CONSULTING EARTH SCIENTISTS

VIBRATION MONITORING PLAN

11-19 FRENCHMANS ROAD, RANDWICK NSW

PREPARED FOR CENTURION PROJECT MANAGEMENT PTY LTD

CES DOCUMENT REFERENCE : CES190901-FRE-AG

Written by: A. Crabtree

Reviewed by: D. Lowe

Authorised by: **Duncan Lowe**

Client: Frenchmans Lodge Properties Pty Ltd
Centurion Project Management Pty Ltd
Level 25, 88 Phillip Street
Sydney, NSW 2000

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Suite 3, Level 1• 55 Grandview Street • Pymble NSW 2073 • Australia
Telephone: 02 8569 2200 • Fax: 02 9983 0582 • ABN 67 151 524 757 • www.consultingearth.com.au

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1 INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was commissioned by Frenchmans Lodge Properties Pty Ltd, care of Centurion Project Management Pty Ltd (the Client) to prepare this Vibration Monitoring Plan (VMP) for the proposed demolition and construction activities for the new SummitCare Aged Care building facility with two basement levels located at 11-19 Frenchmans Road, Randwick NSW (herein referred to as the Site).

2 SITE INFORMATION

Based on a review of available aerial photographs and the architectural drawings by Boffa Robertson Group Pty Ltd (BR Group), provided by the Client, the Site comprises 2,715 m². It is formally defined as Lot 10 in Deposited Plan (DP) DP845575, and Lot 3 and Lot 4 in DP 13779 in the Local Government Area (LGA) of Randwick City Council.

The Site is currently occupied by an existing aged care facility that includes a large two-storey brick building, a two-storey brick office building, a second smaller brick building and two double storey residential buildings. The Site is flanked to the south by Frenchmans Road, the main frontage of the site and to the north by McLennan Avenue. The Site Location Plan is presented in Figure 1.

A number of residential buildings neighbour the Site, these are namely:

- 9 Frenchmans Road; single storey residence adjacent to the Site's most western boundary. This building is located approximately 3 m from the proposed construction work.
- 8 Astolat Street; two-storey residence adjacent to the Site's north-west boundary. This building is located approximately 7 m from the proposed construction work.
- 27 McLennan Avenue; two-storey residence adjacent to the Site's north-west boundary. This building is located approximately 5 m from the proposed construction work.

- 29 McLennan Avenue; single-storey residence adjacent to a small portion of the Site's north-west boundary. This building is located approximately 9 m from the proposed construction work.
- 25 McLennan Avenue; two-storey residence adjacent to the Site's north-east boundary. This building is located approximately 3.5 m from the proposed construction work.
- 21 Frenchmans Road; two-storey residence adjacent to the Site's south-east boundary. This building is located approximately 4.5 m from the proposed construction work.

3 DILAPIDATION SURVEYS

Prior to commencement of the demolition or construction activities it is recommended that a building and structure condition (dilapidation) survey be undertaken for each of the adjacent residences listed in Section 2.

4 PROPOSED CONSTRUCTION & DEMOLITION ACTIVITIES

4.1.1 DEMOLITION

The demolition works at the Site will use mobile equipment such as excavators, hydraulic hammers, bulldozers, dumper truck and haulage trucks to remove the existing buildings and structures.

It is assumed that off-site removal of excess spoil and demolition materials (expected to include concrete, brick, timber, and vegetation) will be necessary.

4.1.2 PILING FOR SHORING WALL

The construction of a shoring wall around the Site's perimeter is to be undertaken to protect sensitive receivers in close proximity, including underground services and surrounding neighbouring residences. Construction of the shoring wall will include the use of a bored pile or continuous flight auger (CFA) piling rig. The shoring piles are expected to extend below the basement floor level (RL 71.7 m AHD) to approximate depths up to 8 m. Bored pile and CFA pile methods will create significantly less ground vibration than driven piles and are therefore considered suitable for construction at the Site. It is assumed that pile boring methods will not utilise percussive drilling techniques.

From review of the Geotechnical Investigation (GI) carried out by CES (CES document reference CES190901-FRE-AC) dated 02 December 2019, the Site is underlain by sandstone encountered

at depths of between 0.80 m to 1.80 m. Marine sands overlie the sandstone bedrock and this in turn is overlain by topsoil varying in thicknesses from 0.6 m to 1.5 m across the Site.

