297 Te Puna Station Road

Proposed Industrial Development

Te Puna, Tauranga

CNVMP

Construction Noise and Vibrations Management Plan

Date: 19 December 2022

Prepared for: Te Puna Industrial Limited

Prepared by: Earcon Acoustics Limited

Reference: J005252.OP

Application: RC13360L

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CNVMP - Document Control

297 Te Puna Station Road, Te Puna, Tauranga

Proposed Industrial Development

J005252.OP

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1 Preamble

The exact nature and layout of the proposed facilities across the site is not known at this stage, and as such the full detailed locations of potential noise sources is also not known. As such, this management pertains to the works detailed in the Geotechnical Investigation, in addition to types of construction works generally expected in the construction of industrial facilities and associated infrastructure.

It is expected that the works planned at this stage would require a phase of preloading earthworks, followed 12 months later by final formation works. As it is not known at this stage what construction(structure) works are proposed across the site, this assessment is conservatively made against the lower noise limits associated with works designated "long-term duration".

The Geotechnical Investigation associated with the development at its current stage (WSP – 02/12/2022) does not include piling requirements. Nevertheless, as the site may include future facilities which may require support on piles, the recommendations and mitigation measures of this management plan cover piled foundations.

With regards to compliance with the noise and vibration limits, we note the distances to the closest receivers are significant in context of construction noise and vibration. Provided best practice is adhered to, and the mitigation and contingency measures detailed in this management plan are implemented, noise and vibration levels, based on the works proposed at this stage, can readily be managed within compliance limits at all receivers.

2 Introduction

This management plan has been prepared to manage noise and vibration effects potential construction works for industrial facilities at the subject site 297 Te Puna Station Road.

The site for the proposed development is across three lots on the southern side of Te Puna Station Road in Tauranga. The site is currently accessible through a gravel road from the northern boundary. The proposed industrial operations include a container storage and refurbishment facility at the eastern end of the site, with the western end designated for other industrial activities. The proposed development also includes an internal road from the middle of the northern boundary with Te Puna Station road, to the centre of the site heading east.

The exact nature and layout of the operations is not known at this stage. As such, this management pertains to types of construction works generally expected in the construction of industrial facilities and associated infrastructure (e.g. roads.) It is expected that the works planned at this stage would require a phase of preloading earthworks, followed 12 months later by final formation works. As it is not known at this stage what construction(structure) works are proposed, this assessment is conservatively made against the lower noise limits associated with works designated "long-term duration".

This management plan is based on recommendations in the following reports:

- Geotechnical Investigation Report by WSP dated 2/12/2022

3 References

The noise and vibrations resulting from the proposed construction works shall be measured and assessed in accordance with the following standards:

Noise

- **Management of Construction Noise:** NZS 6803:1999
- **Measurement of Environmental Noise:** NZS 6801: 2008
- **Assessment of Environmental Noise:** NZS 6802: 2008

Vibrations

- **Management of Vibration Effects on Buildings:** DIN 4150-3:1999-02
- **Management of Vibration Effects on People:** BS 5228-2:2009

4 Site

4.1 Identification

The proposed development site is located within three lots on the southern side of Te Puna Station Road, in Te Puna, Tauranga. For ease of reference in this report, directional boundaries are noted in the figure below. For context, the subject site is circa 450m along the boundary with Te Puna Station Road.

