Construction Noise and Vibration Assessment (CNVA)

147-153 Edgewater Drive

Pakuranga, Auckland

Proposed Residential Development

Date: 5th November 2025

Prepared for: A & L Sargeant Ltd.

Prepared by: Earcon Acoustics Limited

Reference: J007260.CA

Earcon Acoustics Limited, Level 8, 139 Quay St - Auckland
www.earcon.co.nz 09 443 6410 Info@earcon.co.nz

Document Control

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Contact	Issue	Date	Rev
Alex Jacob alex.jacob@earcon.co.nz	For Internal Review	05/11/2025	Revision B
Fadia Sami fadia.sami@earcon.co.nz	For Resource Consent	05/11/2025	Revision B

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Executive Summary

The subject site is adjacent to residential dwellings. The topography of the site and the proximity and elevation of adjacent buildings would expose them to noise and vibrations from the proposed works.

The works require piling for retention and foundation piles proposed using either CFAs or traditional augering rigs/attachments, in addition to site wide cut and fill operations and compacting.

Noise

The site is in proximity to dwellings, and the proposed development requires excavation and piling. As such it is proposed that

- 2m high boundary fencing along southern boundaries with occupied receivers
- 4m high boundary fencing along the northern boundary.
- Piling and vibratory compacting limited to Monday-Friday 8:30am to 5pm.

With the proposed fencing, combined with the proposed management controls, noise levels could be maintained as low as practicably possible during the site works.

Notwithstanding that, and based on predictions of noise levels the following noise limits are recommended to be adopted for specific receivers;

During Piling

- Option 1: Continuous Flight Auger (CFA)
    - **157 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.
- Option 2: Augering attachment on excavator
    - **157 Edgewater Drive:** Up to 78dB LA_{eq} and 95dB LA_{max} for circa 1 week at any receiver reducing to 73-75dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 70-73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **126 Edgewater Drive, 2, 4 Susanne Place:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

During Earthworks *(for up to 1 week at any receiver):*

- Up to 73dB LA_{eq} and 90dB LA_{max} at 157 Edgewater Drive, 2, 4 Susanne Place.

In context of effects of these exceedances, we note that 3dBA is the general threshold of most people's ability to differentiate between sound levels. As such, the effects at 73dBA are generally similar to effects at 70dBA. For the exceedances at 75-78dBA, as a general guideline, these would be tolerable for a few weeks provided in all cases that prior notification, explanation and scheduling are communicated to the neighbours.

Noise Levels are predicted to comply with the 70dB LAeq and 85dB LAmax limits at all receivers during all other works provided the operational and procedural requirements of the Construction Noise and Vibration Management Plan (CNVMP) are adhered to and all best practice measures are followed in order to mitigate noise levels.

Vibration

Due to the proximity of the works to the adjacent properties, vibration generating works have the potential to exceed the criteria limits unless vibration levels are controlled and managed. As such, equipment restrictions are proposed whereby:

- Augering limited to attachment on excavator no larger than 23T (or using CFA with no size restrictions)
- Pre-start monitoring of casing is required if vibratory casing is deemed the only practicable option (to establish if casing can be done within the noise and vibration limits)
- Earth moving excavators:
    - Within 15m of the southern boundary limited to no larger than 23T.
    - More than 15m from the southern boundary limited to no larger than 15T.
- Compacting in the site within 15m of a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 4T can be used only with vibratory functions OFF.
    - Vibratory compacting limited to hand held compactors only, plate or rolling, no larger than 300kg.
- Compacting at more than 15m from a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 2T can be used.

If concerns arise pertaining to bore stability, the use of the following alternate methodologies shall be considered:

- Use of a CFA (Continuous Flight Auger)
- Over-boring to allow non-vibratory hydraulic insertion of casing
- Cased Auger Piling (auger and casing screwed simultaneously into soil)
- Use of Bentonite slurry.

Provided all mitigation procedures (e.g. intensity management) are implemented, and the requirements of the Construction Noise and Vibration Management Plan (CNVMP) are adhered to, it is expected that vibration levels can be managed:

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers, other than:
    - Vibration levels may during up to 3 days of augering reach up to circa 3mm/s at 157 Edgewater Drive.
    - Vibration levels may during up to 3 days of compacting reach up to circa 4mm/s at 157 Edgewater Drive and up to 3m/s at 2, 4 Susanne Place.

We note that while these would exceed the long term amenity limit of 2mm/s the levels would be below the short duration limit of 5mm/s (referenced for context only).

In context of vibration effects, provided prior warning and explanation is afforded in a timely manner to affected neighbours as per the requirements of the CNVMP, the predicted vibration levels for the durations required are noted to be tolerable in residential environments and are overall considered acceptable.

1 Introduction

This report has been prepared to assess the construction noise and vibration effects of the works associated with the proposed development at the subject site at 147-153 Edgewater Drive in Pakuranga, Auckland for a residential development.

The site for the proposed development is within four lots in a generally residential area on the eastern side of Edgewater Drive. The site is currently occupied by four dwellings, one within each of the lots, founded at the general centre of each lot. The site topography is generally flat other than a slope down to the south-east towards the reserve. The subject site also includes ancillary structures, driveways and parking areas.

The proposed development comprises the demolition and removal of the existing dwellings and the construction of two standalone six-storey apartment buildings. The northern block designated Block A includes an underground basement garaging level. The southern block, is designated Block B. The development also includes a driveway from the southern end tracking around Block B to the centre of the site and second driveway from Edgewater Drive, in addition to parking areas at the southern boundary and adjacent the northern façade of Block B.

The development requires cut and fill operations across the sites, with the majority of works comprising cuts with the deepest to circa 4.5m across the footprint of the northern block A for establishment of the garaging level. Cuts at the centre proposed to circa -1.5m, reducing to cuts and fills in the order of ±0.5m at the southern end. The depths of cuts and fills require support with retaining walls. In accordance with Geotechnical advice, retaining is proposed to be established with palisade walls comprising bored cast in-situ concrete piles.

Also in accordance with Geotechnical advice, it is our understanding that the buildings will require support on piles proposed to be established with bored cast in-situ concrete piles to depth in the order of circa 14m below current ground level (augered from the depths of cuts at the northern Block A). Compacted hardfill is likely to be required to form level building platforms.

Due to shallow groundwater (relative to augering depths) and presence of sand in the underlying strata, open bores for both retention and foundations are likely to either require temporary casing insertion and extraction in addition to pumping or alternatively using slurry (e.g. bentonite), or alternatively the use of a Continuous Flight Auger (CFA) if practicable to use.

The proposed development requires extensive augering works relative to the size of the site. As such, this assessment considers use of either traditional augers, or CFAs. We note that the proposed depths of augering (generally less than 15m) and the stratigraphy of the ground makes the use of CFAs feasible and may be advantageous in context of speed and practicability (i.e. no need for casing) and in context of noise and vibration (no extraction and clearing of auger).

As such, the proposed development requires cut and fill operations for the establishment of foundations, in addition to general excavation and trenching for services, compaction, concrete operations, and augering for retention and foundation piles, in addition to potential casing or alternatively use of a CFA. This report:

- Identifies noise and vibrations generating activities associated with the site preparation, excavation, and construction of the proposed development,
- Assesses the noise and vibration from activities against established standards
- Proposes mitigation measures and strategies to reduce the impact on potential receivers.

The overall works are anticipated to take more than 20 weeks and are therefore considered "long-term duration". This report is based on information provided by:

- Site Plans by Peddlethorp dated 23/04/2025
- Civil Plans by Dodd Civil Consultants dated 04/2025
- Geotechnical Investigation Report by LDE dated 17/04/2025

2 Site

2.1 Identification

The proposed development site is located within four lots in a generally residential area on the eastern side of Edgewater.

- LOT 143 DP 56698 [147 Edgewater Drive]
- LOT 142 DP 56698 [149 Edgewater Drive]
- LOT 141 DP 56698 [151 Edgewater Drive]
- LOT 140 DP 56698 [153 Edgewater Drive]

For ease of reference in this report, directional boundaries are noted in the figure below. For context, the subject site is circa 47m along the northern boundary, and 67m along the western boundary with Edgewater Drive.

Figure 1 - Site Location (AUP Geomaps)

2.2 Zoning

In accordance with the Auckland Unitary Plan – Operative Version, the subject site and adjacent receiver sites are zoned *Residential – Mixed Housing Suburban Zone*

Figure 2 - Site Zoning - (AUP Geomaps)

2.3 Services

As per the figure below, the site is underlain by services with a Ø150mm concrete wastewater pipe crossing north to south at the eastern and northern ends. A Ø300m concrete stormwater pipe crosses the site at the southern end. Consideration is given in this report and the associated mitigation measures to the potential for underlain services to propagate vibrations beyond surface vibrations.

Figure 3 - Services Underlying Site – (AUP Geomaps)

2.4 Heritage Sites

No heritage buildings or structures were identified in proximity to the subject site.

2.5 Vicinity

The neighbouring area adjacent to the subject site is mainly dwellings and apartment buildings. The following receiver sites are in the vicinity of the proposed development in context of noise and vibration propagation, as shown in the figures below.

- North – 157 Edgewater Drive (Ambridge Rose Manor): Two storey Aged Care facility founded at circa 1.5m from the northern boundary of the subject site. The upper floor is further offset from the boundary at circa 5.5m. It is our understanding this apartment buildings is associated with the development (under the same ownership). Nevertheless, effects on this building are considered independent of this.
- South – 2 Susanne Place: Single-storey dwelling founded at circa 3m from the boundary of the subject site.

- South-west – 1-2/1 Susanne Place: Single-storey dwelling founded at circa 38m from the boundary of the subject site.
- South-west – 141 Edgewater Drive: Two-storey dwelling founded at circa 48m from the boundary of the subject site.
- South-east – 4 Susanne Place: Single-storey dwelling founded at circa 9m from the boundary of the subject site. The lot includes a minor dwelling at the northern end, founded at circa 2m from the boundary of the subject site.
- South-east – 6 Susanne Place: Two-storey dwelling founded at circa 24m from the boundary of the subject site.
- South-east – 8 Susanne Place: Single-storey dwelling founded at circa 44m from the boundary of the subject site.
- West – 120 Edgewater Drive: Single-storey dwelling founded at circa 48m from the boundary of the subject site.
- West – 124 Edgewater Drive: Single-storey dwelling founded at circa 32m from the boundary of the subject site.
- West – 126 Edgewater Drive: Single-storey dwelling founded at circa 23m from the boundary of the subject site.
- West – 126A Edgewater Drive: Single-storey dwelling founded at circa 36m from the boundary of the subject site.
- West – 124A Edgewater Drive: Single-storey dwelling founded at circa 49m from the boundary of the subject site.
- West – 126B Edgewater Drive: Single-storey dwelling founded at circa 47m from the boundary of the subject site.
- West – 128 Edgewater Drive: Single-storey dwelling founded at circa 23m from the boundary of the subject site.
- West – 218A Edgewater Drive: Single-storey dwelling founded at circa 44m from the boundary of the subject site.
- West – 130 Edgewater Drive: Two-storey dwelling founded at circa 22m from the boundary of the subject site.
- West – 132 Edgewater Drive: Single-storey dwelling founded at circa 21m from the boundary of the subject site.

Figure 4 – Site Vicinity [AUP - Geomaps]

2.6 Stratigraphy

With reference to the Geotechnical Investigation Report, the following is understood regarding the stratigraphy of the site, as it pertains to the potential for noise and vibrations during earthworks. Depths quoted here are representative only. Reference should be made to the Geotechnical Investigation for detailed strata depths and compositions:

- Topsoil to depths of 0.0m-0.4m, with localised uncontrolled fill of clayey silts and fine gravels, overlying
- Ash to depths of 0.4m-2.0m, overlying
- Puketoka formation alluvium silts and clays to depths of 7.4m-11.5m, overlying
- Waitemata group transitional materials of silty clays and sands to depths of 10.5m-13m, overlying
- Waitemata group bedrock of very weak to weak interbedded sandstone and siltstone.
- Groundwater was encountered at depths ranging from 1.2m.

Based on the proposed development, and Geotechnical recommendations it is our understanding that:

- **Retention:** The depths of cuts and fills require support with retaining walls. In accordance with Geotechnical advice, retaining is proposed to be established with palisade walls comprising bored cast in-situ concrete piles.
- **Foundations** it is our understanding that the buildings will require support on piles proposed to be established with bored cast in-situ concrete piles to depth in the order of circa 14m below current ground level (augered from the depths of cuts at the northern Block A).
- **Casing:** Due to shallow groundwater (relative to augering depths) and the presence of sand in the underlying strata, open bores for both retention and foundations are likely to either require temporary casing insertion and extraction in addition to pumping or alternatively using slurry (e.g. bentonite), or alternatively the use of a Continuous Flight Auger (CFA) if practicable to use.

Based on the above, **augering, potential casing, excavation, carting, concrete pouring, and compacting** are likely to be the highest noise and vibration generating activities.

3 Proposed Development

The proposed development comprises the demolition and removal of the existing dwellings and the construction of two standalone six-storey apartment buildings. The northern block designated Block A includes an underground basement garaging level. The southern block, is designated Block B. The development also includes a driveway from the southern end tracking around Block B to the centre of the site and second driveway from Edgewater Drive, in addition to parking areas at the southern boundary and adjacent the northern façade of Block B.

3.1 Proposed Works

The overall works are anticipated to take more than 20 weeks and are therefore considered "long-term duration". The proposed works on the subject site include; site preparation, excavation works, piling, potential casing, foundation establishment and construction. The following is a general description of the works, with the caveat that this is indicative, and details of the works may vary.

3.1.1 Demolition and Site Clearance

The dwellings, in addition to associated foundations and ancillary structures on the site are proposed to be demolished. Demolition will consist of soft stripping of removable elements. Demolition works will mostly involve the use of an excavator with bucket, ripping or crushing attachments. Concrete foundations and pavements can also be demolished by ripping and picking. Clearance work will occur in conjunction with the demolition works.

