Sensitivity: General

CARRINGTON ROAD IMPROVEMENTS PROJECT
ASSESSMENT OF ACOUSTIC EFFECTS

Rp 001 20241088 | 7 February 2024

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1.0 SUMMARY

We have assessed the construction and traffic noise and vibration effects from the proposed upgrades to Carrington Road, Auckland. The Project involves the establishment of priority bus lanes and cycle lanes along both sides of the road and raised safety platforms at all connecting local roads entering Carrington Road. The Project will result in road widening in some areas, outside the existing road reserve.

1.1 Construction noise and vibration

Construction will occur near to some buildings, as close as 2 metres, where widening moves the footpaths to the façade of buildings, and where a new pedestrian bridge is constructed across the rail line at Mt Albert. Most buildings are 10 to 15 metres from the works. This means that at times, the construction noise criteria will be infringed when works occur outside a building, and that the vibration amenity criteria will at times be infringed when equipment works outside or passes a building.

These effects will be managed through a Construction Noise and Vibration Management Plan and Schedules. The construction methodology will be developed so that the vibration building criteria will be complied with, and the vibration amenity criteria will be complied with as far as practicable. This means that bored piling is preferred over any other piling types, and smaller equipment or non-vibratory compaction may be chosen within a certain distance from buildings. In any event, communication and consultation with affected parties will assist in determining how to best manage noise and vibration effects during the construction phase.

The construction of the watermain along the western side of Carrington Road will be incorporated into the road upgrades as part of the wider Project. We do not anticipate any noticeable additional noise or vibration generation due to the watermain works. While these works will almost entirely be in the road, a short section will be within 20m of a historic heritage building (the former Oakley Hospital Main Building, ID 01618) outside the current road reserve and has therefore been assessed accordingly.

1.2 Traffic noise

The upgrades to the road are intended to assist with the traffic increase from the proposed residential intensification on the Unitec site. The increase in traffic volume would occur irrespective of the Project. We have predicted existing, and future, noise levels with and without the Project in place. The Project would make no perceptible difference to the traffic noise levels. Traffic volumes are not anticipated to change due to the upgrades, and noise levels would remain similar to existing levels.

A glossary of technical terminology is included in Appendix A.

2.0 INTRODUCTION

2.1 Project description

Carrington Road is a 1.6km-long arterial road on the Auckland isthmus which connects New North Road at the Mt Albert Town Centre in the south; and Great North Road at the Point Chevalier Town Centre in the north. Auckland Transport (AT) has proposed the Carrington Road Improvements Project (CRIP or the Project) to serve planned growth and intensification in the area; and to achieve the long-term strategic network outcomes for the corridor, particularly a higher level of service for active modes and public transport.

To these ends, the CRIP comprises the following road upgrades which include a section of widening on the western side of the road between Woodward Road and State Highway 16 (SH16):

- Bus/special vehicle lanes (TBC) for most of the corridor length in both directions, and new/relocated bus stops;
- Improved walking and cycling facilities along the entire corridor length in both directions, new midblock crossings, and a new pedestrian bridge to supplement the existing Mt Albert Rail Bridge;
- Upgraded intersections along the entire corridor length, including four new/upgraded signalised intersections,
- New stormwater management infrastructure, including treatment and conveyance swales on Segar Avenue; and
- Public realm placemaking/landscaping, and new street trees.

In conjunction, Watercare Services Limited (Watercare) has proposed the Point Chevalier Watermain No. 2 Project (the Watermain) along Carrington Road. The Watermain is a Ø750mm concrete-lined steel (CLS) pipeline approximately 1km in length between Seaview Terrace and Sutherland Road, and forms part of a wider scheme to improve supply, maintain levels of service, and provide resilience to both the Point Chevalier and Khyber water supply zones. The design and planning for the Watermain has been expedited to realise efficiencies with the CRIP, and to enable the projects to be constructed concurrently.

Unless otherwise noted, the CRIP and Watermain projects are referred to collectively in this report as 'the Project'. The Project extent is shown in Appendix C. A full Project Description can be found in Section 3 of the Assessment of Effects on the Environment (AEE) report.

2.2 Receiving environment

Carrington Road is a busy arterial road with cycle and foot paths on both sides of the road. The Project traverses, for large extents, established residential areas on both sides of the road. On the northbound side of the road from Woodward Road to SH16, the previous Unitec site is currently being redeveloped for intensive residential use. Several multi storey apartment buildings are currently being constructed and will be completed in the near future, and more are consented and being prepared for construction. These buildings form part of the existing environment.

In addition to residential sites, there are a number of other sensitive uses adjacent to the road such as the Whatua Kaimarie Marae, two childcare centres (Collective Kids and The Learning Corner) and Gladstone Primary School.

The Project is bordered by SH16 to the north and the Western Rail Line to the South. Both are high noise transport corridors.

3.0 EXISTING ENVIRONMENT

The existing environment provides a baseline for assessing noise and vibration effects. Effects can be assessed by quantifying the noise levels that people could experience due to the implementation of a project. The change in sound environment can then be discussed in relation to people's ability to perceive the change (refer Section 5.1.2). In addition, measured sound levels for locations in the vicinity of existing major roads may be used to verify the computer noise model.

3.1 Noise level surveys

The existing sound environment at activities sensitive to noise adjacent to the Project is controlled by traffic on the existing Carrington Road. At either end of the Project, SH16 and Great North Road to the north, and the rail line and New North Road to the south also affect the ambient sound levels.

We measured ambient sound levels along the Project. The measurements consisted of short duration (15 minute) attended surveys at five positions, generally located in line with building façades where accessible, at various distances adjacent to the existing alignment.

The surveys were undertaken on 7 November 2024 between 2pm and 5pm. The weather at the time of the surveys was fine, with some cloud and a slight breeze.

The location of the surveys is shown on Figure 1. We chose the locations to represent the full extent of the Project but avoid construction noise from the Unitec site. The short duration survey results are intended to give context to the overall environment along the alignment.

Figure 1: Noise survey locations (north to the right)

Table 1: Noise level survey results (south to north)

Position	Location	Start time	Measured noise level	Background sound level
			dB $L_{Aeq(15min)}$	dB L_{A90}
MP1	Prospero Terrace	16:36	59	49
MP2	Woodward Road	16:05	62	55
MP3	Gladstone Road School	14:12	65	52
MP4	Segar Avenue	15:00	61	54
MP5	Sutherland Road	15:30	62	57

We observed all locations are strongly affected by road traffic noise from Carrington Road. The noise levels at MP1 are lower as the location is down a dead-end street parallel to Carrington Road, below the rail bridge. Two trains passed during the survey, and their noise has contributed to the noise level measured at MP1.

3.2 Computer noise modelling

We used a computer noise model to calculate the noise levels of the existing situation at all Protected Premises and Facilities (PPFs) within 100 metres of the Project. PPFs are defined further in Section 5.1.1. The computer model of the existing situation includes the existing Carrington Road and all major local roads. We did not include the rail line in the model as rail noise is of a different character to road noise and generally occurs infrequently for defined periods only.

We used the measured sound levels to generally verify the results from the computer noise model for the existing situation. While both the measurements and modelling are subject to uncertainty, the measured and the modelled noise levels of the existing situation generally align (refer Section 5.2.1).

In our view, the results confirm that the computer model of the existing situation performs to an appropriate accuracy, which enables us to use the model to predict the existing noise levels at all dwellings without the need to measure existing noise levels at each building.

Overall, noise levels along the Project alignment are elevated. Carrington Road is a busy arterial route with a constant traffic stream.

Existing noise levels are discussed further in Section 5.3.

3.3 Existing vibration levels

While we did not measure vibration levels during the site visit, we observed if traffic vibration was perceptible. We did not perceive traffic vibration while standing on the footpaths adjacent to the road. The road surface was relatively smooth with little inconsistencies, which suggests that the existing road quality is good.

4.0 CONSTRUCTION NOISE AND VIBRATION

4.1 Performance standards

The noise and vibration performance standards discussed in this section take account of the fact that construction noise and vibration levels are likely to be higher than would be experienced from ongoing day to day use of the upgraded road. However, higher noise and/or vibration levels are not necessarily unreasonable as long as they are managed and mitigated by implementing the best practicable option (BPO). The relevant performance standards make allowances for the temporary but high impact effects that construction can have on neighbouring receivers.

4.1.1 Construction Noise

Noise Criteria

We reviewed the following guidelines and standards for the assessment of construction noise:

- Auckland Unitary Plan: Operative in Part (AUP:OP), specifically rules E25.6.27 and E25.6.29 relating to construction noise in all zones except the City Centre and Metropolitan Centre zones, and construction noise in the road
- NZS 6803:1999 Acoustics – Construction Noise

We recommend the use of NZS 6803 which provides context to the relevant performance standards.

Separately from the above guidelines and standards, Section 16 of the Resource Management Act 1991 (RMA) requires every occupier of land to "*adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level*".

The project is programmed to be constructed over approximately 24 to 30 months. Table 2 below shows the relevant noise standards for long duration works (more than 20 weeks), which apply to this Project. These criteria are those of NZS 6803, and largely reflect the AUP:OP criteria.[1]

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[1] The AUP:OP has simplified the duration adjustments of NZS 6803. While in NZS 6803 only daytime noise limits are adjusted up or downward for short and long duration projects respectively, the AUP:OP also adjusts the night-time criteria. There is no practical difference in reducing the night-time noise limit from 45 dB L_{Aeq} to 40 dB L_{Aeq}. Either instance does not allow any noisy construction work to occur, and the methodology of dealing with the works remains generally the same for either limit.

As most aspects of the Project construction will exceed 20 weeks' duration, we consider that the "long-term duration" criteria are most appropriate for this Project, in accordance with Section 7.2.1 of NZS 6803. The long-term criteria are five decibels more stringent during daytime than the criteria for "typical duration" (up to 20 weeks' duration). While construction in some areas may take less than 20 weeks, we recommend applying the same criteria to the entirety of the Project. Retaining the same noise criteria for the entire Project will avoid confusion as to where each noise criterion will apply and will be more practicably managed and measured as equipment passes from one area of the works to another.

Only buildings that are occupied at the time of construction are relevant assessment positions. Where no people are present (e.g. commercial buildings at night-time), compliance with the noise limits is not relevant.

The criteria of Table 2 and Table 3 apply at 1 metre from the most affected façade of an occupied building.

Table 2: Recommended upper limits for construction noise received in residential zones and dwellings in rural areas[2]

Time of week	Time period	dB L_{Aeq}	dB L_{AFmax}
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

Table 3: Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year[3]

Time period	dB L_{Aeq}
0730-1800	70
1800-0730	75

While the Project works are generally of longer duration (several years), each individual building will likely be affected only for limited periods (i.e. weeks or months) of high noise levels.

2 NZS 6803:1999 Acoustics – Construction Noise, Section 7.2.3 Table 2.

3 NZS 6803:1999 Acoustics – Construction Noise, Section 7.2.4 Table 3.

Works in the road

AUP rule E25.6.29 provides specific construction noise rules for works within a road. E25.6.29(3) enables infringements of the noise limits in Table 2 between 7am and 10pm where:

a) Exceedances are less than 10 days at any one receiver, or

b) Works cannot practicably comply, or

c) A works access permit is obtained from Auckland Transport or New Zealand Transport Agency, or

d) "*For planned works where the works will take more than 8 hours to complete and a construction noise and vibration management plan is provided to Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29 (5)*".

Rule E25.6.29(2) enables infringements of the noise limits in Table 2 between 10pm and 7am where:

a) Exceedances are less than 3 nights at any one receiver, and

b) Works cannot practicably be done during the day, or the road controlling authority requires they be done at night, or

c) Works cannot practicably comply, or

d) A works access permit is obtained from Auckland Transport or New Zealand Transport Agency, or

e) "*For minor planned works a construction noise and vibration management plan is provided to Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29 (5)*".

Night works or extended weekend works will likely be required by NZTA and KiwiRail where works on the bridges are undertaken that cross SH16 and the rail line. Not all works can practicably comply, and a CNVMP will be prepared to minimise effects in accordance with E25.6.29 (5).

Infringement of criteria

During construction some activities would likely occur close to buildings. In some instances, there is the potential for noise levels to exceed the recommended construction noise standards. For most large-scale construction projects, infringements of the construction noise standards for brief periods are common, and management will ensure that effects are reasonable.

NZS 6803 anticipates that at times construction noise cannot be made to comply with the recommended criteria. Statements such as *"construction noise from any site should not generally exceed the numerical noise limits"*[4] indicate that intermittent infringements are not unreasonable, as long as the BPO has been applied to the management and mitigation of that construction noise.

Whether the duration of a construction activity that infringes the standards can be considered reasonable depends on site specific circumstances and may vary from site to site and activity to activity. For instance, where daytime noise standards are exceeded for several days, but neighbouring residents are not at home, no one would be affected and therefore mitigation may not be required beyond communication with the residents.

If night-time works occur, based on our experience on similar projects, this would likely only happen for a few nights in any one location (e.g. across the rail line). In that instance, this may be acceptable if residents have been informed and a clear time frame has been provided. However, if night-time works are expected to be ongoing for several consecutive nights, and at a noise level that affects residents' ability to sleep, then alternative strategies may need to be considered, such as offering

4 NZS 6803:1999 Acoustics – Construction Noise, Section 7.1.2.

temporary relocation for those affected residents. Such management measures are further discussed in Section 4.5.

4.1.2 Construction Vibration

Building criteria

AUP rule E25.6.30 (1)(a) requires construction vibration to be measured and assessed in accordance with German Standard DIN 4150-3:2016 "*Vibrations in buildings – Part 3: Effects of vibration on structures*".

The short-term (transient)[5] vibration limits in Figure 2 apply at building foundations in any axis. The long-term (continuous)[6] vibration limits in Table 4 apply at all floor levels, but levels are normally highest in horizontal axes on the top floor.

DIN 4150-3 limits are for avoiding cosmetic building 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 Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*." Much higher vibration levels (i.e. an order of magnitude higher) would be needed for potential structural damage.

We refer to these criteria as "building criteria" as they are designed to protect buildings.