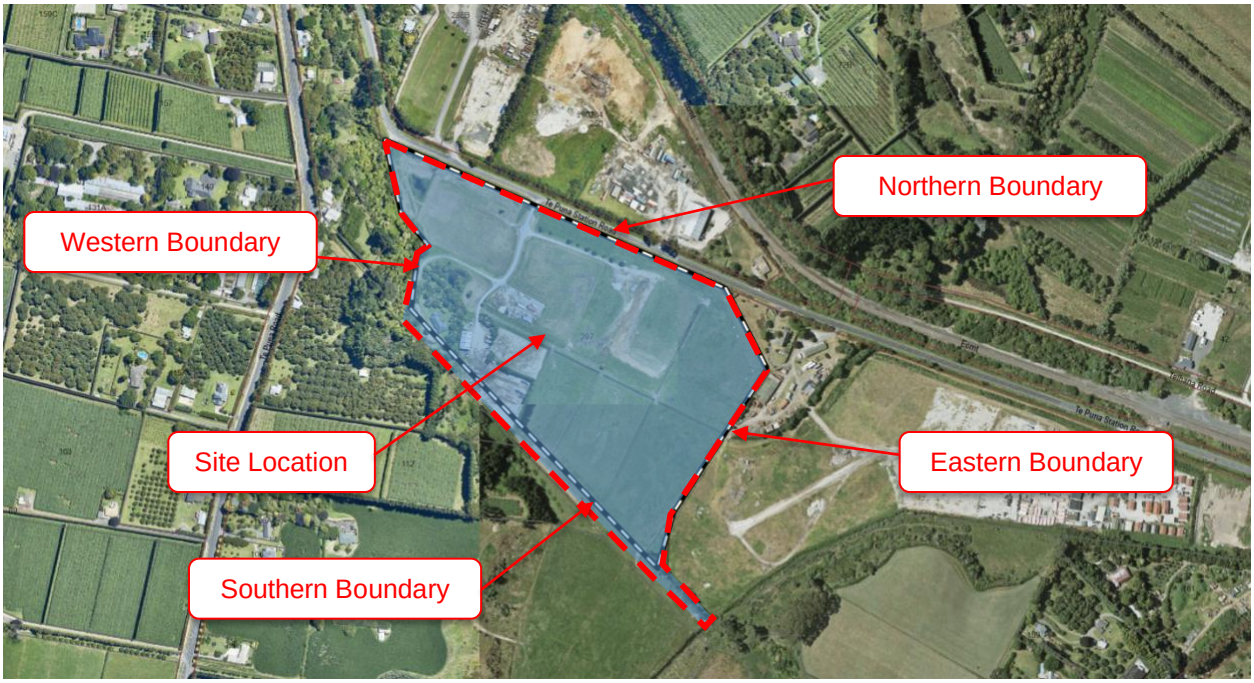

Figure 1 - Site Location – [WBOP Maps]

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

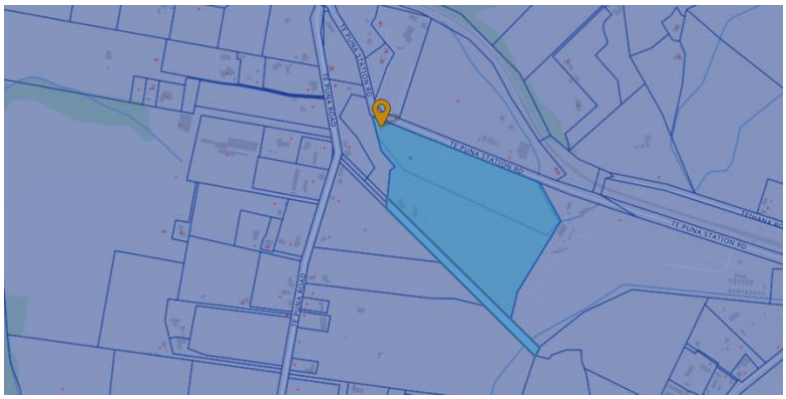

Figure 2 - Site Boundaries – [LINZ]

Part Lot 3 DP 22158
Section 3 SO 61751
Section 2 SO 61751

5 Proposed Works

Notwithstanding the fact the locations and scale of future facilities is unknown at this stage, it is our understanding that the following works are proposed (*email - Momentum Planning - 13/12/2022*):

- Re-locate roadside drain, establish landscape bunds and all planting as per structure plan and site landscape plan,
- Form the 2x stormwater ponds and swale network (to be sediment retention ponds/diversion channels during earthworks and construction periods),
- Pre-load lease areas in accordance with geotechnical report recommendations (site-general requirements and workshop-specific requirements to be met).
- 12 months later, complete final formation and surfacing to lease areas (compacted metal). Construct internal road sealed and kerbed. Construct foundations for workshop. Construct incidental proprietary waste management system servicing workshop.
- Re-purpose ponds for permanent storage/treatment purposes, complete any outstanding wetland planting prior to industrial uses commencing.

