ACOUSTICS AND AIR

UNSW D14
COLLEGE WALK

CONSTRUCTION & OPERATIONAL NOISE REPORT

REPORT NO. D14W01
VERSION A

NOVEMBER 2018

PREPARED FOR

UNSW C/- LEND LEASE D & C PARTNER
LEVEL 14, TOWER THREE, INTERNATIONAL TOWERS SYDNEY
EXCHANGE PLACE, 300 BARANGAROO AVENUE
BARANGAROO NSW 2000

WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Final	7/11/2018	Brian Clarke	Sam Demasi

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

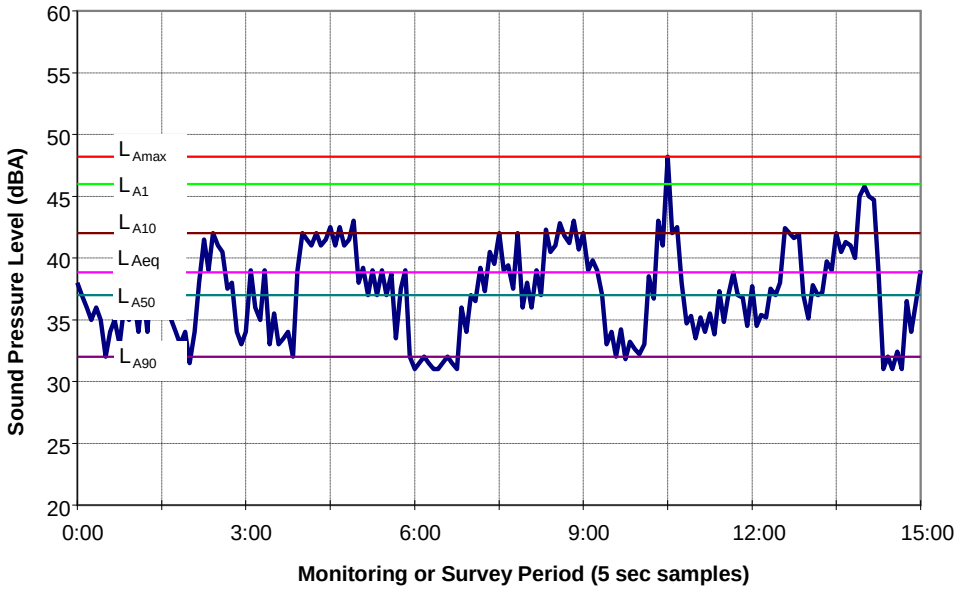
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening, and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This report accompanies a State Significant Development Application (SSDA) (SSD 9606) submitted to the Department of Planning and Environment (DP&E) pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for a new multi-purpose educational building referred to as the 'new Building D14' within the University of New South Wales (UNSW) Kensington campus.

This proposal relates specifically to the construction of a new eight storey multi-purpose building that can accommodate a variety of uses including a new study space, new flexible teaching and learning environments, faculty office space and retail opportunities and a function room at ground level.

Wilkinson Murray Pty Limited has reviewed and assessed the drawings and relevant documentation prepared in respect of the Significant Development Application (SSDA) submission.

The assessment has considered the following requirements:

10. Noise and Vibration

- Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction and operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

→ Relevant Policies and Guidelines:

- NSW Noise Policy for Industry 2017 (EPA)
- Interim Construction Noise Guideline (DECC)
- Assessing Vibration: A Technical Guideline 2006
- Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008).

It is noted that the transport corridors are sufficiently remote from the site that the last policy is not relevant to this site.

2 OVERVIEW OF PROPOSED WORKS

The subject site is located within the grounds of the UNSW Kensington Campus and is identified as Building D14. Site enabling works within the 'University Hall Precinct' to allow the proposed development, are to be carried out byway of a separate Review of Environmental Factors (REF) under Part 5 of the EP&A Act 1979. The Part 5 REF proposes activities including demolition of existing structures, removal of trees, diversion, installation and/or upgrade of hydraulic, stormwater and electrical infrastructure and minor regrading/resurfacing to selected access pathways, College Road and landscaped areas within the site.

The project proposes the demolition of the existing UNSW Hall Building (also coded as D14) and the construction a new multi-purpose building which will accommodate the following functions:

- Workplace (interim function)
- University Council chambers and associated facilities (interim function)
- Academic Faculty (post interim function – no lab space)
- Student-led space (study spaces)
- Teaching rooms (known as Learning Environments (LE) CATS spaces)
- Retail
- Makers Space
- End of Trip Facilities and general amenities
- Outdoors spaces that link to Alumni Park, College Walk, and the old Tote/Figtree

. The Gross Floor Area (GFA) of the development is anticipated to be 15,000m^2.