Figure 2: Short-term (transient)[1] vibration at building foundations (DIN 4150-3 2016: Figure 1)

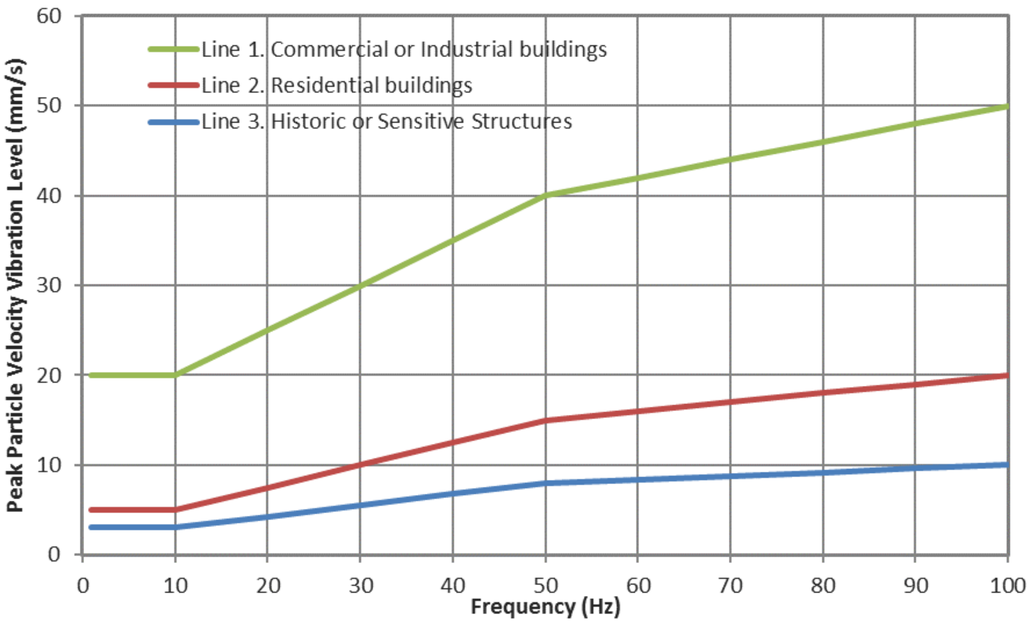


Table 4: Vibration at horizontal plane of highest floor (DIN 4150-3 2016: Tables 1 and 4)

Building Type	Peak Particle Velocity Vibration Level (mm/s)	
	Short-term (transient)[5]	Long-term (continuous)[6]
Line 1. Commercial or Industrial	40	10
Line 2. Residential	15	5
Line 3. Vibration sensitive	8	2.5

[5] 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*"

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

The project works are within 20m of buildings within the AUP heritage overlay. We have assessed the vibration sensitivity of the former Oakley Hospital Main Building using:

- The AUP Heritage Overlay and supporting Schedules
- A recent publicly available heritage assessment by Archifact[7]
- The Heritage NZ website listing (which does not provide any relevant information for our assessment)

The purpose is to identify the most appropriate construction vibration limits for the building to enable assessment in accordance with AUP E25.6.30 (1) (a). In summary:

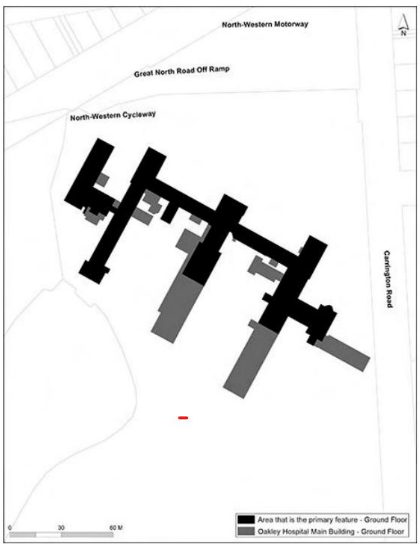
- The masonry building was formally a hospital and educational facility but is currently unoccupied.
- AUP Schedule 14.1 (ID:01618) identifies the heritage values as historical (A), social (B), physical attributes (F), aesthetic (G) and context (H). Physical attributes (F) are the heritage value that can inform vibration sensitivity. The listing refers to the primary features identified in Schedule 14.3.
- AUP Schedule 14.3 identifies the Primary features in maps 14.3.2 and 14.3.3 (reproduced in Figure 3). The relevant primary features are those in black. The closest is at least 12m from the worksite.
- Section 10 of the Archifact assessment describes the physical attributes as: *"The former Oakley Hospital Main Building is a prominent building for the region and is best understood and experienced in the round as a complex structure. It benefits from being appreciable at a range of scales from a variety of locations and is afforded visual and spatial relief through relatively low-lying or undeveloped surroundings*."

Figure 3: Oakley Hospital AUP schedule listings

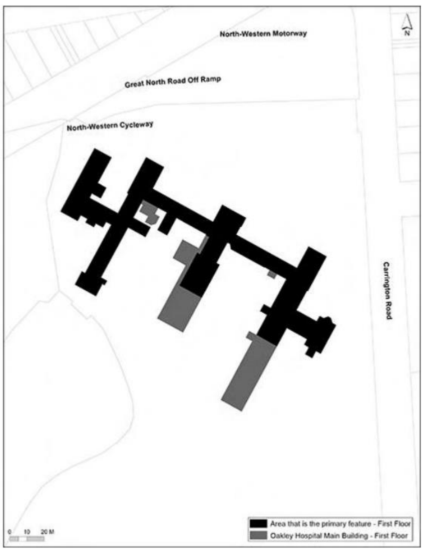
Table 1: Historic Heritage Places

ID	Place Name and/or Description	Verified Location	Verified Legal Description	Category	Primary Feature	Heritage Values	Extent of Place	Exclusions	Additional Rules for Archaeological Sites or Features	Place of Maori Interest or Significance
01618	Oakley Hospital Main Building	1 Carrington Road, Mount Albert	LOT 5 DP 314949	A	Refer to Schedule14.3 for the area of the Oakley Hospital Main Building that is identified as the primary feature that must be the used in applying rules relating to demolition or destruction	A,B,F,G,H	Refer to planning maps and Schedule 14.3	All buildings and structures constructed after 1905, whether attached to the Oakley Hospital Main Building or freestanding; all vegetation within the extent of place; all post 1905 modifications to the interior of the Oakley Hospital Main Building		

Map 14.3.2 Schedule ID 1618 – Oakley Hospital Main Building (Ground Floor)



Map 14.3.3 Schedule ID 1618 – Oakley Hospital Main Building (First Floor)



7 Archifact report 2230301, titled "*Former Oakley Hospital Main Building and extent of place*", dated July 2023

We consider the building should be assessed using either the 'commercial' (line 1) or 'residential' (line 2) criteria in DIN 4150. We reach this recommendation in the absence of any known or identified vibration sensitive structures or features that "…*because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)*". Further confidence could be provided by engaging heritage, structural, settlement, planning or other relevant experts if required.

Amenity criteria

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 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.

The 2 mm/s PPV criterion is referred to as the "amenity criterion" as it is intended to protect, to some degree, the amenity of people occupying buildings during the works.

At night-time (10pm to 7am), an amenity criterion of 0.3 mm/s PPV applies, subject to the exceptions below.

Works in the road

For road works, AUP E25.6.29(4A) states that:

"The vibration levels specified in Standard E25.6.29(1A)(b) do not apply to works within the road where:

a) for planned works, a copy of the works access permit issued by Auckland Transport or approval from the New Zealand Transport Agency is provided to the Council five days prior to work commencing; and

b) a construction noise and vibration management plan is provided to the Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29(5) below."

Works within 20m of a building included in Schedule 14.1 of the AUP:OP

The road and watermain works will be within 20m of the former Oakley Hospital Main Building (refer Section 4.1.2 above). This means that AUP:OP Standard E26.8.5.1(5) applies, which requires that a vibration management plan must be prepared by a suitably qualified and experienced person to establish that vibration levels with meet E25.6.30 Vibration. This management plan must include the information set out in E26.8.8 and be provided to Council no less than 5 days prior to works commencing.

The Vibration Management Plan must include information including the area affected by the works, contact names and number of the works supervisor, description of works and the duration, equipment and processes, and a methodology for monitoring the proposed works to measure compliance with DIN 4150-3 at the scheduled historic heritage building.

4.2 Construction noise and vibration assessment methodology and assumptions

4.2.1 Construction methodology

Given that the Project will be implemented in the future and no contractor has been engaged yet, we have based our assessment on an indicative construction methodology provided by the Project team. The construction methodology will be confirmed during the detailed design phase and finalised once a contractor has been engaged for the work.

4.2.2 Sequence

The general sequence of construction is likely to be as follows:

- Site establishment, such as vegetation removal, construction of site compounds and laydown areas
- Main works, such as earthworks, construction of bridges and retaining walls, road construction and services relocation
- Finishing works and demobilisation, such as finalising the road surfacing, road marking and landscaping

We understand that it is likely that the Project will be constructed in five stages ranging in duration from 4 to 8 months. Works for each stage would occur in various areas simultaneously, but sufficiently apart that different receivers would be affected.

The indicative staging will potentially be as follows:

- Stage 1: three work sites
  - New North Road bridge piers and columns (anticipated to be approximately 2 main piers, as well as up to 6 piers on the northern side and 10 on the southern side carrying the approach structure)
  - Carrington Road widening, kerb, footpath, cycle lane and bus stops on the western side past Gates 1 and 2
  - Rawalpindi Reserve works (service works)
- Stage 2: three work sites
  - New North Road bridge abutments and tie ins
  - Carrington Road widening, kerb, footpath, cycle lane and bus stops on the western side including past Woodard Road and Gates 3 and 4
  - Segar Ave stormwater works
- Stage 3: two work sites
  - New North Road approach existing bridge reconfiguration, kerb, footpath, cycle lane, bus stops and raised safety platforms on the eastern side of the road. Likely done during Christmas period
  - Carrington Road kerb, footpath, cycle lane, bus stops, raised safety platforms on the eastern side of the road between Sutherland Rd and Segar Ave
- Stage 4: three work sites

  - New North Road approach new bridge
  - Carrington Road kerb, footpath, cycle lane, bus stops, raised safety platforms on the eastern side of the road from Segar Ave to Gladstone Primary School
  - SH16 bridge reconfiguration on the eastern side of the road. Likely done during Christmas period
- Stage 5: two work sites
  - Carrington Road kerb, footpath, cycle lane, bus stops, raised safety platforms on the eastern side of the road from Gladstone Primary School to Prospero Terrace
  - SH16 bridge reconfiguration on the western side of the road and NW crossing. Likely done during Christmas period

Works on the pedestrian bridge across the rail will likely be undertaken largely offline. Piling works and bridge placement will be undertaken during a Block of Line, which may include night-time and weekend works. Surfacing of the completed road is proposed to be undertaken for the full length and width of the road, at night-time.

4.2.3 Watermain construction

At the same time as the road modifications are constructed, the watermain will also be installed. The pipe will run generally along the western road boundary, along an area that will be converted from the current berm to the widened roadway.

The pipe is proposed to be relatively shallow below the surface (some 1.2 to 1.5m below ground level) which means that any trenching can be retained with shoring. No sheet or vibratory piling is anticipated to be required. Works will involve an excavator, trucks and plate compactor for the excavation, fill and compaction of the pipe trench.

While the watermain is generally located in the road, one section of pipe as well as a new isolation valve chamber will be constructed outside the existing road reserve, on the Unitec site. The chamber would be located about 16m from the former Oakley Hospital Main Building (historic heritage building). Given the depth of the watermain in this area is no more than 1.5m, and the chamber is proposed to be some 1.7m deep, we understand from the Project team that sheet or vibro piling will not be required. Rather, the chamber can be constructed using shoring. Therefore, no high vibration activities are likely required.

4.2.4 Construction Times

NZS 6803 provides noise criteria for different times in the day, and the week, generally assuming construction hours to be 7.30am to 6pm, Monday to Saturday, with shoulder periods of 6.30 to 7.30am and 6 to 8pm.

We recommend that only critical work should occur outside these hours (or on public holidays and Sundays) where it cannot be undertaken safely within normal working hours. Similarly, night-time works close to dwellings should only be undertaken where it is impractical to undertake the works during daytime, e.g. where road or rail closures are required to undertake the works safely.

Where works are undertaken outside normal working hours, they will need to be considered and mitigated through a Site-Specific Noise and/or Vibration Management Schedule (Schedule) (refer Section 4.5.2).

4.2.5 Construction Duration

The overall construction duration of the Project is anticipated to be between 25 and 30 months.

Construction of the Project will be done in stages (refer Section 4.2.2). This means that high noise and/or vibration levels are experienced by individual buildings only for a limited period (e.g. weeks or months) compared with the overall construction duration of the Project of up to 30 months.

The exception is laydown areas and site yards, which will generally remain in place for a large part of the duration of construction of the Project. However, these yards do not generate high noise levels (refer Section 4.3.4).

4.3 Assessment of construction noise effects

4.3.1 Noise level predictions

Noise level predictions for construction projects take into account the sound power levels of each item of equipment and the noise propagation characteristics over distance, including the effects of ground and air absorption. We have calculated indicative noise levels in accordance with NZS 6803 and ISO 9613-2:1996 *"Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation"* for all relevant construction scenarios, assuming multiple items of equipment operating simultaneously, but taking account of spatial separation and the time component. This approach is deliberately conservative to represent the reasonable worst-case noise levels that may infrequently occur.

Other than the variations in noise level due to the factors discussed above, there are numerous additional aspects that affect construction noise generation. Some of these aspects are variations among individual items of equipment, the state of equipment repair, exact locations of each item and operator idiosyncrasies. Generally, these factors cannot be accounted for as they cannot be reasonably quantified. However, the conservative approach outlined above is considered to generally account for these variables.

Predictions are based on existing buildings in the vicinity of the Project boundary, including the new apartment buildings on the Unitec site that are currently under construction and may be constructed in the future (under the assumption that these buildings will be occupied). However, if any additional new buildings within 150m of the Project are occupied by the time of construction, these will also be addressed when mitigation is determined and that will be reflected in the Construction Noise and Vibration Management Plan (CNVMP) (refer Section 4.5.1). If any of the buildings are not occupied during construction, they are not noise sensitive receivers and would not be assessed by the CNVMP.

We have predicted construction noise levels based on experience with similar projects and in similar circumstances. We assembled a list of likely equipment that would be used on a medium to large scale roading project in New Zealand. Appendix B sets out a list of equipment and its respective sound power levels. It is important to keep in mind that this list is indicative only and is essentially the "best estimate" of equipment that could be used on the Project.

4.3.2 Activity sound power levels

Based on the sound power levels in Appendix B, we predicted combined "activity sound power levels" (refer Table 5 below). We note that not all equipment will operate consecutively and continuously. For instance, for the site establishment, the chain saws and chipper may operate at the same time, but trucks and rollers may be used at a later stage of the site establishment phase when site compounds are constructed.

Although the contractor may use different plant and equipment from what is on this list, based on experience with other road construction projects we consider that noise emissions will be similar for each activity.

From the activity sound power levels, we determined the distance at which the 70 dB L_{Aeq} day-time noise criterion can be complied with, without mitigation by noise barriers.

Table 5: Activity sound power levels and compliance distance (without shielding)

Activity	Activity sound power level (dB L_{WA})	Indicative compliance distance (m) with day-time limit (70 dB L_{Aeq})
Retaining wall construction	111	52
Bridge foundations (piling)	111	52
Service relocation	111	52
Earthworks	109	44
Pavement preparation	108	40
Site establishment	108	40
Surfacing	103	25
Construction yard	100	18

It is important to bear in mind that in an urban environment, noise levels will drop off faster as there are intervening structures and building. Therefore, the above distances are highly conservative and will in reality be likely halved due to shielding provided from buildings.

In addition, some of the activities can be mitigated with the use of temporary and movable noise barriers. That would apply to activities such as service relocation where concrete breaking will likely be undertaken using a small concrete breaker or a jack hammer, both of which are small enough to be effectively shielded.

4.3.3 Envelope of Noise Effects

Based on the predicted noise levels, we have developed effects envelopes, i.e. distances at which compliance with the daytime noise criteria can be achieved without noise mitigation in place.

The following activities have been used to determine the envelope of effects. These are the activities we consider have the greatest impact on construction noise or will be used across the widest part of the designations:

- Piling and construction of bridges and retaining walls: These may generate high noise levels due to the likely direct line-of-sight between dwellings and machinery and the high sound power levels of the equipment – these activities will be localised and apply only for small areas. Similar noise levels apply to service relocations; however, smaller equipment can be used and shielding with movable barriers applied; and
- Surfacing and pavement preparation works: These will occur across the entire Project and generate elevated noise levels due to the equipment noise levels and the number of items likely used. However, works will move along the alignments and therefore only be in any one location for limited times (e.g. a few weeks out of the overall construction period).