5.1 Geotechnical Recommendations

As per Geotechnical Investigation (WSP - 2/12/2022) it is our understanding that the following methodologies are required to the works, in context of noise or vibration generating works:

5.1.1 General Fill

- The earthworks plan indicates that fill is proposed up to 2.6m
- Due to the underlain soft soils, the fill is likely to induce significant settlement
- Fill areas require pre-loading prior to construction, including compacted sand and settlement plates left in place for 12 months.

5.1.2 Bunds

- To be constructed with compacted fill to a height of 2.5m
- Batter slopes required at 1V:4H or flatter.
- Bunds may require additional fill or trimming over time (measured monthly)

5.1.3 Te Puna Station Road Extension

- Dewatering and rerouting of existing drain is required
- Embankment to be constructed with compacted rock fill
- Preloading of 1m high required to induce settlement

5.1.4 Foundations

- Preloading required with 2m fill left for 12 months.
- Ground requires raising above flood level with compacted engineered fill.

6 Neighbouring Receivers

6.1 Vicinity

The neighbouring area adjacent to the subject site to the east, and across Te Puna Station Road to the North are predominantly industrial. Sites further to the east, and to the south and west are rural, and most include dwellings. In context of noise and vibrations, the following receiver sites are in the vicinity of the proposed development:

6.1.1 Industrial

- **North – 288B Te Puna Station Road:** Open yard of a heavy equipment hire operation with boundary at circa 25m from the northern boundary of the subject site.
- **North – 250-264 Te Puna Station Road:** industrial facility including outdoor and indoor operations across Te Puna Road at circa 25m from the boundary of the subject site.
- **East – 245 Te Puna Station Road:** Industrial facility with buildings and outdoor operations at the eastern boundary of the subject site.
- **East – 205 Te Puna Station Road:** Industrial facility with buildings and outdoor operations at circa 75m from the boundary of the subject site across the 245 Te Puna Station Operations.

6.1.2 Rural / Dwellings

The following approximate distances to closest buildings, understood to be habitable (dwellings,) pertain to noise assessment whereby measurements are for the closest distance between a dwelling and the subject site and in the direction of that closest measurement. The list is not intended to be inclusive of all receivers The distances are noted here for context only. Calculations and modelling are based on LINZ data exports and take into account topography and locations of noise sources.

Direction	Address	Approximate Distances (Closest to Subject Site)	
		Site Boundary To Subject Site Boundary	Site Boundary to Closest Building
N	288, 288A Te Puna Station Road	40m	95m
N	328 Te Puna Station Road	150m	25m
NNW	166 Te Puna Road	120m	34m
NW	163 Te Puna Road	185m	25m
NW	159A Te Puna Road	135m	12m
NW	158 Te Puna Road	70m	40m
W	159A Te Puna Road	145m	15m
W	157 Te Puna Road	115m	50m
W	147 Te Puna Road	120m	52m

Direction	Address	Approximate Distances (Closest to Subject Site)	
		Site Boundary To Subject Site Boundary	Site Boundary to Closest Dwelling
W	139 Te Puna Road	155m	5m
W	148 Te Puna Road	35m	35m
W	138 Te Puna Road	≈85-115m	≈2-5m
W	118 Te Puna Road	20m	165m
W	117 Te Puna Road	240m	15m
W	112 Te Puna Road	125m	100m
W	107 Te Puna Rad	318m	≈5m
SW	110 Te Puna Road	165m	55m
SW	106 Te Puna Road	290m	≈5m
SW	106A Te Puna Road	290m	≈5m
SW	88 Te Puna Road	410m	≈5m
SW	86B Te Puna Road	370m	≈5m
SW	88A Te Puna Road	380m	55m
SSW	56D Te Puna Road	285m	100m
S	56E Te Puna Road	250m	125m
S	97B Clarke Road	480m	85m
E	139 Clarke Road	435m	72m
E	145 Clarke Road	430m	55m
E	159 Clarke Road	425m	15m
E	161 Clarke Road	417m	65m
NE	76 Teihana Road	125m	105m
N	72C Teihana Road	120m	90m

Table 1 - Rural Receivers – Representative Distances to boundaries

7 Noise Sources

The following subsections can be used to estimate noise levels from different equipment at different receivers. Please note that these are general estimates only. Accurate measurements and calculations conducted by qualified acousticians are required for verification of compliance.