3.1.2 Excavation

The development requires cut and fill operations across the sites, with the majority of works comprising cuts with the deepest to circa 4.5m across the footprint of the northern block A for establishment of the garaging level. Cuts at the centre proposed to circa -1.5m, reducing to cuts and fills in the order of ±0.5m at the southern end. For the purposes of this report, cut and fill operations are expected to mid to large-sized excavators with picking/ripping and loader/bucket attachments for earth moving and carting.

3.1.3 Retention

The depths of cuts and fills require support with retaining walls. In accordance with Geotechnical advice, retaining is proposed to be established with palisade walls comprising bored cast in-situ concrete piles.

Due to ground water (in context of augering depths) and the presence of sand in the strata, open bores for both retention and foundations risk collapse without casing support. As such, augering to the proposed depths may either require temporary casing insertion and extraction in addition to pumping and use of slurry, or alternatively the use of a Continuous Flight Auger (CFA) if practicable to use.

We note that CFA piling rigs generate significantly less noise and vibration level as the auger does not require repeated extraction and clearing (usually requiring counter rotation of the auger). CFA piling with very large rigs (e.g. 50T+) generates lower vibration and lower noise levels than traditional augering with mid-sized rigs (e.g. 15T-120T rigs). We note the main source of noise from CFAs is usually from the spooling of the engine at the elevation of the excavator body. The following videos and images are representative of CFA augering with a 78T rig (CFA on 58T crawler) to depths in the order of 15m.

- https://www.dropbox.com/scl/fi/qnrwf5idgyl6r54sz43pq/IMG_0264.MOV?rlkey=nf3161p03386joyxxc3a0nekb&dl=0
- https://www.dropbox.com/scl/fi/mz4f6ibruuonsjpur4658/IMG_0267.MOV?rlkey=amy5f8wojiqwz3obuebz3a65b&dl=0

Figure 5 – 78T CFA rig (58T Crawler) operating adjacent a boundary

If traditional augering rigs are used, we note these require augering to depths that can be achieve with mid-sized augering rigs, or augering attachments on mid-sized excavators.

As such, this phase of the construction is expected to require either CFA augering or traditional augering rigs with casing support, earth moving, compacting and concrete mixing and pumping as the highest noise and vibration generating activities.

If bores can be established and supported without need for CFA piling (e.g. using slury/bentonite), then taking into account the piling depths, bore diameter and the topography of the site the augering works are likely to require rigs in the order of circa 23T.

For the purposes of this assessment, and considering the expected depth of bores, retention piling, if not achieved by CFA, then can be achieved with mid-sized excavators with mounted augers. Image below, and the following videos, are representative of the type of piling operation involved if CFAs are not used.

- https://www.dropbox.com/s/g5w9s4ojbqqqac5/IMG_8594.MOV?dl=0
- https://www.dropbox.com/s/7a5buevxbnd33st/IMG_4082.MOV?dl=0
- https://www.dropbox.com/s/pfm263tfk49oz53/IMG_5360.MOV?dl=0

The use of an augering attachment on an excavator provides a number of benefits in context of noise and vibration when compared with augering rigs, especially when bores are required close to receivers:

- The main noise source being the engine can be positioned away from the boundary.
- Vibrations from excavator movement occur farther from receivers.
- The elevation of noise can be reduced compared to rigs
- The reach of the boom can be used to clear the auger away from the receivers
- Highest vibrations through tracks occur farther from the receiver (auger clearing)

Figure 6 - Example of Augering with attachment on long reach 23T excavator boom

Figure 7 - Example of augering with attachment on short reach 13T excavator boom

3.1.4 Foundations

in accordance with Geotechnical advice, it is our understanding that the buildings will require support on piles proposed to be established with bored cast in-situ concrete piles to depth in the order of circa 14m below current ground level (augered from the depths of cuts at the northern Block A).

For the purposes of this assessment, where piles foundations are required, piling is expected to require augering attachment on a mid to large-sized excavator or augering rigs, supported by excavators, or similar to retention piling, using CFAs. This phase of the construction is expected to require either CFA augering or traditional augering rigs with casing support, earth moving, compacting and concrete mixing and pumping as the highest noise and vibration generating activities.

If bores can be established and supported without need for CFA piling (e.g. using slury/bentonite), then taking into account the piling depths, bore diameter and the topography of the site the augering works are likely to require rigs in the order of circa 15T-23T.

3.1.5 Casing

If concerns arise pertaining to bore stability, the use of the following alternate methodologies can be considered:

- Use of Continuous Flight Auger (CFA)
- Over-boring to allow non-vibratory hydraulic insertion of casing
- Cased Auger Piling (auger and casing screwed simultaneously into soil)

Notwithstanding that, if casing insertion and extraction is unavoidable, then pre-start test runs shall be monitored for vibrations. This is to establish intensity and mitigation measures required to achieve compliance (e.g. over-boring) or alternatively if other methodologies are needed. Vibrations from casing insertion and extraction vary significantly depending on ground conditions and equipment used, even on a seasonal basis pertaining to moisture content in the soil. As such vibration monitoring during test runs is required if vibratory casing is deemed the only practicable option.

3.1.6 Compacting

Compacting would also be required for establishment of foundation grade. We note in this context the proximity of the proposed building footprints to the boundaries, where adjacent neighbours are also in proximity to the boundary. Restrictions on compacting equipment are required to control vibrations at the neighbouring receivers.

3.1.7 Construction

Considering the structure of the proposed buildings and provided no high noise generating activities are undertaken at elevation (e.g. use of rattling wrenches), noise levels during

construction are expected to be in line with use of general construction hand-held and bench-top tools. If high noise levels are required at elevation, alternative methodologies should be considered (e.g. torque wrenches), or additional shielding such as acoustic blankets on the structure façade or scaffolding, may be required.

3.2 Acoustic Fencing

Based on the proximity of the neighbouring receivers to the works, and the elevation of the receivers, it is reasonable to assume that acoustic perimeter fencing will be required for noise levels to be reduced, insofar as practicable, during highest noise generating activities at the boundaries; these being augering and excavations. In addition to the elevation of receivers, we also take into account the type, extent and duration of works at the different boundaries in context of required shielding. We note the following pertaining to the boundaries:

- Works associated with Block A at the northern end are offset from the northern boundary, whereby it is possible to establish elevated shielding (e.g. acoustic blankets on scaffolding.
- Shielding is most effective when close to either the source or the receiver. If at a distance from both, shielding becomes less effective. Furthermore, when the elements of the source of noise are elevated and receivers included elevated facades (upper floors), shielding becomes less effective.
- Where shielding cannot practicably be established at locations and elevations that make it effective, alternative measures are proposed to control noise through limitations of equipment and methodologies, or using localised shielding where practicable.

As such, the following is proposed:

- **Boundary Fencing with occupied receivers along the southern and southwestern boundaries:** Acoustic fencing, a minimum 2m height, is proposed to be established along the southern boundaries with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to landscape fences or chain-link fences. Fencing to be maintained at least until foundations are established.
- **Boundary Fencing with occupied receivers along the northern boundary (unless approval of apartment occupants is provided):** Acoustic fencing, a minimum 4m height, is proposed to be established along the northern boundary with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to scaffolding. Fencing to be maintained at least until foundations are established.

Due to the elevation and offset of the neighbours, combined with the distances of works to the boundaries, shielding of some receivers may not be practicable other than through use of additional localised shielding or hoisted shielding if required.

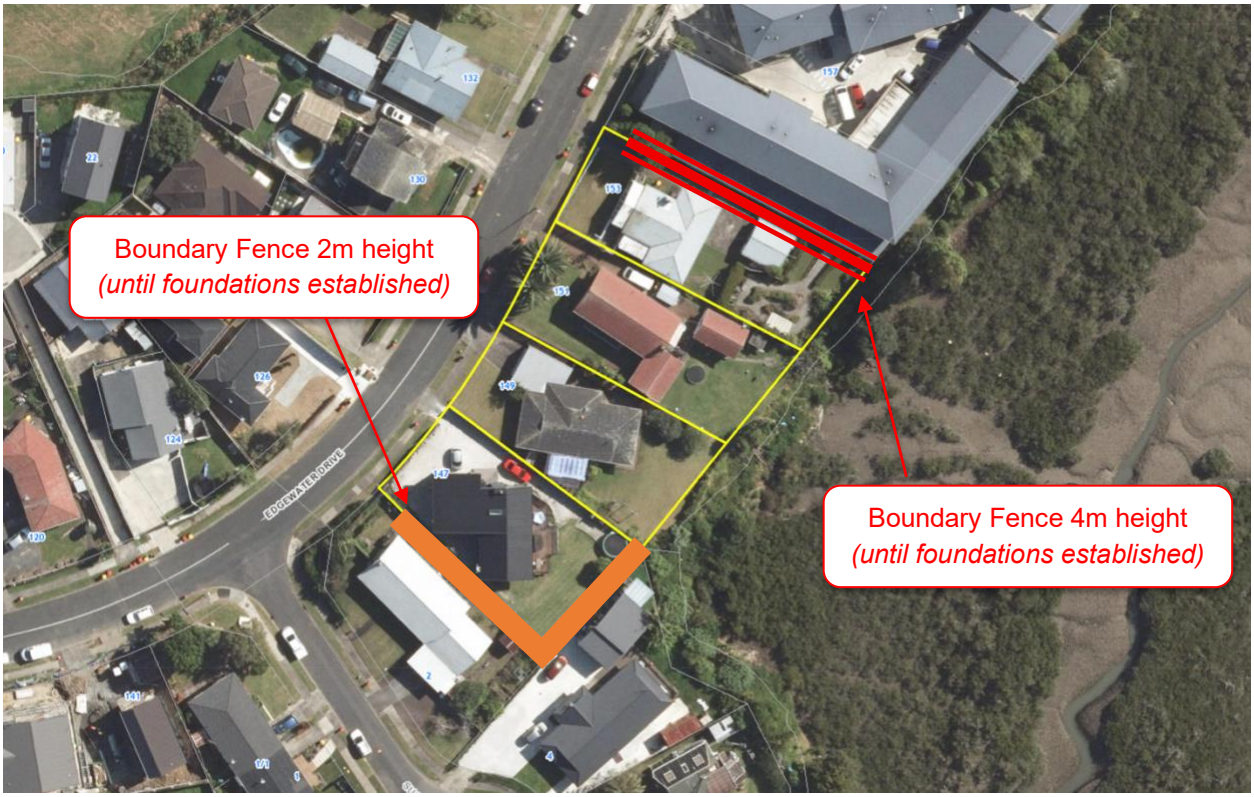


Figure 8 - Proposed Acoustic Fencing until foundations are established

3.3 Equipment and Activities

3.3.1 Noise

The following table lists relevant noise generating equipment expected to be used at different stages during the excavation and construction works on the subject site. Noise data is quoted below based on measurements undertaken by Earcon Acoustics and collated where available with data published in NZS 6803:1999, and BS 5228: Part 1:1997.

Activity	Equipment	Sound Pressure
		LA_{eq} at 10m [dB]
Truck - 20-24 Tonne	Truck - 20-24 Tonne Idling	58
	Loading soft materials	72
	Loading solid materials	75
	Tipping fill	76
Ground excavation	5T-8T Tracked Excavator	65
	9T-12T Tracked Excavator	68
	13T-15T Tracked Excavator	73
	20T-23T Tracked Excavator	75
Piling (Bored)	8T-10T Tracked Excavator	72
	13T-15T Augering Rig/Attachment	75
	Augering attachment on 23T Excavator	78
	Continuous Flight Augering (CFA) Rig	75
Levelling Ground	Grader	62
General	Water Pump	68
	Compressor	66
Lifting	Tracked Mobile Crane (30T)	66
	Tracked Mobile Crane (55T)	70
Compacting Fill	Vibratory roller 3T	67
	150kg-200kg Plate Compactor *	74
	300kg Plate Compactor *	78
Concreting	Pump + Cement Truck Discharging (Foundations)	68
	Pump with boom + Cement Truck (Upper Floors)	73
	Poker Vibrator	69

** Static Distance*

Table 1 – Equipment noise levels

3.3.2 Vibrations

The following table lists relevant vibrations generating activities expected to occur during the retention and foundation works. Vibrations data is quoted below in accordance with examples noted in standard BS 5228: Part 2:2009.

Activity	Ground	Mode	Distance	PPV
			m	mm/s
Rotary Boring - 500mm	Fill/Sand/Clay	Augering	10	0.4
		Hitting Base	14	0.3
Rotary Boring – 600mm	Sands and Gravels	Hitting Base	3.5	2.4

Table 2 - Activity Equipment Vibrations Levels - BS5228-2:2009

The following table lists relevant vibrations generating activities expected to occur during excavation works. Vibrations data is quoted below from Earcon measurements made on similar sites. These levels are for general reference only, and as noted in the Vibrations section of this report, site specific parameters (e.g. stratigraphy) and dynamics (e.g. operators) affect resultant vibration levels significantly, even for the same activity.

Activity	Mode	Distance	Frequency	PPV
		m	Hz	mm/s
Screw Piling	Hydraulic Driving	5	15	0.2-0.3
Augering	Ø 500mm augering from clear ground to 6m	3	20	0.5-1.0
		5	20	0.4-0.9
Clearing Auger	Counter rotation of auger – vibration through excavator	3	12	1.7-2.0
		5	12	1.5-1.7
Compacting Vibratory OFF	10t - Single Smooth Drum	8	25	1.2-1.7
		15	25	1.0-1.5
Compacting Vibratory On	14.5T - Padfoot	10	25	3.0-5.0
	4.5t - Padfoot	10	25	2.0-3.0
20T Excavator	Digging - Fragmented Rock	10	20	0.5-1.5
20T Excavator	Earth Moving	10	100	0.2-1.0
Truck - Laden	Driving on Irregular Ground	5	80	0.05-0.2

Table 3 - Activity Vibrations Levels – Earcon Records

4 Assessment Standards

This section details the regulatory and standards-based criteria for noise and vibrations for the construction activities on the subject site. The next section summarises the assessment criteria used in this report based on the standards in this section.