The zones are shown in the figures in Appendix C.

4.3.4 Predicted noise levels

Daytime

Closest dwellings are between 2 and 10 metres from the closest works (generally footpath works). Smaller equipment can be used for the construction of footpaths because they are designed to carry less weight, thus requiring less compaction. Traffic lanes will be between 5 and 15 metres from closest dwellings. Most dwellings fronting Carrington Road are predicted to receive noise levels that at times infringe the daytime noise criterion of 70 dB L_{Aeq}. However, works will occur in stages and therefore not remain in one place for extended periods. Therefore, the infringements will be of limited duration intermittently during the day, or for a few days, before moving on.

Table 6 shows the addresses of those houses where the daytime noise limit may be infringed, and figures showing the noise envelope are included in Appendix C. Due to the constrained work corridor, nearly all houses fronting the road will likely at times receive noise levels that infringe the relevant noise criteria.

Table 6: Dwellings where the daytime noise criterion may be infringed

Address	Address	Address
26, 28, 78-86 (even), 90-96 (even), 97, 98-112 (even), 116-120 (even), 119, 145, 152-160 (even), 153-161 (uneven), 166, 165-169 (uneven), 168-184 (even), 173, 179-185 (uneven), 188, 190, 191-195 (uneven), 196-206 (even), 201, 210, 212,1-4/214, 222, 224 Carrington Road	1 Carrington Road apartment buildings	66-70 (even), 71-81 (uneven) Woodward Rd
	1-3 Benfield Ave	2, 3, 7 Tasman Ave
	1, 2, 4 Counsel Terrace	6 Sutherland Rd
	1, 2 Fifth Ave	1-8 Seaview Tce
883 – 918 New North Road	1-4 Fontenoy Street	1 Segar Ave
2 Mt Albert Road	1, 2, 3, 5, 22A Willcott Street	1, 2 Prospero Tce

We predict daytime noise levels up to 85 dB L_{Aeq} for closest buildings (e.g. where works are within 2m of the façade). This is particularly the case for the piling works required for the Carrington Road bridge where piling will need to occur just outside 901 New North Road. We understand that irrespective of the methodology chosen, bored piling (600 to 750mm in diameter) will be used.

For most buildings fronting the works, we predict noise levels of around 75 dB L_{Aeq} when works are adjacent to buildings. Once works move along the alignment, noise levels will reduce to be compliant with the 70 dB L_{Aeq} noise criterion. Infringing noise levels would be intermittent, when equipment is operating immediately outside a house, but would move along with the works until the next stage of works is undertaken.

Given the staged approach to the works, it is not currently possible to state with any confidence how long noise levels may infringe the limits. Road works, while progressing along an alignment, will be undertaken for several months at a time for each stage (refer Section 4.2.2) and during that time infringements may occur from time to time, but not for the entire construction period.

Therefore, we recommend that rather than focussing on durations or times of infringements, the focus should be on the management and mitigation of effects of the entire Project through the CNVMP and Schedules (refer Section 4.5) as in our experience this will achieve the best outcome for affected parties.

Night-time

Where night-time works are required, such as for the bridge placement across the rail line adjacent to New North Road, closest dwellings are at 224 Carrington Road and 887 – 901 New North Road (uneven numbers only).[8] We anticipate that piling and retaining wall construction can generally occur during daytime as these works are outside the rail corridor. Where piles are too close to the rail for secure installation, these works will need to be undertaken during a Block of Line (BOL). This normally

8 The ECE at 222 Carrington Road would be unoccupied at night-time and therefore not a sensitive receiver.

occurs in over the summer break, i.e. in early January. The bridge placement will also require a BOL, and therefore, night-time or weekend works. We anticipate that the pedestrian bridge can be constructed in one to two nights. Bridge placement involves the use of low loaders and two mobile cranes, one either side of the rail line.

We predict external noise levels from bridge placement of around 60 dB L_{Aeq} for the upstairs residential uses in the buildings at 887 – 901 New North Road, and up to 75 dB L_{Aeq} for the apartment buildings at 224 Carrington Road. An offer of temporary relocation for the dwellings noted above for the night(s) of these works should be considered, following consultation and confirmation of construction methodology. If bedrooms face away from the works, noise levels inside the dwellings may be reasonable. However, if they are facing the works, internal noise levels may be at a level that results in sleep disturbance.

Overall, the noise levels from the road construction works are similar to those that would be experienced should the road be resurfaced during a normal maintenance schedule.

4.3.5 Effects description

Daytime

Noise levels affect people in their place of residence or work. Construction noise is inherently higher than ongoing operational noise, which is widely considered reasonable due to its limited and finite duration.

Generally, construction noise is assessed in relation to people inside buildings. We have therefore assumed that people will choose to not spend any extended periods in an outdoor area next to high noise construction activities. We have also assumed that people will keep their windows and doors closed to reduce internal noise levels. Generally, New Zealand dwelling facades reduce noise levels by 20 to 25 decibels. We have assumed conservatively a noise level reduction of 20 decibels, though any new dwellings would achieve 25 to 30 decibels noise level reduction, and commercial buildings with concrete or brick façades can even achieve noise level reductions of more than 35 decibels if there are no windows or doors facing to the works.

How people may experience noise inside or outside a building is described in Table 7. It should be noted that Table 7 does not take account of non-sensitive activities such as factories, storage spaces and similar uses.

Table 7: Potential noise effects for varying noise levels

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
Up to 65	Conversation becomes strained, particularly over longer distances.	Up to 45	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	50 to 55	Face to face and phone conversations and TV watching would continue to be affected. Office work can generally continue.

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
75 to 80	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60	Phone conversations would become difficult, and face to face conversations would need slightly raised voices. For residential activities TV and radio sound levels may need to be raised. Continuing office work may become difficult.
80 to 90	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70	Face to face conversations would require raised voices. In a residential context, people may actively seek respite if these levels are sustained for more than a period of a few hours. Concentration would start to be affected; continuing office work would be difficult and may become unproductive.

Night-time

The noise level received inside a noise sensitive space (e.g., bedroom) will depend on the external noise level, sound insulation performance of the façade (particularly the glazing) and room constants (such as the room dimensions and surface finishes). These factors can vary widely.

The Construction Noise Standard (NZS6803) recommends noise limits assessed at 1 m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, a 20-decibel reduction is particularly conservative for modern buildings. The sound insulation performance can be measured, or generally be estimated with knowledge of the façade glazing type as follows:

- Sealed glazing: 30 decibels façade sound level difference
- Closed windows (openable): 20 – 25 decibels façade sound level difference
- Open windows: 15 decibels façade sound level difference

Table 8 provides guidance on the potential night-time effects inside sensitive spaces, depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

- Typically acceptable (green)
- Sleep disturbance for some occupants (amber)
- Sleep disturbance for most occupants (red)

Table 8: Night-time noise levels in bedrooms of dwellings

External Noise Level (dB L_{Aeq})	Estimated Internal Noise Level (dB L_{Aeq})			
	Sealed glazing	Openable windows (modern building)	Openable windows (older style building)	Open windows
70 – 75	40 – 45	45 – 50	50 – 55	55 – 60
65 – 70	35 – 40	40 – 45	45 – 50	50 – 55
60 – 65	30 – 35	35 – 40	40 – 45	45 – 50
55 – 60	25 – 30	30 – 35	35 – 40	40 – 45
50 – 55	20 – 25	25 – 30	30 – 35	35 – 40
45 – 50	15 – 20	20 – 25	25 – 30	30 – 35

Table 8 shows that consultation and management will be required when night-time works occur in the vicinity of dwellings, where internal noise levels would affect sleep. This is likely to be the case for the bridge placement across the rail line adjacent to New North Road.

4.4 Assessment of construction vibration effects

4.4.1 Vibration predictions

Construction vibration is a separate issue from construction noise. Construction equipment that produces high noise levels does not necessarily also produce high vibration levels and vice versa.

Vibration prediction is less reliable than noise prediction as it is dependent on accurate modelling of ground conditions. Ground conditions are often non-homogeneous and complex in three dimensions, and consequently difficult to quantify across large construction extents.

As a result, we have determined "safe distances" based on vibration measurements[9] previously performed for high vibration sources such as vibratory rollers. The safe distances are based on vibration prediction tools as contained in Hassan (2006).[10] These have been cross-checked against empirically derived relationships as contained in BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites* Part 2: Vibration, the Transport Research Laboratory Report referenced by that standard, and previous measurements carried out by MDA. In addition, a 100% safety margin has been applied to the regression curve derived from the measured data, to take account of ground condition uncertainty and reduce residual risk for assessment against the building criteria, which in our opinion make the predictions conservative. This means that measured vibration levels were not used directly to predict potential vibration levels, but rather that the measured levels have been increased by 100%.

We have used the results from these measurements and predictions to determine risk radii within which buildings are at medium or high risk of receiving vibration levels at or above the building criteria (refer Section 4.2.1). The risk radii also consider the amenity criterion.

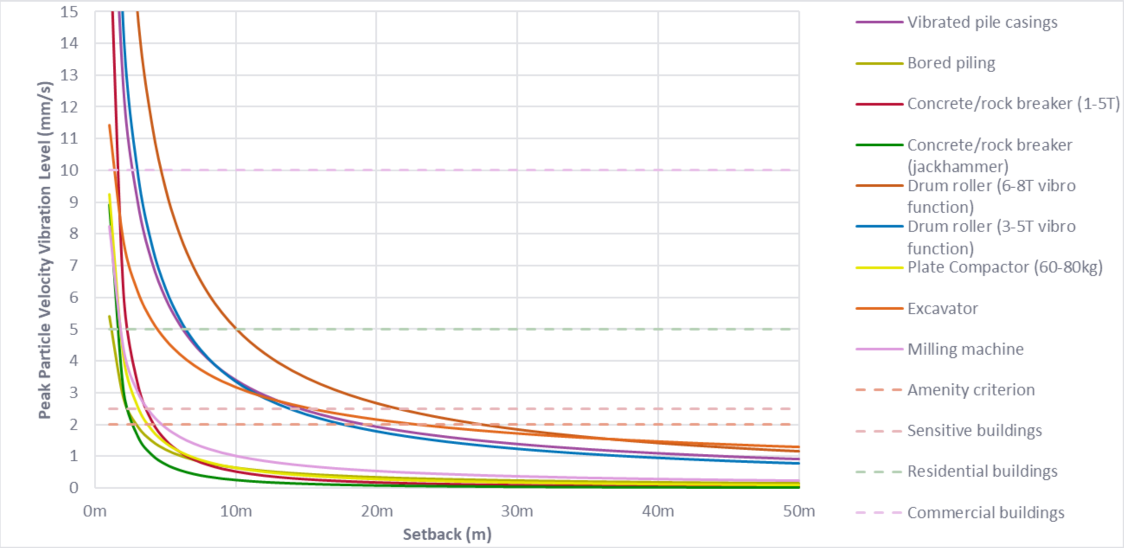
9 Measurements performed at State Highway 18, MacKays to Peka Peka, AMETI and other projects

10 Hassan, O., "Train Induced Groundborne Vibration and Noise in Buildings", Multi-Science Publishing Co Ltd, ISBN 0906522 439, 2006.

4.4.2 Equipment vibration levels

The activities that pose the greatest risk of exceeding the vibration criteria (annoyance and building as set out in Section 4.1.2) are vibratory rolling and vibropiling, however, we have included the regression curves for other activities also. The regression curves for vibratory rollers, bored piling, and vibropiling are shown in Figure 4 overleaf.

Figure 4: Vibration regression curves



4.4.3 Envelope of vibration effects

We use risk categories to define the risk of exceeding the amenity and building criteria for occupied buildings at various distances from the vibration inducing works.

The distances for the building criteria include a 100% safety factor as described in Section 4.4.1. However, the amenity criterion does not include the safety factor as it is a trigger for management and consultation, and we consider that the conservative 100% safety margin is not necessary.

Vibration criteria are significantly more stringent at dwellings during the night (0.3 mm/s PPV) and have the potential to be exceeded at distances greater than 100m from any works using vibratory rollers (see Table 9). On this basis, vibration intensive activities adjacent to residential areas should be scheduled for the daytime wherever practicable.

The risk categories are defined as follows:

- High Risk — Predicted to exceed both the amenity and building criteria
- Medium Risk — Predicted to exceed the amenity criterion, but comply with the building criteria; and
- Low Risk — Predicted to comply with both amenity and building criteria.

Table 9: Activity and vibration risk zones

Activity/Equipment	Risk Zones (distance from works)	
	Daytime	Night-time
Vibratory Roller	High: <10 m Med: 10 – 20 m Low: >20 m	High: <20 m Med: 20 – 105 m Low: >105 m

Drawings showing the approximate risk zones for the highest vibration inducing equipment (vibratory rollers) are shown in Appendix D of this report. A significant number of dwellings and other sensitive buildings (e.g. the Former Oakley Hospital Main Building) are within 10 m from the closest extent of the works – generally the reinstated footpath, but also the upgraded carriageway – which means that these buildings will likely be affected by construction vibration at times. Therefore, it is critical that the construction methodology be reviewed closer to the time of construction to ensure that vibration levels are managed appropriately.

We understand that piling for the bridge across the rail line, and any associated retaining walls will prioritise bored rather than impact or vibratory piling. Bored piling is a relatively low vibration activity, and we recommend that this be taken into consideration for the design of the Project.

4.4.4 Predicted vibration levels

Closest dwellings are between 5 and 15 metres from construction activity. Here, vibratory rollers will likely be used. We have predicted that management and mitigation will be needed to avoid infringing the building criteria at approximately 56 buildings .With the use of smaller equipment, or non-vibratory compaction, we predict that the 5 mm/s PPV criterion can be complied with at all times. This means we consider that the construction methodology should be developed to ensure no vibratory compaction within 10m of buildings and that therefore compliance with the building criteria can be achieved at all times.

Up to 112 buildings may at times experience vibration above the daytime amenity criterion of 2 mm/s PPV. Here, communication should be provided to ensure people are readily informed about potential effects and the duration and magnitude of works. Any infringements of the amenity criterion will be limited in duration (e.g. when machinery passes a building) rather than continuous and for an extended period. Effects can be managed through the CNVMP.

Figures showing the vibration zones are included in Appendix D.

4.4.5 Vibration effects

Vibration levels can be perceived well below a level at which cosmetic building damage may occur. For structural damage to occur, vibration levels would need to be magnitudes higher again. People tend to react to low vibration levels, and it is important to inform residents in the vicinity of the works of the potential for construction vibration to be felt.

Table 10 shows how people may react to various vibration levels. These effects do not consider less sensitive uses such as factories and similar.

Table 10: Vibration effects

Vibration level (mm/s PPV)	Potential effects indoors
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.