We note for reference that the Geotechnical Investigation does not include piling requirements at this stage. Nevertheless, as the site may include future facilities that may require support on piles, the recommendations of this management plan cover piled foundations

7.1 Equipment and Activities at 10m from Source

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.

Activity	Equipment	Sound Pressure LA_{eq} at 10m [dB]
Truck - 20-24 Tonne	Truck - 20-24 Tonne Idling	58
	Loading soft materials	72
	Loading solid materials	75
Ground excavation	5-8T Tracked Excavator	65
	12-15T Tracked Excavator	73
	23T-30T Tracked Excavator	76
Piling (Bored)	13-15T Tracked Auger Rig	75
	23-30T Tracked Augering Rig	78
	30T- 40T Continuous Flight Auger	80
Driven Piling	5T-6T hammer with shrouding, non-metallic dolly, steel piles	80-84
	5T-6T hammer, no shrouding, steel dolly, steel piles	90-92
	1T-2T hammer, no shrouding, non-metallic dolly, timber pile	75-78
Levelling Ground	Grader	62
	Roller	68
General	Water Pump	68
	Compressor	66
Compacting Fill	Vibratory roller 3T – Non Vibratory	67
	12T Smooth Drum Compactor – Vibratory	76
	6T Padfoot Compactor – Vibratory	73
	Plate Compactor	74
Concreting	Concrete Pump + Truck Discharging (Foundations)	68
	Pump + Cement Truck Discharging (Structure - 22m boom)	78
	Poker Vibrator	69

Table 2 - Activity Noise Levels at 10m from source

7.2 Noise Reduction over Distance

When the source of noise is at a distance farther than 10m from the source, the following figure can be used to estimate the reduction in noise level based on the distance involved when there is no shield or barrier between the source and the receiver (free field). This reduction level in dBA can be deduced from the Sound Pressure (LA_{eq} dBA) value in Table 1