The near-term objective is to accommodate interim uses for this building that will accommodate office administration, including the UNSW Council Chambers and meeting spaces including ceremonial.

It is noted that the proposed construction activities will not generate significant levels of vibration. Therefore, the issue of construction vibration is not considered further in this report.

The operation of the building consists of normal educational operations where noise from mechanical plant presents the main source of any potential noise emissions from the site.

2.1 Site Location

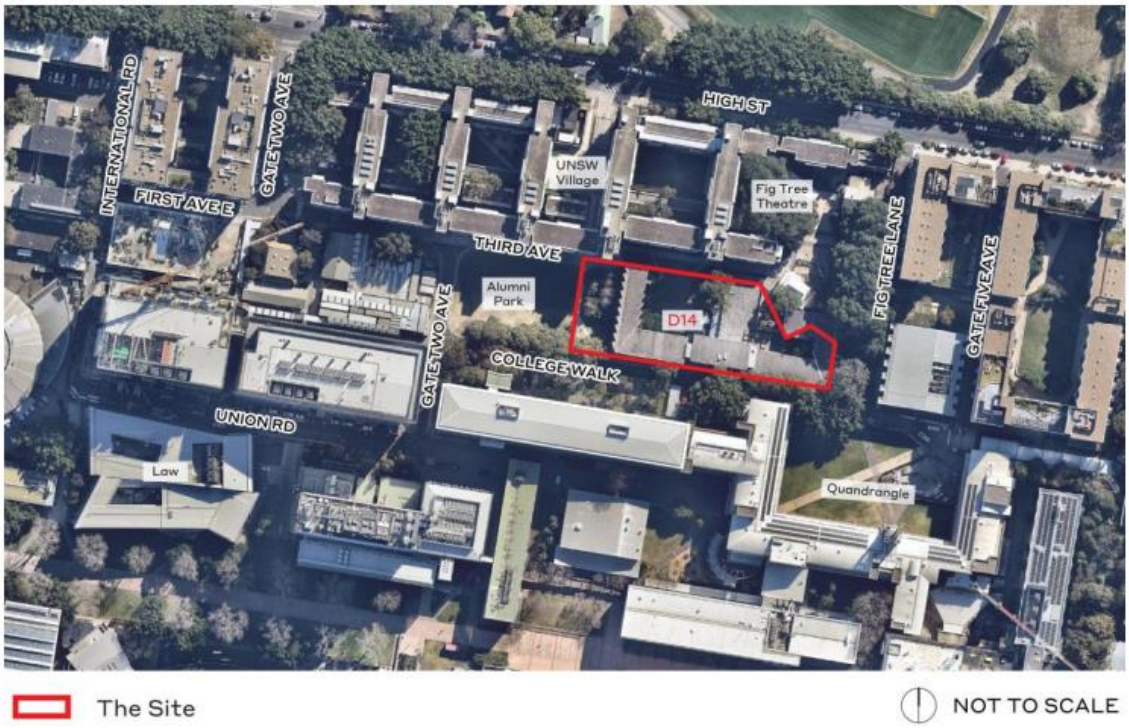
The site is located at the UNSW Kensington campus which is situated within the Randwick Local Government Area (LGA). The UNSW Kensington campus lies to the south of the Royal Randwick Racecourse, to the west of the Prince of Wales Hospital Campus / Randwick Health Precinct, and between the Kensington and Kingsford town centres on Anzac Parade.

The campus is located 8km south of the Sydney CBD and about 6km north-east of Sydney Airport.

