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North Penrith Serviced Apartments
Lot 3008 – DP 1184498
Lord Sheffield Circuit

Noise Impact Assessment

DOCUMENT CONTROL REGISTER

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1 INTRODUCTION

This report presents our assessment of traffic impacts on the amenity of the future occupants of the proposed mixed use development at Lot 3008 Lord Sheffield Circuit, Thornton – Quest.

The assessment has been based on noise and vibration levels generated by train movements on the Western Railway Line which runs to the south of the site and traffic noise generated by traffic along surrounding roadways.

Noise and vibration results have been used to predict internal noise levels within the development. Where necessary, appropriate noise/vibration attenuation treatments have been recommended to prevent excessive impacts on future tenants.

This report is based on architectural drawings provided by St Hilliers & DKO Architects to this office.

2 SITE DESCRIPTION

The subject site is located in the block bound by Lord Sheffield circuit and Aviators Way, Thornton. Within proximity to the site is the Western Railway Line to the south of the site.

The figure below details the site location along with measurement and logging locations.

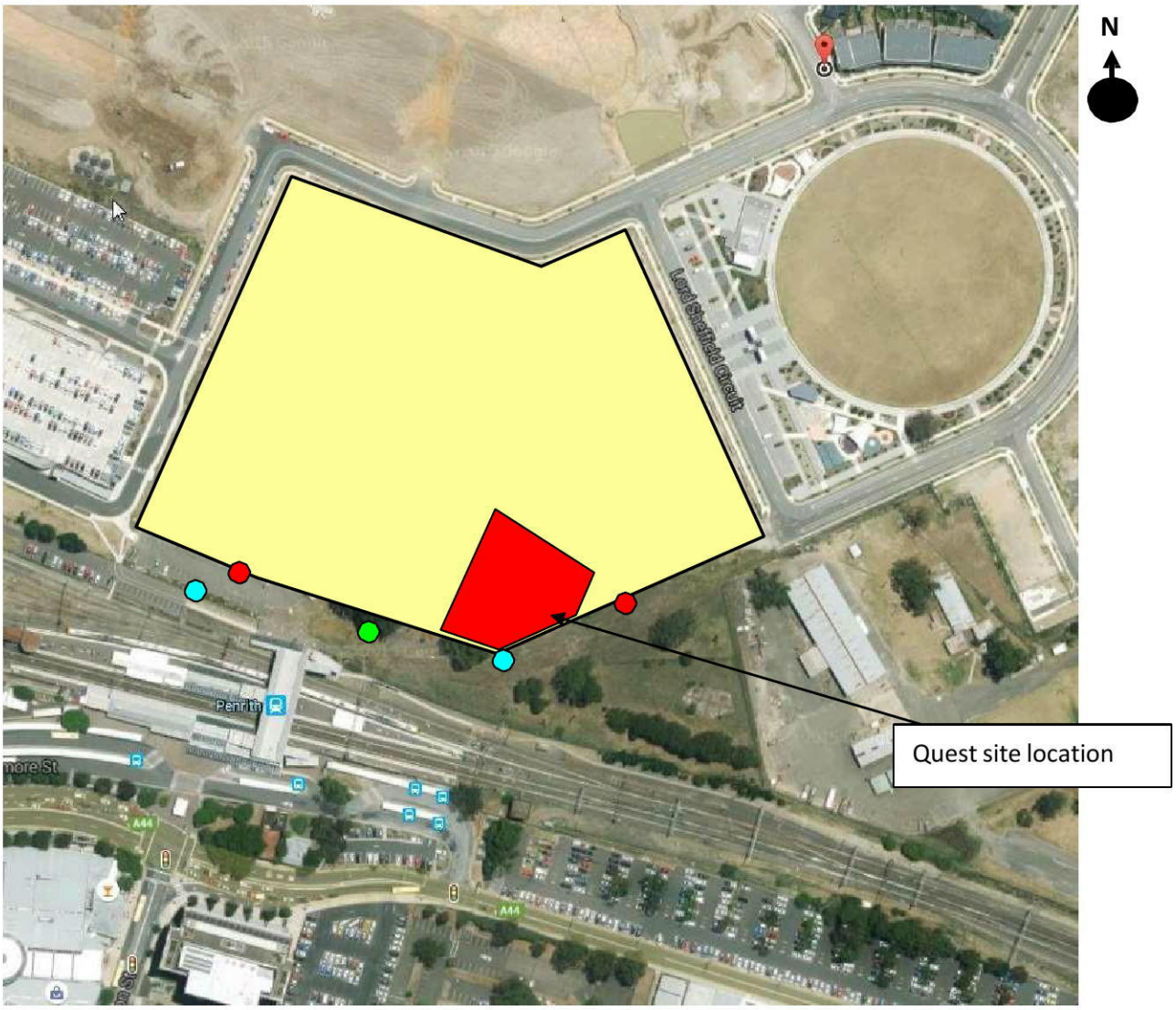
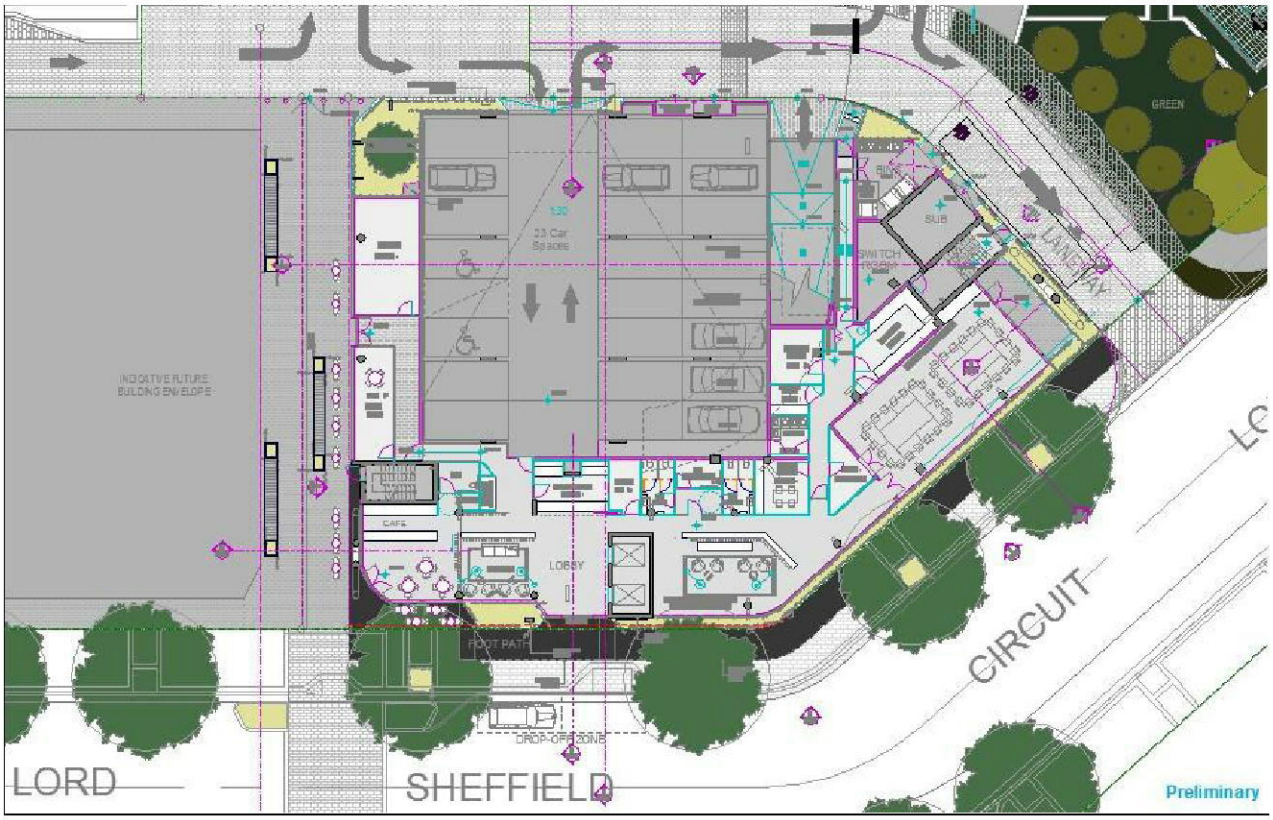