4.1 Noise Regulations and Standards

The following rules apply to the site and to surrounding sites:

E25.6.27. Construction noise levels in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone

(1) Construction activities in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone must not exceed the level in Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone when measured 1m from the façade of any building that contains an activity sensitive to noise that is occupied during the works.

Time of week	Time Period	Maximum noise level (dBA)	
		Leq	Lmax
Weekdays	6:30am – 7:30am	60	75
	7:30am – 6:00pm	75	90
	6:00pm – 8:00pm	70	85
	8:00pm – 6:30am	45	75
Saturdays	6:30am – 7:30am	45	75
	7:30am – 6:00pm	75	90
	6:00pm – 8:00pm	45	75
	8:00pm – 6:30am	45	75
Sundays and public holidays	6:30am – 7:30am	45	75
	7:30am – 6:00pm	55	85
	6:00pm – 8:00pm	45	75
	8:00pm – 6:30am	45	75

Table 4 - Referencing Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone

(3) For a project involving a total duration of construction work that is less than 15 calendar days, the noise levels in Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.27.2 Construction levels for noise affecting any other activity above may be increased by 5dB in all cases.

(4) For a project involving a total duration of construction work that is more than 20 weeks the noise limits in Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.27.2 Construction noise levels for noise effecting any other activity above pay be decreased by 5dB in all cases..

4.2 Vibration Regulations and Standards

The effects of Vibrations should be assessed against their effects on both humans and buildings. The following sections reference the criteria pertaining to each, in context of regulatory requirements and international standards. In accordance with the Auckland Unitary Plan, pertaining to construction vibrations:

E25.6.30 Vibration

(1) Construction and demolition activities must be controlled to ensure any resulting vibration does not exceed:

- *a) the limits set out in German Industrial Standard DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures when measured in accordance with that Standard on any structure not on the same site; and*
- *b) the limits in Table E25.6.30.1 Vibration limits in buildings in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.*

Receiver	*Period*	*Peak Particle Velocity Limit*
Occupied activity sensitive to noise	*Night – time 10pm to 7am*	*0.3 mm/s*
	Daytime 7 am to 10pm	*2 mm/s*
Other occupied buildings	*At all times*	*2 mm/s*

Table 5 - Referencing Table E25.6.30.1 of the AUP

Works generating vibration for three days or less between the hours of 7am to 6pm may exceed the limits in Table E25.6.30.1 Vibration limits in buildings above, but must comply with a limit of 5mm/s peak particle velocity in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building, where:

- *i. all occupied buildings within 50m of the extent of the works generating vibration are advised in writing no less than three days prior to the vibration-generating works commencing; and*
- *ii. the written advice must include details of the location of the works, the duration of the works, a phone number for complaints and the name of the site manager.*

4.2.1 Human Response

In accordance with Standard BS5228.2, Annex B.2, the threshold of human perception of vibrations is in the range of 0.14mm/s to 0.3mm/s. Vibrations above 0.3mm/s are noted to be perceptible, and above 1.0mm/s are noted to likely cause complaint, albeit be tolerable if below 10 mm/s. As per guidelines of BS5228.2, the following are vibration levels and the associated human response:

Vibration level	Effect
0.14 mm/s	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.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	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.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Table 6 - Reference Table B.1 of BS5528.2 Guidance on effects of vibration levels

4.2.2 Effects on Buildings

In accordance with the *DIN 4150-3:1999 "Structural Vibration – Part 3: Effects of Vibration on Structures"* standard additional factors apply to limit the effects of vibrations at different frequencies on different types of buildings. The DIN 4150-3:1999 guidelines are summarised in the table below:

Structure Type	Peak Particle Velocity - PPV (mm/s) at the foundation at a frequency of		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100Hz*
Industrial	20	20-40	40-50
Residential	5	5-15	15-20
Sensitive Structures	3	3-8	8-10
**At Frequencies above 100Hz, the values in this column can be used as minimum values*			

Table 7 - DIN4150-3:1999 - Guideline values of vibration velocity, for evaluating the effects of short-term vibrations

The DIN 4150-3:1999 standard provides a higher level of protection for residential buildings, especially, and takes into account the effects of vibrations at different frequencies.

4.3 Criteria

4.3.1 Metrics

In accordance with the Auckland Unitary Plan and NZ standards NZS6801, NZS6802, and NZS6803, the following metrics are used to quantify noise:

- L_{WA} [dB]: A-Frequency Weighted sound power level. This metric is primarily used to describe the power output from a sound source for the purposes of modelling.
- LA_{eq} [dB] or L_{eq} [dBA]: A-Frequency Weighted time average sound level. This metric represents the full audio range weighted against the response of the human ear. This is the primary descriptor of noise for receivers.
- LA_{max} [dB] or L_{max} [dBA]: Maximum sound pressure level.

In accordance with BS 5228-2:2009 the following metrics are used to quantify vibrations:

- PPV [mm/s]: Peak Particle Velocity is the instantaneous maximum velocity reached by a vibrating element, represented in mm/s
- Frequency [Hz]: Frequency of vibrations.

4.3.2 Noise Levels

In consideration of the following:

- The proposed works are anticipated to take more than 20 weeks and are considered long duration.
- Works on-site will be restricted to the hours of 7:30am to 6:00pm Mondays to Saturdays. More restrictive night time and Sunday noise limits are not applicable.

In accordance with the Auckland Unitary Plan requirements for the subject site zoning, the noise limits are:

Monday – Saturday 7:30am to 6:00pm

- L_{eq} 70 dBA
- L_{max} 85 dBA

4.3.3 Vibration Levels

Vibrations emanating from construction activities must be considered against two criteria; Effects on Buildings and Structures, and Effects on Humans. Taking the following into account:

- The subject site is in proximity to occupied buildings, and the proposed works are anticipated to take longer than 20 weeks. Human response to vibrations should be considered.
- Works on-site will be restricted to daytime hours. More restrictive human response considerations for the avoidance of sleep disturbance during night time are not applicable.
- The DIN-4150-3 standard provides a high level of protection for buildings, and is frequently used in New Zealand, in addition to being referenced in Auckland Unitary Plan. Based on this standard for non-industrial buildings, at the most sensitive frequency, the limit is 5mm/s. For sensitive structures the limit is lower at 3mm/s
- The Auckland Unitary Plan requires a lower limit during daytime works for occupied structures of 2mm/s.
- The BS 5228-2 standard as it pertains to human response, identifies a threshold of 1mm/s where lower levels of vibrations unlikely to cause annoyance.

In consideration of the above, the following assessment criteria will be adopted in this report, where all Vibration limits in mm/s reference the maximum absolute unweighted PPV (peak Particle Velocity) in any axis.

- Occupied Buildings: This is in accordance with E25.6.30.(1).(b) of the Auckland Unitary Plan, which takes into account the human response factors of continuous vibrations:
    - 2mm/s
- Unoccupied Buildings / Structures - Residential. The following limits are as per DIN 4150-3:1999 as referenced in 25.6.30.(1).(a) of the AUP, based on the residential structures:
    - 5mm/s @ 1-10 Hz, 5mm/s-15mm/s @ 10-50Hz, 15mm/s-20mm/s @ 50-100Hz, 20mm/s @ more than 100Hz

We note that in accordance with AUP-OP E25.6.30 (for works exceeding the amenity limit):

"All occupied buildings within 50m of the extent of the works generating vibration are advised in writing no less than three days prior to the vibration-generating works commencing; and the written advice must include details of the location of the works, the duration of the works, a phone number for complaints and the name of the site manager. "

5 Noise Assessment

This section details the assessment of noise levels on the site including models for prediction of noise from the proposed works.

5.1 Noise Modelling

5.1.1 Software

To predict noise propagation at the subject site from the proposed works, an environmental model was constructed for the works using the CadnaA computer modelling program. The following applies to the modelling software CadnaA:

- The modelling method for noise propagation over distance is based on the international standard ISO 9613: "Acoustics – Attenuation of sound during propagation outdoors" methodology.
- The model allows importing digital ground elevation contours and data to define the topography and data for each of the noise sources, and the locations, geometry and elevations of the noise receivers.
- The modelling also takes into account a multitude of additional absorption and reflection effects including ground and façade reflections.
- The program then calculates the LA_{eq} dB level, without time averaging, as the metric for the noise levels at the receivers for the purposes of this assessment.

5.1.2 Work Phases

To assess the highest levels expected from the overall works, modelling was done against the activities expected to generate the highest noise levels; namely the excavation works including piling. The modelling takes into account practicable equipment restrictions at different locations, selected as a balance between speed of progress and level of effects.

5.1.3 Modelled Mitigation Measures

The modelling includes the proposed mitigation measures of 2m, 4m acoustic fences along the northern and southern boundaries with adjacent receivers, and localised within the driveway.

5.1.4 Modelling - Activity Locations

Modelling was done for a wide range of activities and machinery locations, including for the highest noise generating phases in multiple locations representative of the works.

5.1.5 Modelled Equipment:

The following equipment was selected as representative of the highest noise generating works, with the machinery, and associated noise power levels, as noted in the table below. Modelling was done for the surrounding receiver elevations above ground level. We note that the

equipment selection is for modelling purposes only, and specific restrictions on equipment may be proposed further in this report.

Equipment	Sound pressure Level at 10m (dBA)
Excavator – 15T	73
Excavator – 23T	75
Truck – Loading	75
Augering (Alternatives)	
• Continuous Flight Augering (CFA) Rig	75
• Auger on 23T Excavator	78
Tracked Mobile Crane (30T)	66
Driven Compacting Roller 3T – non vibratory	68
Concrete Mixer and Pump	74
300kg Plate Compactor	78*

** reference level at static distance*

Table 8 - Modelling Scenarios

5.2 Modelling Analysis

Construction works are dynamic activities that have to respond to localised effects that can be impractical to predict. To accommodate for this, models are designed with conservative assumptions, and cover key activities, to represent the higher end of the noise levels expected. The following conservative assumptions were inherent in the noise models for the subject site:

- **Simultaneity**: In each modelled scenario, all machinery that can reasonably be expected to operate at the same phase of works, was assumed running at full capacity simultaneously. This does not usually occur, as sequential dependencies may require one or more machines to idle while others complete their tasks.
- **Excavation Depth***:* in each modelled scenario, noise generating machinery was assumed to operate at the highest elevation applicable. This is intended to identify the highest noise levels expected from these machines on the closest receivers. In reality, the deeper the excavations get the more shielding effects and distance effects are expected to reduce the noise levels at the receivers.
- **Time Averaging:** In all modelled scenarios, machinery was assumed to run continuously regardless of sample time period. In reality, construction works are usually highly variable with machines cycling from off (setting up), to idling (preparation) to on (operating.) Taking time averaging into account, either as a result of operational processes, or as an enforced process, would usually reduce the noise level for the compliance criteria L_{Aeq}.

5.3 Predicted Noise Levels

Provided the mitigation measures detailed in the following section, and in the CNVMP are adhered to, the predicted noise levels can be maintained as low as practicably possible. Notwithstanding that, due to proximity and elevation of the adjacent neighbours, noise levels are expected to exceed the compliance limits at some receivers during the highest noise generating activities in proximity. Considering the compliance limits of 70dB LA_{eq} and 85dB $LA_{max,}$ and taking into account the proposed equipment restrictions and mitigation measures detailed in this report, noise exceedances are expected at 1m from the facades facing the subject:

During Piling

- Option 1: Continuous Flight Auger (CFA)
    - **157 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

- Option 2: Augering attachment on excavator
    - **157 Edgewater Drive:** Up to 78dB LA_{eq} and 95dB LA_{max} for circa 1 week at any receiver reducing to 73-75dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 70-73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **126 Edgewater Drive, 2, 4 Susanne Place:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

During Earthworks *(for up to 1 week at any receiver):*

- Up to 73dB LA_{eq} and 90dB LA_{max} at **157 Edgewater Drive, 2, 4 Susanne Place**.

All Other works

- Can be managed within the compliance limit of 70dB LA_{eq} and 85dB LA_{max} at all receivers.

6 Vibration Assessment

Prediction and modelling of vibration propagation is impractical in context of construction due to the number of variables involved. Vibration prediction in construction and excavation is usually impractical and highly caveated.

The varying geological layers across a site and the constantly changing site-specific dynamics make any predictions generic and broad at best. Furthermore, it has been noted on several sites that without active monitoring and supervision, for the same machine, with the same equipment, at the same location, doing the same activity; two operators can generate significantly different vibration levels.

Focus is made in this assessment on vibration levels that can be expected in a well-managed and monitored site. Emphasis is made on achieving compliance through appropriate management procedures established from pre-activity assessments on-site followed by vibration monitoring and notifications.

The vibration levels quoted in the following sections come under two categories:

- Standard BS 5228: Levels quoted in this standard pertain to different ground strata that may not be applicable to specific sites. Vibration levels from BS5228 are referenced as indicative of the range and scale that can be expected in order to identify affected neighbours, and not as accurate predictors of levels in any specific location.
- Earcon Measurement: Vibration levels quoted from Earcon measurements pertain to actively monitored and supervised sites, comparative with the subject site, operating with effective management procedures. These quoted measurements represent vibration levels achieved while maintaining reasonable work pace and intensity.

This assessment considers examples and measurements noted in standards or taken for similar activities at different distances, assesses these against the criteria, and identifies activities at specific locations that have the potential to exceed the criteria limits

Excessive vibrations are sometimes the result of unusual activities or incidents such as dropping of large objects. These should be minimised and controlled through training, management controls and supervision.