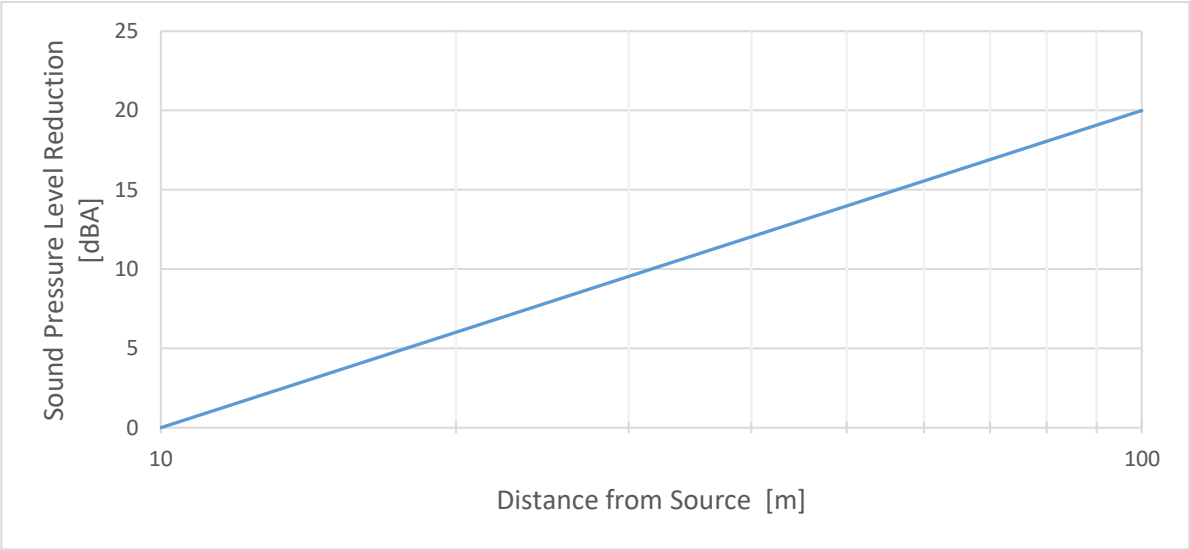

Figure 3 - Sound Pressures Level Reduction Over Distance – Hard Ground

7.3 Noise Reduction from Shielding

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

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

7.4 Noise Reflection from Facades

Compliance for receiver buildings is at 1m from the façade of the building. As per NZS6803:1999, the following correction must be made to estimate the noise level at the façade of a building

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

8 Vibration Sources

8.1 General

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

Activity	Mode	Distance	Frequency	PPV
		m	Hz	mm/s
Vibratory Piling	Soft Ground	10	35	3.79
Impact driving – 5T-6T	Fill / Caley Sand	3-5	10-20	≈18-20
		6-8	10-20	≈13-15
		10-12	10-20	≈6-8
		18-20	10-20	≈1.5-2
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 Vibration Levels – Measurements at similar sites

Prediction and modelling of vibration propagation are impractical for construction and excavation activities due to the number of variables involved. Vibration prediction in construction and excavation is usually impractical and highly caveated. Vibration levels shall be controlled through appropriate management procedures established from pre-activity assessments on-site.

8.2 Driven Piling - General

The following table lists vibration levels pertaining to driven piles into different soil conditions generally commensurate with the subject site. While these are not expected to match the subject site, the data is considered indicative and comparative only, with levels generally in-line

with levels measured in-situ as shown in the table above. Vibrations data quoted below in accordance with examples in standard BS 5228: Part 2:2009.

Ref	Activity	Ground	Mode	Distance	PPV
				m	mm/s
C20	305 mm × 305 mm Steel H-pile – Driven	3 m fill, blaes, clay and boulders over 8 m soft to firm silty clay over sandstone	4t Drop Hammer	13	0.19
C25	305 mm × 305 mm Steel H-pile – Driven	Not Recorded	Diesel Hammer driving pile	25	0.13
C28	305 mm × 305 mm Steel H-pile – Driven	Alluvial peat and clay, boulder clay, sand, bunter sandstone	Diesel Hammer driving pile	8	1.4
C30	Simulation test	Fill and alluvium over keuper marl	Dropping test weight on ground	25	0.7

Table 4 – Driven Piling – Indicative Vibration Levels - BS5228-2:2009

We note the following regarding noise from driving timber piles:

- Driving timber poles usually measure circa 5-6dBA lower than driving steel piles.
- Use of 1-2T weights are usually circa 3-4dBA lower than using 5-6T weights
- Use of a non-shrouded hammer usually 4-5dBA higher than an open hammer.

With regards to the potential need for driven piling, we note for reference the following link to videos of steel piles being driven in proximity to a school facility. The equipment shown here is high quality, well maintained and operation included best practice mitigation measures (shrouded, non-metallic dolly, initial vibratory insertion, rig positioning away from buildings, etc.) This is noted to be at a larger scale than would be necessary for the subject site, but still shows the process is manageable, even in this case next to active school facilities. It also shows how quickly a pile can be inserted.

https://www.dropbox.com/sh/eq37c5c8052ghad/AACnoiVc6Ri66DJXr8ZjZHOoa?dl=0

8.3 Driven Piling - Timber

Referencing in-situ measurements at similar sites, as collated with values quoted in the BS5228:2-1999 standard for soils as analogous as possible to the subject site it can be generally estimated that vibration level ranges are as follows for SED Timber piles driven into soft soils by 1T hammer dropping circa 1m:

- ≈10mm/s at 2m
- ≈7mm/s at 3m
- ≈6mm/s at 5m
- ≈5mm/s at 7m
- ≈4mm/s at 10m

Vibrations are expected to have frequencies in the 8-15Hz range.