Figure 1 – Subject Site and Measurement Locations

- Attended noise measurements
- Unattended noise monitoring location
- Attended vibration measurements
- Subject site

The proposed Quest site is detailed in the figure below.



3 NOISE DESCRIPTORS

Traffic and rail noise constantly varies in level, due to fluctuations in speed, vehicle types, road/rail conditions and traffic densities. Accordingly, it is not possible to accurately determine prevailing traffic noise conditions by measuring a single, instantaneous noise level. To accurately determine the effects of traffic noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters. These parameters are used to measure how much annoyance would be caused by a particular noise source.

In the case of environmental noise three principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced at the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of traffic noise.

4 RAIL AND TRAFFIC NOISE

This section of the report details the acoustic assessment into railway and traffic noise intrusion onto the proposed development.

4.1 ACOUSTIC CRITERIA

4.1.1 NSW SEPP Requirements

Condition 102 of the NSW State Environmental Planning Policy states:

> *"(1) This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*
>
> *(a) a building for residential use,*
>
> *(b) a place of public worship,*
>
> *(c) a hospital,*
>
> *(d) an educational establishment or child care centre.*
>
> *(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
>
> *(3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
>
> *(a) in any bedroom in the building--35 dB(A) at any time between 10 pm and 7 am,*
>
> *(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway)--40 dB(A) at any time".*

4.1.2 Australian Standard AS 2107:2000

Australian Standard 2107 – "*Recommended Design Sound Levels and Reverberation Times for Building Interiors*", will be used to establish the internal noise levels for the different spaces of the development.