4.1.3 EXCAVATION

Based on the Development Application (DA) drawings, it is understood that the proposed development comprises a four-storey aged care building facility with two basement levels.

Review of the site sections provided by BR Group Pty Ltd indicate that the proposed basement excavations extend to a maximum depth of approximately 8 m, as follows:

- In the north (closest to McLennan Avenue) the excavation will be approximately 6 m below existing ground level.
- In the south (closest to Frenchmans Road) the excavation will extend to a depth of approximately 8 m.
- In the west, the excavation is proposed to be approximately 8 m deep.

Plant and equipment required for excavation works is likely to include a hydraulic excavator(s) or backhoe (s), bulldozer and haulage trucks. For excavation of the sandstone bedrock, it is assumed that excavators and/or bulldozers with ripper attachments or hydraulic rock breakers and/or rock saws will be used.

4.1.4 FOOTINGS

The proposed lower basement level is at a significant depth (i.e. greater than 6m) below the top of inferred sandstone bedrock level. Footings for the proposed building such as strip, raft or pad footings are expected to be founded in sandstone.

4.1.5 WORKING HOURS

It is understood that the demolition, piling, and construction work at the Site is to take place Monday to Friday between the hours of 07:00 am and 05:00 pm.

5 ASSESSMENT OF VIBRATIONS

5.1.1 GUIDANCE DOCUMENTS

Assessment of vibration and acceptable levels of vibration is complex and is dependent on many variables and the interaction of these variables including, transmitting media, distance from the vibration source, ground conditions, the magnitude and nature of the vibrations produced, response of a particular building or structure to vibration, an individual's sensitivity, and perception to/of vibration.

Various publications and Standards have been released to prescribe acceptable levels of vibration. These include German Standards (DIN4150-3:1999 (Structural Vibration - Part 3: Effects of vibrations on Structures)), British Standards (BS 6472-1:2008 (Guide to evaluation of human exposure to vibration in buildings - Part 1)), AS2436-2010: Guide to Noise and Vibration Control on Construction, Demolition and Maintenances and other International Standards ((ISO) 2631 (2018), Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration).

The NSW Department of Environment and Conservation (now part of the NSW Environment Protection Authority) publication "Assessing Vibration: A Technical Guide", presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques.

The Acceptable Vibration Dose Values presented in Table 1 are for continuous vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time).

Table 1: Summarised Acceptable Vibration Dose Values for Continuous Vibration

Place	Time[1]	Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working areas[2] (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Source: DECC, 2006

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above.

It should, be noted that the above values are applicable to continuous vibrations, the vibrations induced during earthworks are typically non-continuous intermittent vibrations. The earthworks carried out at the Site will occur during the day.

The range of applicable damage and annoyance risk vibration velocity criteria are summarised in Table 2.

Table 2: Vibration Velocity - Damage and Annoyance Risk Criteria

Receiver Type	Damage Risk (mm/s)		Annoyance Risk (mm/s)	
	Horizontal	Vertical	Horizontal	Vertical
Electronic/Computers	5	5	N/A	N/A
Residential/Dwellings	15	5	1.2	0.45
Commercial/Offices	40	20	1.6	0.6
Industrial/Workshops	40	20	3.2	1.2
Mechanical (On/Off)	20/5	20/5	N/A	N/A
Subsurface/Pipe work	50 to 100	50 to 100	N/A	N/A

Source: German Standards (DIN4150-3 1999 (Structural Vibration Part 3: Effects of Vibration on Structures)

Excessive vibration levels may result in structural damage being incurred by neighbouring residential properties, structures, or utilities. Potential structural or cosmetic damage to buildings due to vibration are assessed in line with British Standard BS 7385 Part 2 and/or German Standard DIN4150-3. British Standard 7385 Part 1: 1990, identifies different levels of structural damage as: These British standards have been updated with BS ISO 4866:2010. Mechanical vibration and shock — Vibration of fixed structures — Guidelines for the measurement of vibrations and evaluation of their effects on structures.

- Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.
- Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.
- Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.

