96 Beach Haven Rd & 13 Cresta Ave

Proposed Residential Development

Beach Haven, Auckland

CNVA

Construction Noise and Vibrations Assessment

Date: 29th September 2021

Prepared for: Da-Silva Builders Ltd

Prepared by: Earcon Acoustics Limited

Reference: J004866

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Document Control

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Table of Contents

Executive Summary

The subject site is adjacent to residential buildings. 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 and site wide cut and fill operations and compacting.

With regards to noise, the site is in proximity to residential dwellings, and the proposed development on this site requires excavation and potential augering. As such it is proposed that

- 2.4m height acoustic fence to be established at boundaries of Cresta Ave driveway
- 2m height acoustic fencing to be established at boundaries within 35m of works
- Piling if required, to be bored cast in-situ or piles concreted in augered bores.
- Truck movements into or out of the site limited to 1 movement in any 10 minute period.
- Noise generating works limited to Mon-Sat 7:30am to 6pm.

With the proposed fencing, combined with the proposed monitoring and 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 Retaining Wall Augering – (up to 3 days at any one receiver): Up to 75dB LA_{eq} and 90dB LA_{max} at 120 Beach Haven Road facades adjacent and facing the subject site.
- During Excavation and Compacting (for circa 1-2 weeks at any one receiver): Up to 73dB LA_{eq} and 90dB LA_{max} at 100D, 98C, 2/92 Beach Haven Road, and 2/5, 2/7, 2/9, 3/17, 29 Cresta Ave and 120 Beach Haven Road facades facing the subject site

Noise Levels are predicted to comply with the 70dB LAeq and 85dB LAmax limits at all other receivers during all works and 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.

With regards to vibrations, 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 monitored and managed. As such, it is proposed that prior to commencement of vibratory activities, vibrations monitoring shall be undertaken during initial test runs to establish intensity levels and suitable operating procedures and methodologies for control of vibration levels. Equipment restrictions are proposed where

- Augering shall be limited to excavators\rigs no larger than 15T
- Earth moving excavators shall be limited to no larger than 23T.

- Driven compactors no larger than 6T can be used, and within 10m of a receiver building can only be operated with vibratory functions OFF.
- Vibratory compacting within 10m of a receiver shall be limited to hand held compactors only – Plate or Rolling, no larger than 300kg.
- Construction traffic entry and egress to be managed from Cresta Ave driveway.

Vibration levels can be attenuated to within compliance levels at all neighbouring receivers provided all mitigation measures and good practice procedures detailed in the CNVMP (Construction Noise and Vibrations Management Plan) are implemented.

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, 96 Beach Haven Road & 13 Cresta Ave, in Beach Haven, Auckland for a residential development comprising four buildings.

The site for the proposed development is on two rear lots accessible through driveways on the northern side of Beach Haven Road and eastern side of Cresta Ave. Each of the lots is currently occupied by a timber framed dwelling in addition to ancillary structures including garages and driveways. The site comprising both lots is generally flat with a 1V:4H gradient towards the gully at the western boundary.

The proposed development comprises 72 apartments across four buildings all three storeys high, driveways from both Beach Haven Road and Cresta Ave, parking areas along the Cresta Ave driveway and along the eastern boundary, in addition to support services and paved areas across the site.

The development requires cut and fill operations throughout the site for establishment of foundations, with cuts to maximum depths of circa 2m below current ground level and fills up to 1.6m. In accordance with Geotechnical advice, shallow foundations are suitable for the proposed structures. As such, the development requires cut and fill operations for the establishment of foundations and services, in addition to general excavation, compaction, concrete operations, and potential for some augering for retaining piles where excavation depths exceed 1.5m.

This report:

- Identifies noise and vibrations generating activities associated with the site preparation, demolition, excavation, and construction of the proposed development,
- Assesses the noise and vibrations from these activities against the established standards for construction, and
- Proposes mitigation measures and strategies that can 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 and Architectural Plans by Brewer Davidson Architecture dated 07/042021
- Geotechnical Investigation Report by Lander Geotechnical dated 02/03/2021
- Storm water management plan by Airey Consultants Ltd dated 16/04/2021
- Earthworks timeline estimates by email dated 27/09/2021

2 Site

2.1 Identification

The proposed development site is located across two lots in a residential neighbourhood on the northern side of Beach Haven Road and eastern side of Cresta Ave in Beach Haven, Auckland. For ease of reference in this report, directional boundaries are noted in the figure below. For context, the subject site other than the driveway, is approximately 56m on its east-west axis and circa 110m on the north-south axis.

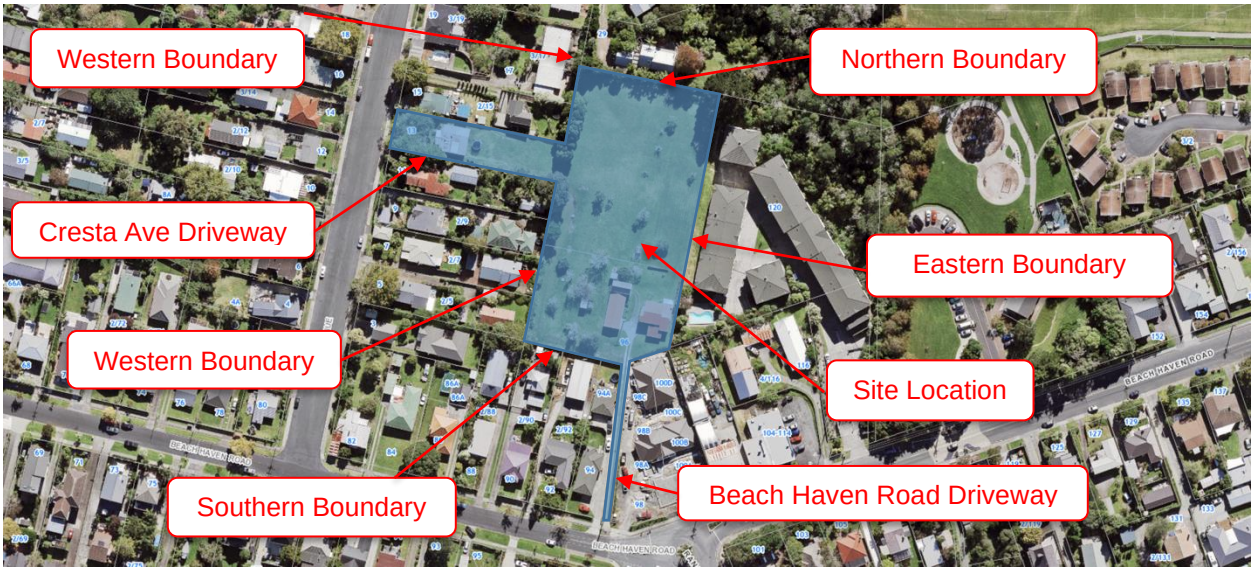
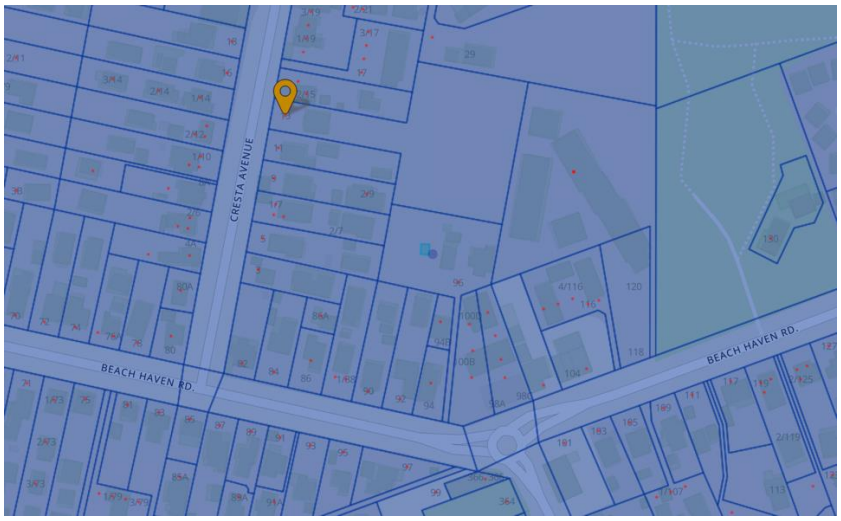


Figure 1 - Site Location

The proposed development covers the following land parcels, as shown in the figure below:



Lot 1 DP 157383
Lot 2 DP 157383

Figure 2 - Site Boundaries

2.2 Zoning

In accordance with the Auckland Unitary Plan – Operative Version, the subject site and adjacent sites to the north are currently zoned *Residential – Single House Zone*. Sites to the East and South are Zoned *Residential – Mixed Housing Urban*. Sites to the East are zoned *Residential – Mixed Housing Suburban*. The site is subject to a Private Plan Change Request to become Mixed Residential – Mixed Housing Urban and Suburban.