The assessment in the following sections pertains to vibrations resulting from normal activities expected at the subject site and based on the stratigraphy of the site. The main activities to consider are Piling, Excavations and Compacting.

6.1 CFA Piling

The activities involved in CFA piling of the scale proposed, if well managed and monitored, generate vibrations in the order of **0.5 – 1.0mm/s at 5m** from the body of the excavator (main source) as per Earcon measurements at similar sites. Vibrations were also noted to be centred around the frequencies of **20Hz-50Hz.** These vibration levels generally correspond to examples cited in Standard BS 5228. Based on the proposed buildings and retention footprint, the closest retention piling locations would occur at more than 3m from the closest building footprints, or along irregular terrain that would effectively attenuate vibration propagation. As such, provided all mitigation procedures (e.g. intensity management) are implemented, it is expected that vibration levels from CFA piling operations can be managed

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers.

6.2 Augering

Augering / Boring: The activities involved in rotary boring of the scale proposed, if well managed and monitored, generate vibrations in the order of **1.5 – 2.0mm/s at 5m** from the body of the excavator (main source) as per Earcon measurements at similar sites. Vibrations were also noted to be centred around the frequencies of **15Hz-25Hz.** These vibration levels generally correspond to examples cited in Standard BS 5228. Based on the proposed buildings and retention footprint, the closest retention piling locations would occur at circa 3-5m from the closest building footprints, albeit across irregular terrain generally effective in mitigating vibration propagation. As such, in context of both noise and vibration

- Augering limited to attachment on excavator no larger than 23T (or using CFA with no size restrictions)
- Pre-start monitoring of casing is required if vibratory casing is deemed the only practicable option (to establish if casing can be done within the noise and vibration limits)

Provided all mitigation procedures (e.g. intensity management) are implemented, it is expected that vibration levels from compacting operations can be managed

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers, other than
    - Vibration levels may during up to 3 days of augering reach up to circa 3mm/s at 157 Edgewater Drive.

6.3 Excavator Operations

As with most vibration generating activities, vibration levels from excavator earth moving operations (e.g. Bucket hitting ground) vary significantly depending on operators. With proper site management, these are usually well controlled and managed. These have been found to be between 0.3mm/s-1mm/s at circa 10m. Vibration levels generated from excavator movements have been noted on several sites to be between 0.15mm/s and 0.40mm/s at circa 10m. In consideration of the proximity of the site to adjacent receivers, and in context of the area available on the site:

- Earth moving excavators:
    - Within 15m of the southern boundary limited to no larger than 23T.
    - More than 15m from the southern boundary limited to no larger than 15T.

Provided all mitigation procedures (e.g. intensity management) are implemented, it is expected that vibration levels from excavator operations can be managed:

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers

6.4 Compacting

A key activity associated with the development is compacting using vibratory equipment. This has the potential to produce vibrations under **4mm/s at 10m** using driven compactors with vibratory functions on as per measurements conducted on similar, well managed sites. Notwithstanding this, compacting has the potential to generate elevated vibration levels depending on site specific dynamics and parameters. Although compacting would occur within the cut depths (i.e. shielded by the retaining walls), vibratory compacting restrictions are proposed. In addition, management controls and training of personnel to operate equipment in a manner that minimises vibrations from this activity is required. We note that using driven compactors with vibratory functions OFF requires significantly more passes (and the associated longer duration,) albeit this is necessary in proximity to residential buildings for protection of structures. Based on the above, the following applies:

- Compacting in the site within 15m of a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 4T can be used only with vibratory functions OFF.
    - Vibratory compacting limited to hand held compactors only, plate or rolling, no larger than 300kg.
- Compacting at more than 15m from a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 2T can be used.

Provided all mitigation procedures (e.g. intensity management) are implemented, it is expected that vibration levels from compacting operations can be managed:

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers, other than
    - Vibration levels may during up to 3 days of compacting reach up to circa 4mm/s at 157 Edgewater Drive and up to 3m/s at 2, 4 Susanne Place.

7 Compliance

7.1 Noise

Due to the proximity and elevation of the neighbouring facades adjacent the boundary, and in particular during augering and earthworks, noise levels will likely be higher at these façades. Based on the assessment of practicable mitigation measures available, we recommend applying the following limit exceedances:

During Piling

- Option 1: Continuous Flight Auger (CFA)
    - **157 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

- Option 2: Augering attachment on excavator
    - **157 Edgewater Drive:** Up to 78dB LA_{eq} and 95dB LA_{max} for circa 1 week at any receiver reducing to 73-75dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 70-73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **126 Edgewater Drive, 2, 4 Susanne Place:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

During Earthworks *(for up to 1 week at any receiver):*

- Up to 73dB LA_{eq} and 90dB LA_{max} at **157 Edgewater Drive, 2, 4 Susanne Place**.

All Other works

- Can be managed within the compliance limit of 70dB LA_{eq} and 85dB LA_{max} at all other receivers during all other works

Notwithstanding the above, with the proposed perimeter fences, and with monitoring and management controls, noise levels can be managed as low as practicably possible during the site work and are considered to be acceptable at all receivers.

7.2 Vibration

Provided all mitigation procedures (e.g. intensity management) are implemented, and the requirements of the Construction Noise and Vibration Management Plan (CNVMP) are adhered to, it is expected that vibration levels will be:

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers, other than
    - Vibration levels may during up to 3 days of augering reach up to circa 3mm/s at 157 Edgewater Drive.
    - Vibration levels may during up to 3 days of compacting reach up to circa 4mm/s at 157 Edgewater Drive and up to 3m/s at 2, 4 Susanne Place.

8 Mitigation Measures

This section details the proposed mitigation measures to reduce, insofar as practicable, noise and vibrations at the surrounding sites. We note these mitigation measures form an integral part of the Construction Noise and Vibration Management Plan.

8.1 Time Restrictions

- **Augering/Piling and vibratory compacting** limited to the hours of Monday – Friday 8:30am to 5:00pm.
- All **other noise or vibration generating works** shall be limited to the hours of Monday – Saturday 7:30am to 6:00pm.

Noise or Vibration generating work shall **not** occur on Sundays.

8.2 Fencing

- **Boundary Fencing with occupied receivers along the southern and southwestern boundaries:** Acoustic fencing, a minimum 2m height, is proposed to be established along the southern boundaries with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to landscape fences or chain-link fences. Fencing to be maintained at least until foundations are established.
- **Boundary Fencing with occupied receivers along the northern boundary (unless approval of apartment occupants is provided):** Acoustic fencing, a minimum 4m height, is proposed to be established along the northern boundary with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to scaffolding. Fencing to be maintained at least until foundations are established.

Suitable acoustic blankets include:

- Duraflex 'Noise Control Barrier - Performance Series' (www.duraflex.co.nz) ,
- Hushtec 'Premium Series Noise Barrier' (www.duraflex.co.nz)
- Soundex 'Acoustic Curtain - Performance Series' (www.ultimate-solutions.co.nz),
- Soundbuffer Acoustic Curtain (www.soundbuffer.co.nz)
- Safesmart Acoustic Curtain (www.safesmartaccess.co.nz)

Suitable solid fencing includes:

- 12mm Plywood panels affixed to poles
- 12mm Saveboards (www.saveboard.nz)
- PVC Panels on weighted footings

8.3 Equipment Restrictions

The following restrictions shall be imposed on the sizes and operation of equipment:

- Augering limited to attachment on excavator no larger than 23T (or using CFA with no size restrictions)
- Earth moving excavators:
    - Within 15m of the southern boundary limited to no larger than 23T.
    - More than 15m from the southern boundary limited to no larger than 15T.
- Compacting in the site within 15m of a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 4T can be used only with vibratory functions OFF.
    - Vibratory compacting limited to hand held only no larger than 300kg.
- Compacting at more than 15m from a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 2T can be used.

8.4 Casing Methodology Requirements

If concerns arise pertaining to bore stability, the use of the following alternate methodologies should be considered:

- Use of CFA (Continuous Flight Auger)
- Over-boring to allow non-vibratory hydraulic insertion of casing
- Use of Bentonite slurry.
- Cased Auger Piling (auger and casing screwed simultaneously into soil)

Notwithstanding that, if the use of vibro casing insertion and extraction is unavoidable, then pre-start test runs shall be monitored for vibrations. This is to establish intensity and mitigation measures required to achieve compliance (e.g. over-boring) or alternatively if other methodologies are needed. Vibrations from casing insertion and extraction vary significantly depending on ground conditions and equipment used, even on a seasonal basis pertaining to moisture content in the soil. As such Pre-start monitoring of casing required if vibratory casing is deemed the only practicable option.

Pre-start Monitoring is intended to establish if, with all mitigation measures implemented, casing can be undertaken within consented noise and vibration limits. If casing cannot be undertaken within the consented limits, then an alternative methodology must be considered, such as use of bentonite.

8.5 Equipment Recommendations

- Rattling Guns: the use of rattle guns on steel or concrete structures can generate high and potentially tonal noise levels especially when occurring at elevation. The impulsiveness, sudden onset, and tonality of the events makes them particularly annoying especially considering the presence of residential facilities in the area. Alternatives include: Shear snap off bolts, Hydraulic torque wrenches.
- Stud Shots: The noise levels generated from stud shots on steel structures is highly tonal, loud, and impulsive, and can be cause for disruption and significant annoyance to neighbouring receivers. We would recommend consideration screw fixing as a best practicable option to minimise noise.

8.6 Operational Recommendations

- Concrete Pumping – Structure: If mobile concrete pumps are required, these can be positioned away from the closest residential receivers to allow for concrete pours out of hours if required structurally (or for traffic control purposes to do so.) If static pumps are proposed, it is recommended these are positioned within the structure of the building to use it as a shield for control of noise propagation. Static pumps can also be locally shielded by acoustic enclosures (e.g. using acoustic blankets)

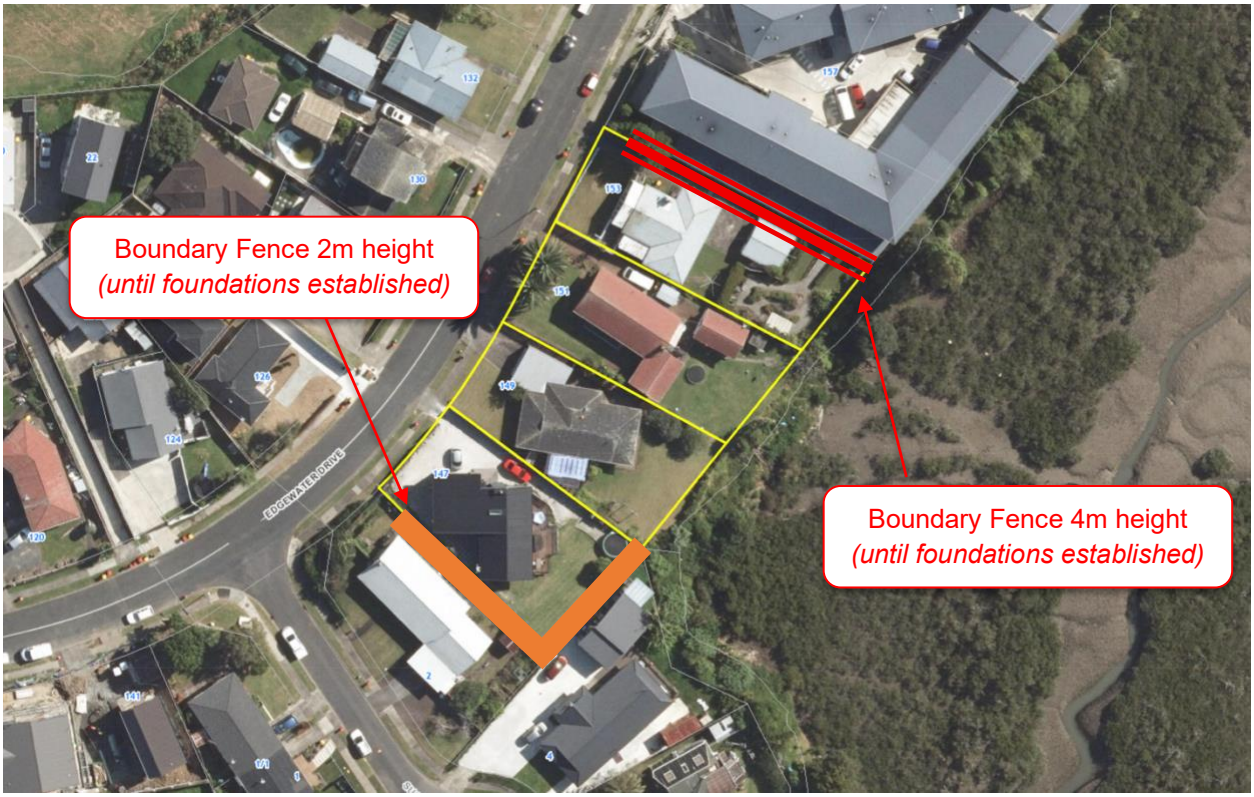


Figure 9 - Proposed Acoustic Fencing until foundations are established

Figure 10 - Example of Acoustic blankets affixed to existing landscape fences

Figure 11 - Example of Plywood Fencing

Figure 12 - 4m Plywood Fence with acoustic blanket lining

Figure 13 – 4m-6m Acoustic Blankets on Scaffolding

Figure 14 – 4m-6m Acoustic Blankets on Scaffolding

9 Assessment of Effects

9.1 AUP OP Assessment

As the Permitted Activity Standards stipulated under the AUP OP for construction noise - E25.6.27 cannot be met due to the proximity and elevation of the adjacent receivers with line of sight into the works, and no practicable options to shield them, consent is required for a Restricted Discretionary Activity pursuant to E25.4.1(A2) and assessment against the criteria below is provided.