Table 1 – Recommended Design Sound Levels

Space /Activity Type	Recommended design Sound Level dB(A)L_{eq}	
	Satisfactory	Maximum
Commercial Areas – Shops	45	50
Living Areas	30	40
Sleeping Areas	30	35

4.1.3 Project Criteria

A summary of the projects internal noise level criteria incorporating all relevant legislative requirements are detailed in the table below.

Table 2 – Internal noise Level Summary

Space /Activity Type		Project Internal Noise Level Criteria
Commercial Areas		50 dB(A) $L_{eq\ (15hr)}$
Residential	Sleeping Areas	35 dB(A) $L_{eq\ (9\ hr)}$ and 35 dB(A) $L_{eq\ (1\ hr)}$ between 10pm and 7am
	Living Areas	40 dB(A) $L_{eq\ (15\ hr)}$ and 45 dB(A) $L_{eq\ (1\ hr)}$ all times of the day and night

5 NOISE MEASUREMENTS

5.1 UNATTENDED RAIL NOISE MONITORING

Unattended noise monitoring was conducted from the 6th to 15th October 2015 using an Acoustic Research Laboratories noise monitor. The monitor was programmed to store 15-minute statistical noise levels throughout the monitoring period. The monitor was calibrated at the beginning and end of the measurement period using a RION NC-73 sound level calibrator with no significant drift detected. All noise measurements were taken on A-weighted fast response mode. There were no adverse meteorological conditions during the time of monitoring. Noise logger data is provided in Appendix 1.

Table 3 – Rail and Traffic Noise Measurements facing Railway Line

Location/Time of Day	Measured Noise Levels dB(A)$L_{eq(period)}$
Daytime (7am – 10pm)	65
Night Time (10pm to 7am)	60

5.2 ATTENDED TRAFFIC NOISE MEASUREMENTS

Attended rail and traffic noise measurements were also undertaken to supplement the long term noise monitoring data. These were conducted on the 16th October, 2015 using a Norsonic 140 Sound Level Analyser. The analyser was set to an A-weighted fast response and calibrated before and after the measurements using a Rion NC-73 calibrator. No significant drift was noted.

Table 4 – Attended Traffic Noise Measurements

Location	Time of Day	Measured Noise Level dB(A)$L_{eq(15min)}$
Facing Railway Line	9.30am-9.45am	66 dB(A)

6 EVALUATION OF NOISE INTRUSION

Internal noise levels will primarily be as a result of noise transfer through the windows, doors, roof and light weight walls, as these are relatively light building elements that offer less resistance to the transmission of sound. All masonry external walls/roofs will not require upgrading.

The predicted noise levels through the windows, lightweight walls, doors and roof are discussed below. The predicted noise levels have been based on the measured levels and spectral characteristics of the external noise, the area of building elements exposed to traffic and rail noise, the absorption characteristics of the rooms and the noise reduction performance of the building elements.

Calculations were performed taking into account the orientation of windows, barrier effects (where applicable), the total area of glazing, facade transmission loss and the likely room sound absorption characteristics. In this way the likely interior noise levels can be predicted.

In all cases, the selected glazing type (refer below) reduces internal noise levels to within the nominated criteria for the various space types.

6.1 RECOMMENDED GLAZING

The following tables list the recommended glazing assemblies for this project to achieve the internal traffic noise requirements. All external windows and doors listed are required to be fitted with Q-lon type acoustic seals.

The glazing thicknesses recommended are those needed to satisfy acoustic requirements and do not take into account other requirements such as structural, safety or other considerations. These additional considerations may require the glazing thickness to be increased beyond the acoustic requirement.

Table 5 – Recommended Glazing Construction – Commercial Spaces

Façade	Elements	Recommended Glazing	Acoustic Seals
Retail – Ground floor	Doors/Windows	6mm float	Yes

Table 6 – Recommended Glazing Construction – Residential Spaces

Façade	Room	Recommended Glazing	Acoustic Seals
Southern Façade Facing Railway Line	Bedrooms (hotel rooms)	10.38 laminated	Yes
	Living Room	6.38 laminated	Yes
All other facades	Bedrooms	6mm float	Yes
	Living Room	6mm float	Yes

In addition to meeting the minimum glazing thickness requirements given, the design of the window mullions, perimeter seals and the installation of the windows/doors in the building openings shall not reduce the STC rating of the glazing assembly below the values nominated in the table below.
The window/door suppliers should provide evidence that the systems proposed have been tested in a registered laboratory with the recommended glass thicknesses and comply with the minimum listed STC requirements. Also, the glazing installer should certify that the window/doors have been constructed and installed in a manner equivalent to the tested samples. Windows not mentioned in Table 5 and Table 6 should be minimum 5mm toughened.

Table 7 - Minimum STC of Glazing (with Acoustic Seals)

Glazing Assembly	Minimum STC of Installed Window
6mm float	29
6.38mm laminated	31
10.38mm laminated	35

6.2 EXTERNAL WALLS

The proposed masonry external walls are acoustically acceptable and will not require further upgrading.

7 RAILWAY VIBRATION ASSESSMENT

Trains induce ground born vibration that is transmitted through the subsoil. This vibration can be perceptible close to railways, both as tactile vibration and as structure borne noise.