We note for reference that the outcome of the plan change request would be inconsequential to the assessment and management of construction noise and vibrations. The same rules, standards and criteria apply to both current and proposed zones.

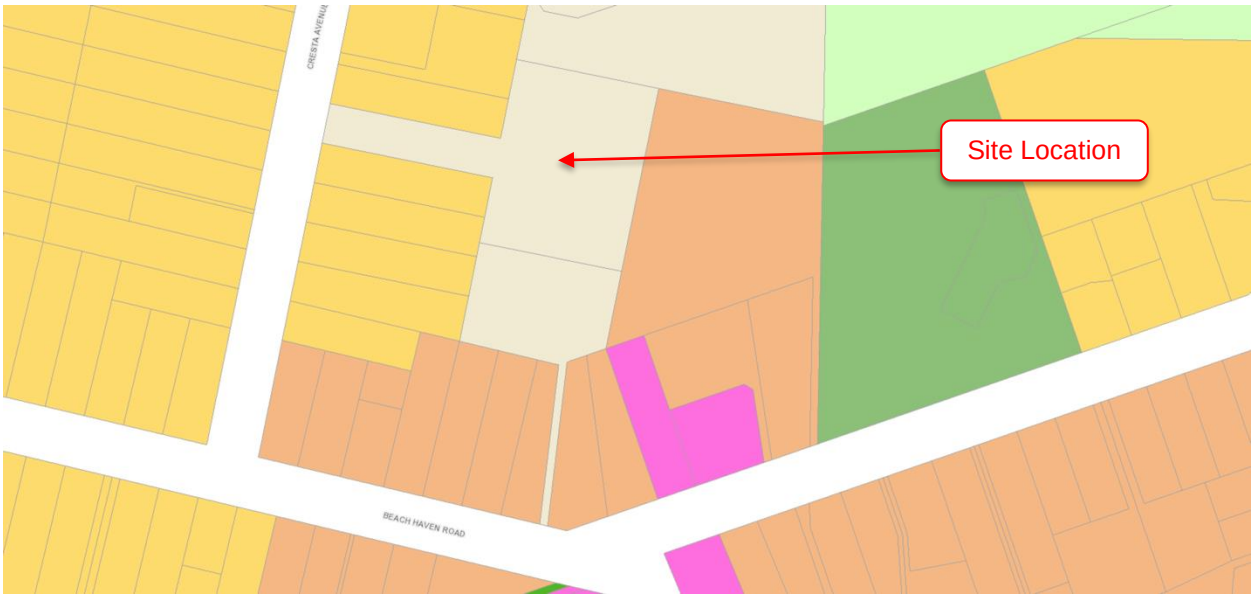


Figure 3 - Site Zoning

2.3 Heritage Sites

No heritage overlay sites were identified in proximity to the subject site.

2.4 Services

As per the figure below, the site is underlain by underground services, with a wastewater pipe crossing the north-eastern corner, and the Cresta Ave Driveway. In addition, a stormwater pipe runs along the southern and south western boundaries. Consideration is given in this report and the associated mitigation measures to the potential for underlain services to propagate vibrations beyond surface vibrations.

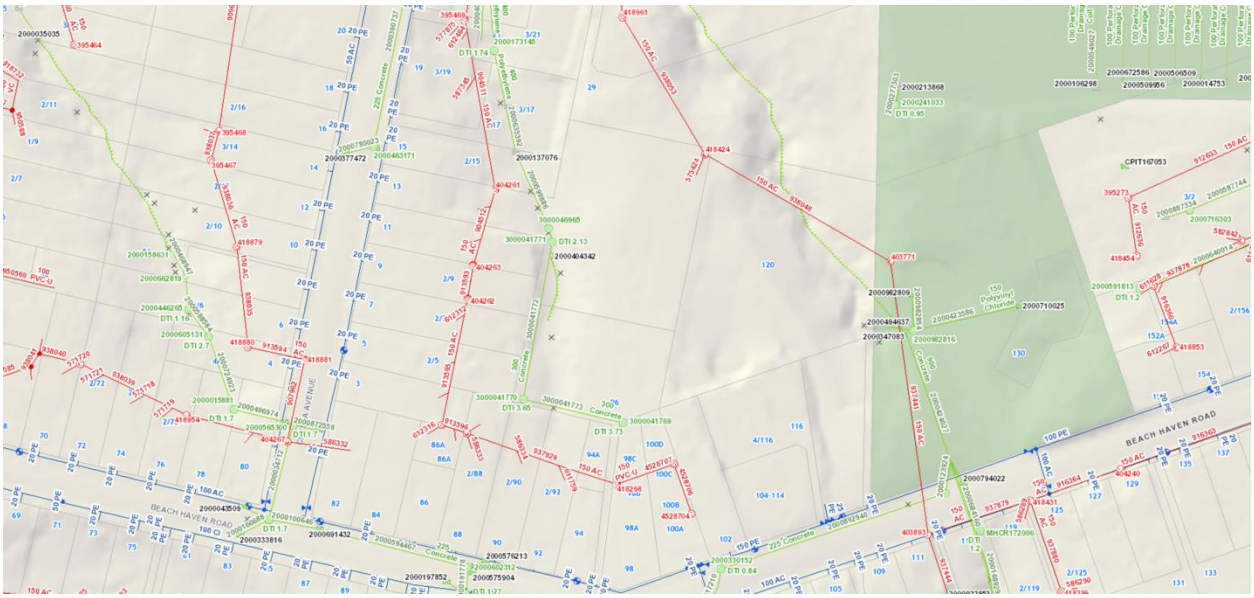


Figure 4 - Services Underlying Site

2.5 Vicinity

The neighbouring area adjacent to the subject site is predominantly residential with 1,2 storey dwellings, 3 storey apartment buildings, and ancillary structures. In context of noise and vibrations, the following receiver sites are in the vicinity of the proposed development, as shown in the figure below. Reference to single or multi-storey in this context pertains to the façade facing the subject site as viewed from the subject site.

- North – 29 Cresta Ave: Single storey residential dwelling founded at a slightly lower elevation that the subject site with a building footprint circa 4m from the boundary.
- East – 120 Beach Haven Road: Multi tenancy three storey residential buildings with two blocks founded 5m from the eastern boundary.

- South – 100D, 94A, 2/92, 2/90 Beach Haven Road: Single storey residential dwellings (other tha 2/90 Beach Haven Road being two storeys.) 94A and 2/90 Beach Haven Road founded 10m from the southern boundary, and 2/92, 100D Beach Haven Road founded circa 2.5m from the boundary.
- West – 2/5, 2/7, 2/9, 11, 2/15, 3/17 Cresta Ave: Single Storey residential dwellings (other than (2/15 Cresta Ave being two storeys) with 2/5, 2/7, 2/9 Cresta Ave founded circa 5-6m from the western boundary, 11 Cresta Ave founded 40m from the western bundary (albeit 5m from the proposed driveway boundary,) 2/15 at 15m from the boundary (albeit 4m from the proposed driway boundary) and 3/17 at 6m from the boundary.

Figure 5 - Site Vicinity - [AUP GIS]

Figure 6 - Aerial Site View - Facing General North - [Openstreet Maps - Apple]

2.6 Stratigraphy

With reference to the Geotechnical Investigation, the following is understood regarding the stratigraphy of the site, as it pertains to the potential for noise and vibrations during excavation for the proposed building footprints:

- Topsoil to depths of 0.1m to 0.8m; overlying
- Residual ECBF soils of clay and silt to depths of 3.85m; overlying
- Transitional ECBF clay soils.

Based on Geotechnical recommendations:

- Shallow foundations are suitable for proposed buildings.
- Building footprints are not atop any services, as such bridging is not required.
- Compacting of excavated soils for re-use in fill operations may require use of padfoot compactors.

We note that retaining walls are likely required where excavations exceed 1.5m in depth. Due to the proximity of the works to adjacent residential receivers, the use of driven piles (sheet piling, impact piling) is precluded. Piles can be established as either bored cast in situ piles, or poles concreted in augered bores.

