first so that the building shells provide shielding from noise on the remainder of the site

### 5.7.5 Concrete and rock breaking

Rock breaking is anticipated to be the highest noise and vibration generating activity on site. There are several management measures that can be employed to reduce impacts as follows:

- Minimise the amount of breaking needed (e.g. use a crushing shear or pulveriser attachment in place of a breaker where practicable, or use a cut and lift approach to enable breaking offsite)
- Match the size of breaker to the scale of the works. It should be large enough to carry out the work efficiently, but not over-sized (avoiding unnecessary noise and vibration)
- For concrete breaking, make an initial perimeter saw cut at the perimeter to reduce vibration transfer to nearby buildings
- Ensure effective noise mitigation is in place using noise barriers and enclosures and a breaker shroud
- Use pneumatic drills to pre-fracture rock which can then be scraped out with a large excavator rather than using a rock breaker
- Minimise the breaking period (e.g. remove larger boulders for breaking offsite), and/or the number of breaking periods (e.g. complete all breaking in one extended period rather than two shorter periods with the same overall duration). These options should be discussed with receivers to determine the preferred approach
- For rock breaking, initial breaking should be undertaken away from buildings and monitored to inform compliance. The data can then be used to choose the appropriate breaker close to buildings
- Match the chisel/tip type to the material and use a dampened bit to avoid ringing
- Avoid 'blank' firing by placing the chisel on the rock or concrete before starting, and minimising firing after it breaks through

### 5.7.6 Alternative mitigation options

Where all practicable noise and vibration mitigation measures have been implemented and considered, and noise or vibration levels are predicted to exceed relevant limits by a significant margin or for an extended period, an offer of temporary resident relocation should be considered. Such a measure should be considered as a last resort as it will generally inconvenience the building occupiers.

Temporary relocation offers are generally associated with night-time works and sleep disturbance rather than daytime noise levels, however, the need for offers of temporary relocation would be assessed following engagement with neighbouring residents. Any such alternative mitigation options would be assessed on a case-by-case basis.

### 5.7.7 Temporary noise barriers

Temporary noise barriers should be used where a noise limit is predicted to be infringed and would noticeably reduce the received level. They should be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 10 decibels.

Where practicable, the following guidelines must be incorporated in the design and utilisation of temporary noise barriers:

- The panels should be constructed from materials with a minimum surface mass of 15 kg/m$^2$. Suitable panels include 12 mm plywood or similar material. Such barrier would achieve the maximum noise level reduction required to achieve compliance with the relevant noise levels predicted in Section 5.5**Error! Reference source not found.**. Any alternatives should be approved by a suitably qualified acoustic professional.
- For this Project, we have assessed barrier heights of:

- 3.6 m at 9-15 Carrick Place, the Carrick Place frontage of 216B Dominion Road and 111 Valley Road; and
- 2.4 m at the Dominion Road frontage of the construction site, the Valley Road frontage not required for access; and the north and west boundaries of 224-234 Dominion Road

– The panels should be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels

– The panels should be positioned as close as practicable to the noisy construction activity to block line-of-sight between the activity and noise sensitive receivers. Where positioned on the site boundary, additional local barriers should be considered near the activity to ensure effective mitigation for sensitive receivers on upper floor levels with residual line-of-sight.

We note that there is a general perception that that "heavier" barriers (e.g. concrete or shipping container) achieve a better noise level reduction. This is not the case. Once a barrier has sufficient surface mass, it will perform appropriately. Any heaver materials will not achieve additional noise level reduction.

### 5.7.8 Monitoring

Monitoring is undertaken by a suitably qualified person who measures levels in real time. This enables:

– Review of the implementation of the CNVMP, including the mitigation and management measures and engagement

– Verification that the predicted levels are representative, and the response protocols are appropriate for the resulting effects

– Determination of compliance

Unattended long duration monitoring is not normally considered useful for construction sites. For instance, from experience, we have found that vibration monitors installed in a neighbouring building can show repeated high vibration levels that were in fact caused by residents moving around the house rather than the construction site. Similarly, noise monitoring equipment records all noise sources in the vicinity, including traffic, household activities as well as construction. Therefore, attended monitoring during intensive construction activity is a more efficient and effective way of recording noise and vibration levels from construction as the attendant will be able to record the activities being undertaken on site and how they are received at the building.