7.1 STRUCTURE BORNE NOISE

The Department of Planning *'Development Near rail Corridors and Busy Road – Interim Guideline'* only requires structure borne noise assessment to be conducted where buildings are over or adjacent land over tunnels.

The Interim Guideline stipulates that ground borne noise may be an issue in habitable rooms which are shielded from the airborne noise of the railway. In such cases, residential buildings must be designed such that 95th percentile of train pass-bys complies with a ground borne L_{max} noise limit of 40 dB(A) (daytime) and 35 dB(A) (night-time), measured using a "slow" response time setting in the centre of the space.

7.2 TACTILE VIBRATION CRITERIA

As the site is located within 60m of the railway line, a vibration assessment is recommended by the Rail Infrastructure Corporation "Interim Guidelines for Councils - Consideration of rail noise and vibration in the planning process". This Guideline recommends that habitable rooms should comply with the criteria in British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" as this standard includes guidance for the assessment of human response to building vibration including intermittent vibrations such as that caused by trains.

Human response to vibration has been shown to be biased at particular frequencies which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the resident is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 "Evaluation of Human Exposure to Vibration and Shock in Buildings (1 to 80Hz)" which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

The standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the "Daytime" (7am-10pm) and "Night time" (10pm-7am). For this project the aim will be for a low probability of adverse comment.

Table 8 – Vibration Dose Values (m/s1.75) with various degrees of adverse comment that may be expected

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 15hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 9hr night	0.13	0.26	0.51
Commercial buildings 15hr day	0.4	0.8	1.6

7.3 RAIL TRAFFIC VIBRATION MEASUREMENTS

Train vibration measurements were conducted on undisturbed ground at the location shown in figure 1. The measurements were carried out on the 20th March 2014.

Vibration measurements equipment consisted of a Svan 912 AE Sound Analyser. The analyser was connected to a SV08 four channel input module fitted with a Dytran triaxial accelerometer.

7.4 MEASUREMENT RESULTS: VIBRATION DOSE VALUES

The maximum train passby ground vibration acceleration, the typical passby period (gained from both the noise and vibration measurements) and the estimated number of train passbys were used to calculate the overall eVDV values for each period of the day. The results are presented in Table 9.

eVDV values were determined based on the daily train timetable information from the CityRail website. The VDV per train used in the eVDV calculation was determined by using the highest measured vibration level during a passby.

Table 9 – Measured Vibration Dose Levels

Location	Time Period	Calculated eVDV $m/s^{1.75}$	Criteria eVDV $m/s^{1.75}$	Complies
Southern Boundary facing Railway line	Day (7am – 10pm)	0.08	0.2	Yes
	Night (10pm -7am)	0.06	0.13	Yes

In the event the future train use increases, say by 10%, predicted eVDV will not increase significantly (no more than approximately 0.02 more than the levels predicted in the table above) and will not impact recommended vibration isolation treatments.

7.5 STRUCTURE BORNE NOISE MEASUREMENTS

As the proposed development is not located directly above or on land adjacent and above a railway tunnel the assessment of structure born noise levels is not required to be assessed future.

7.6 DISCUSSION

Based on the results of the vibration dose values presented in table above, no additional acoustic or vibration treatments are required to be conducted to the proposed development to ensure compliance with the relevant standards as presented within this report.

8 NOISE EMISSION ASSESSMENT

8.1 BACKGROUND NOISE MONITORING

Unattended noise monitoring was conducted from the 6th to 12th October 2015 using an Acoustic Research Laboratories noise monitor. The monitor was programmed to store 15-minute statistical noise levels throughout the monitoring period. The monitor was calibrated at the beginning and end of the measurement period using a RION NC-73 sound level calibrator with no significant drift detected. All noise measurements were taken on A-weighted fast response mode.

Measured background noise levels are presented below. Refer to Appendix 1 for noise logging data.

Table 10 – Measured Background Noise Levels

Location	Period/Time	Background Noise Level dB(A) L_{90}
Monitor location	Day (7am-6pm)	58
	Evening(6pm-10pm)	52
	Night(10pm-7am)	47

8.2 NOISE EMISSION OBJECTIVES

Noise emissions from the development will have to achieve the following requirements.

8.2.1 NSW Industrial Noise Policy

The NSW EPA Industrial Noise Policy, has two criteria which need to be satisfied namely Intrusiveness and Amenity. These are described below:

- *Intrusiveness Criteria* - This guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

- *Amenity Criteria* - This guideline is intended to limit the absolute noise level from all "industrial" noise sources such as mechanical plant to a level that is consistent with the general environment.

The EPA's Industrial Noise Policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface.

Noise levels are to be assessed at the property boundary or nearby dwelling, or at the balcony or façade of an apartment.

8.2.1.1 Intrusiveness Criterion

The guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor do not exceed the background noise level by more than 5dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

Background noise levels adopted are presented in Section 8.1. Noise emissions from the site should comply with the noise levels presented below when measured at nearby property boundary.