The development requires site wide excavation, cut and fill operations, earthmoving, and concrete mixing and pouring operations.

As such, **excavation, concrete pouring, compacting, and potential localised augering for retention** are likely to be the highest noise and vibration generating activities.

3 Proposed Development

3.1 Proposed Buildings

The proposed development comprises 61 Units in 12 Blocks aligned around the permitter of the site. The development also includes a driveway along the eastern boundary. The following is a site plan and a representative elevation view of the proposed buildings (shown in more detail in Appendix VIII.)

Figure 7 - Site Plan - detailed in Appendix VIII – [Brewer Davidson]

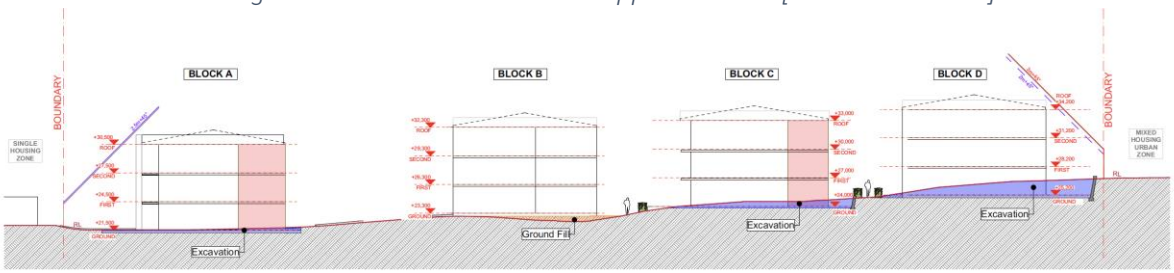


Figure 8 – Sample Elevations – West – [Brewer Davidson]

3.2 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; demolition, site preparation, excavation works, potential retention piling, 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. Proposed development drawings are shown in Appendix VIII

3.2.1 Demolition and Site Clearance

The current buildings, 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. Clearance work will occur in conjunction with the demolition works.

3.2.2 Retention

The depth of excavation in some locations may require retaining walls along the building footprints prior to cut operations. Due to proximity to adjacent residential receivers, driven piling is precluded. As such, this phase of the construction may require augering with attachment on excavator, earth moving, compacting and concrete mixing and pumping as the highest noise and vibration generating activities. We note the relatively shallow depths of bores for retention (<10m) can be achieved with augering attachments on small to mid-sized excavators.

3.2.3 Excavation

The proposed development involves cut and fill operations throughout the full site, with cuts up to 2m below current ground level and fill up to 1.6m, for establishment of building foundations. For the purposes of this report, cut and fill operations are expected to require excavators with picking/ripping and loader/bucket attachments for earth moving and carting, in addition to compactors, including potential requirement for padfoot compactors.

3.2.4 Foundations

In accordance with the Geotechnical Investigation, buildings can be supported on shallow foundations. In addition, the building footprints are not atop any services, and as such do not require bridging. Compacting would be required for establishment of foundation. As such, this phase of the construction is expected to require augering, earth moving, compacting and concrete mixing and pumping as the highest noise and vibration generating activities.

3.2.5 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. Construction also requires concrete pumping to elevation.

3.3 Acoustic Perimeter Fencing

Based on the proximity of the neighbouring receivers to the works, it is reasonable to assume that acoustic perimeter fencing will be required for noise levels to be minimised at the ground level facades of the adjacent properties during highest noise generating activities; these being augering, excavation, and cut operations. We note the following regarding fencing:

- Entry and egress to the site is recommended (as per further in this report for amenity reasons) to occur from the Cresta Ave entrance. It will be necessary to protect the adjacent neighbours from truck noises. Buildings along the boundaries of the driveway from Cresta Ave are 1 storey other than 2/15 Cresta Ave having a second storey. 2.4m fencing would be required along the full boundary length of the driveway from Cresta Ave.
- The three storey residential building blocks at the eastern boundary (120 Beach Haven Rd) are noted to have solid concrete facades at the ground level with minimal glazing and no doors or penetrations. Considering the distances to the proposed work areas, fencing would have little if any effect on noise at the upper floor facades facing the subject. As such, fencing is not required at the eastern boundary as it would be of little value, other than protection of the outdoor pool area at the south of the site.
- Considering the scale of the site, it is likely that works are staged or progress from one area to the next. If that occurs, shielding will be required for the area of works.

As such, for each stage of works, at the area where works are underway;

- Driveway Fencing: To protect adjacent neighbours from noise associated with truck entry and egress to the site, a minimum 2.4m high acoustic fence is required along the northern and southern boundary of the driveway from Cresta Ave adjacent neighbouring facades. This can be constructed plywood hoarding panels a minimum surface density of 10kg/m^2 (e.g., 17.5mm plywood). Driveway fence to be maintained for the duration of the project.
- Work Area Fencing: A minimum 2m high acoustic fence is proposed to be established along the north, west and south boundaries with adjacent receivers within a radius of 35m from where demolition and earthworks (including augering, compacting, cut, fill, etc) are underway. This can be constructed using acoustic blankets 6kg/m^2 affixed to temporary chain link fences or using plywood hoarding panels a minimum surface density of 10kg/m^2 (e.g., 17.5mm plywood). Work area fencing is proposed to be maintained at the 35m radius boundaries of a stage (or the full development) until earthworks are complete at that stage. If earthworks are planned throughout the site, then fencing required to shield all façades of receivers along the northern, western and southern boundaries.

Figure 9 - Work Area boundary fencing - within 35m radius of area of works (if staged)

3.4 Equipment and Activities

3.4.1 Noise

The following table lists relevant noise generating equipment and mechanical plant expected to be used at different stages during the demolition, excavation and construction works on the subject site. Noise data is quoted below based on measurements at similar sites collated with data published in NZS 6803:1999, and BS 5228: Part 1:1997 and 2009.

Activity	Equipment	Sound Pressure LA_{eq} at 10m [dB]
Truck - 20-24 Tonne	Truck - 20-24 Tonne Idling	58
	Loading soft materials	72
Ground excavation	5T-8T Tracked Excavator	65
	12T-15T Tracked Excavator	73
	23T-27T Tracked Excavator	76
Piling (Bored)	Auger on 13T Excavator	75
	13T Tracked Auger	75
	Auger on 6T Excavator	72
Levelling Ground	Grader	62
General	Water Pump	68
	Compressor	66
Compacting Fill	Vibratory roller 3T	67
	6T Padfoot Compactor – Vibratory	73
	15T Padfoot Compactor - Vibratory	76
Concreting	Pump + Cement Truck Discharging (Foundations)	68
	Poker Vibrator	69

Table 1 – Equipment noise levels

We note the following sample videos pertain to augering with attachment on excavator. We note the videos are provided as a direct extract from device with all EXIFF meta data intact for referential purposes:

- 13T@7m: https://www.dropbox.com/s/l8edmnhrn9cyuod/IMG_5362.MOV?dl=0
- 13T@10m Shielded: https://www.dropbox.com/s/p4o1avrixmxrx5i/IMG_5376.MOV?dl=0
- https://www.dropbox.com/s/7a5buevxbnd33st/IMG_4082.MOV?dl=0
- https://www.dropbox.com/s/vtitve8by51ao5q/IMG_5361.MOV?dl=0

3.4.2 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
		Auger Hitting Base	14	0.3
Rotary Boring - 600mm	Soft Ground over Rock	Augering	5	0.54
		Boring with Rock Auger	5	0.43

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

The following table lists relevant vibrations generating activities expected to occur during demolition and 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
Augering	Ø 500mm augering from clear ground to 6m	3	20	**0.62**
		5	20	**0.45**
Clearing Auger	Counter rotation of auger – vibration through excavator	3	12	**1.87**
		5	12	**1.53**
Compacting Vibratory OFF	10t - Single Smooth Drum	8	25	**1.32**
		15	25	**1.19**
Compacting Vibratory On	14.5t - Padfoot	10	25	**3.65**
	4.5t - Padfoot	10	25	**1.87**
20T Excavator	Digging - Fragmented Rock	10	20	**0.60**
20T Excavator	Earth Moving	10	100	**0.30**
Truck - Laden	Driving on Irregular Ground	5	80	**0.06**

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 demolition and 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 Vibrations 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.
- 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:
    - **5mm/s** for **3 days or less**
    - **2mm/s** for **more than 3 days**
- **Unoccupied Buildings / Structures - Residential**. The following limits are in accordance with DIN 4150-3:1999 as referenced in 25.6.30.(1).(a) of the Auckland Unitary Plan, and 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. Sample noise prediction models for surrounding receivers are shown in Appendix IX.