Within the campus, the site is located centrally between Alumni Park (west), the Fig Tree Theatre (north), the UNSW Quadrangle (south) and Fig Tree Lane and Goldstein Hall (east). The site for

the proposed SSDA, in its entirety, is situated within Lot 3 in Deposited Plan 1104617. The site has a total area of approximately 5,000m2. A site location map identifying the site within the context of the wider campus is shown at Figure 2-1 and Figure 2-2 provides a rendered 3D aerial view that shows the new building

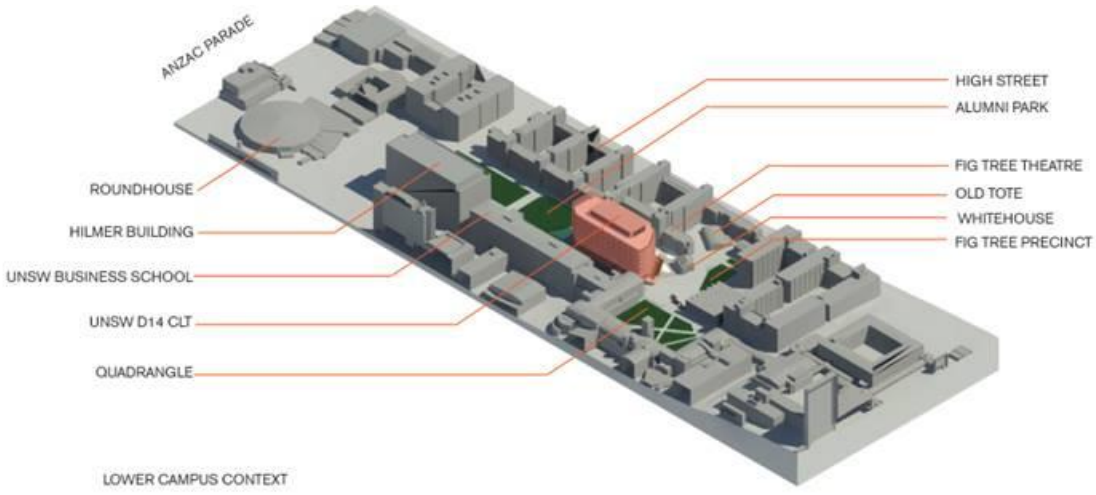
Figure 2-1 Site Plan



2.2 Description of the Proposed Development

The site currently comprises the University Hall building, which is one of the many student accommodation buildings on campus, and a small part of Alumni Park. The existing University Hall building is a part 3 and part 4 storey masonry building comprising 208 rooms with shared facilities including bathrooms and kitchen and other common areas. The built form presents a continuous edge to the south (College Walk) and a courtyard style appearance to the north with linear extensions to the west and east. An open internal courtyard space is provided to the south near Third Avenue.

Figure 2-2 Aerial View



Source:Tzannes

2.3 Surrounding Receivers

The site is surrounded by:

- Multi-Level Student accommodation to the North
- University Buildings to the South and East
- Greenspace to the west

2.4 Construction Hours

Construction works are proposed to be undertaken between the hours of 7.00am and 6.00pm Monday-Friday and between 8.00am and 5.00pm on Saturdays. No work will be undertaken on Sundays or public holidays.

It is noted that the proposed hours for Saturdays are outside EPA's standard hours of construction being 8.00am and 1.00pm. However, this extended period of construction hours will enable the major noise and vibration generating activities to be carried out in a more efficient manner, thereby shortening the period over which sensitive receptors will be exposed.