5.1.2 POTENTIAL CONSTRUCTION VIBRATION SOURCES

Ground borne vibrations are expected to be produced during demolition, piling, and excavation activities. The plant and equipment with the potential to generate vibration include the following:

Demolition

- Excavator(s) equipped with a hydraulic hammer (rock breaker); to break up and remove the floor slabs and walls.
- Manual jackhammer equipment; for areas difficult to reach by larger machinery.

Piling

- Bored piling or CFA rig; to install bored pile foundations (it is assumed that percussive drilling techniques will not be utilised).
- Concrete truck/agitator; as part of the pile installation process.

Excavation

- Rock saw; to facilitate excavation and removal of sandstone rock.
- Bulldozer or hydraulic excavator with ripper attachments for excavation of sandstone.
- Excavator; to load out demolition and excavated materials.
- Haulage Truck(s); to remove demolition and excavated materials.

Existing Vibration Sources

- Existing sources of vibration in the general site area include road traffic on Frenchmans Road and to a lesser extent McLennan Avenue.

5.1.3 ANTICIPATED LEVELS OF VIBRATION

For the purpose of this assessment, ground vibration is expressed in terms of Peak Particle Velocity (PPV) in units of mm per second (mm/s). In consideration of published information and based on CES's experience on similar projects, the anticipated vibration levels for the plant and equipment proposed to be used at the Site are presented in Tables 3 and 4.

Table 3: Estimated Construction Vibration Levels for Earthwork Plant

Plant	Estimated PPV (mm/s) at distance from Source		
	5m	10m	20m
Excavator	4.4	2.5	1.4
Bulldozer	7.0	4.0	2.3
Grader	4.4	2.5	1.4
Backhoe	1.7	1.0	0.6
Piling (boring (non-percussive)	1.4	0.8	0.5

Table 4: Estimated Construction Vibration Levels for Rock Hammers

Plant	Distance from Source (m)			Ground type
	2	10	20	
250kg to 500kg rock hammers	10 to 20mm/s	1 to 5mm/s	<1mm	Class I/II Hawkesbury Sandstone
500kg to 1000kg rock hammers	10 to 25mm/s	0.5 to 5mm/s	0.5 to 0.8mm/s	Class I/II Hawkesbury Sandstone
>1500kg rock hammers	80mm/s	1 to 10mm/s	0.6 to 2mm/s	Class I/II Hawkesbury Sandstone

Table 3 and 4 values adapted from *Construction Noise and Vibration Technical Report,* Adani Pty Ltd, 2013, Excavation Induced Vibrations In Sydney Sandstones Hackney G.A. (2002) and CES experience and monitoring records with and from similar projects.

6 VIBRATION CONTROL CRITERIA

In consideration of the above, the assigned vibration criteria for the Site is as follows:

- Intermittent vibration levels resulting from demolition and excavation activities should be limited to below 7 mm/sec peak particle velocity (PPV) when measured at the footing of any nearby building or structure.

It should be noted that this vibration criteria is a guideline only and not mandatory limits.

6.1.1 DEFINITIONS OF VIBRATION CONTROL THRESHOLD LIMITS

The following approach to Vibration Control Threshold Limits is proposed for the site. The control limits refer to vibrations when measured at the footing of the nearby buildings or structures. The proposed vibration monitoring locations are shown in Figure 2.

- **Alert Level:** The Alert Level is the level above which unexpected vibration has been monitored and increased vigilance is required to be paid to vibration levels. It is also the level at which a detailed plan of action is to be prepared should the Action Level be exceeded.
- **Action Level:** This is the level above which vibration mitigation measures should be implemented to ensure that the Stop Work Level is not exceeded.
- **Stop Work Level:** This is the level above which work will stop until the cause of the excessive vibration is identified and mitigation measures implemented to reduce the vibration levels measured at the sensitive receiver to levels below the Action Level.

6.1.2 PROPOSED VIBRATION CONTROL THRESHOLDS LIMITS

The vibration control threshold limits prescribed in Table 5 are applicable to ensure control of vibration levels at the site.

Table 5: Vibration Control Threshold Limits

Threshold Level	PPV (mm/s)	Example Response
Vibration Monitoring Points: VML01 to VML05 (Figure 2)		
Alert	>3mm/s	Verify monitoring results are valid. Notify Site Supervisor and provide feedback to construction personnel. Prepare Detailed Plan of Action to mitigate vibration should the action level be exceeded.
Action	>5mm/s	Verify monitoring results are valid. Notify Site Supervisor. Confirm the attenuation characteristics of the vibration to assess whether or not vibration levels in exceedance of background levels and prescribed guidelines are detectable at the sensitive receiver. If, confirmed, implement the Detailed Plan of Action to mitigate vibration.