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 version 2019 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.
- Locations of predicted LA_{eq} Levels, as per the figures in Appendix IX, are positioned at approximately 1m from the relevant facades of the receivers at the elevation for the model.

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 excavation works including augering for retaining walls. 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 Modelling - Activity Locations

Modelling was done for a multiple activities and machinery, including for the highest noise generating phases in multiple locations representative of the works in context of the proposed site plan and building footprints. The modelling includes the proposed mitigation measures of acoustic fencing along boundaries.

5.1.4 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 receiver elevations of 1.5m and 4m above ground level. We note that the equipment selection is for modelling purposes only, and further restrictions on equipment are proposed further in this report.

Equipment	Sound pressure Level at 10m (dBA)
Excavator 23T	76
Truck – Loading	73
Auger – Mounted on 13T Excavator / 13T Augering Rig	75
Compacting 5T	73

Table 8 - Modelling Scenarios

5.1.5 Modelling Analysis

Demolition and construction 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 in this report.

- Simultaneity: In each modelled scenario, all machinery 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 (e.g. initial depth of basalt). 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}. In accordance with *Standard NZS6803:1999 clause 6.3 Measurement Time*:
    - *"The Measurement sample time should not exceed one hour, and 15 minutes will often be adequate."*

5.2 Receiver Analysis

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 at the eastern and western boundaries, noise levels are expected to exceed the compliance limits at the upper floor façades 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, noise levels are expected to be:

<u>During Retaining Wall Augering if required – (up to 3 days at any one receiver):</u>

- Up to 75dB LA_{eq} and 90dB LA_{max} at 120 Beach Haven Road facades adjacent and facing the subject site.

<u>During Excavation and Compacting (for circa 1-2 weeks at any one receiver):</u>

- Up to 73dB LA_{eq} and 90dB LA_{max} at 100D, 98C, 2/92 Beach Haven Road, and 2/5, 2/7, 2/9, 3/17, 29 Cresta Ave and 120 Beach Haven Road facades facing the subject site

<u>All Other works</u>

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

6 Vibrations 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 Augering, Excavations and Compacting.

6.1 Augering

Augering / Boring: The activities involved in rotary boring, if well managed and monitored, generate vibrations less than 0.5mm/s at 5m as per Earcon measurements at similar sites, where vibrations were also noted to be centred around the frequencies of 20Hz-31.5Hz. These vibration levels generally correspond to examples cited in Standard BS 5228.

Based on the proposed building footprints over underlain services, the closest piling locations would occur at approximately 7m-10m from the closest receivers. At these distances, it is expected that vibrations associated with augering would comply with the limits. We note that due to the scale of the site, and the proximity of works to the boundary receivers in context of both noise and vibrations.

- Augering shall be limited to excavators\rigs no larger than 15T

Provided all mitigation procedures (e.g., intensity management) and good practice procedures detailed in the CNVMP (Construction Noise and Vibrations Management Plan) are implemented it is expected that vibration levels from augering activities can be managed within the criteria limits at all receivers.

6.2 Compacting

A key activity associated with the development is compacting using vibratory equipment. This has the potential to produce vibrations under 2mm/s at 10m using driven compactors with vibratory functions off 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.

Considering compacting is likely to occur within 5m of adjacent buildings, compacting shall be restricted to use of hand held compactors. No driven compactors can operate within the site. In addition, management controls and training of personnel to operate equipment in a manner that minimises vibrations from this activity is required (e.g. vibratory compactors should not be driven over rocks or stones) Based on the above, the following applies:

- Driven compactors (roller or padfoot) no larger than 6T can be used, and within 10m of a receiver building can only be operated with vibratory functions OFF.
- Vibratory compacting within 10m of a receiver shall be limited to hand held compactors only – Plate or Rolling, no larger than 300kg.

Provided vibrations are monitored during compacting test runs and provided all mitigation procedures (e.g. intensity management) are implemented, it is expected that vibration levels from compacting activities can be managed within all criteria limits at all receivers.

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 0.3 and 0.6mm/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. Examples of tracked excavator vibrations are shown in Appendix X. In consideration of the proximity of the site to adjacent receivers, and in context of the area available on the site:

- Earth moving excavators shall be limited to no larger than 23T.

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

6.4 Truck Movements

Measurements at similar sites with irregular ground indicate that slow speed truck movements, as would be expected through the driveway, yield vibration levels at or less than 0.5mm/s-0.8mm/s at 2-3m. In general, vibrations from slow moving trucks depend on the maintenance of ground conditions free of excessive potholes or sizeable rock fragments.

For the subject site, the driveway from Beach Haven Road is noted to be narrow, and in close proximity to the adjacent residential buildings. Considering the fact that construction traffic is expected through the project, it is recommended that construction traffic (heavy vehicles) entry and egress to the site is arranged from the Cresta Ave driveway.

As such, the following is required:

- Construction traffic entry and egress to be managed from Cresta Ave driveway.
- Truck movements into or out of the site shall be limited to no more than 1 movement in any 10 minute period.

On a well maintained site, with proper best practice operation of equipment as required by the CNVMP, vibration levels from truck movements would be minimal in context of human effects, and well within criteria limits at all receivers.

7 Compliance

Due to the proximity and elevation of the neighbouring upper floor facades adjacent the boundary, and in particular during augering and excavations, 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 Retaining Wall Augering – (up to 3 days at any one receiver):

- Up to 75dB LA_{eq} and 90dB LA_{max} at 120 Beach Haven Road facades adjacent and facing the subject site.

During Excavation and Compacting (for circa 1-2 weeks at any one receiver):

- Up to 73dB LA_{eq} and 90dB LA_{max} at 100D, 98C, 2/92 Beach Haven Road, and 2/5, 2/7, 2/9, 3/17, 29 Cresta Ave and 120 Beach Haven Road facades facing the subject site

All Other works

- Be at or within the compliance limits of 70dB LA_{eq} and 85dB LA_{max} at all other receivers during all other works

Notwithstanding the above, with the proposed perimeter fence, and with monitoring and management controls, noise levels will be maintained as low as practicably possible during the site work.

7.1 Vibrations

Vibrations are expected to be compliant with the AUP requirements and standards whereby vibrations will be:

- Within the structural protection DIN4150-3 criteria limits at all receivers.
- Within the amenity levels at all receivers

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 criteria limits at all receivers.

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 Equipment Restrictions

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

- Augering shall be limited to excavators\rigs no larger than 15T
- Earth moving excavators shall be limited to no larger than 23T.
- Driven compactors no larger than 6T can be used, and within 10m of a receiver building can only be operated with vibratory functions OFF.
- Vibratory compacting within 10m of a receiver shall be limited to hand held compactors only – Plate or Rolling, no larger than 300kg.

8.2 Truck Movements

- Construction traffic entry and egress to be managed from Cresta Ave driveway.
- Truck movements into or out of the site shall be limited to no more than 1 movement in any 10 minute period.

8.3 Fencing

- Driveway Fencing: To protect adjacent neighbours from noise associated with truck entry and egress to the site, a minimum 2.4m high acoustic fence is required along the northern and southern boundary of the driveway from Cresta Ave adjacent neighbouring facades. This can be constructed plywood hoarding panels a minimum surface density of 10kg/m^2 (e.g., 17.5mm plywood). Driveway fence to be maintained for the duration of the project.
- Work Area Fencing: A minimum 2m high acoustic fence is proposed to be established along the north, west and south boundaries with adjacent receivers within a radius of 35m from where demolition and earthworks (including augering, compacting, cut, fill, etc) are underway. This can be constructed using acoustic blankets 6kg/m^2 affixed to temporary chain link fences or using plywood hoarding panels a minimum surface density of 10kg/m^2 (e.g., 17.5mm plywood). Work area fencing is proposed to be maintained at the 35m radius boundaries of a stage (or the full development) until earthworks are complete at that stage. If earthworks are planned throughout the site, then fencing required to shield all façades of receivers along the northern, western and southern boundaries.

Figure 10 - Work Area boundary fencing - within 35m radius of area of works

8.4 Time Restrictions

In consideration of the residential nature of the surrounding area:

- All **noise or vibrations 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.