*Noise*

Construction noise should be monitored:

– The first-time high noise activities occur on site

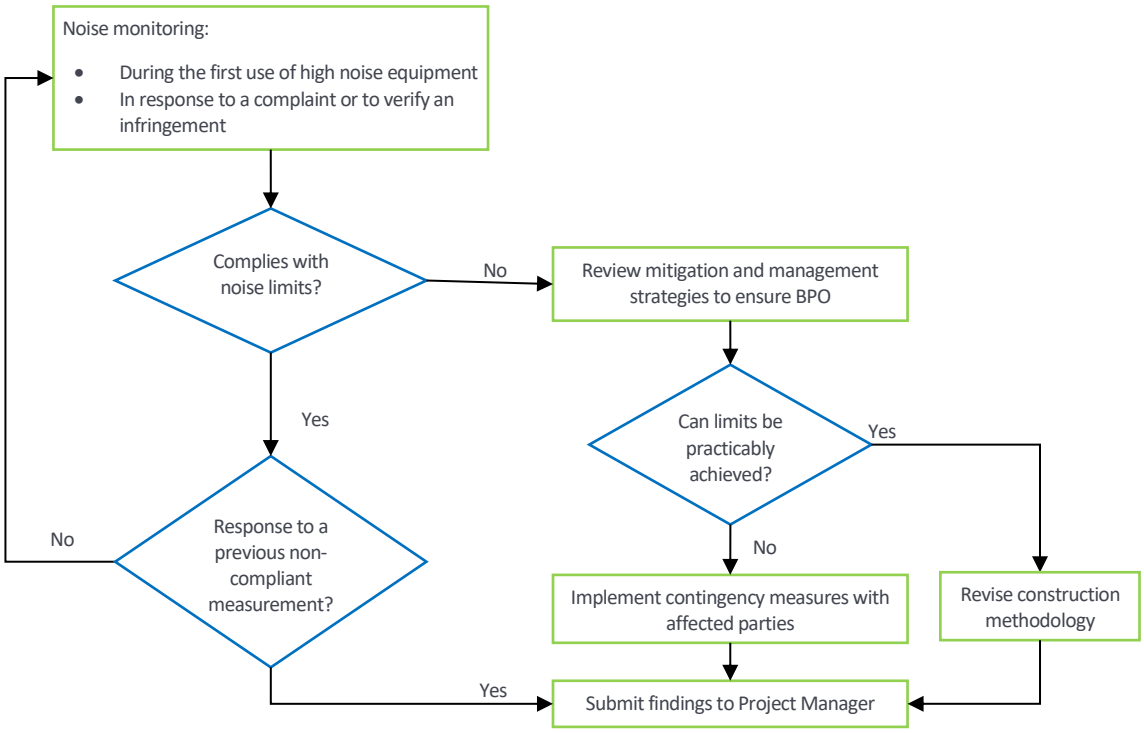
– In response to a reasonable noise complaint

– At 1 m from the building façade facing the construction site, or a proxy position adjusted for distance

– For an appropriate duration, reported with the measured level (e.g. 65 dB $L_{Aeq\,(30min)}$)

A noise monitoring flowchart of how monitoring could be undertaken is shown in Figure 4.