E25.8. Assessment – restricted discretionary activities E25.8.1. Matters of discretion The Council will restrict its discretion to all of the following matters when assessing a restricted discretionary resource consent application: (1) for noise and vibration: (a) the effects on adjacent land uses particularly activities sensitive to noise; and (b) measures to avoid, remedy or mitigate the adverse effects of noise. (2) for internal noise levels of noise sensitive spaces in the Business – City Centre Zone, Business – Metropolitan Centre Zone, Business – Town Centre Zone, Business – Local Centre Zone, Business – Neighbourhood Centre Zone or the Business – Mixed Use Zone: (a) reverse sensitivity effects; and (b) alternative temperature control solutions.

E25.8.2. Assessment criteria The Council will consider the relevant assessment criteria for restricted discretionary activities from the list below:

(1) for noise and vibration:

(a) whether activities can be managed so that they do not generate unreasonable noise and vibration levels on adjacent land uses particularly activities sensitive to noise;

As detailed in Section 8 of this report, a number of mitigation measures are proposed, including:

- Equipment restrictions (e.g. limits on augering rigs, excavators and compactors)
- Operational Restrictions (e.g. limits on vibratory compacting)
- Perimeter Shielding (fencing at boundaries)
- Exclusion zones for equipment.

With the above measures in place, it is our opinion that noise and vibration levels can be maintained at reasonable levels commensurate with the type of works and proximity of the adjacent neighbours and therefore are considered acceptable.

(b) the extent to which the noise or vibration generated by the activity: (i) will occur at times when disturbance to sleep can be avoided or minimised; and (ii) will be compatible with activities occurring or allowed to occur in the surrounding area; and (iii) will be limited in duration, or frequency or by hours of operation; and (iv) will exceed the existing background noise and vibration levels in that environment and the reasonableness of the cumulative levels; and (v) can be carried out during daylight hours, such as road works and works on public footpaths.

As detailed in Section 8 of this report,

- The exceedance of the AUP criteria would only occur during the limited periods of augering and earthworks at or near current ground level. All other activities would be compliant with the AUP limits as per E25.6.7
- The periods of construction work would be daytime hours only, and would not be cause for sleep disturbance.
- Furthermore, the highest noise and vibration generating works (augering with tonal noise) are limited to 8:30am to 5pm weekdays.

Based on the above, it is our opinion that the works, with the mitigation measures implemented, would minimise the effects on neighbours.

(c) the extent to which the effects on amenity generated by vibration from construction activity: (i) will be mitigated by written advice of the activity to adjacent land uses prior to the activity commencing; and (ii) can be mitigated by monitoring of structures to determine risk of damage to reduce occupant concern; and (iii) can be shown to have been minimised by the appropriate assessment of alternative options; and (iv) are reasonable taking into account the level of vibration and the duration of the activity (where levels of 10mm/s peak particle velocity may be tolerated only for very brief periods).

As detailed in Section 8 of this report, a number of measures are implemented to manage and minimise vibration levels at occupied receivers , including restrictions on equipment sizes and operational modes, and consequently power output

Based on the above, it is our opinion that the works, with the mitigation measures implemented, would control vibration levels at neighbouring receivers to within reasonable and tolerable levels.

(d) whether the measures to minimise the noise or vibration generated by the activity represent the best practicable option.

A number of considerations and options were taken in account and assessed for practicability. These include assessment of reducing the noise from the source, and shielding the receivers from the noise source. The mitigation measures proposed in this report restrict equipment size and operation for the works, including limiting compactor operation. Due to the proximity and elevation of the receivers however, little more can be done to reduce noise from works while allowing reasonable progress, and as such the measures proposed are the best practicable options for control of noise and vibrations.

Based on the above, it is our opinion that the measures proposed for the works are the best practicable options available.

9.2 Assessment of Noise Effects

Construction works inevitably result in undesirable noise effects in the surrounding environment. To quote from the national standard NZS6803:1999, pertaining to construction noise:

> *"Although this may mean that the noise is undesirable, it is not necessarily unreasonable when all the relevant factors are taken into consideration. Construction noise is an inherent part of the progress of society. As noise from construction projects is generally of limited duration, people and communities will usually tolerate a higher noise level provided it is no louder than necessary, and occurs within appropriate hours of the day."*

Based on this, it is reasonable to assume that for appropriate hours of the day, works that maintain noise levels within the compliance limits are deemed to have reasonable effects, provided no affected neighbours have specific sensitivities to noise. Examples of these would be schools, early childhood centres, retirement villages, or recording studios. Where special sensitivity receivers are identified, specific assessments are usually required even if noise levels are compliant with the regulatory limits. As such consideration must be given to the occupancies in proximity to a construction site. Noise levels within buildings should be considered when the main use of the surrounding environment during the works is indoors. For reference in this context, the sound insulation levels of old villa type dwellings in New Zealand is generally expected to provide attenuation of 20-25dB with doors and windows closed. As a conservative measure, an attenuation level of 20dB is assumed between external and internal noise levels. A number of other considerations are required when assessing the effects of noise on the surrounding environment, including the site itself, the dynamics of the work (where it occurs within the site), and how the effected receiver occupancies are used (indoors vs outdoors.) The following subsections provide a high level summary of the considerations for the subject site

9.2.1 Effects at Compliance Level

For the subject development, we note that the neighbourhood is predominantly residential. As such, assessment against normal domestic activities is appropriate. Based on the absence of specific noise sensitivities in the immediate surroundings, and with this being a long term duration project, the compliance limit for noise in accordance with the AUP is Leq 70dBA and Lmax 85dBA measured at 1m from the façade of a building, and is considered reasonable. We note this level relates to outdoor noise. Subjectively, this is generally analogous to noise levels adjacent an active state highway during busy hours of the day while small vehicle traffic is flowing. An external noise level of Leq 70dBA would limit outdoor activities, as conversations would require raised voices and the majority of people would only be comfortable for short periods. Taking into account the times of day allowed for this compliance noise level, it is likely to overlap with outdoor recreational activities, potentially during Saturdays. Notwithstanding that, this level would still be compliant. Assessed internally, this noise level would conservatively

result in an internal noise level of Leq 50dBA. For subjective comparison, this noise level is analogous with the interior of an average active home, or noise within a quiet open plan office. We note for reference that conversational speech at 1m separation is approximately 60dBA. As such, this noise level would not interfere with normal conversations.

9.2.2 Effects at Exceedance Level 73dBA

We note that the general threshold of human differentiation of noise levels is circa 3dBA. The majority of people would not be able to tell the different between noise levels 3dBA apart. As such, the effects at 73dBA are generally similar to the effects of compliance at 70dBA.

9.2.3 Effects at Exceedance Level 75-78dBA

Regarding the exceedance at L_{eq} 75-78dBA when assessed internally, noise levels in rooms with facades facing the subject site would conservatively be expected to reach approximately Leq 55-58dBA where exceedances are predicted. For subjective assessment, this noise level is where most people would have to raise their voices slightly in conversations. Construction noises at this level also become noticeable in phone conversations. Based on the above, a 5dBA difference is considered louder, albeit "just louder" and not unusual for the proposed activities, and not excessive in terms of subjective perception especially considering the proximity of the adjacent building to the boundary. An 8dBA difference would be considered "noticeably louder".

As a general guideline, noise levels in the 75-78dBA range would be tolerable for a few weeks provided prior notification, explanation and scheduling are communicated to the neighbours.

9.2.4 Equipment Sizes – Duration vs Noise Level

If plant used is smaller than necessary, the duration of the works would cause more detrimental effects than the benefits of reducing the noise levels slightly. To achieve a reasonable balance between progress pace and noise levels, equipment restrictions are proposed in addition to significant acoustic shielding. This is to maintain the overall effects including duration to levels considered tolerable in residential environments.

9.3 Assessment of Vibration Effects

With regards to effects, the following is quoted from Section B1 of ISO 2631-2:2003 – Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz):

> *"Human response to vibration in buildings is very complex. In many circumstances the degree of annoyance and complaint cannot be explained directly by the magnitude of monitored vibration alone. Under some conditions of amplitude and frequency, claims may arise while measured whole-body vibration is lower than the perception level."*

Notwithstanding the subjective and statistical nature of vibration response; the assessment of vibration effects in accordance with the British Standard BS5228-2:2009 is:

- Perception of vibrations typically starts at 0.3mm/s PPV (Peak Particle Velocity) in residential environments during daytime hours.
- At vibration levels in the order of 1mm/s but less than 10mm/s, vibrations can be tolerated if prior warning and explanation are given to residents.
- Common values of vibrations associated with daily activities in light framed buildings are as follows (as measured and reported by Arne P. Johnson & W. Robert Hannen)
    - Occupants walking and closing doors ≈ 0.5mm/s - 1.25mm/s
    - Occupants running or jumping ≈ 1.25mm/s – 5mm/s
    - Moving furniture ≈ 2.5m/s - 3.5mm/s
- Vibration levels, if maintained at 5mm/s would be highly upsetting and prolonged exposure would not usually be tolerated in residential, office and commercial environments.
- Exposure to short impulses of vibrations at 5mm/s would be tolerable in residential environments for a few days provided occupants are given prior warning and explanation beforehand.

Based on the highest levels predicted, the time of day this would occur, and as per the guidelines of BS5228-2:2009; provided prior warning and explanation is afforded in a timely manner to affected neighbours as per the requirements of the CNVMP, the predicted vibration levels are noted to be tolerable in residential environments and are considered acceptable.

10 Summary

The subject site is adjacent to residential dwellings. The topography of the site and the proximity and elevation of adjacent buildings would expose them to noise and vibrations from the proposed works.

The works require piling for retention and foundation piles proposed using either CFAs or traditional augering rigs/attachments, in addition to site wide cut and fill operations and compacting.

10.1 Noise

The site is in proximity to dwellings, and the proposed development requires excavation and piling. As such it is proposed that

- 2m high boundary fencing along southern boundaries with occupied receivers
- 4m high boundary fencing along the northern boundary.
- Piling and vibratory compacting limited to Monday-Friday 8:30am to 5pm.

With the proposed fencing, combined with the proposed management controls, noise levels could be maintained as low as practicably possible during the site works.

Notwithstanding that, and based on predictions of noise levels the following noise limits are recommended to be adopted for specific receivers;

<u>During Piling</u>

- <u>Option 1: Continuous Flight Auger (CFA)</u>
    - **157 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

- <u>Option 2: Augering attachment on excavator</u>
    - **157 Edgewater Drive:** Up to 78dB LA_{eq} and 95dB LA_{max} for circa 1 week at any receiver reducing to 73-75dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **132, 130, 128 Edgewater Drive:** Up to 75dB LA_{eq} and 90dB LA_{max} for circa 1 week at any receiver reducing to 70-73dB LA_{eq} and 90dB LA_{max} for a further 1 week
    - **126 Edgewater Drive, 2, 4 Susanne Place:** Up to 73dB LA_{eq} and 90dB LA_{max} for circa 1 week.

<u>During Earthworks *(for up to 1 week at any receiver):*</u>

- Up to 73dB LA_{eq} and 90dB LA_{max} at **157 Edgewater Drive, 2, 4 Susanne Place**.

In context of effects of these exceedances, we note that 3dBA is the general threshold of most people's ability to differentiate between sound levels. As such, the effects at 73dBA are generally similar to effects at 70dBA. For the exceedances at 75-78dBA, as a general guideline, these would be tolerable for a few weeks provided in all cases that prior notification, explanation and scheduling are communicated to the neighbours.

Noise Levels are predicted to comply with the 70dB LAeq and 85dB LAmax limits at all receivers during all other works provided the operational and procedural requirements of the Construction Noise and Vibration Management Plan (CNVMP) are adhered to and all best practice measures are followed in order to mitigate noise levels.

10.2 Vibration

Due to the proximity of the works to the adjacent properties, vibration generating works have the potential to exceed the criteria limits unless vibration levels are controlled and managed. As such, equipment restrictions are proposed whereby:

- Augering limited to attachment on excavator no larger than 23T (or using CFA with no size restrictions)
- Pre-start monitoring of casing is required if vibratory casing is deemed the only practicable option (to establish if casing can be done within the noise and vibration limits)
- Earth moving excavators:
    - Within 15m of the southern boundary limited to no larger than 23T.
    - More than 15m from the southern boundary limited to no larger than 15T.
- Compacting in the site within 15m of a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 4T can be used only with vibratory functions OFF.
    - Vibratory compacting limited to hand held compactors only, plate or rolling, no larger than 300kg.
- Compacting at more than 15m from a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 2T can be used.

If concerns arise pertaining to bore stability, the use of the following alternate methodologies shall be considered:

- Use of a CFA (Continuous Flight Auger)
- Over-boring to allow non-vibratory hydraulic insertion of casing
- Cased Auger Piling (auger and casing screwed simultaneously into soil)
- Use of Bentonite slurry.

Provided all mitigation procedures (e.g. intensity management) are implemented, and the requirements of the Construction Noise and Vibration Management Plan (CNVMP) are adhered to, it is expected that vibration levels can be managed:

- Within the structural protection DIN4150-3 criteria limits at all receivers,
- Within the amenity level of 2mm/s at all occupied receivers, other than:
    - Vibration levels may during up to 3 days of augering reach up to circa 3mm/s at 157 Edgewater Drive.
    - Vibration levels may during up to 3 days of compacting reach up to circa 4mm/s at 157 Edgewater Drive and up to 3m/s at 2, 4 Susanne Place.

We note that while these would exceed the long term amenity limit of 2mm/s the levels would be below the short duration limit of 5mm/s (referenced for context only).

In context of vibration effects, provided prior warning and explanation is afforded in a timely manner to affected neighbours as per the requirements of the CNVMP, the predicted vibration levels for the durations required are noted to be tolerable in residential environments and are overall considered acceptable.