Vibration level (mm/s PPV)	Potential effects indoors
0.3	Vibration might be just perceptible in residential environments This is the AUP:OP limit for construction vibration generated at night-time for sensitive receivers.
1	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents. What people feel would be subject to the source/activity (i.e., continuous motion or a one-off event) and associated frequency (i.e., fast or slow vibration), 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. Vibration at this level could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2	Vibration would clearly be felt in all situations. Can be tolerated in indoor environments such as offices, houses, and retail, where it occurs intermittently during the day and where there is effective prior engagement. This is the AUP:OP limit for occupied buildings for construction projects generating vibration. This can be exceeded for works in the road.
5	Unlikely to be tolerable in a workplace or residential environment without prior warning and explanation. If exposure was prolonged, some people could want to leave the building affected. Computer screens would shake, and light items could fall off shelves. This is the AUP:OP limit for construction activities generating vibration between the hours of 7:00 am – 6:00 pm
10	Likely to be intolerable for anything more than a very brief exposure.

For dwellings where the amenity criterion is predicted to be exceeded, residents may be disturbed by vibration if no prior warning is given. We recommend engagement prior to construction generating vibration to avoid such a situation. We note, however, that vibration inducing equipment generally moves along the alignment, i.e. vibration levels will not remain high for any length of time.

Overall, with mitigation and management, we predict that construction vibration effects can be appropriately managed to avoid building damage and manage amenity effects. People will at times feel vibration as equipment operates close-by, but with timely information the effects can be minimised.

4.5 Management and mitigation measures

The most effective way to control construction noise and vibration is through good on-site management and communication between managers, staff and affected receivers. We have included recommended measures in this report, based on the assumed construction equipment and methodologies.

Good noise and vibration management is essential in reducing adverse effects as far as practicable, irrespective of the number of dwellings potentially affected or if noise levels may already be compliant with the relevant criteria.

4.5.1 Construction Noise and Vibration Management Plan

All appropriate mitigation and management are generally set out in a CNVMP, which would be used to manage works on site and sets out how the construction contractor interacts with the neighbouring affected parties. A CNVMP is required by the AUP:OP where works in the road plan on infringing the relevant noise and vibration criteria. In addition, the CNVMP will include the information required by E26.8.8 (Vibration Management Plan) where works are within 20m of a historic heritage building.

AUP 25.6.29(5)A states that a *"construction noise and vibration management plan must be prepared by a suitably qualified and experienced person and include the following:*

a) details of the community consultation to be undertaken to advise the occupiers of properties located within 100m of the proposed works of all of the following:

   (i) the area affected by the work;

   (ii) why the work is required to be undertaken at night (where relevant);

   (iii) the times and days when the noise and vibration is likely to be generated;

   (iv) a contact name and number of the works supervisor who can be contacted if any issues arise; and

   (v) how noise and vibration complaints will be managed and responded to;

b) a description of the works and its duration, anticipated equipment to be used, the processes to be undertaken and the predicted noise and vibration levels; and

c) identification of the best practicable options that will be undertaken to mitigate and minimise any noise and vibration being produced that is likely to exceed the relevant levels of [Table 2 and Table 3]*"*

AUP E26.8.8 states that

(1) The vibration management plan must include a description of the following:

   (a) A description of the area affected by the works,

   (b) A contact name and number of the works supervisor who can be contacted if any issues arise;

   (c) A description of the works and its duration, anticipated equipment to be used and the processes to be undertaken; and

   (d) A methodology for monitoring the proposed works to measure compliance with DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures in relation to the scheduled historic heritage building or structure.

There is significant cross over between the CNVMP and Vibration Management Plan, and we consider that these two documents can be combined in the CNVMP.

In addition, the CNVMP should include information required by NZS 6803 Section 8 and Annexure E2 such as:

- Summary of noise and vibration standards;
- Summary of assessments/predictions;
- General construction practices, management and mitigation that will be used for the Project;
- Noise management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and all night-time works;
- Monitoring and reporting requirements;
- Procedures for handling complaints; and
- Procedures for review of the CNVMP throughout the works.

The construction methodology is not yet finalised, therefore, the CNVMP should be prepared when more detail is available.

4.5.2 Schedules

In addition, Site Specific Noise and/or Vibration Management Schedules (Schedules) are a useful tool in determining how the noise and vibration effects from specific activities or in specific areas will be managed and potentially affected parties communicated with. Schedules would generally be prepared where there is a high risk of infringing the noise and/or vibration standards. Often, at the time of CNVMP preparation, not all details are known of potential infringements. These would then be addressed when they become clear during construction and are targeted at a certain task or area.

The Schedules would therefore contain detailed information on communication, management and mitigation specific to the particular aspect of works.

The following information would normally be included in a schedule:

- The activity start and finish dates;
- The nearest neighbours to the activity;
- A location plan;
- The activity equipment and methodology;
- Predicted noise/vibration levels;
- Recommended BPO mitigation;
- Documented communication and consultation with affected persons;
- Monitoring details; and
- Any pre-activity building condition survey for any buildings predicted to receive vibration levels infringing the building criteria.

They would be attached to the CNVMP, providing additional information that would sit alongside the general management and mitigation options within the CNVMP.

4.5.3 General mitigation and management measures

The following general noise and vibration mitigation measures should be implemented throughout the construction of the Project as a matter of good practice and are considered the baseline mitigation for most circumstances:

- Communication and consultation: the most important and effective management measure is public liaison and communication with people occupying buildings in the vicinity of the Project. Providing timely and detailed information to those potentially affected helps to alleviate uncertainty and concerns and builds trust between the contractor and the receivers.
- Training: all staff should participate in an induction training session prior to the start of construction, with attention given to relevant criteria, management and mitigation procedures and sensitivity of receivers.
- Equipment selection: e.g. prioritise quieter construction methodologies, electric motors over diesel engines, rubber tracked equipment over steel tracked equipment, choose suitably sized equipment and avoid tonal reversing or warning alarms
- Timing of works: where practicable, avoid night-time and Sunday works
- Stakeholder engagement: should be undertaken for occupiers of properties within 200 m of any high noise night (and weekend) works and within the setback distance for buildings receiving vibration levels meeting or exceeding the amenity criterion of 2 mm/s PPV
- Noise barriers: temporary noise barriers should be used where practicable. They should be installed prior to the relevant works commencing and maintained throughout those works.

Effective noise barriers typically reduce the received noise level at ground level by up to 10 decibels.

- Alternative mitigation options: Where all practicable noise and vibration mitigation measures have been implemented and considered, and noise or vibration levels are predicted to infringe relevant limits by a significant margin or for an extended period (e.g. more than two consecutive nights), 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. Note that temporary relocation offers are generally associated with night-time works and sleep disturbance rather than daytime noise levels, and that this will be similar for the Project. Any such alternative mitigation options would be assessed on a case-by-case basis and be recorded in a schedule.
- Building condition surveys: where there is a risk that the vibration building criteria are infringed, we recommend that a building condition survey is undertaken prior to, and again following completion of, the identified works. This will ensure that both the building owner and the contractor have certainty about the existing building condition and any damage that may have been caused by the works. In any event, we recommend that the former Oakley Hospital Main Building receives a building condition survey prior to any works on the watermain, valve chamber or road upgrades.
- Best practice general measures: Complaints can arise irrespective of compliance with the noise and vibration limits. To minimise complaints, general mitigation and management measures include avoiding unnecessary noise, high engine revs, maintenance of equipment, switching off stationary equipment, and locating equipment as far as practicable from sensitive receivers, ensuring advanced communication is complete prior to commencing identified activities; and undertaking monitoring as appropriate.

5.0 TRAFFIC NOISE AND VIBRATION

5.1 Performance standards

We reviewed the following guidelines and standards for the assessment of operational noise:

- AUP-OP, specifically Rule E25.6.33 relating to transport noise and referencing New Zealand Standard NZS 6806:2010 (NZS 6806),
- NZS 6806:2010 Acoustics – Road-traffic Noise – New and altered roads, and
- If bus stations allow for public address systems, then these should be designed to comply with the underlying zone noise limits.

While traffic on the carriageway lanes (including the bus lanes) will generate noise, the cycle and foot paths are not sufficient noise generators to be assessed here.

5.1.1 NZS 6806

NZS 6806 has been adopted as the appropriate standard for the assessment of traffic noise across New Zealand and compliance is also required under the AUP-OP and therefore has been adopted for this Project.

The intent of NZS 6806 is to provide a pragmatic approach to the use of noise mitigation. This approach includes the requirement that a roading project needs to have a noticeable noise effect before mitigation is considered, and that any mitigation needs to achieve a noticeable reduction in noise level.

NZS 6806 sets criteria to be applied to traffic noise assessments where a project triggers certain thresholds. The Standard and its triggers are briefly explained below.

- Assessment Positions are described as "Protected Premises and Facilities" (PPF). PPFs include: "*dwellings (including those that have building consent but are not built yet), educational facilities and their playgrounds within 20m of any school building, boarding houses, retirement villages, Marae, hospitals with in-patient facilities and motels/hotels in residential zones."*

  Any potential future dwellings that are not yet consented are not PPFs. Given the current well-developed character of the Project area, we consider that our predictions for the existing PPFs will also cover future additional development. Businesses and industrial operations are not PPFs as they are not considered noise sensitive and are often noise generators in their own right.

- Assessment Extent is 100m from the edge of the carriageway (i.e. the kerb) for urban areas.

- Assessment Areas are areas which collectively consider PPFs that would all benefit from the same mitigation (e.g. noise barriers).

- Design Year is a year 10 to 20 years after opening of the Project. We understand that the Project is intended to be implemented as soon as practicable, with the year of completion about 2028. However, traffic data provided was for the year 2031. We understand from the traffic experts that traffic volumes cannot grow further as this would put the occupancy beyond the capacity of the road. Therefore, we understand that the traffic volume for 2031 is "maximum reasonable capacity".

- Noise Criteria Categories are set out in NZS 6806 for 'new' and 'altered' roads. This Project is an upgrade to the existing Carrington Road. The noise criteria categories are set out in Table 11 below.

Table 11: Noise criteria categories

Category	Altered Road dB $L_{Aeq(24h)}$
A (primary external noise category)	≤ 64
B (secondary external noise category)	64 – 67
C (internal noise category)	40 (Provided the external noise level is > 67)

The applicable category at any PPF depends on the best practicable option (BPO) test, by progressively applying the noise criteria categories to determine which can practicably be achieved. NZS 6806 is clear that preference is to be given to structural mitigation (i.e. mitigation within the road) over building modification mitigation. NZS 6806 therefore requires achievement of the lowest external noise level with practicable structural mitigation, before considering building modification to mitigate internal noise levels.

- Assessment Scenarios are the various operational scenarios that we assess and compare. The Standard includes the following scenarios:
  - Existing noise environment: consists of the current road layout and traffic volume. The current road surface along the road is Asphaltic Concrete (AC14).
  - Future Do-nothing scenario: consists of the existing roads as for the existing noise environment, with traffic volume at the Design Year (2031). This scenario assumes that all level crossings remain open irrespective of the increase in rail traffic which would make this option likely impracticable.
  - Future Do-minimum scenario: consists of the proposed Project at the Design Year (2031), without any specific noise mitigation. This scenario means that the only barriers included are solid safety barriers (e.g. on the bridges), which are required for reasons other than noise mitigation. We have assumed that the same road surface (AC14) will be retained as the

“base” road surface for the Project and have included it in the Do-minimum scenario. Local roads that are not proposed to be altered by the Project are not included in the assessment.

  - Future Project with mitigation: consists of the proposed Project roads at the Design Year (2031), and includes any mitigation that is designed specifically to reduce noise levels (where required). No different road surface material was considered for any of the Project areas. We understand that for strength and skid resistance reasons, AC or Stone Mastic Asphalt (SMA) would be chosen for highly trafficked roads. Both AC and SMA have a similar correction factor and are therefore able to be used interchangeably. Porous asphalt is unsuitable for bus lanes and intersections, and is therefore not a practicable solution here.

- Mitigation Requirements are set out in the Standard based on the BPO. Mitigation is split into:
  - Structural mitigation (road surface, barriers, bunds); and
  - Building modification mitigation (improvement of building façades and ventilation, subsequent to the implementation of the structural mitigation, generally only considered for PPFs receiving noise levels within Category C).

Any mitigation should achieve a noticeable noise level reduction of an average of 3 decibels.

5.1.2 Subjective perception of noise level changes

The subjective impression of changes in noise can generally be correlated with the numerical change in noise level. While every person reacts differently to noise level changes, research shows a general correlation between noise level changes and subjective responses.[11] Table 12 shows indicative subjective responses to explain the noise level changes discussed in this report.

The perception of these noise level changes generally applies to immediate changes in noise level. This is not the case for this Project as existing roads are proposed to be modified in a minor way. However, people may subjectively have an annoyance reaction to a greater or lesser degree, depending on their perception of the Project.

Table 12: Noise level change compared with general subjective perception

Noise level change	General subjective perception[12]	Potential effects from the change in noise level[13]
1–2 decibels	Insignificant/imperceptible change	None/Not Significant
3–4 decibels	Just perceptible change	Not Significant to Slight
5–8 decibels	Appreciable to clearly noticeable change	Moderate to Substantial
9–11 decibels	Halving/doubling of loudness	Substantial to Very Substantial
>11 decibels	More than halving/doubling of loudness	Very Substantial

Noise is measured on a logarithmic scale, meaning that a doubling in traffic volume (e.g. from 10,000 vehicles per day (vpd) to 20,000 vpd) results in a noise level increase of 3 decibels, a just-perceptible

[11] For instance, LTNZ Research Report No. 292: Road traffic noise: determining the influence of New Zealand Road surfaces on noise levels and community annoyance, Table 18.

[12] Based on research by Zwicker & Scharf (1965); and Stevens (1957, 1972).

[13] Based on the Guidelines for Environmental Noise Impact Assessment, iema, Nov 2014.

change. A tenfold increase in traffic volume (e.g. from 10,000 to 100,000 vpd) would result in a noise level increase of 10 decibels, which would sound twice as loud.

5.1.3 Annoyance effects

People's responses to a particular level of road traffic noise can vary greatly. Many studies have been carried out overseas in an attempt to determine a general relationship of response to noise of a residential community as a whole.

People's responses to a particular level of road traffic noise can vary greatly. Many studies have been carried out overseas in an attempt to determine a general relationship of response to noise of a residential community as a whole.

Annoyance can be caused by a multitude of (acoustic related) issues such as:

- Noise level, e.g. how loud a noise level is
- Change in environment, e.g. how much the noise level changes due to a project, "loss of quiet"
- Character of noise, e.g. low or high frequency noise, man-made versus natural sound
- Attitude of people towards a project, e.g. if the project may benefit the person or not
- Duration of the noise, e.g. if the noise occurs only during some time of the day/week/year
- Location of noise (e.g. if a new noise source moves to the currently "quiet side" of a house)

While all of the above factors affect people's annoyance, most are difficult to quantify as they involve subjective and personal responses that cannot be studied on a population basis.

There are several notable studies of annoyance on which the 2018 World Health Organisation Noise Guidelines for the European Region[14] are based. They combine these studies to produce a table of the percentage of people highly annoyed (%HA) versus external noise level (L_{den}). The relevant table of the WHO guidelines is reproduced in Table 13 below. We approximately converted the L_{den} value to an $L_{Aeq(24h)}$ (based on the traffic distribution across a 24-hour period) to be directly comparable with the road noise assessment descriptor.

Table 13: WHO Guidelines Annoyance vs Noise Level

dB L_{den}	dB $L_{Aeq(24h)}$ (indicative)	% highly annoyed
40	35	9.0
45	40	8.0
50	45	8.6
55	50	11.0
60	55	15.1
65	60	20.9
70	65	28.4
75	70	37.6
80	75	48.5

14 https://www.who.int/europe/publications/i/item/9789289053563

The table shows that about 28% of people may be highly annoyed at an external road traffic noise level of 64 dB $L_{Aeq(24h)}$, which is the upper end of the NZS 6806 Category A for altered roads. At 67 dB $L_{Aeq(24h)}$, the upper end of Category B for altered roads, 1/3 of people may be highly annoyed.