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
- Perimeter Shielding.
- Monitoring conditions prior to commencement of works to establish best processes to control noise

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.

(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 excavations 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 are limited to daytime 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 maintain vibration levels within the compliance limits at occupied receivers, including:

- Restrictions on equipment size and consequently power output
- Monitoring conditions prior to commencement of works to establish best processes, and in particular operating intensity levels, to control noise

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 compliance levels as per the requirements of the Auckland Unitary Plan.

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

The decision to recommend an increase of the allowed noise and vibration limit at the adjacent receivers was not taken lightly. 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 following details some of the assessed considerations:

Reducing noise from the source

The mitigation measures proposed in this report restrict equipment size and operation for the works, including limiting compactor operation to hand held only. In addition, manned monitoring is required at the commencement of any activity to allow for procedural adjustment that reduce noise and vibrations.

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.

Shielding Receivers

The main consideration here is the elevation of the upper floors at the adjacent receivers:

- Elevated Acoustic curtains: Acoustic shielding high enough to shield upper floor receivers would usually require extensive scaffolding. The elevation of the noise source during augering means unless shielded to full two storey height (i.e. circa 6m), permitter fencing would have no attenuation effect on upper floor receivers.
- Acoustic Enclosures: The use of acoustic enclosures is not practicable due to the need for mechanised equipment for the site works.

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 pertaining to 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 75dBA

Regarding outdoor activities, noise levels at outdoor areas of receivers are predicted to be below compliance levels. As such, the effects on outdoor activities from the exceedance would be generally less than compliance level effects at 70dBA. Furthermore, the exceedances are associated with works limited to weekday daytime hours when outdoor activities are less likely.

Regarding the exceedance at L_{eq} 75dBA, when assessed internally, noise levels in rooms with facades facing the subject site would conservatively be expected to reach approximately Leq 55dBA where exceedances are predicted. We note the majority of the adjacent buildings are single storey whereby shielding is effective.

For subjective assessment in a residential occupancy, this noise level is where most people would have to slightly raise their voices in conversations, and those watching TV need to slightly increase the volume to hear clearly. Construction noises at this level also become distracting in phone conversations.

Based on the above, the 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.

10 Summary

The subject site is adjacent to residential buildings. 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 and site wide cut and fill operations and compacting.

10.1 Noise

The site is in proximity to residential dwellings, and the proposed development on this site requires excavation and potential augering. As such it is proposed that

- 2.4m height acoustic fencing to be established at boundaries of Cresta Ave driveway
- 2m height acoustic fencing to be established at boundaries within 35m of works
- Piling if required, to be bored cast in-situ or piles concreted in augered bores.
- Truck movements into or out of the site limited to 1 movement in any 10 minute period.
- Noise generating works limited to Mon-Sat 7:30am to 6pm.

With the proposed fencing, combined with the proposed monitoring and 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 Retaining Wall Augering – (up to 3 days at any one receiver): Up to 75dB LA_{eq} and 90dB LA_{max} at 120 Beach Haven Road facades adjacent and facing the subject site.
- During Excavation and Compacting (for circa 1-2 weeks at any one receiver): Up to 73dB LA_{eq} and 90dB LA_{max} at 100D, 98C, 2/92 Beach Haven Road, and 2/5, 2/7, 2/9, 3/17, 29 Cresta Ave and 120 Beach Haven Road facades facing the subject site

Noise Levels are predicted to comply with the 70dB LAeq and 85dB LAmax limits at all other receivers during all works and 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 Vibrations

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 monitored and managed. As such, it is proposed that prior to commencement of vibratory activities, vibrations monitoring shall be undertaken during initial test runs to establish intensity levels and suitable operating procedures and methodologies for control of vibration levels. Equipment restrictions are proposed where:

- Augering shall be limited to excavators\rigs no larger than 15T
- Earth moving excavators shall be limited to no larger than 23T.
- Driven compactors no larger than 6T can be used, and within 10m of a receiver building can only be operated with vibratory functions OFF.
- Vibratory compacting within 10m of a receiver shall be limited to hand held compactors only – Plate or Rolling, no larger than 300kg.
- Construction traffic entry and egress to be managed from Cresta Ave driveway.

Vibration levels can be attenuated to within compliance levels at all neighbouring receivers provided all mitigation measures and good practice procedures detailed in the CNVMP (Construction Noise and Vibrations Management Plan) are implemented.

Appendix I- CNVMP

Construction Noise and Vibration Management Plan

96 Beach Haven Road & 13 Cresta Ave
Proposed Residential Development
Beach Haven, Auckland

Construction Noise & Vibration Management Plan (CNVMP)

Da-Silva Builders Ltd

For Resource Consent

Prepared By:	Earcon Acoustics Limited
Date:	29 September 2021
Reference:	J004866.MP
Application #:	

QUALITY ASSURANCE

Document: 96 Beach Haven Road & 13 Cresta Ave, Beach Haven, Auckland
Construction Noise & Vibration Management Plan
For Resource Consent

Contact	Issue	Date	Rev
Alex Jacob alex.jacob@earcon.co.nz 021 572 518	For Internal Review	29/09/2021	B
Fadia Sami fadia.sami@earcon.co.nz 021 437893	For resource consent	29/09/2021	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 demolition, excavation and construction works for the proposed buildings at 96 Beach Haven Road & 13 Cresta Ave in Beach Haven, Auckland. This CNVMP is required in accordance with the Resource Consent Conditions pertaining to the development.

All Resource Consent Conditions pertaining to noise and vibrations shall be appended and attached to this Plan and all copies of it. Contact details must be completed in the subsequent appendix as part of this management plan

The proposed development comprises 72 apartments across four buildings all three storeys high, driveways from both Beach Haven Road and Cresta Ave, parking areas along the Cresta Ave driveway and along the eastern boundary, in addition to support services and paved areas across the site.

The development requires cut and fill operations throughout the site for establishment of foundations, with cuts to maximum depths of circa 2m below current ground level and fills up to 1.6m. In accordance with Geotechnical advice, shallow foundations are suitable for the proposed structures. As such, the development requires cut and fill operations for the establishment of foundations and services, in addition to general excavation, compaction, concrete operations, and potential for some augering for retaining piles where excavation depths exceed 1.5m.

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.

Property Affected		
120 Beach Haven Rd*	92 Beach Haven Rd	15 Cresta Ave
116 Beach Haven Rd	2/92 Beach Haven Rd	2/15 Cresta Ave
4/116 Beach Haven Rd	90 Beach Haven Rd	17 Cresta Ave
102 Beach Haven Rd	2/90 Beach Haven Rd	1,2,3/17 Cresta Ave
104-114 Beach Haven Rd	88 Beach Haven Rd	19 Cresta Ave
100A Beach Haven Rd	2/88 Beach Haven Rd	1,2,3/19 Cresta Ave
100B Beach Haven Rd	86A Beach Haven Rd	21 Cresta Ave
100C Beach Haven Rd	3 Cresta Ave	1,2,3/21 Cresta Ave
100D Beach Haven Rd	5 Cresta Ave	29 Cresta Ave
98 Beach Haven Rd	2/5 Cresta Ave	29A Cresta Ave
98A Beach Haven Rd	7 Cresta Ave	12 Cresta Ave
98B Beach Haven Rd	2/7 Cresta Ave	14 Cresta Ave
98C Beach Haven Rd	9 Cresta Ave	16 Cresta Ave
94 Beach Haven Rd	2/9 Cresta Ave	
94A Beach Haven Rd	11 Cresta Ave	

** Multi Occupancy building. All occupancies must be notified (e.g. letter in each mailbox)*

3. CRITERIA

3.1 Noise Compliance Limits

The following criteria apply for noise compliance:

Table A2: Noise Compliance Criteria

Activity	Receivers	Time	Noise	
			L_{eq}	L_{max}
Augering	• 120 Beach Haven Road	Monday – Saturday 07:30am to 6:00pm	75dBA	90dBA
Excavation	• 120 Beach Haven Road • 100D Cresta Ave • 98C Cresta Ave • 2/92 Beach Haven Road • 2/5 Cresta Ave • 2/7 Cresta Ave • 2/9 Cresta Ave • 3/17 Cresta Ave • 29 Cresta Ave	Monday – Saturday 07:30am to 6:00pm	73dBA	90dBA
All Other*	All	Monday – Saturday 07:30am to 6:00pm	70dBA	85dBA

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

3.2 Vibration Compliance Limits

The following criteria apply for Vibrations 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	Any	2mm/s for more than 3 days			
		5mm/s for 3 days or less			
Unoccupied	Any	5mm/s	5-15mm/s	15-20mm/s	20mm/s

3.3 Predicted 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. Provided best practice measures, in addition to the recommendations and mitigation measures detailed in this CNVMP are adhered to, noise levels at relevant receivers are predicted to be in accordance with the noise compliance criteria detailed in section 3.1 above.