Appendix I- CNVMP

Construction Noise and Vibration Management Plan

Construction Noise & Vibration Management Plan (CNVMP)

147-153 Edgewater Drive

Pakuranga, Auckland

Proposed Residential Development

Prepared By:	Earcon Acoustics Limited
Date:	05 November 2025
Reference:	J007260.MP.1
Application #:	

Document Control

Document: Construction Noise & Vibration Management Plan (CNVMP)
147-153 Edgewater Drive, Pakuranga, Auckland
Proposed Residential Development
J007260.MP.1

Contact	Issue	Date	Revision
Alex Jacob alex.jacob@earcon.co.nz	For Internal Review	05/11/2025	B
Fadia Sami fadia.sami@earcon.co.nz	For Resource Consent	05/11/2025	B

1. INTRODUCTION

This Construction Noise and Vibration Management Plan (CNVMP) has been prepared to manage the noise and vibration effects of the works associated with the proposed excavation and construction works for the proposed development at 147-153 Edgewater Drive in Pakuranga, Auckland for a new residential development. This CNVMP is required in accordance with the Resource Consent Conditions pertaining to the development. Contact details must be completed in the subsequent appendix as part of this management plan

The site for the proposed development is within four lots in a generally residential area on the eastern side of Edgewater Drive. The site is currently occupied by four dwellings, one within each of the lots, founded at the general centre of each lot. The site topography is generally flat other than a slope down to the south-east towards the reserve. The subject site also includes ancillary structures, driveways and parking areas.

The proposed development comprises the demolition and removal of the existing dwellings and the construction of two standalone six-storey apartment buildings. The northern block designated Block A includes an underground basement garaging level. The southern block, is designated Block B. The development also includes a driveway from the southern end tracking around Block B to the centre of the site and second driveway from Edgewater Drive, in addition to parking areas at the southern boundary and adjacent the northern façade of Block B.

The development requires cut and fill operations across the sites, with the majority of works comprising cuts with the deepest to circa 4.5m across the footprint of the northern block A for establishment of the garaging level. Cuts at the centre proposed to circa -1.5m, reducing to cuts and fills in the order of ±0.5m at the southern end. The depths of cuts and fills require support with retaining walls. In accordance with Geotechnical advice, retaining is proposed to be established with palisade walls comprising bored cast in-situ concrete piles.

Also in accordance with Geotechnical advice, it is our understanding that the buildings will require support on piles proposed to be established with bored cast in-situ concrete piles to depth in the order of circa 14m below current ground level (augered from the depths of cuts at the northern Block A). Compacted hardfill is likely to be required to form level building platforms.

Due to shallow groundwater (relative to augering depths) and presence of sand in the underlying strata, open bores for both retention and foundations are likely to either require temporary casing insertion and extraction in addition to pumping or alternatively using slurry (e.g. bentonite), or alternatively the use of a Continuous Flight Auger (CFA) if practicable to use.

The proposed development requires extensive augering works relative to the size of the site. As such, this assessment considers use of either traditional augers, or CFAs. We note that the

proposed depths of augering (generally less than 15m) and the stratigraphy of the ground makes the use of CFAs feasible and may be advantageous in context of speed and practicability (i.e. no need for casing) and in context of noise and vibration (no extraction and clearing of auger).

As such, the proposed development requires cut and fill operations for the establishment of foundations, in addition to general excavation and trenching for services, compaction, concrete operations, and augering for retention and foundation piles, in addition to potential casing or alternatively use of a CFA.

The overall works are planned to take more than 20 weeks and are therefore considered “long-term duration”. An up-to-date timeline for the works shall be appended to this plan and all copies of it.

2. IDENTIFICATION OF NEIGHBOURING RECEIVERS

Communications are based on the level of effects anticipated at neighbouring receivers. Continuous communication will be necessary as part of the management plan for receivers with specific sensitivities or exposure to higher noise or vibration levels. The following locations are the sensitive receivers regarding adverse noise effects. Written communications (e.g. letter) shall be distributed to all affected neighbours in accordance with the guidelines detailed in Section 5.

Table A1: Neighbouring Receivers.

Receivers - Written Communications		
2 Susanne Place	120 Edgewater Drive	128 Edgewater Drive
1-2/1 Susanne Place	124 Edgewater Drive	218A Edgewater Drive
141 Edgewater Drive	126 Edgewater Drive	130 Edgewater Drive
4 Susanne Place	126A Edgewater Drive	132 Edgewater Drive
6 Susanne Place	124A Edgewater Drive	
8 Susanne Place	126B Edgewater Drive	

Where an address includes multiple occupancies, each occupancy must be included in the written communication (e.g., letter drop)

3. CRITERIA

3.1 Noise Compliance Limits

The following criteria apply for noise compliance when measured at 1m from a façade:

Table A2: Noise Compliance Criteria

Activity	Time	Receivers	Noise	
			L_{eq}	L_{max}
Piling *(CFA Option)*	Monday – Friday 8:30am to 5:00pm	• 157 Edgewater Drive	75dBA	90dBA
		• 132 Edgewater Drive • 130 Edgewater Drive • 128 Edgewater Drive	73dBA	90dBA
		All Others	70dBA	85dBA
Piling *(Traditional Auger Option)*	Monday – Friday 8:30am to 5:00pm	• 157 Edgewater Drive	78dBA	95dBA
		• 132 Edgewater Drive • 130 Edgewater Drive • 128 Edgewater Drive	75dBA	90dBA
		• 126 Edgewater Drive • 2 Susanne Place • 4 Susanne Place	73dBA	90dBA
		All Others	70dBA	85dBA
Earthworks	Monday – Saturday 07:30am to 6:00pm*	• 157 Edgewater Drive • 2 Susanne Place • 4 Susanne Place	73dBA	90dBA
All Other	Monday – Saturday 07:30am to 6:00pm	All	70dBA	85dBA

** Other than vibratory compacting, which is limited to Mon-Fri 8:30am to 5:00pm*

*** Excludes non-noise generating activities such as interior painting.*

3.2 Vibration Compliance Limits

The following criteria apply for Vibration compliance:

Table A3: Vibrations Compliance Criteria

Occupation	Receiver	Maximum absolute unweighted PPV in any axis at frequency range			
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	More than 100Hz
Occupied	157 Edgewater Drive	3mm/s during Augering 4mm/s during Compacting			
	2 Susanne Place 4 Susanne Place	3mm/s during Compacting			
	All	2mm/s			
Unoccupied	All	5mm/s	5-15mm/s	15-20mm/s	20mm/s

3.3 Activity Noise Levels

The following table lists relevant noise generating equipment and mechanical plant expected to be used at different stages during works on the subject site. Whenever noise generating activities are planned to occur in proximity to receivers, assessment shall be made against the noise levels at the distances listed below.

Table A4: Activity Noise Levels at 10m from source

Activity	Equipment	Sound Pressure LA_{eq} at 10m [dB]
Truck - 20-24 Tonne	Truck - 20-24 Tonne Idling	58
	Loading soft materials	72
	Loading solid materials	75
	Tipping fill	76
Ground excavation	5T-8T Tracked Excavator	65
	9T-12T Tracked Excavator	68
	13T-15T Tracked Excavator	73
	20T-23T Tracked Excavator	75
Piling (Bored)	8T-10T Tracked Excavator	72
	13T-15T Augering Rig/Attachment	75
	Augering attachment on 23T Excavator	78
	Continuous Flight Augering (CFA) Rig	75
Levelling Ground	Grader	62
General	Water Pump	68
	Compressor	66
Lifting	Tracked Mobile Crane (30T)	66
	Tracked Mobile Crane (55T)	70
Compacting Fill	Vibratory roller 3T	67
	150kg-200kg Plate Compactor *	74
	300kg Plate Compactor *	78
Concreting	Pump + Cement Truck Discharging (Foundations)	68
	Poker Vibrator	69

** Static Distance*

3.4 Activity Vibration Levels

The following table lists relevant vibration generating activities expected to occur during the works, where PPV in Peak Particle Velocity in mm/s in any axis at the distances noted in the tables. Whenever vibration generating activities are planned to occur in proximity to receivers, assessment shall be made against the levels at the distances listed below.

Table A5: Activity Vibration Levels – Measurements at similar sites

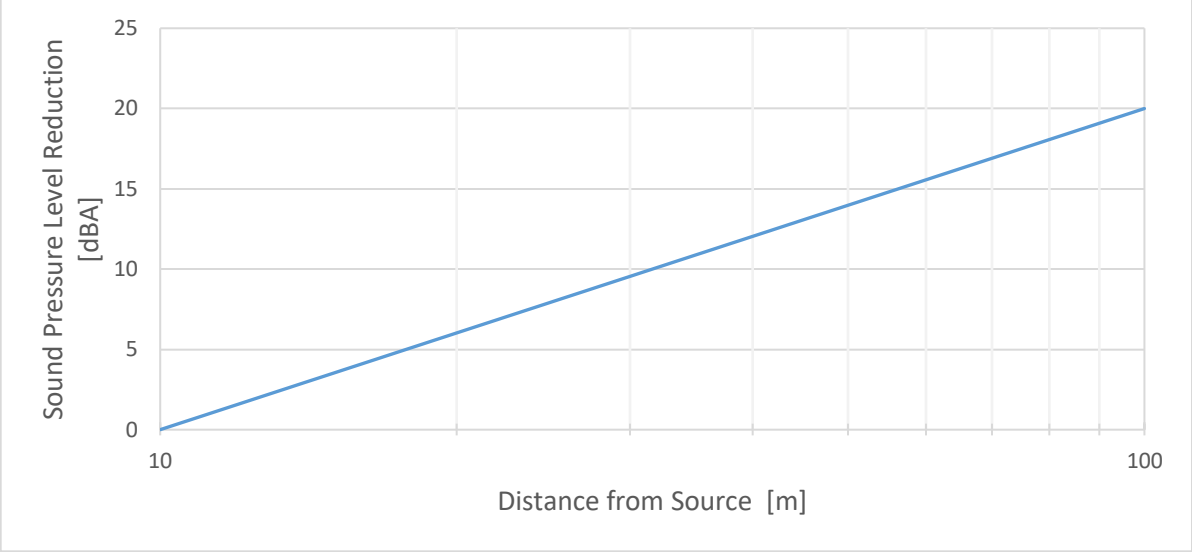
Activity	Mode	Distance	Frequency	PPV
		m	Hz	mm/s
Screw Piling	Hydraulic Driving	5	15	0.2-0.3
Augering	Ø 500mm augering from clear ground to 6m	3	20	0.5-1.0
		5	20	0.4-0.9
Clearing Auger	Counter rotation of auger – vibration through excavator	3	12	1.7-2.0
		5	12	1.5-1.7
Compacting Vibratory OFF	10t - Single Smooth Drum	8	25	1.2-1.7
		15	25	1.0-1.5
Compacting Vibratory On	14.5T - Padfoot	10	25	3.0-5.0
	4.5t - Padfoot	10	25	2.0-3.0
20T Excavator	Digging - Fragmented Rock	10	20	0.5-1.5
20T Excavator	Earth Moving	10	100	0.2-1.0
Truck - Laden	Driving on Irregular Ground	5	80	0.05-0.2

Table A6: Activity Vibration Levels – BS5228-2

Activity	Ground	Mode	Distance	PPV
			m	mm/s
Rotary Boring - 500mm	Fill/Sand/Clay	Augering	10	0.4
		Hitting Base	14	0.3
Rotary Boring – 600mm	Sands and Gravels	Hitting Base	3.5	2.4

3.5 Noise Reduction over Distance

When the source of noise is at a distance farther than 10m from the source, the following figure can be used to estimate the reduction in noise level based on the distance involved when there is no shield or barrier between the source and the receiver (free field). This reduction level in dBA can be deduced from the Sound Pressure (LA_{eq} dBA) value in Table A4



Sound Pressures Level Reduction Over Distance – Hard Ground

3.6 Noise Reduction from Shielding

The accurate determination of the effectiveness of a barrier is a complex process. For in-situ approximation of shielding effects, the following is quoted from the national standard NZS6803:1999:

> *As a working approximation, if there is a barrier or other topographic feature between the source and the receiving position, assume an approximation attenuation of 5dB when the top of the plant is just visible to the receiver over the noise barrier, and of 10dB when the noise screen completely hides the source from the receiver.*

3.7 Noise Reflection from Facades

Compliance for receiver buildings is measured at 1m from the façade of a building. The following correction must be made to estimate the noise level at the façade of a building if it cannot be directly measured:

> *Where the point of interest is 1m from the façade of a building, make an allowance for reflection by adding 3dB to the calculated levels.*

4. MONITORING

Noise and Vibration monitoring shall be undertaken as a result of any complaints or upon request by council, and

- Pre-start monitoring of casing if vibratory casing is deemed the only practicable option.

The results of any noise and/or vibration monitoring shall, upon request, be submitted to Council within 1 week of measurements being conducted.

4.1 Noise

Noise monitoring shall be conducted in accordance with the New Zealand Standards 6803:1999 (Acoustics – Construction Noise). The noise levels shall be measured in accordance with the requirements of NZS6801:2008 "Acoustics - Measurement of Environmental Sound" and assessed in accordance with NZS6802:2008 "Acoustics - Environmental Noise". Monitoring when undertaken shall include:

- Manned monitoring of a test run of any noise generating activity prior to its full implementation During this test run, the appropriate on/off cycle times are established based on the measured noise levels and intensity of operations.
- Reporting: A report is prepared and circulated detailing the measured noise levels for the test run and the appropriate controls, cycle times and intensity of operations to maintain the noise levels as low as practicably possible.
- Management: The established controls, cycle times and intensity of operations are detailed to personnel with supervisory roles on-site and incorporated into the management process for said activity.