Accordingly, using BPO mitigation to achieve the lowest practicable noise levels will ensure better amenity for people and also that a smaller number of people would be annoyed by road traffic noise.

Using the descriptor of the number of people highly annoyed allows a comparison of population responses over a wider area. We have used this measure to represent a comparison from the existing situation to the proposed Project situation over the area affected by the change in traffic flows due to the closing of some level crossings and the upgrade or construction of others, not just in the directly affected roads but also the surrounding ones.

Our assessment is based on Statistics New Zealand information,[15] which shows that for the Albert-Eden Local Board area (into which the Project falls) there are approximately 3.1 people per household.

5.1.4 Station public address systems

Public address systems, should they be installed at the bus stops, should be assessed against the relevant underlying zoning noise rules of the AUP:OP. Bus stops on the northbound side (west of Carrington Road) would be adjacent to the Mixed Use zone up to Fifth Ave, then the Special Purpose zone – Education and finally at the southern end of the Project adjacent to different Residential zones. On the southbound side (east of Carrington Road) the bus stops would be adjacent to various Residential zones and potentially a Special Purpose – Healthcare zone between Sutherland Road and Segar Ave.

In summary the relevant noise limits would be

- Residential zones — 50 dB L_{Aeq} daytime and 40 dB L_{Aeq} and 75 dB L_{AFmax} night-time
- Mixed Use zone — 65 dB L_{Aeq} daytime and 55 dB L_{Aeq} and 75 dB L_{AFmax} night-time[16]
- Special purpose zone – Education — 55 dB L_{Aeq} daytime and 45 dB L_{Aeq} and 75 dB L_{AFmax} night-time
- Special purpose zone – Healthcare — 55 dB L_{Aeq} daytime and 45 dB L_{Aeq} and 75 dB L_{AFmax} night-time

5.1.5 Traffic vibration

Generally, new, well-built roads do not cause perceptible vibration levels from traffic passing over. For that reason, we do not recommend performance standards for traffic induced vibration.

However, the Project is proposed to incorporate raised safety platforms at all local roads accessing Carrington Road. While traffic approaching or turning off Carrington Road will be slow, it still needs to pass over the safety platform. If the safety platform is well designed, vibration generation would be minimised.

Should there be concern about traffic induced vibration, we would recommend applying Norwegian Standard NS 8176 2017 for its assessment.

This standard involves measuring the vibration levels inside a dwelling during at least 15 heavy vehicle passes and using these levels to categorise the proportion of people likely to be disturbed by vibration. The vibration classes are described in Table 14 below.

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[15] https://www.stats.govt.nz/information-releases/2018-census-population-and-dwelling-counts/

[16] This zone also has some low frequency controls at night-time that are not relevant for any potential station PA systems

Table 14: NS 8176 Dwelling Classes

Dwelling Class	Statistical maximum value of weighted velocity limit	Description of effects
Class A	$V_{w,95} \leq 0.1$ mm/s	Corresponds to very good vibration conditions in which exposed people will only exceptionally be able to notice vibrations.
Class B	$V_{w,95} \leq 0.2$ mm/s	Corresponds to good vibration conditions, but exposed people may be disturbed by vibrations to a certain extent.
Class C	$V_{w,95} \leq 0.3$ mm/s	Corresponds to satisfactory vibration conditions for a large proportion of exposed people. Used as the criteria for KiwiRail and NZTA.
Class D	$V_{w,95} \leq 0.6$ mm/s	Corresponds to vibration conditions in which a majority of exposed people can be expected to be disturbed by vibrations.

The applicable class would be Class C, which is normally applied to existing roads.

5.2 Traffic noise assessment methodology and assumptions

We have assessed traffic noise effects on people based on:

- The noise criteria categories of NZS 6806 based on traffic on the Project roads only;
- The change in noise level causing adverse and positive effects depending on magnitude of change (on a population basis), based on traffic on the Project and other local roads in the area that would have an effect on the overall noise levels, to show a more realistic outcome. Note that rail noise is not included in the predictions (for the reasons discussed in the assumptions below); and
- The potential for people to be highly annoyed by the resulting traffic noise levels over the wider area, again based on both Project and local roads, but excluding rail noise.

The reason for the three-pronged approach is that in some circumstances, the effects of a noise level increase can be small (e.g. a noise level increase of less than 3 decibels). At the same time, the resulting noise levels can be very high, particularly adjacent to existing major roads, and cause (potentially further) adverse effects for residential use. Similarly, gauging the effect on the wider community, particularly for a project where the overall traffic movements will change significantly through the change in access across the rail, can best be shown through the annoyance scale.

To undertake our work, we had to make some assumptions:

- We have based our assessment of the overall noise level from road traffic numbers only, i.e. we excluded rail noise at the southern extent of the Project.
- Our computer modelling is based on information from the transportation specialists of the Project, including the likely future bus numbers on the bus lanes. The existing situation is based on traffic data obtained from mobileroad.org and checked with the transport specialists. Future data is based on modelling data provided by the transport specialists.
- Bus numbers are only available for peak hours rather than a 24-hour period. Therefore, we have assumed that 75% of all heavy vehicles on Carrington Road are buses, and the remainder trucks and other heavy vehicles.
- While there are some residential fences, we have not taken those not consideration in our predictions as they are of varying effectiveness for noise reduction. Many fences contain gaps and openings or are not high enough to result in noticeable noise level reductions. In addition,

there is no guarantee that these fences are retained and maintained as they are not under AT's control.

5.2.1 Computer noise modelling

The propagation of traffic noise is affected by multiple factors, such as:

- Terrain elevations, including shielding from intervening terrain and exposure due to elevation;
- Ground condition, including absorptive ground such as meadows or hard reflective ground;
- Atmospheric conditions, including wind or temperature inversions; and
- Road parameters, including road surface, traffic speed, vehicle types and gradient.

Because of the multiple factors and their interaction, computer noise modelling is a vital tool in predicting traffic noise impacts in the vicinity of major roads and for the determination of mitigation measures. Modelling enables a comprehensive and overall picture of noise impacts to be produced, taking into consideration all factors potentially affecting noise propagation.

We used the software SoundPLAN, which is an internationally recognised computer noise modelling programme. In summary, SoundPLAN uses a three-dimensional digital topographical terrain map of the area as its base. In addition, we entered data into the model for existing buildings, proposed earthworks edges and ground absorption within the assessment area. We digitised road traffic noise sources, with road lanes located on the terrain file, for the existing/Do-nothing scenario and the Do-minimum scenario (refer Section 5.1.1).

The SoundPLAN model implements the calculation algorithms of the "Calculation of Road Traffic Noise" (CoRTN) methodology which is referenced in NZS 6806 in Section 4.1.2. The calculation algorithms take account of the factors set out above, including relevant atmospheric and ground conditions within appropriate parameters.

We have used the adjustments for New Zealand road conditions, specifically road surface types, as set out in the Appendix of the Waka Kotahi "Guide to assessing road-traffic noise," V2.0, February 2024.[17] Therefore, modelling results can be compared with the relevant criteria without further adjustment.

Table 15 shows the road parameters that we entered into the computer noise model. The road surface correction for all scenarios is 0 and the speed 50 km/h.

Table 15: Road parameters

	Road Segment on Carrington Rd	Direction	2024 (Existing)		2031 (Do-nothing and Do-minimum)	
			AADT	HV %	AADT	HV %
1	Between New North Road and Woodward Rd	Northbound	7,000	8%	7,000	5%
		Southbound	7,000	7%	7,000	5%
2	Between Woodward Rd and Gate 3	Northbound	7,000	6%	9,000	4%
		Southbound	6,500	6%	10,000	4%
3	Between Gate 3 and Great North Road	Northbound	9,000	4%	9,500	4%
		Southbound	8,000	5%	9,500	4%

17 https://www.nzta.govt.nz/assets/resources/guide-to-assessing-road-traffic-noise/docs/guide-to-assessing-road-traffic-noise.pdf

We used the measurement results from the noise level surveys set out in Section 3.1 to verify that the computer model calculates noise levels within satisfactory tolerances. We derived a 24-hour noise level from the short duration surveys based on mean hourly variances to the 24-hour level for busy Auckland urban roads. Refer Table 15 for the derived daily noise level (based on the measured short duration levels), the predicted noise levels and the difference between prediction and measurement.

Table 16: Computer noise model verification

Position	Address	Derived noise level	Predicted noise level	Difference
		dB $L_{Aeq(24h)}$ dB	dB $L_{Aeq(24h)}$	dB
MP1	Sutherland Road	60	62	+2
MP2	Segar Avenue	59	61	+2
MP3	Gladstone Road School	64	67	+3
MP4	Woodward Road	61	64	+3
MP5	Prospero Terrace	59	59	±0

The predicted noise levels showed reasonably good agreement with the measured levels, which only provided a snapshot of the ambient noise environment at a point in time. Overall, we consider that the model performs within appropriate tolerances to be used to predict noise levels for all scenarios.

5.2.2 Individual receiver noise levels

We have assessed noise effects at all PPFs. We have included predicted noise levels for all PPFs, for all scenarios, in the tables in Appendix E of this Report. The locations of these dwellings are shown in the figures in Appendix F of this Report.

Noise criteria categories for the PPFs are shown as a graphic representation by colouring the buildings with a colour scale, showing buildings receiving noise levels within NZS 6806 Category A in green, Category B in orange and Category C in red. Any buildings not shown in these three colours on the figures are either outside the assessment area, or are not PPFs, e.g. garages, sheds or business premises.

5.2.3 Noise contour plans

Noise contour plans are a useful tool to obtain a graphical overview of a project area. The contours are calculated by SoundPLAN by interpolating a large number of individual points. Therefore, noise contour maps should not be used to “read” noise levels for specific locations. For individual noise levels specific for each PPF, the receiver noise levels in the tables should be used (refer to Appendix E).

Noise contour plans are contained in drawings in Appendix F of this Report. These plans show interpolated noise level bands at 5 decibel intervals from 55 dB to 70 dB $L_{Aeq(24h)}$.

5.2.4 Determination of preferred mitigation option

There are broadly three mitigation options that can be applied to manage road traffic noise, and are discussed in NZS 6806:

- The choice of **road surface material**, a mitigation option that reduces noise at the source (especially for roads with speeds above 40-50 km/h where the road-tyre interaction is the controlling noise source rather than engine noise);
- The installation of **noise barriers** either on the roadside or on the property boundary; and

- The inclusion (for new builds) or retrofitting (for existing buildings) of **Building Modification Mitigation** (e.g., alternative ventilation to enable windows and doors to remain closed, improved joinery and/or glazing, or, in rare cases, the installation of additional wall and ceiling lining).

NZS 6806 states:

> *The noise criteria are intended to address the adverse effects of road-traffic noise on people. Land-use planning is the preferred method of avoiding these effects. Where this is impracticable, the Standard sets out procedures and methods of the prediction, measurement and assessment, and guidelines for mitigation of road-traffic noise in accordance with the duty to adopt the best practicable option*[18]

This indicates that NZS 6806 deals with the residual noise effects after land-use planning has been implemented (or where it has been omitted in the planning stage).

Generally, mitigation is implemented from source to receiver. This means that the road surface is the first choice of mitigation measure as it protects the largest extent of receivers. Second are barriers placed either on the road edge or the property boundary. Barriers protect the area behind them, so are not suitable to shield upper floors of multi storey buildings, however, they are suitable to protect ground floors and outdoor living areas where these are facing a road. Lastly, building modification can be implemented to existing PPFs where these are not sufficiently designed to reduce internal noise levels. Building modification is the least favoured choice as it only protects individual living areas, does not protect outdoor areas and has no benefit to the wider community.

Overall, for this Project, the choice of road surface material for the traffic lanes is the most important and effective noise mitigation measure. We have assumed that the current road surface material (AC14), which is a low noise road surface, will be retained in the future.

Barriers are unlikely to be generally practicable as access to many individual residential sites will need to be maintained. Therefore, barriers may not be BPO in this context.

There is current intensification on the old Unitec site at 1 Carrington Road, with multi storey apartment buildings being constructed. Barriers would not be the BPO in this urban context and would only protect the ground floor. Higher floors would overlook any barrier. Therefore, it is most appropriate to design the apartments with the road noise environment in mind. This would include appropriate façade materials to reduce noise transmission into rooms and providing alternative ventilation for the closest houses to ensure that a suitable internal noise environment can be achieved while having fresh air intake and cooling available. This would be the responsibility of the developer rather than AT.

5.3 Predictions and assessment

We have predicted noise levels for all PPFs, for all scenarios. The assessment in accordance with NZS 6806, change in noise level and number of people highly annoyed are set out below.

5.3.1 NZS 6806

First, we determined whether an assessment in accordance with NZS 6806 is required to be carried out. For that, we determined whether the Standard would apply to the Project with respect to clause 1.5.2 for altered roads. The standard applies only when the Do-minimum noise environment is compared to the Do–nothing noise environment (refer bullet point "Assessment Scenarios" below), and either of the following occurs:

- the Do-minimum noise environment is greater than or equal to 64 dB $L_{Aeq(24h)}$ and noise levels are predicted to increase by 3 dB or more, or;

[18] NZS 6806:2010, Section 1.1.1

- the Do-minimum noise environment is greater than or equal to 68 dB $L_{Aeq(24h)}$ and noise levels are predicted to increase by 1 dB or more.

This Project does not fulfil the trigger levels to be considered an "altered roads" as the noise level increase due to the Project is less than 1 dB for PPFs with noise levels of 68 dB $L_{Aeq(24h)}$ or higher, and less than 3 dB at all other PPFs. This means that the Project has no appreciable effect on the overall noise environment, and therefore does not require traffic noise mitigation.

Nevertheless, we have undertaken an assessment based on the provisions of NZS 6806 which is shown below.

The number of PPFs is summarised in Table 17 below. The traffic noise levels for each PPF are set out in the table in Appendix E of this report. The values are rounded to the closest full number. Therefore, while it appears that in some instances the noise level increase is 1 dB or more for high noise PPFs, this is not the case, and the noise level change is less. Figures showing the location of the PPFs are included in Appendix F.

All PPFs facing Carrington Road currently experience somewhat elevated noise levels. Without the Project, in the future, noise levels would increase by 1 to 2 decibels due to increased traffic volume. We understand from the traffic specialists that the road is nearly at capacity. Therefore, the traffic volume would not increase by a significant margin.

With the proposed upgrades, including bus lanes, noise levels remain generally stable, with changes ranging from a 2 decibel reduction to a 2 decibel increase. In some instances, this means that PPFs receive noise levels in the next higher noise criteria category, however, the changes are marginal and would not be noticeable, particularly given that the character of the noise (i.e. road traffic) will not change.

Table 17: Summary of NZS 6806 assessment

Scenario	Number of PPFs pre NZS 6806 Category		
	Category A	Category B	Category C
Existing	307	42	18
Do-nothing	304	33	30
Do-minimum	301	34	32

Overall, the Project has no noticeable effect on the noise environment. This does not detract from the fact that noise levels are already high, and houses should be designed to deal with the existing (and future) traffic noise levels to ensure residential use is not adversely affected.