**Figure 4: Noise Monitoring Flow Chart**



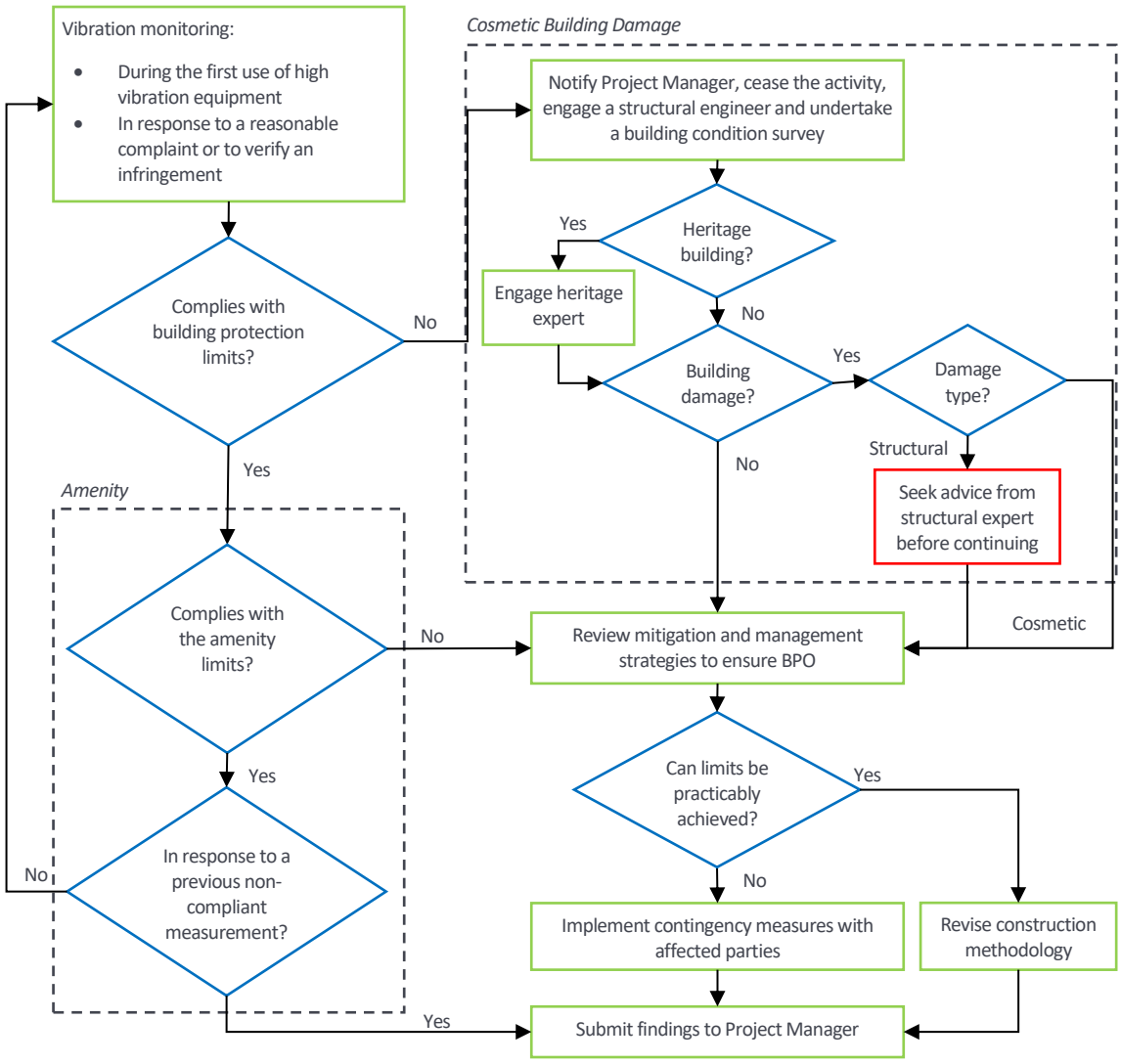

*Vibration*

Construction vibration should be monitored:

- The first time rock breaking is used on site
- In response to a reasonable vibration complaint
- On the foundations and/or the top floor of the closest building as appropriate, provided access to the building has been requested and granted
- For a representative construction duration

A vibration monitoring flowchart is presented in Figure 5.

**Figure 5: Vibration Monitoring Flow Chart**




## 5.7.9 Building condition surveys

Many residents are concerned about the potential for building damage with rock breaking close to neighbouring buildings. While we can perceive vibration at a level significantly lower than what is required to result in any (even cosmetic) building damage, and compliance is predicted with the building protection limits, we recommend building condition surveys for surrounding buildings prior to rock breaking works commencing on site (regardless of compliance).

Building condition surveys document the state of a building, including any existing cracks or other damage. Completing this before construction provides a benchmark if damage claims are made during construction.