We note that accurate prediction and modelling of vibration propagation are impractical, and highly caveated due to the number of variables involved.

Nevertheless, under well managed conditions, vibration levels are generally expected within ranges associated with the general equipment used and the types of soils. Vibration levels should always be controlled through appropriate management procedures established from pre-activity assessments and measurements on-site.

9 Regulatory 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.

9.1 Noise Regulations and Standards

The following rules apply to the site and to surrounding sites as per NZS6803:1999, whereby compliance pertains to measurements at 1m from the façade of a receiver for construction works exceeding 20 weeks (including the construction of the proposed buildings):

Time of week	Time Period	Maximum noise level (dBA)	
		Leq	Lmax
Weekdays	6:30am – 7:30am	55	75
	7:30am – 6:00pm	70	90
	6:00pm – 8:00pm	65	85
	8:00pm – 6:30am	45	75
Saturdays	6:30am – 7:30am	45	75
	7:30am – 6:00pm	70	85
	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 5 - Referencing Table 2 of NZS6803:1999 for Long Duration Construction

9.2 Vibrations Regulations and Standards

9.2.1 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

9.2.2 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.

10 Regulatory Summary

10.1 Noise Limits

The following limits apply for noise compliance of all construction activities in accordance with the NZS6803:1999, whereby compliance pertains to measurements at 1m from the façade of a receiver for construction works exceeding 20 weeks (including the construction of the proposed buildings)

Time of week	Time Period	Maximum noise level (dB)	
		LA_{eq}	LA_{max}
Weekdays	7:30am – 6:00pm	70	85
	6:00pm – 8:00pm	65	80
Saturdays	7:30am – 6:00pm	70	85

Table 8 - Noise Compliance Limits

10.2 Vibration Compliance Limits

The following limits apply for vibration compliance of all construction activities:

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			
Unoccupied	Residential	5mm/s	5-15mm/s	15-20mm/s	20mm/s
Unoccupied	Industrial	20mm/s	20-40mm/s	40-50mm/s	50mm/s

** Guideline Levels as per BS5228 collated with tolerable levels at similar sites.*

Table 9 - Vibration Compliance Limits

11 Mitigation Measures

11.1 Hoisted Shielding – Driven Piling – Steel Piles

During driving of steel piles within 100m of occupied receivers, a V or U-shaped hoisted shield at least 6m in height (acoustic blankets on timber or steel frame) to be hoisted by a support excavator or using operating cranes to shield the closest receivers where required to reduce noise levels.

11.2 Time Restrictions

Noise or vibrations generating site works to be limited to the hours of:

- Piling: Monday – Friday 8:30am to 5:00pm
- All Other Works: Monday – Saturday 7:30am to 6:00pm
- Noise or Vibration generating work shall **not** occur on Sundays or public holidays.

Noise limits shall be adhered to as they apply to activities at specific times and locations.

11.3 General Equipment Restrictions

- Excavators limited to no larger than 30T
- Driven compactors no larger than 12T can be used, but only with vibratory functions OFF within 50m of a receiver building.
- Vibratory compacting within 50m of an occupied receiver limited to no larger than 6T.
- If larger vibratory driven compactors (smooth drum or padfoot) are required closer to receivers, vibration monitoring is required during initial test runs.

11.4 Driven Piling Recommendations

The following is required for the impact driving equipment:

- Use of non-metallic dolly with polymer or composite pad for noise reduction
- Use of shrouded driver heads

11.5 Communication with Neighbours

Written communications (e.g. letter) should be distributed to **all neighbours within 300m of the works if piling is required, or within 150m if piling is not required**, in accordance with the guidelines detailed in Section 12 below. Where an address includes multiple occupancies, each occupancy must be included in the written communication (e.g., letter drop)

11.6 Noise and Vibration Pre-Activity Monitoring

For any high noise or vibration generating activity (e.g. piling), or for any activity likely to cause complaints, the following should be implemented:

- Manned monitoring of a test run of the activity prior to its full implementation. During this test run, the appropriate operational parameters are established based on the measured noise and vibration levels and intensity of operations.
- Reporting: A report is prepared and made available to council detailing the measured noise and vibration levels for the test run, and the appropriate controls and intensity of operations to maintain the noise levels as low as practicably possible.
- Management: The established controls and intensity of operations are incorporated into the management process.