5.3.2 Change in noise level

All PPFs are predicted to receive noise level changes ranging from -2 to +2 dB. These are imperceptible changes, and we recommend no further mitigation in this case.

However, because of the overall high noise levels, especially for houses that receive noise levels in Category C, it may be appropriate to consider building modification mitigation on a case-by-case basis.

5.3.3 Number of people highly annoyed

As described in Section 5.1.3, we have determined the number of people potentially "highly annoyed" by the noise effects of the Project, by comparing the results of the existing and Do-nothing scenarios with the results of the Do-minimum scenario.

The total number of residents in the assessment area, based on a dwelling occupancy of 3.1 people per assessed household, is 1,138 people. Based on this number, we have provided the percentage and number of people that may be highly annoyed by noise from the roads.

Our results are summarised in Table 18 below.

Table 18: Number of people highly annoyed

Scenario	Number of people highly annoyed	Percentage of the total assessed population highly annoyed
Existing	172	15.1%
Do-nothing	180	15.8%
Do-minimum	181	15.9%

Table 18 shows that the number of people highly annoyed by road traffic noise would remain virtually unchanged without and with the Project, supporting our view that the Project has a negligible effect.

5.4 Station PA noise

Any PA system will need to be designed to achieve compliance with the relevant noise limits set out in Section 5.1.4. Most station PA systems in urban settings are highly directional, with speakers pointing down towards the person having pushed the information button. This means that noise levels drop off quickly and are often at or below ambient noise levels within 5 metres.

The design of any PA system (if proposed to be installed) can be resolved during detailed design. With standard acoustic input, compliance will be able to be achieved.

5.5 Health and amenity effects

As discussed earlier, our assessment of effects on people is generally quantitative, relating to the noise level received in the future and the change in noise level experienced due to the Project. There are also several qualitative aspects that affect how people perceive the acoustic effects of a Project. Some of those are discussed below.

While the predicted noise levels for nearly all PPFs are above 50 dB L_{Aeq} (approximately equivalent to 53-55 dB L_{den}) identified by the World Health Organisation 2018 as the level above which adverse health effects may occur, we consider this threshold is not appropriate as an assessment basis. All development has some effects, and the vast majority of PPFs currently experience similar noise levels to those that will be experienced with the Project. The current environment is already impacted by traffic noise, and the Project will have no to insignificant effects on the overall noise environment. The use of low noise road surface already results in the best noise mitigation option that is available for the environment (urban arterial) and use (residential with many driveways). We therefore consider that while it would be preferable to reduce noise levels further, this is not a feasible outcome for this Project.

5.6 Other traffic noise sources

Traffic noise is not only generated by traffic movements on the road (controlled by the road-tyre-interaction for speeds above 40 – 50 km/h). Other aspects can also have an impact on road traffic noise but are not covered by NZS 6806 or the Calculation of Road Traffic Noise (refer Section 5.1.1).

For this Project, these include:

- Traffic signals that cause traffic to slow down and speed up, resulting in a change in engine noise characteristics when decelerating and accelerating;

- Bus stops that require diesel buses to accelerate away, resulting in a higher noise level than carrying through; and
- Bridge joints where traffic needs to pass over a metal piece or vertical discontinuities which may cause a bump/impact of the tire. While no changes to the two bridges are proposed, the Project may include a resurfacing of the road, which may result in a bigger vertical discontinuity between road surfaces if not constructed well.

Each of these causes may influence traffic noise generation. Generally, the character of the traffic noise changes to include a tonal (e.g. buses starting from stop) or impact (e.g. bridge joints) component or cause a noise level or character change (e.g. traffic accelerating or braking).

Good design can reduce the change in noise level or character. For instance, the design of bridge joints is important in the reduction of impulsive noise. The joints should be smooth and interlocking, with absorptive materials in the cavity below, and road surfacing should be smoothly leading into the joint rather than provide a lip for tyres to pass over.

The above aspects should be taken into consideration during the detailed design of the Project to ensure that unnecessary and unreasonable noise generation is avoided.

6.0 RECOMMENDATIONS

Should consent be given to this Project, we recommend that the following aspects be covered in any conditions:

- Construction noise shall be measured and assessed in accordance, and comply, as far as practicable, with NZS 6803:1999 Acoustics – Construction Noise.
- Construction vibration shall be managed to comply with the vibration criteria of DIN 4150-3:2016 Vibrations in buildings – Part 3: Effects on structures. Where vibration levels are predicted to exceed 2 mm/s PPF, communication with affected receivers shall be undertaken.
- Construction noise and vibration shall be managed and mitigated using a Construction Noise and Vibration Management Plan (CNVMP), and activities predicted to infringe the relevant noise and vibration criteria shall be managed and mitigated using Schedules to the CNVMP.
- Traffic noise shall be managed and mitigated through the use of low noise road surface (AC14).

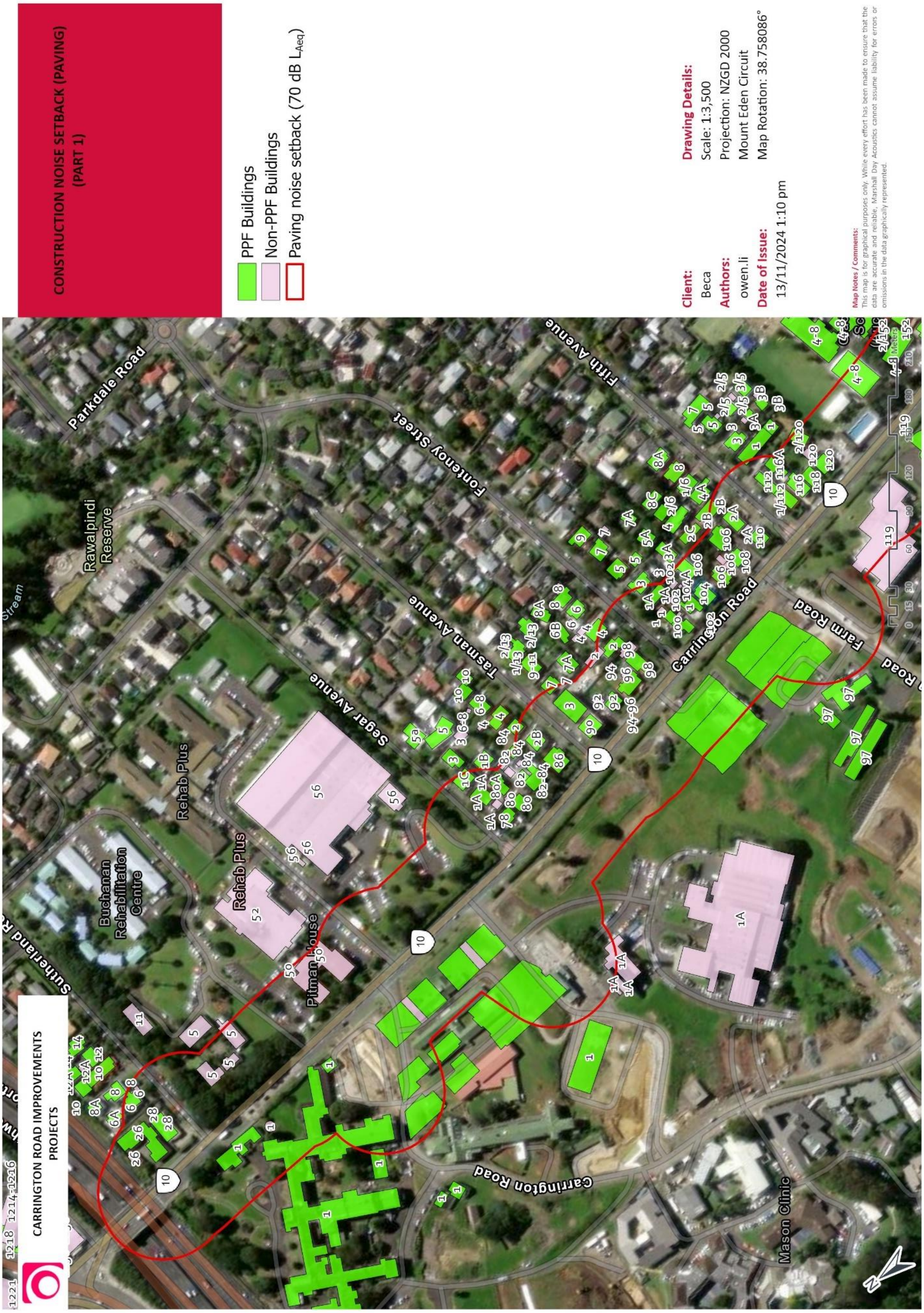
APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
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. 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).
dB	Decibel. The unit of sound level.
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
$L_{Aeq(24h)}$	The L_{Aeq} sound level averaged over a 24-hour period from midnight to midnight.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e. L_{AFmax}
NZS6801	New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound*
NZS6802	New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*
NZS6803	New Zealand Standard NZS 6803: 1999 *Acoustics - Construction Noise*
NZS 6806	New Zealand Standard NZS 6806:2010 *Acoustics - Road-traffic noise - New and altered roads*
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. 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).
PPV	Peak Particle Velocity. The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.
DIN 4150-3	Deutsche Industrie Norm 4150-3:2016 *Vibrations in buildings – Part 3: Effects on structures*

APPENDIX B EQUIPMENT SOUND POWER LEVELS

Activity	Plant type	Indicative Sound power level (dB L_{WA})
Site establishment (vegetation clearance, yard establishment)	Chainsaw	114
	Chipper	117
	Dump trucks	106
	Hydraulic excavator	103
	Vibratory roller	103
Earthworks (alignment works)	Dump truck	106
	Hydraulic excavator	103
	Bulldozer	109
	Compactor	108
	Water truck	105
Service relocation	Concrete saw	115
	Concrete trucks	103
Retaining wall construction	Vibration piling rig	116
	Rotary piling rig	111
	Concrete trucks	103
	Crane	98
	On-road trucks	100
Bridge foundations (piling)	Rotary piling rig	111
	Concrete trucks	103
Foundations and structures (bridge construction)	Crane	106
	Concrete pump	103
	Vibratory pokers	114
	Concrete trucks	103
Pavement preparation	Vibratory roller	103
	Water trucks	105
Surfacing	Paving machine	103
	Road rollers	103
	Asphalt delivery trucks	105
Yard activities	Vehicle movements	102
	Material handling	105
	Administration area	50
	Workshop	80

APPENDIX C CONSTRUCTION NOISE ZONES



MARSHALL DAY Acoustics

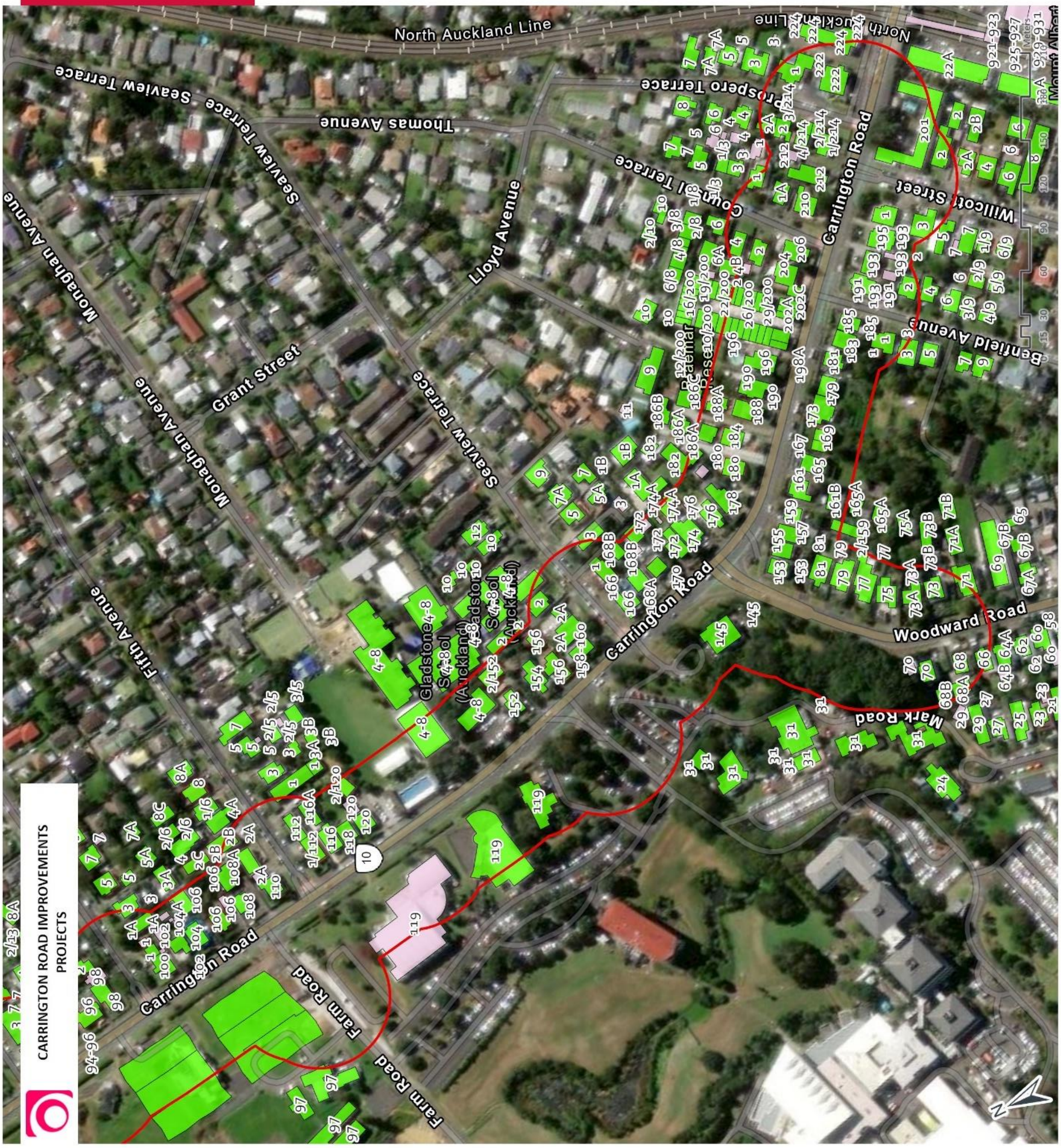
CONSTRUCTION NOISE SETBACK (PAVING) (PART 2)

- PPF Buildings
- Non-PPF Buildings
- Paving noise setback (70 dB L_{Aeq})

Client: Beca
Authors: owen.li
Date of Issue: 13/11/2024 1:10 pm

Drawing Details:
Scale: 1:3,500
Projection: NZGD 2000
Mount Eden Circuit
Map Rotation: 25.346176°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