A building condition surveys should be undertaken at the following times:

- Before construction starts, where vibration is predicted to exceed the building protection limits (Section 5.1.2), or where this is reasonably requested by residents because they are concerned about special features of their building
- During construction, where vibration is measured to exceed the building protection limits in (Section 5.1.2) and/or in response to a reasonable damage claim (Section 5.7.3)
- After construction, to avoid subsequent claims of damage from construction vibration

Each building condition survey should:

- Be undertaken by a suitably qualified person
- Provide a description of the building
- Determine the appropriate structure type classification[8] with respect to DIN 4150-3:2016 *"Vibrations in buildings – Part 3: Effects of vibration on structures"* (i.e. historic/sensitive, residential or commercial/industrial)
- Document and photograph the condition of the building, including any cosmetic and/or structural damage

## 6.0 SITE NOISE EMISSIONS

### 6.1 Performance standards

Table 11 summarises the AUP noise limits between adjacent sites. The various limits are set out in AUP Rules E25.6.2, E25.6.7 and E25.6.19. These are to be measured or assessed as the incident level on the façade of any building on any other site within the Local Centre zone and at or within the boundary of any Residential zone.

**Table 11: AUP noise limits at neighbouring sites**

| Zones | Day & Time | | Level |
|---|---|---|---|
| Residential zone to Residential zone | Monday to Saturday | 7.00 am – 10.00 pm | 50 dB $L_{Aeq}$ |
| | Sunday & Public Holidays | 9.00 am – 6.00 pm | |
| *Measured within the boundary of an adjacent site* | At all other times | | 40 dB $L_{Aeq}$<br>75 dB $L_{Amax}$ |
| Local Centre zone to Residential zone | Monday to Saturday | 7.00 am – 10.00 pm | 55 dB $L_{Aeq}$ |
| | Sunday & Public Holidays | 9.00 am – 6.00 pm | |
| *Measured within the boundary of an adjacent site* | At all other times | | 45 dB $L_{Aeq}$<br>60 dB $L_{eq}$ at 63 Hz<br>55 dB $L_{eq}$ at 125 Hz<br>75 dB $L_{Amax}$ |
| Local Centre zone to Local Centre zone | Monday to Sunday | 7.00 am – 10.00 pm | 60 dB $L_{Aeq}$ |
| | | 10.00 pm – 7.00 am | 50 dB $L_{Aeq}$<br>60 dB $L_{eq}$ at 63 Hz<br>55 dB $L_{eq}$ at 125 Hz<br>75 dB $L_{Amax}$ |
| *Measured or assessed as the incident level on the façade of any building on any other site* | | | |

These noise limits apply to activities from the proposed café and retail units as well as mechanical noise (e.g. kitchen extract fans, air conditioning) and traffic movements on site.

They are not relevant for normal residential noise such as people using their outdoor balconies.

[8] Classifications with respect to Tables 1 and 4 of DIN 4150-3:2016 "Vibrations in buildings – Part 3: Effects of vibration on structures" (i.e. historic/sensitive, residential or commercial/industrial)

## 6.2 Overview

The operational noise sources from the site are as follows:

- Vehicle movements on site, i.e. residents' cars, rubbish and delivery vehicles
- Mechanical services plant
- Noise emissions from the retail/café units on the ground floor of the development

We discuss each of these below.

## 6.3 Vehicle movements

Vehicle access to the site is from Valley Road along the eastern site boundary. The driveway slopes down to the basement carpark. The entry into the covered carpark is about halfway along the eastern boundary. Only occupants of 111 Valley Road are likely to notice vehicle noise from the site as it is immediately beside the driveway, with partial shielding by the decorative wall at the entrance.

We understand that approximately 101 vehicle movements would occur on site during the peak hour. We based our predictions on a car sound power level of 86 dB $L_{WA}$. These movements would result in a noise level of 55 dB $L_{Aeq}$ (prior to daytime averaging provisions in accordance with NZS 6802) at the boundary with 111 Valley Road, which readily complies with the daytime noise limit of 60 dB $L_{Aeq}$.

Night-time movements would be significantly lower (less than a tenth of the daytime peak hour), and we therefore predict compliance with the 50 dB $L_{Aeq}$ night-time noise limit also.