12 Proactive Communication

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

12.1 Prior to any works commencing on site

- A sign shall be provided on-site, readily visible and readable from public areas, complete with contact details for the neighbours to raise any concerns related to noise.
- All neighbours in the vicinity including receivers listed in section 5 above shall be advised in writing (e.g., mailed letter or letter drop) no less than 1 week prior to works commencing.
- The letter shall describe the overall works, mitigation measures, levels of noise and vibrations, 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.

12.2 Prior to commencement of any vibratory activities

- All occupied buildings designated as receivers are advised in writing (e.g., letter drop) no less than three days prior to 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.

12.3 Throughout the works

- Provide regular updates prior (at least 3 days) to any high noise or vibration generating activities that may give rise to disturbance.
- Communicate with the noise sensitive receivers when complaints occur to address their concerns and ensure compliance.

12.4 Where direct communication 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.

13 In Response to 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.

14 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.

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

14.1 Noise Monitoring

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.

14.2 Vibration Monitoring

During activities expected to generate 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, Piling, Excavation and Compacting.

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

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

15 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., 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 breaking excavator not lifting on arm).
- Time Management: Whenever practicable, scheduling noise or vibration generating works during times of least or no occupancy at receiver buildings.
- Ancillary Equipment: All pumps, generators and other static equipment to be located as far as possible from adjacent residential receivers.
- Truck beds carting spoil can be lined (e.g., with dunnage) to minimise impact on steel. Trucks on standby should turn their engines off instead of idling.
- Materials and equipment should be placed and NOT dropped. This applies to placing materials and objects on the ground or on transport vehicles.
- Personnel and visitors arriving or departing the site in vehicles should avoid slamming doors, using horns, revving engines, shouting, using amplified music or causing disturbance.
- Communications over distance should be through handheld radios, rather than shouting. Where possible, squelch should be lowered on handheld radios.

16 Contingency Measures

16.1 General Works

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, or use of shipping containers/site offices, 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. using silenced diesel generators and compressors, or using muffled plant.
- **Smaller Equipment:** Consider using smaller equipment when noise levels need to be reduced. Smaller plant have lower power outputs and generate less noise and vibrations at the expense of taking more time.
- **Hoisted Shielding:** During augering in proximity to occupied receivers, a V or U-shaped hoisted shield at least 6m in height (acoustic blankets on timber or steel frame) can be hoisted by a support excavator or using operating cranes to shield the closest receivers where required.

16.2 Driven Piling Contingency Measures

The following measures shall be considered, and where practicable implemented, if vibration or noise levels exceed the predicted levels, or in response to reasonable complaints. There are a number of control measures that can be used for management of vibrations from impact piling:

- **Reducing the drop height of the hammer**: This reduces the energy per blow, and hence vibrations with minimal change to frequency, albeit takes longer to embed piles.
- **Reducing the hammer weight:** This can be managed in conjunction with the drop height to establish energy levels that allow progress while managing vibration levels.
- **Predrilling:** This reduces the surface friction and vibrations at the surface which account for the majority of ground borne vibration propagation.
- **Trenching:** Where required, this involves establishing a trench between the location of piling and the receiver, usually up to circa 1m depth. Trenches attenuate propagation of surface (Rayleigh Wave) vibrations which account for most ground propagation.

17 Training

Measures shall be put in place to monitor noise on site and to control noise from personnel and sub-contractors and their hours of work. All site workers shall 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 shall be included in all toolbox meetings, and reference shall be made to any complaints or issues occurring pertaining to noise or vibrations.

18 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 I- Site Contact Details

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 II - Resource Consent Conditions- Noise and Vibration

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.