CARRINGTON ROAD IMPROVEMENTS PROJECTS

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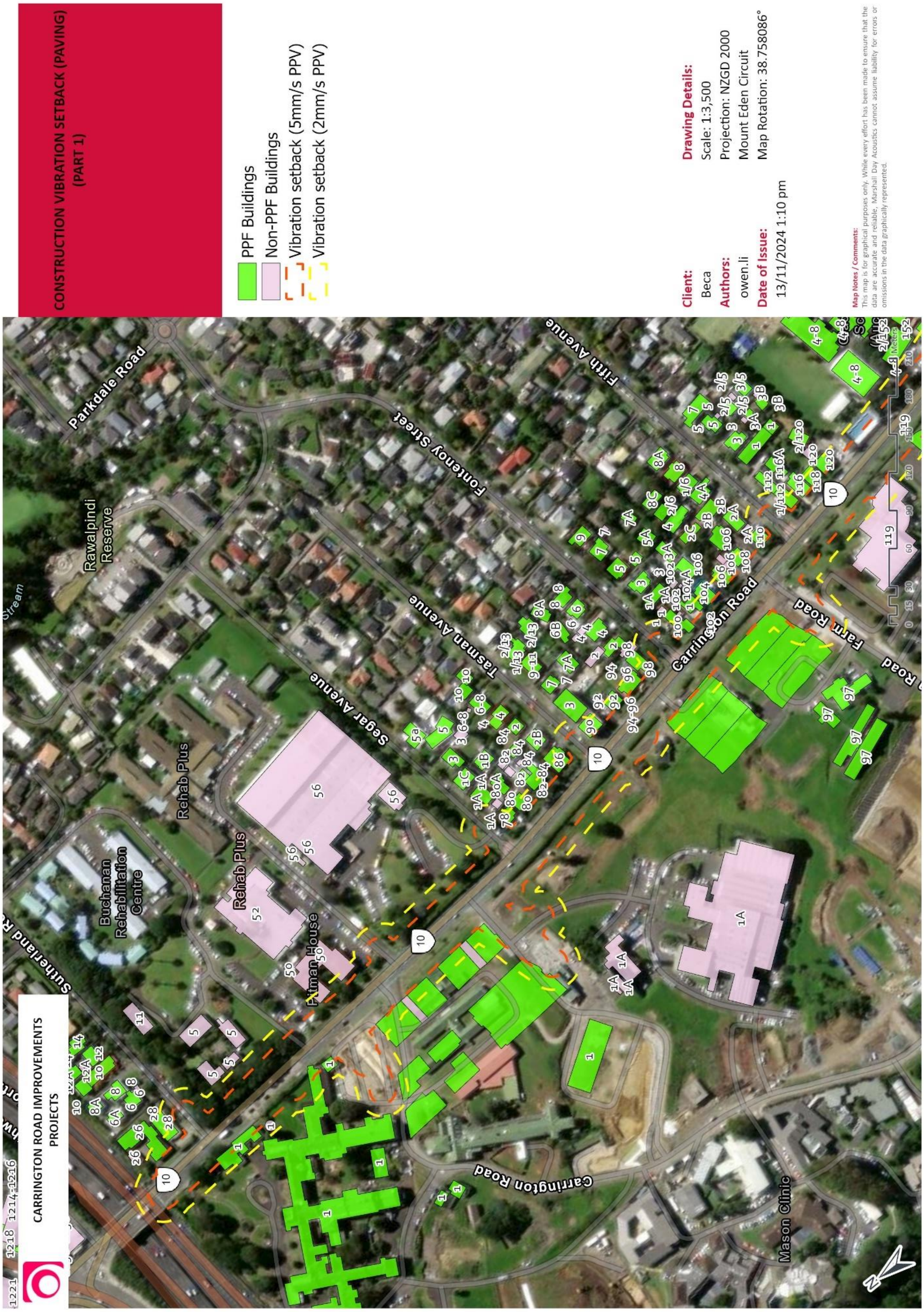
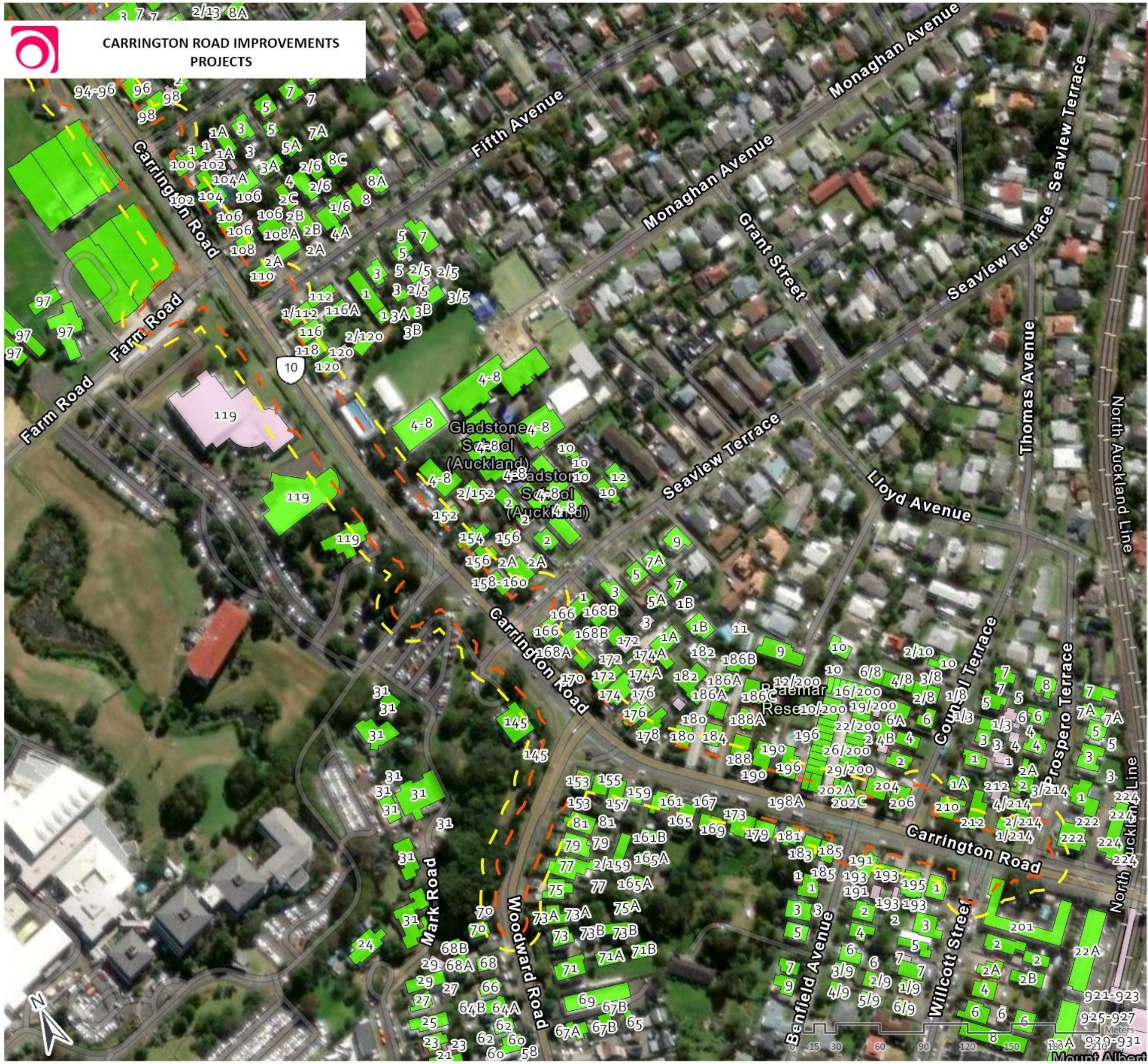
APPENDIX D VIBRATION ZONES





CONSTRUCTION VIBRATION SETBACK (PAVING) (PART 2)

- PPF Buildings
- Non-PPF Buildings
- Vibration setback (5mm/s PPV)
- Vibration setback (2mm/s PPV)

Client: Beca
Authors: owen.li
Date of Issue: 13/11/2024 1:10 pm

Drawing Details:
Scale: 1:3,500
Projection: NZGD 2000
Mount Eden Circuit
Map Rotation: 25.346176°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

MARSHALL DAY Acoustics

APPENDIX E INDIVIDUAL NOISE LEVELS FOR PPFS

The PPF cells are coloured green for Category A, yellow for Category B, and red for Category C.

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
Apartment Building 1 East (RC1)	2.FL	67	68	69
Apartment Building 1 Middle (RC1)	1.FL	59	59	60
Apartment Building 1 West (RC1)	7.FL	59	61	61
Apartment Building 10 (RC3)	8.FL	59	59	59
Apartment Building 11 (RC3)	5.FL	52	52	51
Apartment Building 2 East (RC1)	2.FL	67	68	69
Apartment Building 2 Middle (RC1)	1.FL	59	60	60
Apartment Building 2 West (RC1)	7.FL	59	60	60
Apartment Building 3 (RC2)	2.FL	68	67	68
Apartment Building 4 (RC2)	2.FL	67	67	68
Apartment Building 5 (RC2)	2.FL	67	67	68
Apartment Building 6 (RC2)	2.FL	67	67	68
Apartment Building 7 (RC3)	5.FL	59	60	60
Apartment Building 8 (RC3)	7.FL	41	40	40
Apartment Building 9 (RC3)	9.FL	57	57	57
1 Benfield Avenue	GF	49	50	50
2 Benfield Avenue	GF	52	53	53
3 Benfield Avenue	GF	50	51	51
4 Benfield Avenue	GF	52	53	52
5 Benfield Avenue	GF	48	49	49
6 Benfield Avenue	GF	51	52	51
7 Benfield Avenue	GF	48	48	48
9 Benfield Avenue	GF	48	49	48
9 Braemar Terrace	GF	44	45	45
10 Braemar Terrace	GF	43	44	44
26 Carrington Road	GF	67	67	67
28 Carrington Road	GF	65	65	65
78 Carrington Road	GF	66	66	66
80 Carrington Road	GF	67	67	67
82 Carrington Road	GF	56	56	56
84 Carrington Road	GF	49	50	50
86 Carrington Road	1.FL	68	69	68
90 Carrington Road	2.FL	68	69	69
92 Carrington Road	GF	67	67	68
97 Carrington Road	GF	43	44	44
97 Carrington Road	GF	50	51	51
97 Carrington Road	GF	43	43	43
97 Carrington Road	GF	43	44	44
98 Carrington Road	GF	67	68	68
100 Carrington Road	GF	68	69	69
102 Carrington Road	GF	66	66	66
104 Carrington Road	GF	67	68	68

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
106 Carrington Road	GF	68	68	68
108 Carrington Road	GF	67	67	67
110 Carrington Road	GF	67	68	68
112 Carrington Road	GF	56	56	57
116 Carrington Road	GF	66	68	67
118 Carrington Road	GF	66	68	67
119 Carrington Road	GF	60	61	63
119 Carrington Road	1.FL	66	67	68
120 Carrington Road	GF	67	68	68
145 Carrington Road	1.FL	64	66	66
152 Carrington Road	GF	68	69	69
153 Carrington Road	GF	63	63	65
154 Carrington Road	GF	68	69	69
155 Carrington Road	GF	64	64	66
156 Carrington Road	GF	69	70	70
156 Carrington Road	GF	51	52	52
157 Carrington Road	GF	65	65	67
159 Carrington Road	GF	65	65	67
161 Carrington Road	GF	65	66	67
165 Carrington Road	GF	54	55	55
166 Carrington Road	GF	69	71	70
167 Carrington Road	GF	56	57	57
169 Carrington Road	GF	56	56	57
170 Carrington Road	GF	65	66	66
172 Carrington Road	GF	66	67	67
173 Carrington Road	GF	58	59	58
174 Carrington Road	GF	66	67	67
176 Carrington Road	GF	68	69	68
178 Carrington Road	GF	67	68	67
179 Carrington Road	GF	62	63	62
180 Carrington Road	2.FL	67	68	67
181 Carrington Road	GF	62	63	63
182 Carrington Road	GF	47	48	48
182 Carrington Road	GF	51	52	52
183 Carrington Road	1.FL	66	67	67
184 Carrington Road	3.FL	65	66	65
185 Carrington Road	GF	64	65	65
188 Carrington Road	GF	68	68	67
190 Carrington Road	GF	67	67	66
191 Carrington Road	GF	64	64	65
193 Carrington Road	GF	64	64	65
195 Carrington Road	GF	65	65	65
196 Carrington Road	GF	67	67	67
201 Carrington Road	GF	67	68	68

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
204 Carrington Road	GF	69	70	69
206 Carrington Road	GF	68	69	68
210 Carrington Road	GF	65	65	63
212 Carrington Road	GF	67	67	67
222 Carrington Road	GF	50	50	50
222 Carrington Road	GF	60	61	60
224 Carrington Road	1.FL	59	60	60
224 Carrington Road	1.FL	50	51	51
1/112 Carrington Road	GF	66	67	67
1/200 Carrington Road	2.FL	60	60	60
1/214 Carrington Road	GF	66	66	66
10/200 Carrington Road	2.FL	49	50	50
104A Carrington Road	GF	54	55	55
108A Carrington Road	GF	52	53	53
11/200 Carrington Road	2.FL	49	49	49
116A Carrington Road	1.FL	56	57	57
12/200 Carrington Road	2.FL	48	48	49
13/200 Carrington Road	2.FL	43	44	44
14/200 Carrington Road	2.FL	43	44	44
15/200 Carrington Road	2.FL	47	48	48
158-160 Carrington Road	GF	67	69	69
16/200 Carrington Road	2.FL	47	48	48
161B Carrington Road	GF	49	50	50
165A Carrington Road	GF	45	46	46
165A Carrington Road	GF	46	47	47
168A Carrington Road	GF	63	64	64
168B Carrington Road	GF	50	51	51
17/200 Carrington Road	2.FL	43	43	43
170A Carrington Road	GF	52	54	54
174A Carrington Road	GF	51	51	52
18/200 Carrington Road	2.FL	43	44	44
184A Carrington Road	GF	49	50	50
186A Carrington Road	GF	47	47	48
186B Carrington Road	GF	45	46	46
186C Carrington Road	GF	47	48	48
188A Carrington Road	GF	51	51	51
19/200 Carrington Road	2.FL	50	51	51
198A Carrington Road	1.FL	70	71	70
198B Carrington Road	1.FL	70	71	70
2/120 Carrington Road	GF	57	58	59
2/152 Carrington Road	GF	55	57	57
2/159 Carrington Road	GF	48	49	49
2/200 Carrington Road	2.FL	57	58	58
2/214 Carrington Road	GF	60	61	61

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
20/200 Carrington Road	2.FL	51	52	52
202A Carrington Road	1.FL	70	71	70
202B Carrington Road	1.FL	70	71	70
202C Carrington Road	1.FL	70	71	70
21/200 Carrington Road	2.FL	52	52	53
22/200 Carrington Road	2.FL	52	53	53
23/200 Carrington Road	2.FL	53	53	53
24/200 Carrington Road	2.FL	53	54	54
25/200 Carrington Road	2.FL	54	54	54
26/200 Carrington Road	2.FL	54	55	55
27/200 Carrington Road	2.FL	55	56	56
28/200 Carrington Road	2.FL	56	57	57
29/200 Carrington Road	2.FL	57	58	58
3/200 Carrington Road	2.FL	56	56	56
3/214 Carrington Road	GF	56	56	56
4/200 Carrington Road	2.FL	54	55	55
4/214 Carrington Road	GF	53	52	53
5/200 Carrington Road	2.FL	53	54	54
6/200 Carrington Road	2.FL	52	53	53
7/200 Carrington Road	2.FL	51	52	52
8/200 Carrington Road	2.FL	51	51	51
80A Carrington Road	GF	53	53	54
82-84 Carrington Road	GF	65	65	65
9/200 Carrington Road	2.FL	50	50	51
94-96 Carrington Road	GF	67	67	68
1 Counsel Terrace	GF	50	50	50
2 Counsel Terrace	GF	54	54	54
3 Counsel Terrace	GF	48	48	48
4 Counsel Terrace	GF	52	53	53
5 Counsel Terrace	GF	48	48	48
6 Counsel Terrace	GF	51	52	52
7 Counsel Terrace	GF	47	48	48
10 Counsel Terrace	GF	49	49	49
45352 Counsel Terrace	GF	47	48	48
45505 Counsel Terrace	GF	48	49	49
45506 Counsel Terrace	GF	45	46	46
45507 Counsel Terrace	GF	44	45	45
45508 Counsel Terrace	GF	45	45	45
45509 Counsel Terrace	GF	45	45	45
45510 Counsel Terrace	GF	40	41	41
45567 Counsel Terrace	GF	46	46	46
1A Counsel Terrace	GF	54	54	53
4B Counsel Terrace	GF	47	48	48
6A Counsel Terrace	GF	47	47	47