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
Ground excavation	5T-8T Tracked Excavator	65
	12T-15T Tracked Excavator	73
	23T-27T Tracked Excavator	76
Piling (Bored)	Auger on 12T Excavator	75
	13T Tracked Auger	75
	Auger on 6T Excavator	72
Levelling Ground	Grader	62
General	Water Pump	68
	Compressor	66
Compacting Fill	Vibratory roller 3T	67
	6T Padfoot Compactor – Vibratory	73
	15T Padfoot Compactor - Vibratory	76
Concreting	Pump + Cement Truck Discharging (Foundations)	68
	Poker Vibrator	69

3.4 Predicted Activity Vibration Levels

The following tables list 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.

Provided best practice measures, in addition to the recommendations and mitigation measures detailed in this CNVMP are adhered to, vibration levels at relevant receivers are predicted to be in accordance with the vibration compliance criteria detailed in section 3.2 above.

Table A5: Activity Vibration Levels – Measurements at similar sites

Activity	Mode	Distance	Frequency	PPV
		m	Hz	mm/s
Augering	Ø 500mm augering from clear ground to 6m	3	20	0.62
		5	20	0.45
Clearing Auger	Counter rotation of auger – vibration through excavator	3	12	1.87
		5	12	1.53
Compacting Vibratory OFF	10t - Single Smooth Drum	8	25	1.32
		15	25	1.19
Compacting Vibratory On	14.5t - Padfoot	10	25	3.65
	4.5t - Padfoot	10	25	1.87
20T Excavator	Digging - Fragmented Rock	10	20	0.60
20T Excavator	Earth Moving	10	100	0.30
Truck - Laden	Driving on Irregular Ground	5	80	0.06

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
		Auger Hitting Base	14	0.3
Rotary Boring - 600mm	Soft Ground over Rock	Augering	5	0.54
		Boring with Rock Auger	5	0.43

4. MONITORING

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

During activities expected to generate high ground vibrations in the vicinity of any neighbouring buildings, it will be necessary to monitor vibrations at commencement of the activities.

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

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.

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

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:

The following mitigation measures shall be implemented:

- Working Hours: Noise or vibrations generating site works shall be limited to the hours of:
    - All noise or vibration works: Monday – Saturday 7:30am to 6:00pm
    - Noise or Vibration generating work shall not occur on Sundays or public holidays.

- Driveway Fencing: an acoustic fence shall be constructed at the northern and southern boundaries of the driveway from Cresta Ave facing adjacent receiver buildings:
    - A minimum 2.4m in height, with no holes or perforations.
    - This can be constructed with plywood panels a minimum 10kg/m^2 (e.g. 17.5mm) with no gaps between panels or with the ground. Fence to be maintained for the duration of the project.

- Work Area Fencing: Prior to the commencement of works, an acoustic fence shall be constructed at the boundaries with adjacent residential receivers within 35m of where works are underway:
    - A minimum 2m in height, with no holes or perforations and constructed with no air gaps between blankets
    - This can be achieved acoustic blankets 6kg/m^2 on chain-link fences, constructed with no gaps between the ground and the bottom of the fence.
    - Fence to be maintained until establishment of foundations.

- Equipment Restrictions:
    - Augering limited to attachment on excavator or piling rig no larger than 15T
    - Earth moving excavators shall be limited to no larger than 23T.
    - Driven compactors no larger than 6T can be used, and within 10m of a receiver building can only be operated with vibratory functions OFF.
    - Vibratory compacting within 10m of a receiver shall be limited to hand held compactors only – Plate or Rolling, no larger than 300kg.
    -
- Truck Movements
    - Truck movements into or out of the site shall be limited to no more than 1 movement in any 10 minutes period.
    - Construction traffic entry and egress to be managed from Cresta Ave driveway.

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 muffled plant.
- Shrouding: breakers can be equipped with acoustic shrouds around attachments, including PVC skirt to ground level. This can reduce noise levels by circa 5dBA.
- 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.

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.
- 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)
- 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.
- Augering clearing: Counter rotation of the auger for clearing should be avoided if steel on steel impact occurs. Manual cleaning of auger should be used to avoid high noise.

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 Project Manager:

Contact Number

Contact person in control of the site

Name Onsite Manager:

Contact Number

Health Safety & Environmental Manager

Name HS&E Manager:

Contact Number

Construction Works

Is construction in stages? Yes/No

If Yes give details. ……

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 references 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.

Appendix VII – Stratigraphy

Client : BENTLEY STUDIOS LIMITED

Project Location : 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

Job Number: J01675

Auger Borehole No. HA05

Sheet 5 of 16

Vane Head: 1900 | Logged By: RG | Processor : PL | Date: 04.02.21

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					Piezometer Details: 0.0m-0.5m - Bentonite Seal; 0.5m-5.0m - Screened with Filter Sock
clayey SILT, orange mottled light grey. Very stiff, moist, low plasticity [RESIDUAL EAST COAST BAYS FORMATION]	0.5		193+		
becoming medium plasticity	1.0		193+		
becoming low plasticity, with trace fine sand	1.5		152/66	2.3	
becoming moderately sensitive	2.0		160/52	3.1	
	2.5		171/83	2.1	
fine sandy SILT with minor clay, orange mottled light grey. Loose, moist, low to no plasticity, with trace limonite	3.0		193+		
	3.5		193+		
becoming moderately sensitive	4.0		182/58	3.1	
becoming medium dense	4.5		UTP		
slightly clayey SILT with trace fine sand, light grey mottled orange. Hard, wet, low plasticity, with trace limonite	5.0		UTP		
EOB at 5.0m. Target Depth.	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

Topsoil, Fill, Clay, Silt, Sand, Gravel, Organic, Pumice, Sandstone, Siltstone, Limestone, Volcanic, Plutonic, No Core

Figure 11 - Representative Bore Hole Log - [Lander Geotechnical]