Table 11 – Intrusiveness Noise Emission Goals

Location	Period/Time	Intrusiveness Noise Emission Goal dB(A) $L_{eq(15min)}$
Nearby Residences	Day (7am-6pm)	63
	Evening(6pm-10pm)	57
	Night(10pm-7am)	52

8.2.1.2 Amenity Criterion

The guideline is intended to limit the absolute noise level from all noise sources to a level that is consistent with the general environment.

The NSW EPA Industrial noise policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different areas. They are rural, suburban, urban and urban/industrial interface. This site is categorised by suburban receivers.

For the purposes of this condition:

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm.
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sunday and public holidays.

Table 12 – Amenity Noise Emission Goals

Location	Period/Time	Amenity Noise Emission Goal dB(A) $L_{eq(Period)}$
Nearby Residences	Day (7am-6pm)	60
	Evening(6pm-10pm)	50
	Night(10pm-7am)	45
Commercial premises	When in use	65

8.3 MECHANICAL PLANT

Mechanical plant items are not typically selected at DA stage.

Detailed review of all external mechanical plant should be undertaken at construction certificate stage (once plant selections and locations are finalised). Acoustic treatments should be determined in order to control plant noise emissions to the levels set out in section 8.2 of this report.

All plant can be satisfactorily attenuated to levels complying with noise emission criteria through appropriate location and (if necessary) standard acoustic treatments such as noise screens, enclosures, in-duct treatments (silencers/lined ducting) or similar.

9 CONSTRUCTION NOISE AND VIBRATION

This section presents a specification for the processes, which will be followed to manage noise and vibration associated with the proposed construction activities which are required as part of the Project and the potential for noise and vibration impact to receivers within close proximity.

The principal objective of this study is to undertake an evaluation of works to be performed during the operation of the various activities during construction and develop a management plan to ensure noise and vibration is:

1. Minimised to all surrounding receivers.

2. Does not exceed OH&S standards at surrounding receivers.

3. Is monitored when potentially high noise and vibration generating activities are being used.

This assessment will formulate/present the relevant noise and vibration criteria which construction activities are required to comply with. Additionally effective mitigation measures will be recommended where possible to ensure criteria is achieved and impacts are.

The principal issues, which will be addressed in this report, are:

- Identification of the noise and vibration standards which will be applicable to this project.

- Formulation of a strategy for construction activities to comply with the standards identified in the above point.

9.1 PROJECT OBJECTIVES

The objective of this management plan is to set up a protocol to ensure noise and vibration emissions from the construction works associated with the project comply with applicable standards, recommend required management controls and treatments are adopted where required and detail the required monitoring to ensure standards are met.

9.2 PROJECT DESCRIPTION AND POTENTIALLY EFFECTED PROPERTIES

The proposed project includes the excavation of material including infill and soft sand stone and construction of the development. The expected activities can be expected to include:

1. Removal of infill material.
2. Excavation.
3. Building constructions.

9.3 CONSTRUCTION NOISE CRITERIA

It is proposed to utilise Australian Standard AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*, which is the standard commonly applied by Councils for the regulation of construction noise, the New South Wales Construction Noise Guideline developed by The NSW EPA and OH&S requirements are presented in this section of the report.

9.3.1 Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

9.3.2 EPA Construction Noise Guideline

The Department of Environment and Climate Change have developed a specific construction noise guideline in the aid of reducing the impact of construction associated noise.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

9.3.3 EPA Construction Noise Guideline - Qualitative Assessment Method

The guideline refers to a qualitative assessment method in which construction noise is assessed on a case by case basis with regard to various activities to be conducted on site. This assessment method was developed to smaller scale projects.

Essentially this method of assessment requires that the proponent take into consideration and employ all reasonable and feasible measures to ensure that the impact on noise receivers is minimised. This is generally conducted in the following manner:

- The drafting of a noise management plan outlining all reasonable and feasible mitigation methods for the reduction of noise impact;
- The assessment of high impact equipment such as rock-hammers and piling equipment for lower noise producing methods of construction/excavation;
- The implementation of a complaints handling register and community consultation system;
- Employee (builders, contractors etc) education in effective noise reducing techniques and site etiquette; and
- The operation of plant in a quiet and efficient manner (i.e. turning off machinery when not in use).

This qualitative assessment method has been used for the basis of this report and has been used as the basis for the development of acoustic management and treatments of proposed construction activities.

In addition, the guideline specifies goals which can be used in the effort of minimising noise from construction related activities. These noise goals are presented within the table below.

Table 13 – EPA Recommended Construction Noise Goals

Governing Body	Receiver Type	External sound level Goal, $L_{eq\ 15\ min}$ dB(A)
EPA	Residential	Background + 10 dB(A)[1]
		75 dB(A)[2]

1: Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. (DECC CNG, 2008).

2: Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided. (DECC CNG, 2008).

These criteria for resultant noise from construction activities are aimed at maintaining comfort levels within the surrounding residential dwellings. Additionally, noise mitigation techniques as discussed in this report should be used if noise emissions exceed the above criteria. All work is to be carried out in accordance with AS 2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*.