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
1 Fifth Avenue	GF	51	52	52
1 Fifth Avenue	GF	51	52	53
3 Fifth Avenue	GF	50	51	51
4 Fifth Avenue	GF	45	46	46
5 Fifth Avenue	GF	49	50	50
7 Fifth Avenue	GF	49	50	50
8 Fifth Avenue	GF	46	47	47
45414 Fifth Avenue	GF	47	48	48
45415 Fifth Avenue	GF	48	49	50
45444 Fifth Avenue	GF	47	48	48
45445 Fifth Avenue	GF	44	45	45
2A Fifth Avenue	GF	54	55	55
2B Fifth Avenue	GF	49	51	50
2C Fifth Avenue	GF	47	48	48
3A Fifth Avenue	GF	49	51	51
3B Fifth Avenue	GF	52	53	53
4A Fifth Avenue	GF	51	51	52
8A Fifth Avenue	GF	46	47	47
8C Fifth Avenue	GF	45	46	46
1 Fontenoy Street	GF	58	59	59
2 Fontenoy Street	GF	51	52	51
3 Fontenoy Street	GF	52	53	53
4 Fontenoy Street	GF	51	52	52
5 Fontenoy Street	GF	47	48	48
5 Fontenoy Street	GF	51	52	52
6 Fontenoy Street	GF	50	51	50
7 Fontenoy Street	GF	48	49	49
8 Fontenoy Street	GF	49	49	49
9 Fontenoy Street	GF	48	48	49
1A Fontenoy Street	GF	55	56	55
3A Fontenoy Street	GF	47	48	48
5A Fontenoy Street	1.FL	48	50	50
6B Fontenoy Street	GF	47	48	48
7A Fontenoy Street	GF	45	46	46
8A Fontenoy Street	GF	46	47	47
1224 Great North Road	1.FL	55	55	56
1253 Great North Road	GF	50	50	50
1253 Great North Road	GF	44	44	44
1253 Great North Road	GF	40	40	40
1253 Great North Road	GF	45	45	45
1255 Great North Road	GF	56	57	57
1214-1216 Great North Road	2.FL	46	46	46
21 Mark Road	GF	43	44	44
23 Mark Road	GF	42	43	43

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
24 Mark Road	GF	45	47	47
25 Mark Road	GF	42	43	43
27 Mark Road	GF	41	42	42
29 Mark Road	GF	43	45	45
31 Mark Road	GF	51	52	52
31 Mark Road	GF	47	48	48
31 Mark Road	GF	43	45	45
31 Mark Road	GF	46	47	47
31 Mark Road	GF	45	46	47
31 Mark Road	GF	48	49	49
1B Miniver Street	1.FL	53	54	54
1C Miniver Street	1.FL	51	52	52
1D Miniver Street	1.FL	45	45	45
2 Montrose Street	GF	45	46	45
1 Mount Albert Road	GF	40	40	40
3 Mount Albert Road	GF	35	36	36
5 Mount Albert Road	GF	36	37	37
8 Mount Albert Road	GF	36	37	37
1A Mount Albert Road	1.FL	58	58	58
882 New North Road	GF	44	45	45
883 New North Road	1.FL	47	48	48
885 New North Road	1.FL	46	46	46
887 New North Road	1.FL	49	50	50
888 New North Road	1.FL	49	49	49
892 New North Road	1.FL	51	51	51
894 New North Road	1.FL	51	52	52
898 New North Road	1.FL	53	54	54
920 New North Road	1.FL	54	55	54
936 New North Road	1.FL	49	50	50
938 New North Road	1.FL	49	50	50
940 New North Road	1.FL	49	49	49
942 New North Road	1.FL	48	49	49
944 New North Road	1.FL	48	49	49
948 New North Road	1.FL	48	48	48
877-881 New North Road	1.FL	48	48	48
895-901 New North Road	1.FL	67	68	68
914-918 New North Road	1.FL	59	60	60
922-926 New North Road	1.FL	52	53	53
928-930 New North Road	1.FL	51	52	52
932-934 New North Road	1.FL	50	51	51
32 Point Chevalier Road	GF	53	54	54
22-24 Point Chevalier Road	3.FL	63	63	63
1 Prospero Terrace	GF	53	54	54
2 Prospero Terrace	GF	51	52	51

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
3 Prospero Terrace	GF	49	50	49
4 Prospero Terrace	GF	49	50	50
5 Prospero Terrace	GF	46	47	47
6 Prospero Terrace	GF	46	47	47
7 Prospero Terrace	GF	45	46	45
8 Prospero Terrace	GF	46	47	47
2A Prospero Terrace	GF	50	51	51
7A Prospero Terrace	GF	46	47	47
1 Seaview Terrace	GF	54	55	56
2 Seaview Terrace	GF	49	51	51
2 Seaview Terrace	GF	51	52	52
2 Seaview Terrace	GF	52	53	53
3 Seaview Terrace	GF	51	52	53
5 Seaview Terrace	GF	49	51	51
7 Seaview Terrace	GF	45	46	46
9 Seaview Terrace	GF	48	49	49
10 Seaview Terrace	GF	46	47	47
10 Seaview Terrace	GF	46	48	48
10 Seaview Terrace	GF	47	49	49
12 Seaview Terrace	GF	45	46	46
45508 Seaview Terrace	GF	52	53	53
45508 Seaview Terrace	GF	47	48	48
45508 Seaview Terrace	GF	63	64	64
45508 Seaview Terrace	GF	50	51	51
45508 Seaview Terrace	GF	47	48	48
45508 Seaview Terrace	1.FL	52	53	54
45508 Seaview Terrace	GF	49	50	50
45508 Seaview Terrace	1.FL	64	65	65
1A Seaview Terrace	GF	49	50	51
1B Seaview Terrace	GF	47	48	48
2A Seaview Terrace	GF	59	60	60
2A Seaview Terrace	GF	53	54	54
5A Seaview Terrace	GF	47	48	49
7A Seaview Terrace	GF	49	50	50
3 Segar Avenue	GF	54	53	53
5 Segar Avenue	GF	53	52	53
1A Segar Avenue	GF	59	59	59
1B Segar Avenue	GF	51	51	51
1C Segar Avenue	GF	57	56	57
5a Segar Avenue	GF	52	51	52
6 Sutherland Road	GF	55	54	55
8 Sutherland Road	GF	49	49	49
10 Sutherland Road	GF	53	51	52
10 Sutherland Road	GF	49	49	49

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
12 Sutherland Road	GF	47	47	47
14 Sutherland Road	GF	49	48	49
12A Sutherland Road	GF	49	49	49
6A Sutherland Road	GF	53	53	53
8A Sutherland Road	GF	52	52	52
2 Tasman Avenue	GF	50	51	51
3 Tasman Avenue	2.FL	58	59	59
4 Tasman Avenue	GF	50	50	50
7 Tasman Avenue	GF	50	50	50
10 Tasman Avenue	GF	48	48	48
10 Tasman Avenue	GF	47	47	47
41275 Tasman Avenue	GF	49	49	50
41306 Tasman Avenue	GF	47	48	48
45510 Tasman Avenue	GF	47	48	48
45605 Tasman Avenue	GF	49	50	50
2B Tasman Avenue	GF	54	54	54
7A Tasman Avenue	GF	49	50	50
1 Willcott Street	GF	65	65	66
2 Willcott Street	GF	52	51	52
2 Willcott Street	GF	47	48	47
3 Willcott Street	GF	54	54	55
4 Willcott Street	GF	49	49	49
5 Willcott Street	GF	48	49	49
6 Willcott Street	GF	48	48	48
6 Willcott Street	GF	47	48	47
7 Willcott Street	GF	48	48	48
8 Willcott Street	GF	46	46	46
45536 Willcott Street	GF	47	48	48
45537 Willcott Street	GF	47	48	47
45538 Willcott Street	GF	51	51	51
45539 Willcott Street	GF	50	51	51
45540 Willcott Street	GF	46	47	46
45541 Willcott Street	GF	46	47	46
22A Willcott Street	1.FL	62	62	62
22A Willcott Street	1.FL	46	46	46
2A Willcott Street	GF	51	51	51
2B Willcott Street	GF	47	48	48
58 Woodward Road	GF	43	43	43
60 Woodward Road	GF	42	43	43
62 Woodward Road	GF	42	43	43
65 Woodward Road	GF	43	44	44
66 Woodward Road	GF	42	43	43
68 Woodward Road	GF	41	42	42
69 Woodward Road	GF	42	43	43

Address	Floor	Existing dB $L_{Aeq(24h)}$	Do-Nothing dB $L_{Aeq(24h)}$	Do-Minimum dB $L_{Aeq(24h)}$
70 Woodward Road	GF	43	45	45
71 Woodward Road	GF	44	44	44
73 Woodward Road	GF	46	46	46
75 Woodward Road	GF	47	48	48
77 Woodward Road	GF	50	51	51
79 Woodward Road	GF	50	52	52
81 Woodward Road	GF	53	54	54
64A Woodward Road	GF	42	43	43
67A Woodward Road	GF	42	43	43
67B Woodward Road	GF	41	42	42
68A Woodward Road	GF	41	42	42
68B Woodward Road	GF	43	45	45
71A Woodward Road	1.FL	45	46	46
71B Woodward Road	1.FL	46	47	47
73A Woodward Road	GF	46	47	47
73B Woodward Road	GF	45	46	46
75A Woodward Road	GF	45	46	46

MARSHALL DAY Acoustics

APPENDIX F TRAFFIC NOISE LEVEL FIGURES

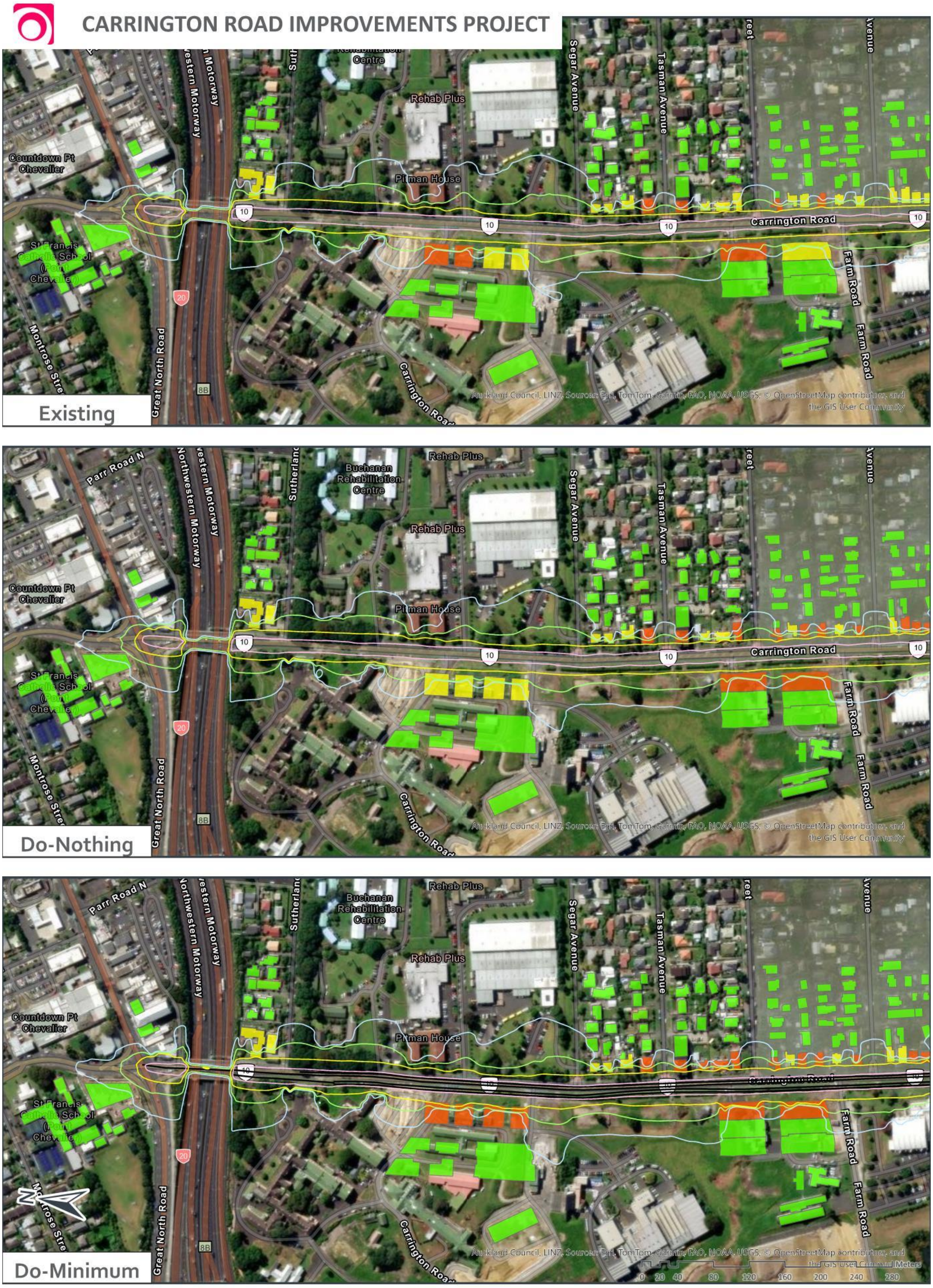
CARRINGTON ROAD IMPROVEMENTS PROJECT

Overview Map

Map Legend

Dwellings (dB $L_{Aeq(24h)}$)		Contours dB $L_{Aeq(24h)}$
<64	Category A	55
64 - 67	Category B	60
>67	Category C	65
Project Roads		70


CARRINGTON ROAD IMPROVEMENTS PROJECT
Existing
Do-Nothing
Do-Minimum
Carrington Road
Lloyd Avenue
Fifth Avenue
Seaview Terrace
Counsel Terrace
Prospero Terrace
North Auckland
Mount Albert Road
Braemar Reserve
Gladstone School (Auckland)
Willcott Street
Benfield Avenue
Mount Albert Railway Station
New North Road
Mount Albert Lawn Tennis Club
Farm Road
10
Auckland Council, LINZ, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
0 20 40 80 120 160 200 240
Meters
Supermarket


CARRINGTON ROAD IMPROVEMENTS PROJECT
Existing
Do-Nothing
Do-Minimum
Carrington Road
Segar Avenue
Tasman Avenue
Farm Road
Great North Road
Northwestern Motorway
Rehab Plus
Pitman House
Buchanan Rehabilitation Centre
Countdown Pt Chevalier
Parr Road N
Montrose Street