Appendix VIII – Proposed Development

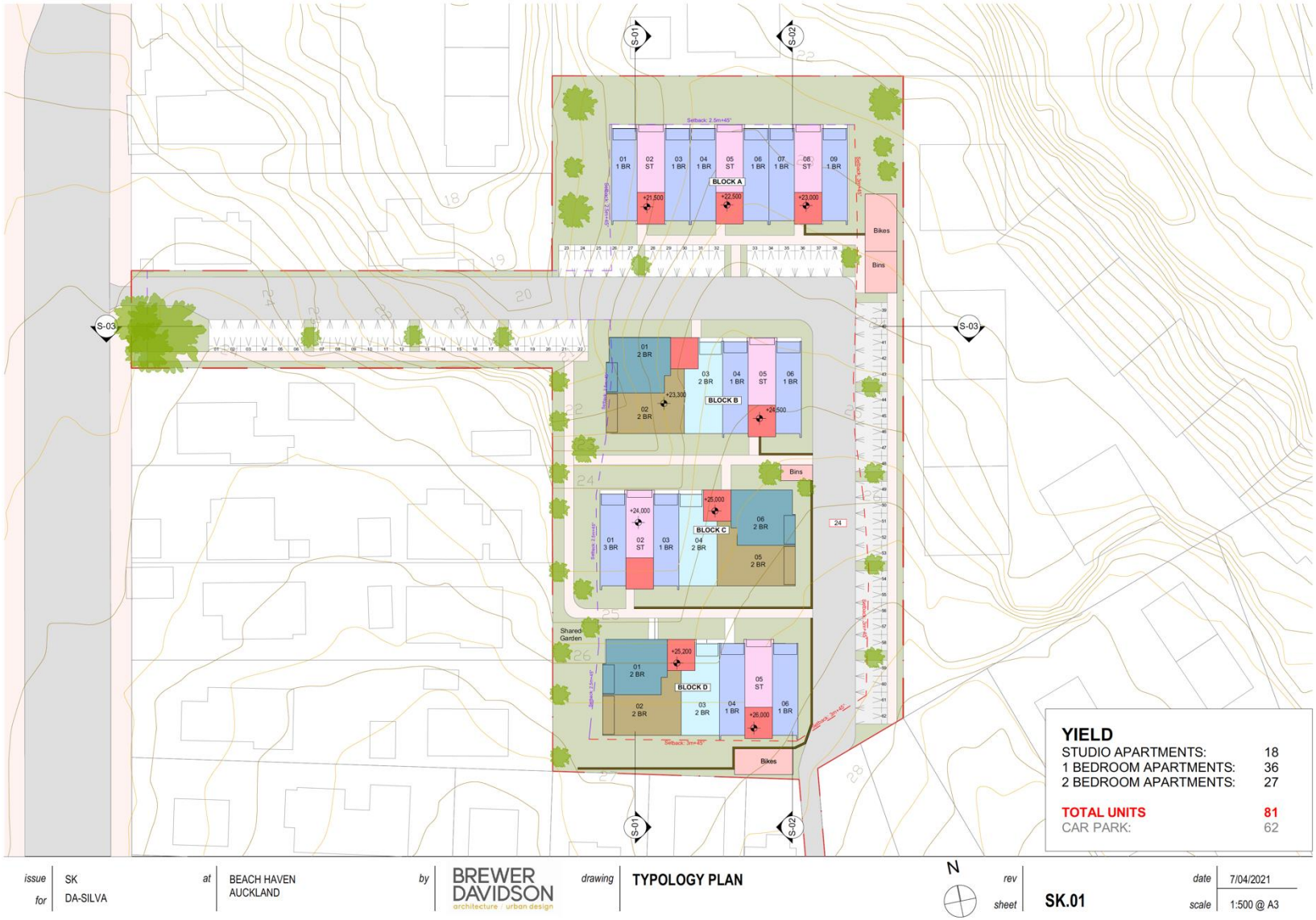
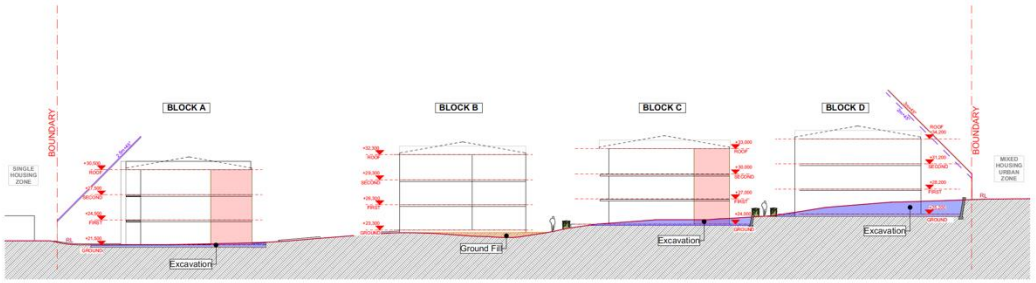
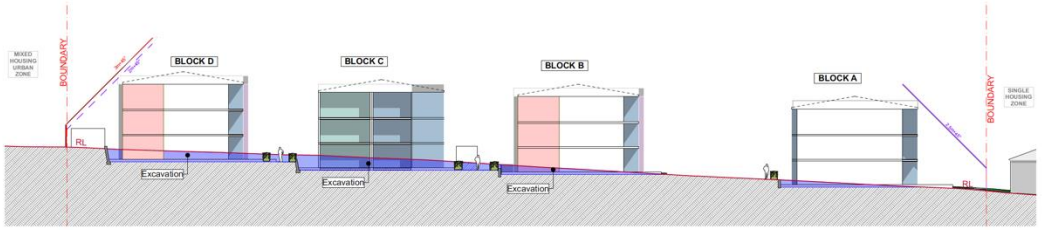


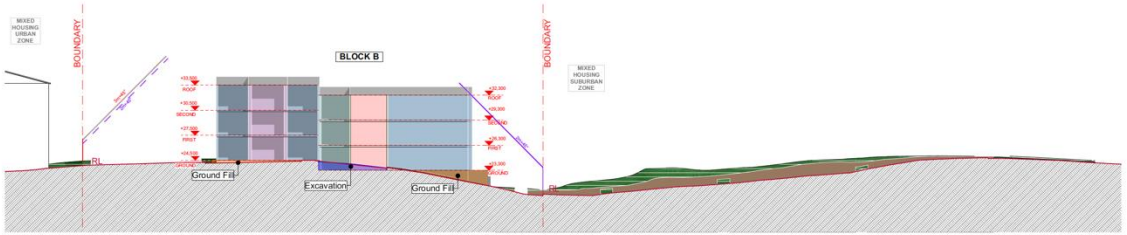
Figure 12 - Proposed Site Plan



SECTION 01



SECTION 02



SECTION 03

issue for	SK DA-SILVA	at	BEACH HAVEN AUCKLAND	by	BREWER DAVIDSON architecture / urban design	drawing	SECTIONS	rev sheet	SK-20	date scale	7/04/2021 1:500 @ A3