9.4 SUMMARISED NOISE EMISSION GOAL

Noise emission goal have been summarised below based on the requirements above and background noise data collected on site.

Based on the noise logging conducted at the site and detailed in Section 8.1 of this report the background noise level at the site during normal construction hours is 50 dB(A) L_{90}.

Table 14 –Noise Emission Goal

Noise Receivers	Time Period	Noise Emission Goal
Surrounding residential receivers	Normal Daytime Construction Hour's as Stipulated within the DA Conditions of Consent	60 dB(A) $L_{10,\ 15\ min}$

If the noise goal is still exceeded after applying all practical engineering controls to limit noise emissions, investigate management and other techniques to mitigate noise emissions

9.4.1 OH&S guidelines

Regulation 49 of the Occupational Health and Safety Regulation specifies maximum levels of noise which a 'worker' may be exposed to. Acoustic treatment to the work environment or hearing protection is recommended for workers exposed to higher noise levels. These maximum OH&S noise levels are presented in the table below.

Table 15 – OH&S Maximum Noise Level Exposure

	Energy Averaged Over 8 Hour Day	Maximum Noise Level During Day
OH&S maximum noise level exposure	85 dB(A) L_{eq}	140 dB(C)$_{Peak}$

9.5 CONSTRUCTION VIBRATION CRITERIA

Construction vibration criteria associated with works on the project when measured at the potentially affected receivers should not exceed the following sets of vibration criteria to ensure no architectural or structural damage to surrounding buildings and human comfort is maintained. These standards have been selected as they are widely used in the assessment of vibration associated with construction activities within Australia, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"*; and
- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The criteria and the application of these Standards are discussed in separate sections below.

9.5.1 German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the Table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 16 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

9.5.2 British Standard BS 6472:1992

British Standard BS 6472:1992 develops criteria relating to levels of building vibration that may be expected to give rise to *"adverse comment"*, in the frequency range most applicable to impacts associated with construction, which is 1 to 80Hz. These threshold values are used as criteria for assessing the loss of amenity and are presented below in Table 3.

Table 17 – BS 6472:1992 Criteria to Avoid "Adverse Comment"

Type of Occupancy	Time of Day	Peak Particle Velocity (mms^{-1}) between 1Hz to 80Hz Likely to Cause *"Adverse Comment"*			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration Excitation with Several Occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.3 to 0.6	0.8 to 0.6	8.4 to 12.6	24 to 36
	Night	0.2	0.6	2.8	8
Offices	Day	0.6	1.6	18	51
	Night	0.6	1.6	18	51
Workshops	Day	1.2	3.2	18	51
	Night	1.2	3.2	18	51

The limits indicate that people in buildings are significantly less susceptible to horizontal vibration than to vertical vibration. Furthermore, Section 4.1 of BS 6472 notes that situations can exist where vibration magnitudes above those generally corresponding to minimal *"adverse comment"* levels can be tolerated, particularly for temporary disturbances and infrequent and intermittent events such as those associated with construction projects.

9.6 PROPOSED CONSTRUCTION VIBRATION CRITERIA

Based on the stands detailed above vibration generated on the site from construction activities should not exceed 10mm/s at any neighbouring receiver.

9.7 CONSTRUCTION HOURS

Working hours are subject to planning approval conditions. Typically the hours of work at sites will be:

- 7:00am to 6:00pm Monday to Friday
- 7:00am to 1:00pm on Saturdays (if inaudible on neighboring residential premises), otherwise 8:00 am to 1:00 pm;
- No work on Sundays, Public Holidays or Saturdays adjacent to a Public Holiday.

Works which are proposed to be conducted outside of these hours will be subject to special approval.

9.8 CONSTRUCTION NOISE ASSESSMENT

Noise generated by plant and equipment will be managed to generally comply with the nominated noise goals and where this noise goal may be exceeded, noise will be managed based on principles outlined in Australian Standard 2436, the EPA guidelines and the Conditions of Consent.

Noise levels have been predicted at the boundary of the identified affected receivers, based on the demolition plant/equipment with the potential to produce significant noise.

It is noted that:

- Many of the noise sources are present over a small period of the day or may be present for a few days with a significant intervening period before the activity occurs again.

The predicted noise levels taken into consideration the following factors:

- The distance between the noise source and the receiver.
- The screening effect provided by any remaining building structure or building shell. In particular, noise from works done on higher level will be substantially screened by the remaining building structure to receivers located on lower levels.

The A-weighted sound power levels for typical equipment/processes anticipated to generate significant noise during the demolition works are outlined in the table below;

Table 18 – Sound Power Levels of Proposed Equipment

CONSTRUCTION ACTIVITY	EQUIPMENT /PROCESS	SOUND POWER LEVEL - dB(A)
Excavation	Truck	108
	Bobcat	105
	30 Ton Excavator	114
	Impact drill	105
	Angle grinders	105
	Electric Saw	102
	Excavator (with hydraulic hammer)	114
	Bobcat	105
Construction	Angle Grinders	105
	Electric Saw	102
	Drilling	95
	Hammering	110
	Concrete Vibrator	100
	Cement Mixing Truck	105
	Concrete Pumps	105

* - includes 5 dB(A) addition for characteristics of noise source.