We understand that the rubbish truck (assumed sound power level of 97 dB $L_{WA}$) will be loaded by backing into the basement carpark entrance twice a week during daytime only. This would mean that, at most, two heavy vehicle movements would occur in a 15-minute period. We predict a noise level from the rubbish truck of 52 dB $L_{Aeq}$ at the boundary with 111 Valley Road, which readily complies with the relevant daytime noise limit even if the trucks arrive during the peak hour (which is unlikely).

A loading bay is provided for at the end of the carpark driveway, adjacent to the building at 109 Valley Road. It is likely that smaller commercial vehicles such as small moving trucks (approximate sound power level of 91-93 dB $L_{WA}$) would use this space. This building is commercial in use (currently used for medical purposes) and has no openings (i.e. windows or doors) in the solid concrete block façade facing the site. Therefore, compliance with the relevant noise limits can easily be achieved at this receiver.

The closest residential zone is at 107/107A Valley Road, beyond the site of 111 Valley Road, some 26 metres from the driveway and partially shielded by the building at 111 Valley Road. For the peak hour, we predict noise levels of 43 dB $L_{Aeq}$ at the closest residential boundary, readily compliant with the 55 dB $L_{Aeq}$ noise limit.

In addition, a small carport with three resident carparks is proposed to be located off Carrick Place, in the northeastern corner of the site. This carpark will be behind a locked gate only accessible to the residents. Traffic noise from the additional few vehicle movements on Carrick Place will not be noticeably affected.

In summary, we predict that noise from vehicle movements on the site can readily comply with the relevant noise limits at all neighbouring sites.

## 6.4 Mechanical services plant

It is expected that there would be individual mechanical plant associated with the retail units and apartments. Some mechanical services plant equipment could operate 24 hours per day, and noise from this equipment must be designed so that the cumulative noise from the site complies with the night-time noise limits presented in Table 11.

In our experience, mechanical plant will be designed to achieve compliance with the noise rules. Suitable acoustic design will be undertaken prior to construction, and the equipment will need to be properly installed and maintained. The plant noise will need to comply together with any other noise sources on the site, i.e. the cumulative site emissions will need to comply with the relevant noise limits in

Table 11. However, since other noise sources on site occur only intermittently and at levels well within the relevant criteria, we are confident that cumulative compliance can be achieved with appropriate design.

## 6.5 Commercial noise

The ground floor retail area is proposed to include a café. Other commercial units are likely to contain retail. In our experience, noise levels from these outlets can readily comply with the relevant noise limits and is generally likely masked by road traffic noise in the area (refer Section 4.0).

As part of the fit out of these spaces, the proposed mechanical services equipment noise will need to be considered as discussed in Section 6.4 above.

# 7.0 INTERNAL NOISE LEVELS

## 7.1 Performance standards

Any spaces in high noise environments must be designed so that the internal sound levels are controlled. The design levels are intended to mitigate reverse sensitivity effects from residents moving into a high noise environment (e.g. the Local Town Centre zone) whilst enabling residents to have appropriate indoor sound levels.

### 7.1.1 Between units on the same site

AUP Rule E25.6.9 requires that noise between units within the Local Centre zone is controlled to achieve the limits in Table 12. These limits apply to noise sensitive spaces (i.e. apartments) and to the commercial units on the ground floor.

**Table 12: Internal noise limits between units in the Town Centre Zone**

| Unit affected | Time | Noise level |
|---|---|---|
| In all units except those containing activities sensitive to noise | At all times | 50 dB $L_{Aeq}$ |
| In bedrooms and sleeping areas within units containing activities sensitive to noise | 10.00 pm – 7.00 am | 35 dB $L_{Aeq}$<br>45 dB at 63 Hz $L_{eq}$<br>40 dB at 125 Hz $L_{eq}$ |
| | 7.00 am – 10.00 pm | 40 dB $L_{Aeq}$ |
| Other noise sensitive spaces | At all other times | 40 dB $L_{Aeq}$ |

### 7.1.2 From external noise sources

Noise sensitive spaces (i.e. the apartments) must be designed to achieve the limits of AUP Rule E25.6.10 summarised in Table 13.