4.2 Vibration

Activities that may generate vibrations at neighbouring properties include, but not limited to Excavation, Compacting and Augering.

- Visual Inspections, including dated photographs, of the neighbouring structures (buildings, pathways, etc.) shall be undertaken prior to any significant vibration generating works commencing.

Vibration monitoring shall be conducted according to the methods of measurement as per a recognised standard such as Australian Standard AS 2973:1987 Vibration and Shock - Human response vibration-measuring instrumentation and DIN4150-3 – Effect of Vibrations on Structures.

5. COMMUNITY COMMUNICATIONS

Communication and consultations with noise and vibration sensitive receivers is essential, where:

- Prior to the commencement of any noise or vibration generating activities:
    - All affected neighbours including receivers listed in section 2 above shall be advised in writing (e.g. mailed letter or letter drop) no less than 2 weeks prior to works commencing.
    - The letter shall describe the overall works including work times and durations, in addition to contact details of the site manager including name and phone number for raising complaints, issues, or general inquiries.
- Prior to the commencement of vibration generating activities:
    - All occupied buildings designated as receivers are advised in writing no less than three days prior to the vibration-generating works commencing; and
    - the written advice must include details of the location of the works, the duration of the works, a phone number for complaints and the name of the site manager.
- Throughout the works the client shall:
    - provide a sign on-site, complete with contact details for the neighbours to raise any concerns related to noise.
    - communicate with the noise sensitive receivers when complaints occur to address their concerns and ensure compliance.
    - provide regular updates prior (at least 3 days) to any high noise or vibration generating activities that may give rise to disturbance.
- Where direct and personal communications and consultation are required:
    - Discuss the works, methodology, equipment, and expected durations and timelines.
    - Review with neighbours the implemented mitigation measures
    - Understand any specific sensitivities and special requirements of the neighbours
    - Discuss time preferences for specific activities generating noise or vibrations
    - Assess and consider the specific requirements and time preferences from the consulted neighbours in terms of practicability

A detailed record of the discussions and considerations undertaken shall be kept on-site for the duration of the project and made available to Council on request.

6. PROCEDURE FOR HANDLING COMPLAINTS

All noise or vibration complaints pertaining to construction activities shall be recorded and managed as follows:

- Acknowledge receipt of the complaint, preferably within 1 day, but no later than 48hours that complaint was received.
- Record details of the complaint including name, address, time of complaints, nature of complaint, description of issue as receiver, time of issue giving rise to complaint, and any specific requests received.
- Identify the activity on-site giving rise to the complaint, including equipment involved, activity undertaken and location of activity. Specific feedback from operators must also be identified (e.g., operator encountered unexpected strata, equipment failure, operator error, etc.)
- Assess
    - Event, whether the issue was unusual (unlikely to recur with best practice procedures) or related to normal operations (likely to recur under current procedures)
    - Mitigation measures first through assessment of whether current mitigation measures are being adhered to, and second, through consideration of contingency measures.
- Communicate with neighbour on findings and plan to mitigate
- Implement changes to procedure, or additional mitigation measures to address issue
- Monitor effects through direct measurements as per Monitoring section of this report.
- Report on findings and actions taken, in conjunction with monitoring results.

Where complaints and issues recur, additional mitigation measures must be considered and assessed in conjunction with acoustic specialists and where practicable shall be implemented. A register of all complaints shall be maintained and made available to Council.

7. MITIGATION

7.1 Mitigation Measures:

Time Restrictions

- **Augering/Piling and vibratory compacting** limited to the hours of Monday – Friday 8:30am to 5:00pm.
- All **other noise or vibration generating works** shall be limited to the hours of Monday – Saturday 7:30am to 6:00pm.

Noise or Vibration generating work shall **not** occur on Sundays.

Fencing

- **Boundary Fencing with occupied receivers along the southern and southwestern boundaries:** Acoustic fencing, a minimum 2m height, is proposed to be established along the southern boundaries with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to landscape fences or chain-link fences. Fencing to be maintained at least until foundations are established.
- **Boundary Fencing with occupied receivers along the northern boundary (unless approval of apartment occupants is provided):** Acoustic fencing, a minimum 4m height, is proposed to be established along the northern boundary with occupied receivers. Fencing can be established using acoustic blankets or materials a minimum 7kg/m^2 surface density (e.g. plywood minimum 12mm thickness) affixed to scaffolding. Fencing to be maintained at least until foundations are established.

Suitable acoustic blankets include:

- Duraflex 'Noise Control Barrier - Performance Series' (www.duraflex.co.nz) ,
- Hushtec 'Premium Series Noise Barrier' (www.duraflex.co.nz)
- Soundex 'Acoustic Curtain - Performance Series' (www.ultimate-solutions.co.nz),
- Soundbuffer Acoustic Curtain (www.soundbuffer.co.nz)
- Safesmart Acoustic Curtain (www.safesmartaccess.co.nz)

Suitable solid fencing includes:

- 12mm Plywood panels affixed to poles
- 12mm Saveboards (www.saveboard.nz)
- PVC Panels on weighted footings

Equipment Restrictions

The following restrictions shall be imposed on the sizes and operation of equipment:

- Augering limited to attachment on excavator no larger than 23T (or using CFA with no size restrictions)
- Pre-start monitoring of casing is required if vibratory casing is deemed the only practicable option (to establish if casing can be done within the noise and vibration limits)
- Earth moving excavators:
    - Within 15m of the southern boundary limited to no larger than 23T.
    - More than 15m from the southern boundary limited to no larger than 15T
- Compacting in the site within 15m of a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 4T can be used only with vibratory functions OFF.
    - Vibratory compacting limited to hand held compactors only no larger than 300kg.
- Compacting at more than 15m from a receiver:
    - Driven compactors (smooth drum or padfoot) no larger than 2T can be used.

Casing Methodology Requirements

If concerns arise pertaining to bore stability, the use of the following alternate methodologies can be considered:

- Use of CFA (Continuous Flight Auger)
- Over-boring to allow non-vibratory hydraulic insertion of casing
- Use of Bentonite slurry.
- Cased Auger Piling (auger and casing screwed simultaneously into soil)

Notwithstanding that, if the use of vibro casing insertion and extraction is unavoidable, then pre-start test runs shall be monitored for vibrations. This is to establish intensity and mitigation measures required to achieve compliance (e.g. over-boring) or alternatively if other methodologies are needed. Vibrations from casing insertion and extraction vary significantly depending on ground conditions and equipment used, even on a seasonal basis pertaining to moisture content in the soil. As such Pre-start monitoring of casing required if vibratory casing is deemed the only practicable option. Pre-start Monitoring is intended to establish if, with all mitigation measures implemented, casing can be undertaken within consented noise and vibration limits. If casing cannot be undertaken within the consented limits, then an alternative methodology must be considered, such as use of bentonite.

Equipment Recommendations

- Rattling Guns: the use of rattle guns on steel or concrete structures can generate high and potentially tonal noise levels especially when occurring at elevation. The impulsiveness, sudden onset, and tonality of the events makes them particularly annoying especially considering the presence of residential facilities in the area. Alternatives include: Shear snap off bolts, Hydraulic torque wrenches.
- Stud Shots: The noise levels generated from stud shots on steel structures is highly tonal, loud, and impulsive, and can be cause for disruption and significant annoyance to neighbouring receivers. We would recommend consideration screw fixing as a best practicable option to minimise noise.

Operational Recommendations

- Concrete Pumping – Structure: If mobile concrete pumps are required, these can be positioned away from the closest residential receivers to allow for concrete pours out of hours if required structurally (or for traffic control purposes to do so.) If static pumps are proposed, it is recommended these are positioned within the structure of the building to use it as a shield for control of noise propagation. Static pumps can also be locally shielded by acoustic enclosures (e.g. using acoustic blankets)

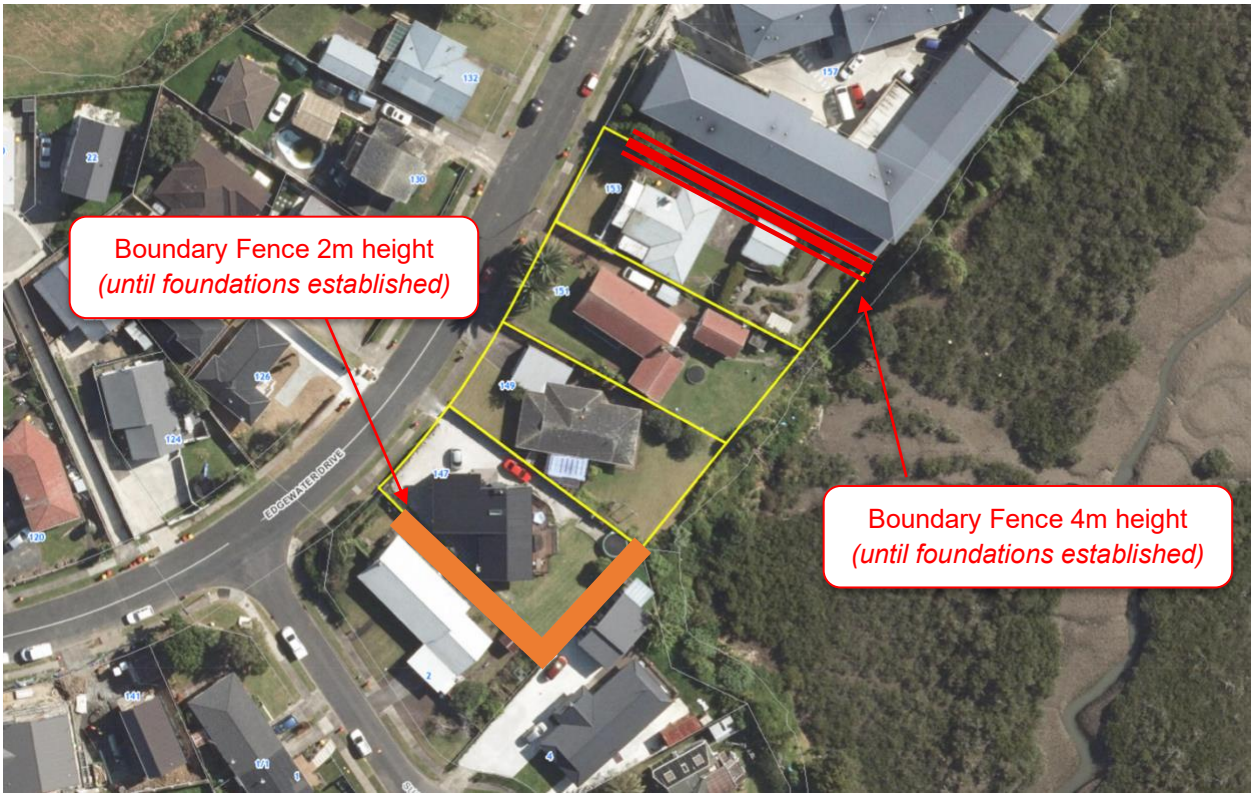


Figure 15 - Proposed Acoustic Fencing until foundations are established

Figure 16 - Example of Acoustic blankets affixed to existing landscape fences

Figure 17 - Example of Plywood Fencing

Figure 18 - 4m Plywood Fence with acoustic blanket lining

Figure 19 – 4m-6m Acoustic Blankets on Scaffolding

Figure 20 – 4m-6m Acoustic Blankets on Scaffolding

7.2 Contingency Measures

The following contingency measures will be considered, insofar as practicable, if noise or vibration levels exceed the criteria limits:

- Screening: Use of either natural screening such as heaps or bunds, or built screening such as acoustic panels or curtains, if noise levels are expected or noted to be elevated.
- Localised Shielding: Temporary acoustic shields can be setup to surround any area of high noise activity, and can be moved to follow the activity. This can be achieved using acoustic blankets affixed on temporary chain-link fences placed as close as practically possible to the noise source.
- Alternative Equipment: Consideration of alternative equipment designed specifically to reduce noise, e.g. use of silenced diesel generators and compressors, or use of muffled plant.
- Smaller Equipment: Consider using smaller equipment when noise levels need to be reduced. Smaller plant have lower power outputs and generate less noise and vibrations at the expense of taking more time.
- Hoisted Shielding: During works in proximity to elevated occupied receivers, a V or U shaped hoisted shield at least 6m in height (acoustic blankets on timber or steel frame) can be hoisted by a support excavator or using operating cranes to shield the closest receivers where required.

The following images are representative of hoisted shielding (contingency measures):

Figure 21 - Hoisted Shielding Example

7.3 Best-Practice Measures

The following best practice control and mitigation measures shall be considered, insofar as practicable, prior to and during any activities with the potential to generate noise and/or vibrations. Best practice mitigation measures to consider are:

- Site Management: Reducing noise sources: e.g. avoiding engines idling when not in use, limiting the use of roading plates, and securing clanking crane hoist chains, and using broadband reversing buzzers instead of tonal beepers.
- Maintenance: Ensuring equipment is well maintained; e.g. ensuring mufflers are in good condition.
- Proper Operation: Ensuring equipment is operated properly, e.g. ensuring all panels and covers are closed during operation, and vibration generating equipment is not operated with excessive pressures (such us excavator lifting on arm)
- Clearing Spoil: Clearing of Augers to be done without intensive counter rotation of auger head. Clearing can be done manually or by rotation in one direction into a heap.
- Time Management: Whenever practicable, scheduling noise or vibration generating works during times of least or no occupancy at receiver buildings, i.e. carrying out noisy works while neighbours are not at home.
- Ancillary Equipment: All pumps, generators and other static equipment to be located as far as possible from adjacent residential receivers.
- Truck beds carting spoil can be lined (e.g., with dunnage) to minimise impact on steel. Trucks on standby should turn their engines off instead of idling.
- Materials and equipment should be placed and NOT dropped. This applies to placing materials and objects on the ground or on transport vehicles.
- Personnel and visitors arriving or departing the site in vehicles should avoid slamming doors, using horns, revving engines, shouting, using amplified music or causing disturbance.
- Communications over distance should be through handheld radios, rather than shouting. Where possible, squelch should be lowered on hand held radios.