The noise levels presented in the above table are derived from the following sources:

1. On-site measurements;
2. Table D2 of Australian Standard 2436-1981; and
3. Data held by this office from other similar studies.

9.9 RECEIVER 1: RESIDENCE TO THE EAST OF THE SITE

The residential receivers to the east of the site are located approximately 200 from the proposed site. The residence will have direct line of sight to the construction site. This is potentially the most affected sensitive receivers. Predicted noise levels are as follows:

Table 19 – Predicted Noise Levels – Residential Receivers to the east

Equipment / Process	Noise Goal dB(A) L_{10} (15,min) (Background+10dB(A))	Predicted Level at Receiver dB(A) $L_{10(period)}$	Complies
Truck	60	49-59	Acoustically acceptable
30 Ton Excavator	60	55-65	Exceeds criteria. See recommendations in section 10 below.
Impact drill	60	46-56	Acoustically acceptable
Angle grinders	60	46-56	Exceeds criteria. See recommendations in section 10 below.
Electric Saw	60	44-54	46-56
Contiguous Piling	60	51-61	Marginal exceedance will be acoustically acceptable
Excavator (hydraulic hammer)	60	55-65	Exceeds Criteria. See recommendations in section 10 below.
Bobcat	60	46-56	Acoustically acceptable
Angle Grinders	60	46-56 when used externally 26-36 when used after installation of the façade	Acoustically acceptable
Electric Saw	69	43-53 when used externally 23-33 when used after installation of the façade	Acoustically acceptable

Table 19 (Continued) – Predicted Noise Levels – Residential Receivers to the East

Equipment / Process	Noise Goal dB(A) L10 (15,min) (Background+10dB(A))	Predicted Level at Receiver dB(A) L10(period)	Complies
Drilling	60	36-46 when used externally 21-31 when used after installation of the façade	Acoustically acceptable
Hammering	60	31-41 when used after installation of the façade	Acoustically acceptable
Concrete Vibrator	60	38-48	Acoustically acceptable
Cement Mixing Truck	60	46-56	Acoustically acceptable
Concrete Pump	60	46-56	Acoustically acceptable

Noise emission from other equipment items will be less than that predicted above, and will also be satisfactory.

9.10 VIBRATION - ACCEPTABLE WORK PRACTICES

Vibration during the construction period is not expected to exceed vibration limits based on the proximity of all receivers to the proposed site.

10 DISCUSSION AND AMELIORATIVE MEASURES

10.1 SITE SPECIFIC RECOMMENDATIONS

- Excavation and piling works:
    - Also, a 15 minutes respite period is generally provided every hour due to the moving/setup of equipment.
    - In addition, we recommend that the nearby sensitive receivers be notified prior to the commencement of high noise generating activities such as hydraulic hammering.

- Construction Works:
    - Calculations indicate that noise from the use of the angle grinder and electric saw may result in marginal to moderate exceedances of allowable noise levels at the receivers around the site when it is operated completely unscreened on the boundary of the site. This occurs when these equipment items are used *externally.* It is during erection of structure that these works would occur. Once building shell is complete, these equipment items would generally be compliant.
    - Noise from hammering is likely to result in excessive noise levels at the receivers, however, the hammering activities will be predominantly intermittent and the noise exceedance will not be continuous.

In addition, notification, reporting and complaints handling procedures should be adopted as recommended in this report.

Other noise management practices which may be adopted are discussed below.

10.2 CONTROL OF CONSTRUCTION NOISE AND VIBRATION

As a part of the noise management of noise and vibration on each site the following process should be conducted when investigating the impact and construction activities.