**Table 13: AUP Internal Sound Levels**

| Room | Time | Internal Sound Levels |
|---|---|---|
| Bedrooms and sleeping areas | 10 pm – 7 am | 35 dB $L_{Aeq}$<br>45 dB $L_{eq}$ at 63 Hz<br>40 dB $L_{eq}$ at 125 Hz |
| Other noise sensitive spaces | At all other times | 40 dB $L_{Aeq}$ |

The sound insulation design must consider the maximum allowable level of noise that can be generated in the zone or any adjacent zone. Additionally, where these internal noise levels can only be complied with when doors or windows to those rooms are closed, then it will be necessary for apartments to be mechanically ventilated and/or cooled. Noise levels from these mechanical systems will also need to be designed to a level of 35 dB $L_{Aeq}$ within habitable spaces (AUP Rule E25.6.10 (3)).

## 7.2 Noise from external sources

The façade design is still in concept design. Solid wall constructions, e.g. precast panels etc, in conjunction with an internal plasterboard lining and absorptive cavity insulation, would be capable of achieving sufficient sound insulation to attenuate external noise to achieve compliance with the internal noise limits. However, compliance for façades facing Dominion and Valley Roads can only be achieved with external windows and doors closed. Therefore, the apartments will require mechanical ventilation and cooling as required by AUP Rule E25.6.10. Noise levels from these mechanical systems will also need to be controlled to a level of 35 dB $L_{Aeq}$ as required by the AUP.

Apartments facing into the site or to the east (Carrick Place) may not require any mechanical ventilation as ambient noise levels are sufficiently low to allow windows to be opened for ventilation and internal noise limits still be compliant.

Attention will need to be given to the glazing to ensure that sound transmission through the glass will sufficiently attenuate external noise. We have performed indicative calculations based on the current design drawings (dated June 2024) to determine potential appropriate glazing thickness.

Our calculations have been based on the following assumptions:

- Room reverberation time of 0.5 seconds
- Maximum glazing panel size per room of 5 $m^2$
- Full height glazing to a height of 2.4 m
- Ceiling height of 2.7 m

To achieve the internal sound levels, it is recommended that minimum 6 mm / 12 mm / 6 mm double glazing or glazing of similar performance is installed throughout the entire development.

## 7.3 Noise within the development

Since most of the site is in the Local Centre zone, the AUP requires that units within the development are designed to ensure noise transmission from neighbouring units is appropriate. The relevant noise limits are set out in Section 7.1.1.

The design of the units (both residential and commercial) will be undertaken at the building consent stage. At that time, the external façade and internal walls will need to be designed to take account of permitted and actual noise levels on the site.

Based on our experience with similar projects, solid façade and inter-tenancy wall materials will ensure that the relevant internal noise limits can be complied with. This will be confirmed at building consent stage.

## APPENDIX A GLOSSARY OF TERMINOLOGY

| | |
|---|---|
| **SPL or $L_P$** | Sound Pressure Level<br>A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels. |
| **SWL or $L_W$** | Sound Power Level<br>Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source. |
| **dB** | Decibel - The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa, i.e. dB = 20 x log(P/Pr) |
| **A-weighting** | A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds.<br>Sound levels using an "A" frequency weighting are expressed as dB $L_A$. Alternative ways of expressing A-weighted decibels are dBA or dB(A). |
| **dBA** | The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. |
| **$L_{Aeq\ (t)}$** | The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. |
| **$L_{A90}$** | The background sound level. The noise level that is exceeded for 90% of the time. |
| **$L_{Amax}$** | The A-weighted maximum noise level. The highest noise level which occurs during the measurement period. |
| **NZS 6801:2008** | New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"* |
| **NZS 6802:2008** | New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"* |
| **NZS 6803:1999** | New Zealand Standard NZS 6803:1999 "*Acoustics – Construction Noise"* |
| **DIN 4150-3:2016** | Deutsche Industrie Norm 4150-3:2016 "*Vibration in buildings – Part 3: Effects on structures"* |
| **PPV** | Peak Particle Velocity. The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment. |
| **Vibration** | When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity.<br><br>Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back). |