8. CONSTRUCTION OPERATOR TRAINING PROCEDURES & CONTACT DETAILS

Measures will be put in place to monitor noise on site and to control noise from sub-contractors and their hours of work. All site workers will be made aware of the noise control requirements. All staff shall undergo environmental induction before working on site. Training shall include, but not be limited to:

- Personnel and visitors arriving or departing the site in vehicles should avoid slamming doors, using horns, revving engines, or causing disturbance with loud music.
- All personnel and visitors should refrain from shouting while on-site. Communications should be managed without the need for shouting.
- Materials and equipment should be placed where required and NOT dropped. This applies to placing materials and objects on the ground or on transport vehicles.
- Heavy equipment should be operated such that objects are not dragged on the ground, but lifted and placed where they belong.
- Noise barriers should not have open gaps between them, or below them. If they need to be separated or moved, the gaps should be closed as soon as possible.
- Equipment not in use should not be left idling. Turn off all equipment when not in use, unless safety requirements demand otherwise.
- Whenever possible, position static noise generating equipment as far as possible and as shielded as possible from neighbouring receivers.
- Visitor inductions shall include notification that noise emissions are controlled at this site, and any noise generating activities have to be approved and minimised.

Noise and vibrations situation reports should be included in all toolbox meetings, and reference should be made to any complaints or issues occurring pertaining to noise or vibrations.

9. DOCUMENT REVIEW

This CNVMP (Construction Noise and Vibrations Management Plan) is a live document and may be updated throughout the lifecycle of the project in response to changes in construction methodologies applicable to the site as work progresses, or in response to complaints from receivers.

Any reviews must take into account compliance requirements with the relevant criteria as they apply at the time of the required review, in addition to any relevant changes on accepted standard construction methodologies.

Any reviews shall be submitted to council for reference and potential comment. Any changes have to be summarised in the revisions page of the document for the reviewed version, each designated by alphabetical increments. Summaries for all revisions shall be retained within the document for future reference.

Whenever a new revision is released and accepted, all previous revisions shall be redacted and removed from use and circulation. All affected parties have to operate under the latest released revision of this document.

Appendix II- Site Contact Details

Construction Noise and Vibrations Management Plan

Noise and Vibrations Management Plan

Contact Details

Project Contacts

Company Name:

Company Business Address:

Company Contact Number:

Onsite person responsible for compliance with this Construction Management Plan

Name: Contact Number:

Email:

Contact person in control of the site

Name: Contact Number:

Email:

Health Safety & Environmental Manager

Name: Contact Number:

Email:

Construction Works

Demolition ☐

Excavations ☐

Construction ☐

Is your Company in control of the site during this stage of work (Yes/No)?

If you answered **NO** only the Company in control of the site may complete and sign for responsibility of the Construction Management Plan.

I have due authorisation and delegation to sign this Construction Management Plan on behalf of the Company listed above and take responsibility for ensuring compliance with our commitment specified herein, the resource consent conditions, district plan and any other relevant legislation.

Signed …… Dated ……

Appendix III – Resource Consent Conditions

Construction Noise and Vibrations Management Plan

Resource Consent Conditions to be attached here

Appendix IV – Project Timeline

Construction Noise and Vibrations Management Plan

Summary of project timeline to be attached here

Appendix V – Standards

Regulatory

Auckland Unitary Plan – Operative

The Auckland Unitary Plan provides, inter alia, a regulatory framework defining the noise and vibration limits on construction sites within the jurisdiction of the Auckland City Council. These limits are referenced in this report and assessed against for compliance analysis.

Noise

NZS 6801: 2008 – Acoustics – Measurement of Environmental Sound

This standard defines the parameters, quantities and metrics to describe noise in community environments, in addition to the procedures and methodologies of measuring and acquiring these quantities.

NZS 6802: 2008 – Acoustics – Environmental Noise

This standard defines procedures for the assessment of noise against compliance criteria.

NZS 6803:1999 - Acoustics – Construction Noise

This standard covers the specifics of measurement and assessment of noise from construction, maintenance and demolition. This standard also provides, for the purposes of noise level predictions, guideline noise levels expected from different machinery associated with construction and demolition activities. NZS 6803:1999 includes reproduced annexes from the British Standard BS 5228: Part 1: 1997. These are cited in this report as "pertaining to BS5228 as referenced in NZS6803".

Vibrations

BS 5228-2:2009 - Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

This standard provides guideline vibration levels for different construction activities, and recommended methods for vibration control on construction and open sites where operations are expected to generate significant vibration levels.

AS 2670.1: 2001 - Evaluation of human exposure to whole-body vibration - General

This standard provides methods for the measurement and assessment of vibrations as they pertain to human health, comfort and perception.

DIN 4150-3:1999-02 – Structural Vibrations – Part 3: Effects of Vibration on Structures

This standard provides methodology for measuring and assessing the effects of vibrations on buildings and structures designed for static loading.

Appendix VI – Methodology

The analysis of noise and vibrations effects in this report will follow the following process:

- Site: Identification of subject site location, structures currently on the site and structures and activities in proximity to site.
- Proximity: Assessment of the location, nature, and sensitivity of noise and vibrations receivers in proximity to the subject site.
- Stratigraphy: Identification of the stratigraphy of the site especially pertaining to areas with strata likely to require noise and/or vibration intensive works to excavate.
- Works: Identification of the proposed works for the site. This includes:
    - Structures assigned for demolition, if any.
    - Depths of excavations
    - Retention methodology
    - Types of foundations
    - Construction process
- Equipment: Identification of required equipment and mechanical plant most likely to generate noise and vibrations:
    - Combinations of equipment operating during each phase
    - Locations of equipment based on stratigraphy and proposed works.
- Modelling of noise propagation at site including:
    - Site and surrounding topography
    - Built environment surrounding site, including heights and elevations
    - Equipment locations and associated noise power levels
    - Elevation / depth of equipment during different phases of works.
    - Inclusion of mitigation measures.
- Vibrations: Analysis of activities likely to generate significant vibrations:
    - Frequency and level of vibrations expected from activities at representative distances.
    - Proximity of vibrations generating activities to surrounding structures.
- Assessment: Analysis of the modelled noise propagation and vibrations levels against defined criteria based on:
    - Regulatory framework, in this case the Auckland Unitary Plan
    - New Zealand & International standards where appropriate pertaining to Noise and Vibration in the environment generally and from construction works specifically.
- Mitigation: Consideration of Best Practicable Options for the mitigation of noise or vibrations from equipment or activities.

Glossary of Terms- Acoustics

Ambient Noise: the total noise, at a given place, a composite of sounds from many sources near and far.

Asymmetric: a waveform not identical on both sides of the mean or zero line, lacks symmetry.

Average: in acoustics where dB levels are extensively used, average may not mean adding up the values and then dividing by the number of samples.

Octave: a range of frequencies whose upper frequency limit is twice that of its lower frequency limit. For example, the 1000 Hertz octave band contains noise energy at all frequencies from 707 to 1414 Hertz.

In acoustical measurements, Sound Pressure Level is often measured in octave bands, and the centre frequencies of these bands are defined by ISO - 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz to divide the audio spectrum into 10 equal parts.

The sound pressure level of sound that has been passed through an octave band pass filter is termed the octave band sound pressure level.

One-third Octave Bands, there are three similar bands in each octave band.

1/1, 1/3, 1/6, 1/12, and 1/24 octaves are all used in acoustics.

Background Noise: the noise at a given location and time, measured in the absence of any alleged noise nuisance sources, also known as Residual Noise.

Broadband Noise: also called wideband noise - noise whose energy is distributed over a wide section of the audible range as opposed to Narrowband Noise.

Class 1: precision grade sound level meters for laboratory and field use - also known as Type 1.

Continuous Spectrum: sound spectrum whose components are continuously distributed over a given frequency range.

Frequency Weighted Sound Levels: Frequency weightings correlate objective sound measurements with the subjective human response. The human ear is frequency selective; between 500 Hz and 6 kHz our ears are very sensitive compared with lower and higher frequencies.

A-weighting: the A-weighting filter covers the full audio range - 20 Hz to 20 kHz and the shape is similar to the response of the human ear at the lower levels

C-weighting: a standard frequency weighting for sound level meters, commonly used for higher level measurements and Peak - Sound Pressure Levels.

Z-weighting: Z for 'Zero' frequency weighting, which implies no frequency weighting. In reality the range is 10 Hz to 20 kHz ±1.5 dB.

dB Level: is the Logarithm of the ratio of a given acoustic quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be indicated.

decibel: dB : a relative unit of measurement widely used in acoustics, electronics and communications. The dB is a Logarithmic unit used to describe a ratio between the measured level and a reference or threshold level of 0dB. The ratio may be Sound Power, Sound Pressure, voltage or Sound Intensity, etc.

Deltatron ®: trade name for IEPE - Integrated Electronics Piezoelectric.

FFT: Fast Fourier Transform : a digital signal processing technique that converts a time record into a narrow band constant bandwidth filtered spectrum. Measurements are defined by specifying the frequency span and a number of lines (or filters).

Frequency: f : the number of times that a Periodic function or vibration occurs or repeats itself in a specified time, often 1 second - cycles per second. It is usually measured in Hertz (Hz).

Frequency Analysis: analysing an overall broadband noise to identify the different contributions in different parts of the audio spectrum. Typically the analysis in made using 1/1-Octave, 1/3-Octave or narrow band (FFT) Analysis.

Frequency Band: a continuous range of frequencies between two limiting frequencies.

Hertz: Hz : the unit of Frequency or Pitch of a sound. One hertz equals one cycle per second.

Impact Sound: the sound produced by the collision of two solid objects. Typical sources are footsteps, dropped objects, etc., on an interior surface (wall, floor, or ceiling) of a building.

Infrasound: sound whose frequency is below the low-frequency limit of audible sound (about 16 Hz).

Integrating (of an instrument): indicating the mean value or total sum of a measured quantity.

kHz: kilohertz : 1 kHz = 1000 Hz = 1000 Hertz.

LA: A-weighted, Sound Level.

LA10: is the noise level just exceeded for 10% of the measurement period, A-weighted and calculated by Statistical Analysis.

LA90: is the noise level exceeded for 90% of the measurement period, A-weighted and calculated by Statistical Analysis.

LAn: noise level exceeded for n% of the measurement period with A-weighted , calculated by Statistical Analysis - where n is between 0.01% and 99.99%.

LAeq: A-weighted, equivalent sound level. A widely used noise parameter describing a sound level with the same Energy content as the varying acoustic signal measured - also written as dBA Leq

LAF: A-weighted, Fast, Sound Level.

LAFmax: A-weighted, Fast, Maximum, Sound Level.

LAFmin: A-weighted, Fast, Minimum, Sound Level.

LAIeq: A-weighted, Impulse, Leq, Sound Level.

LAmax: A-weighted, Maximum, Sound Level

LAS: A-weighted, Slow, Sound Level.

LASmax: A-weighted, Slow, Maximum, Sound Level.

LASmin: A-weighted, Slow, Minimum, Sound Level.

LC: C-weighted, Sound Level.

LCE: C-weighted, Sound Exposure Level

LCeq: C-weighted, Leq, Sound Level

LCF: C-weighted, Fast, Sound Level.

LCFmax: C-weighted, Fast, Maximum, Sound Level.

LCpeak: C-weighted, Peak, Sound Level.

Leq: Equivalent Sound Level

Lpeak: Peak Sound Level

LZ: Z weighted, Sound Level.

LZE: Z-weighted, Sound Exposure Level

LZeq: Z-weighted, Leq, Sound Level.

LZF: Z-weighted, Fast, Sound Level.

LZFmax: Z-weighted, Fast, Maximum, Sound Level.

LZFmin: Z-weighted, Fast, Minimum, Sound Level.

Multi-spectrum: a one or two-dimensional array of spectra, consisting of two or more spectra that were recorded during the same measurement

Narrowband Noise: noise which has its energy distributed over a relatively small section of the audible range.

Natural Frequency: the frequency at which a resiliently mounted mass will vibrate when set into free vibration. The frequency of oscillation of the free vibration of a system if no Damping were present.

Noise: any sound that is undesired by the recipient. Any sound not occurring in the natural environment, such as sounds emanating from aircraft, highways, industrial, commercial and residential sources. Interference of an electrical or acoustical nature.

Octave: a range of frequencies whose upper frequency limit is twice that of its lower frequency limit. For example, the 1000 Hertz octave band contains noise energy at all frequencies from 707 to 1414 Hertz.

Octave Band analyser: an instrument that measures Sound Levels in octave bands.

Peak-to-Peak: the amplitude difference between the most positive and most negative value in a time waveform, that is, the total Amplitude.

Piezoelectric: PE : any material which provides a conversion between mechanical and electrical energy. Piezo is a Greek term which means 'to squeeze'. If mechanical stresses are applied to a piezoelectric crystal, then an electrical charge results. Conversely, when an electrical voltage is applied across a piezoelectric material, the material deforms.

Pitch: is a subjective auditory sensation and depends on the frequency, the harmonic content, and to a lesser extent on the loudness of a sound.

Spectrum: the description of a sound wave's resolution into its components of frequency and amplitude.

Third Octave Band: Octave bands sub-divided into three parts, equal to 23% of the centre frequency. Used when octave analysis is not discrete enough. Divides the audio spectrum into 33 or more equal parts with Constant Percentage Bandwidth filter.

Tone: sound or noise recognisable by its regularity. A simple or Pure Tone has one frequency. Complex tones have two or more simple tones, the lowest tone frequency is called the Fundamental, the others are Overtones.

Vibration: mechanical oscillations occur about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random.