Figure 13 – Sample Sections

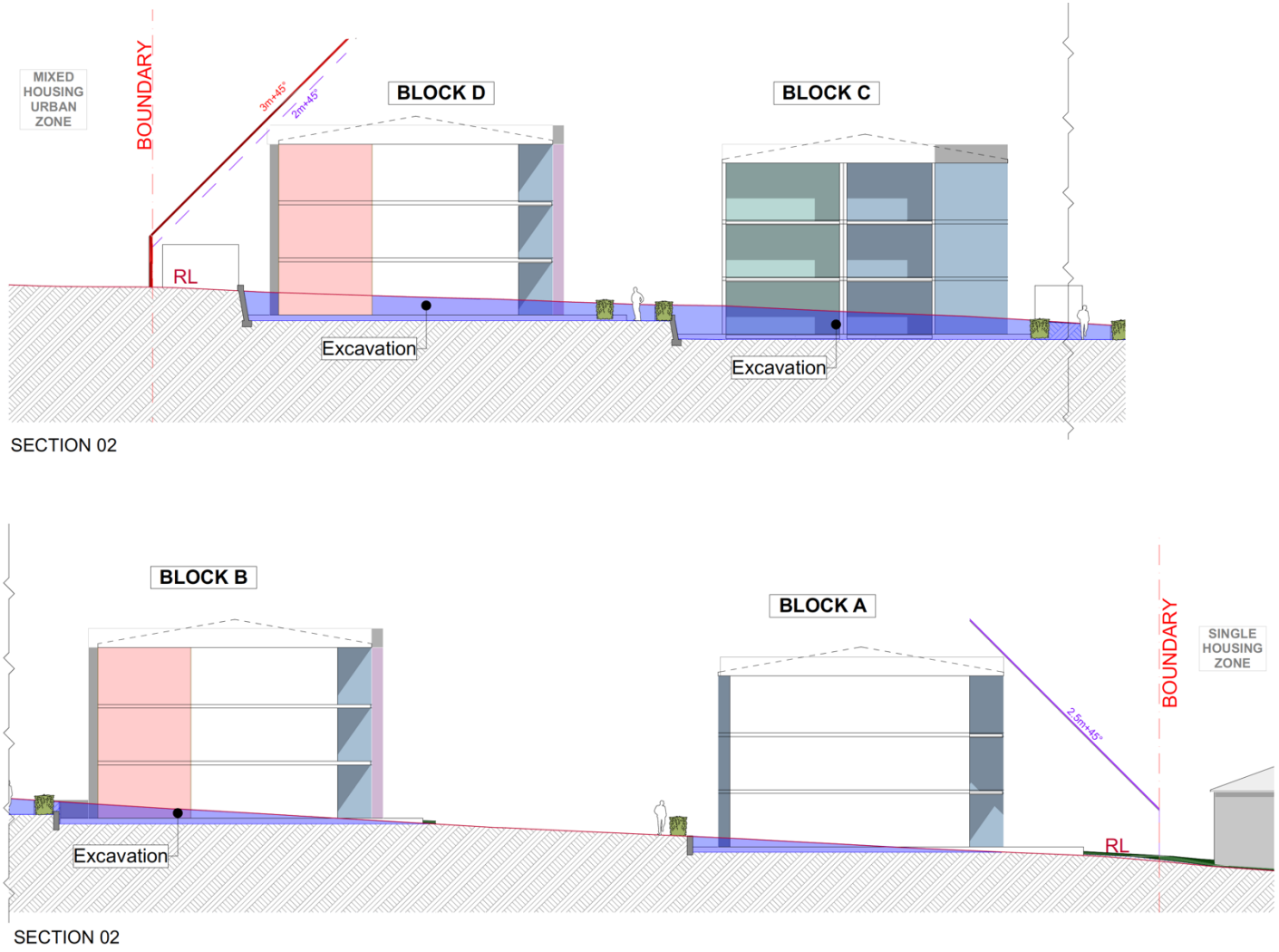


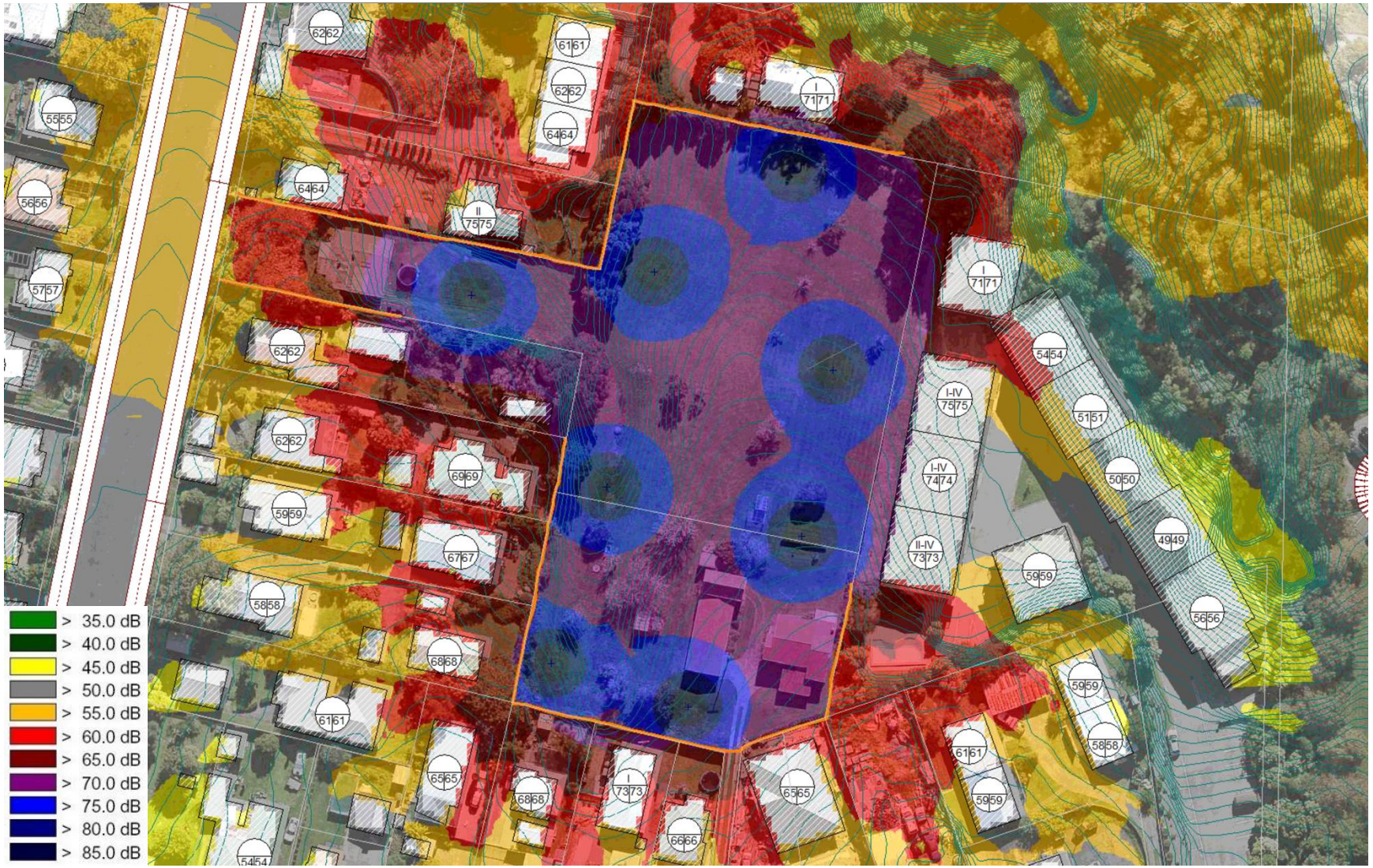
Figure 14 – Sample Sections

Appendix IX – Sample Noise Prediction Models

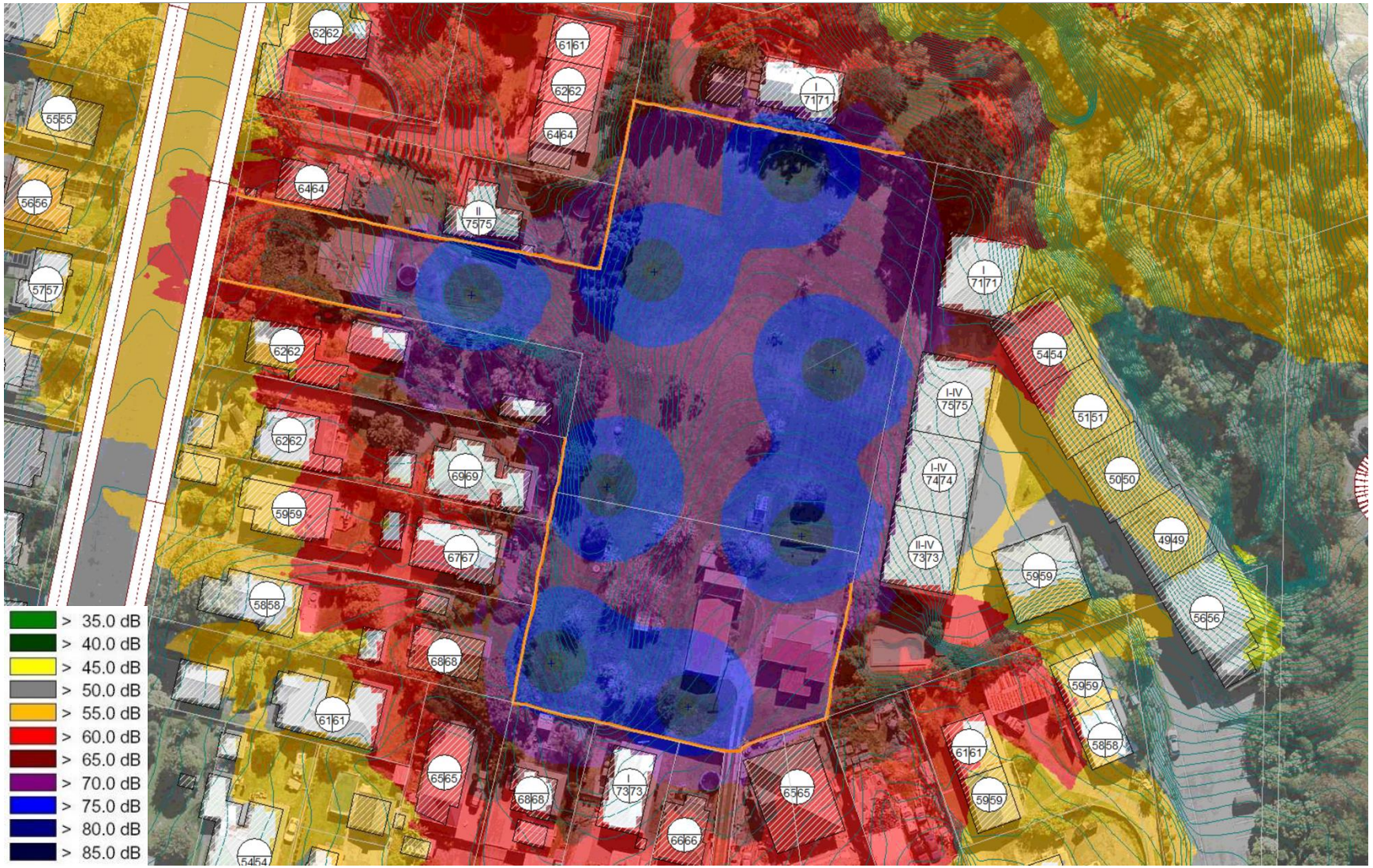
CadnaA Version 2019

Without Time Averaging

Activity	Receiver Height
Excavation and Augering	1.5m Grid (Levels in circles are maximum for full façade height)



Activity	Receiver Height
Excavation and Augering	4m Grid (Levels in circles are maximum for full façade height)



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.