Threshold Level	PPV (mm/s)	Example Response
Stop Work	>7mm	Verify monitoring results are valid. Notify Site Supervisor to Stop Work immediately. Carry out investigation into cause of the vibration. Notify the sensitive receiver. Work only to re-commence once the cause of the excessive vibration has been ascertained and adequate mitigation measures have been implemented to ensure that the Action Level is not exceeded

In consideration of the above, the following monitoring requirements and vibration mitigation measures will be applied to control vibration at the Site when working nearby neighbouring residential buildings.

7 VIBRATION MONITORING

The purpose of vibration monitoring is to assess vibration levels during the demolition, excavation and piling works to ensure levels do not exceed the allowed threshold limit, which for the Site has been determined as 7mm/s PPV.

7.1.1 VIBRATION MONITORING EQUIPMENT

The vibration monitoring is to be manually undertaken using portable vibration monitoring equipment such as Profound Vibra Plus vibrograph, or Instatel Blastmate III (or other similar equipment), equipped with a three-channel geophone.

7.1.2 VIBRATION MONITORING LOCATIONS

The vibration monitoring at the Site is to be conducted at five locations (VML01 to VML05) within 3m to 10m of the Site, the proposed monitoring locations are presented in Figure 2.

The vibration monitoring geophone will be placed externally to the residential structure to be monitored at a location on, or as close as practicable to the building footings at the location closest to the vibration inducing works.

7.1.3 VIBRATION MONITORING FREQUENCY

Vibration monitoring is to be ongoing throughout the demolition, piling, and excavation works and shall not cease until approval to do so is given by the geotechnical practitioner. It is expected that the monitoring will continue over an initial two-week period and be extended as needed depending on the progress of the site works and levels of vibration monitored. The proposed vibration monitoring frequency is presented in Table 6.

Table 6: Proposed Vibration Monitoring Frequency

Activity	Frequency
During first week of demolition, piling or excavation work.	Each alternate working day.
Second to Fourth Weeks after commencement of demolition, piling or excavation work.	Weekly
Fourth Week after commencement of demolition, piling or excavation work.	Monthly
Earthworks (piling or excavation work) within 10 m of sensitive receivers (i.e., residential buildings).	Initially on commencement of earthworks within 10m of a sensitive receiver to confirm that prescribed trigger levels are not being exceeded.
Any other time considered necessary by the geotechnical practitioner.	As required by the Geotechnical Practitioner.

8 VIBRATION MITIGATION CONTROLS

Should the prescribed vibration monitoring thresholds be exceeded, vibration mitigation measures will be prescribed in a Detailed Plan of Action (DPA) prepared by the geotechnical practitioner. A DPA would typically include actions such as the following:

- Increasing the frequency of vibration monitoring.
- Undertake close consultation and dialogue with affected residences, facilities, and persons.
- Ensure all plant and equipment is well maintained and in good working order.
- Ensure all site personnel are vibration awareness trained.
- Carry out intermittent short duration work where tasks are likely to generate high levels of vibration.

- Where practicable, schedule work to avoid simultaneous vibration generating activities.
- Use of alternative plant, equipment and/or construction methods e.g. reduce the size of plant used in close proximity to the affected receiver.
- Heavily dissect rock to be excavated using rock saws.
- Construction of a Vibration Wave Barrier - Ground vibrations do not readily pass through air filled voids. The excavation of a trench or the cutting of a slot in the ground between the vibration source and the receiver therefore acts as an efficient vibration attenuator to mitigate against ground borne vibration.
- Undertake additional building and structure condition (dilapidation) surveys to assess whether or not damage to adjacent building and structures has occurred.

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FIGURES

CONSULTING EARTH SCIENTISTS
Suite 3, Level 1
55 Grandview Street, Pymble, NSW, 2073
ph 8569 2200 fax 9983 0582

Figure 1: Site Location Plan

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Prepared by: A.Crabtree	Checked by: I.Wong

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Figure 2: Vibration Monitoring Location Plan

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