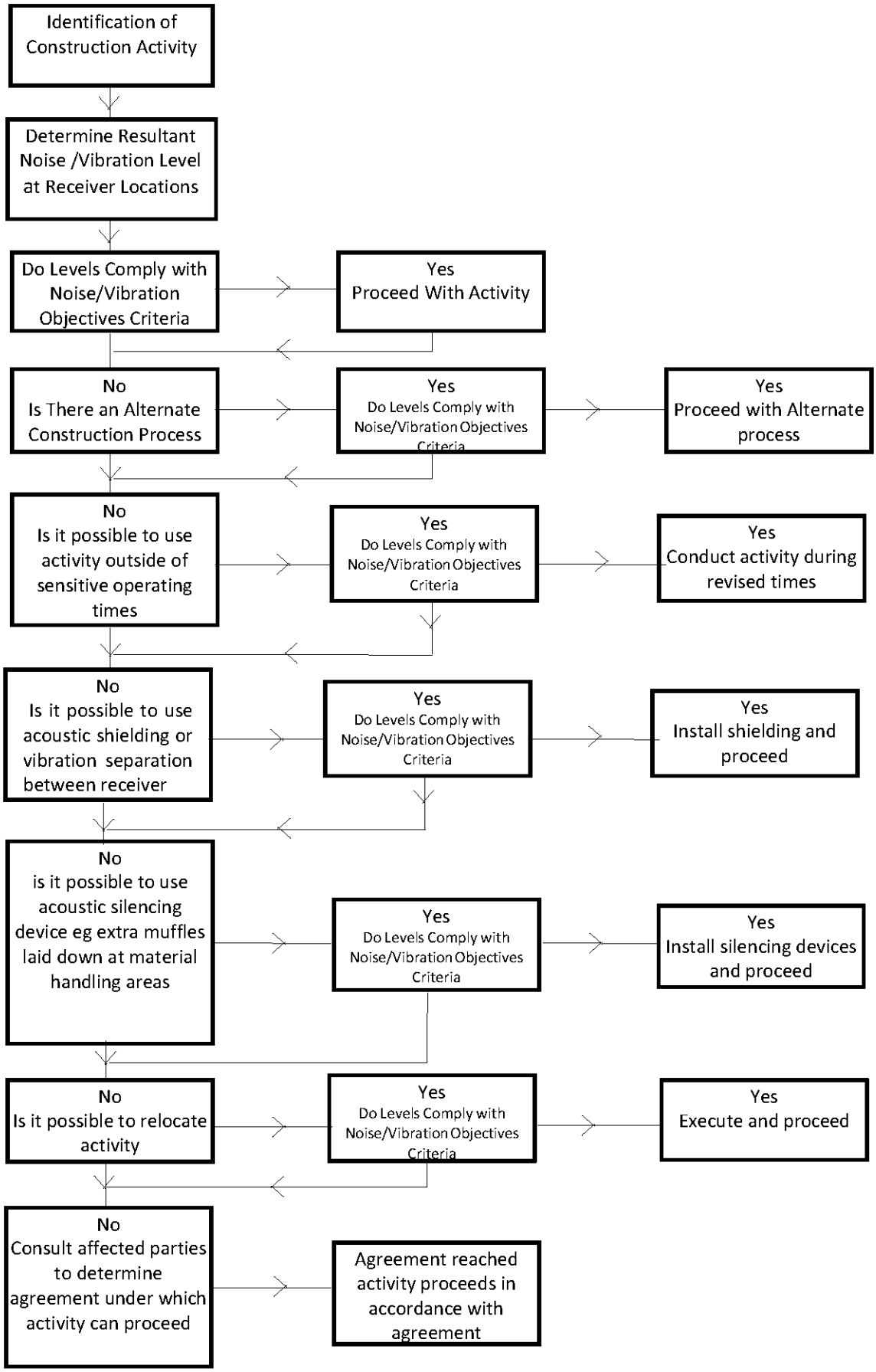


Figure 1 – Process Flowchart

10.3 NOISE AND VIBRATION CONTROL METHODS

The determination of appropriate noise control measures will be dependant on the particular activities and construction appliances. This section provides an outline of available methods.

10.3.1 Selection of alternate appliance or process

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

10.3.2 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependant on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

10.3.3 Silencing devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

10.3.4 Material handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

10.3.5 Treatment of specific equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

10.3.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. A noise plan will be developed for this project outlining work procedures and methods for minimising noise.

10.3.7 Regular noise checks of equipment

To determine the requirement for silencing devices on machinery it is proposed to undertake fortnightly noise check. Noise levels of all machines on site will be measured and if they are found to be higher than nominated for that equipment type, items such as mufflers and engine shrouds will be examined to ensure they are in good working order.

A record of these measurements will be kept on a form similar to that shown in Appendix 1. This measure is expected to maintain noise at constant levels, and prevent any increases.

10.3.8 TREATMENT of EXISTING EQUIPMENT

An effective method of mitigating vibration on existing equipment would be to vibration isolated mounts to existing equipment and installations. Vibration isolation would be required to be investigated on a case by case basis and consist of neoprene mounts as specified (such as waffle pads, supershear flex or the like).

Based on investigations conducted at the site the areas which may be suitable for treatment include tables with sensitive equipment such as microscopes and the like.

10.3.9 Noise and vibration Monitoring

Noise and vibration monitoring will be undertaken to determine the effectiveness of measures which are been implemented. The results of monitoring can be used to devise further control measures.

10.3.10 Combination of methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise.

10.3.11 Saw cutting

Introduction of a saw cut to manage vibration impacting on surrounding receivers from construction activities.

11 CONCLUSION

This report provides the results of our assessment of traffic and train noise and vibration impacts on the amenity of future occupants within the proposed mixed use development at Lot 3008 Lord Sheffield Circuit, Quest project.

The assessment has been conducted with reference to relevant traffic and rail noise requirements. Provided that the treatments set out in section 6 are implemented, noise and vibration impacts on future tenants within the proposed residential developments will comply with relevant acoustic criteria.

Noise emissions requirements have been detailed in Section 8.2.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Mays Chalak
IGS Pty Ltd

APPENDIX 1 – UNATTENDED NOISE MONITORING DATA