3 AMBIENT NOISE MONITORING

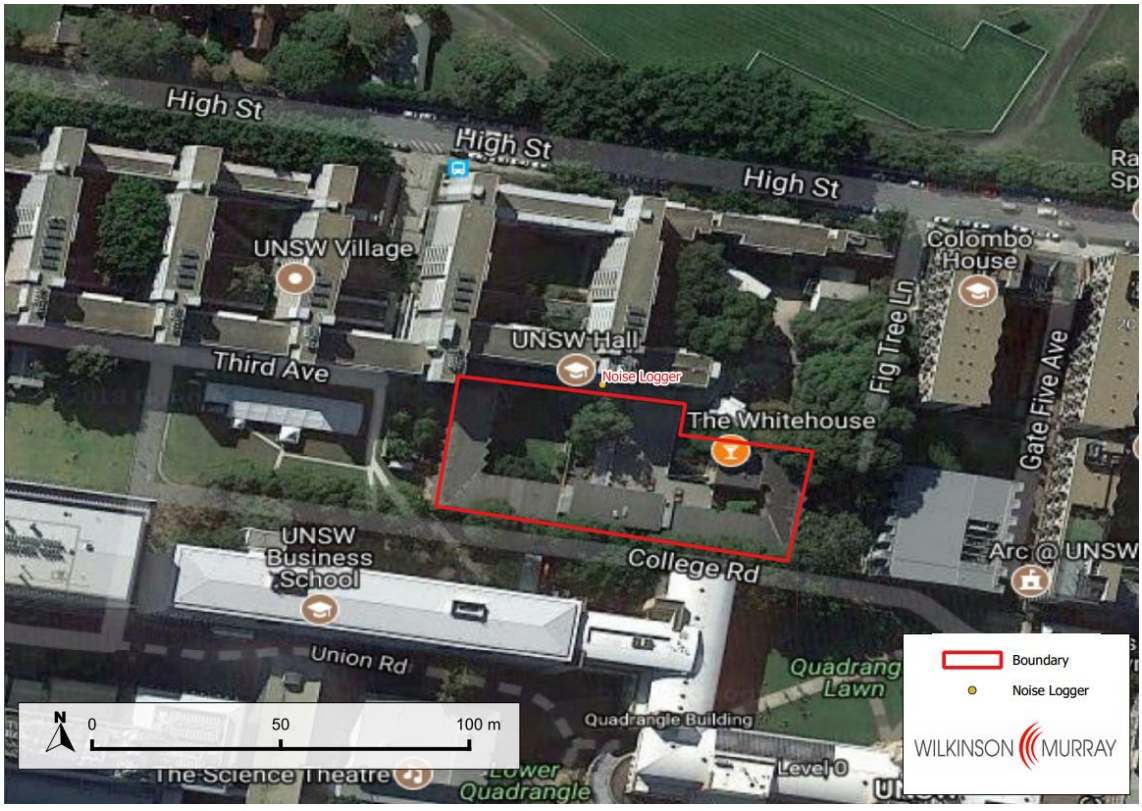
3.1 Ambient Noise Levels at the Site

The residential receivers surrounding the site that may be affected by construction and operational noise have been identified as student accommodation immediately to the north of the site at:

- UNSW Hall
- UNSW Village
- Colombo House
- The Whitehouse to the north east.

These are shown in Figure 3-1.

Figure 3-1 Aerial showing Noise Monitoring Locations



In addition, the following surrounding receivers have been identified:

- Education premises are located to the south of the site on College Road.
- Student Services in the Arc building to the east.
- Open common space to the West.

It is noted that there are no noise sensitive receivers that are located beyond the university campus that have the potential to be impacted by either construction or operational noise.

In order to quantify the existing noise environment, long-term ambient noise levels were monitored on the northern side of the site adjacent to UNSW Hall.

The noise monitoring equipment used for the Wilkinson Murray noise measurements consisted of an ARL Type EL-215 environmental noise logger set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. The L_{A90} level is normally taken as the background noise level during the relevant period.

Detailed results for the monitoring location are shown in graphical form in Appendix A. The graphs show measured values of L_{Aeq}, L_{A90}, L_{A10} and L_{A1} for each 15-minute monitoring period.

Table 3-1 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's *Interim Construction Noise Guidelines (ICNG)* and the NSW *Noise Policy for Industry (NPfI)*.

Table 3-1 Summary of Measured Ambient Noise Levels

Period	Noise Level - dBA	
	RBL (dBA)	$L_{Aeq,period}$ (dBA)
Daytime 7am-6pm	53	62
Evening 6-10pm	52	59
Night Time 10pm-7am	51	57

Noise data measured during inclement weather was excluded in accordance with EPA procedures.

4 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

This section of the assessment relates to construction works. It should be noted that the noise and vibration criteria detailed in the following sections is applicable to all stages of the Masterplan.

4.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the EPA *Interim Construction Noise Guideline*.

4.2 Construction Noise Management Levels

The EPA released the *Interim Construction Noise Guideline (ICNG)* in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq,\ 15min}$ noise management level should not exceed the background noise by more than 10dBA. This is for standard hours: Monday to Friday 7.00am-6.00pm, and Saturday 8.00am-1.00pm. Outside the standard hours, where construction is justified, the noise management level would be background + 5dBA. Table 4-1 details the *ICNG* noise management levels.

Table 4-1 Construction Noise Management Levels at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. 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.

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

In addition, the following construction noise management levels $L_{Aeq,15\ min}$ are recommended for other receivers and areas applicable to this project:

- Active recreation areas (such as parks): external $L_{Aeq\ ,15\ min}$ 65dBA
- Offices, retail outlets: external $L_{Aeq,15\ min}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq\ ,15\ min}$ 45dBA

Based on the above, Table 4-2 presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

Table 4-2 Site-Specific Construction Noise Management Levels

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly noise affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
Residential Accommodation	63	57	56	63	75

* Standard Saturday construction hours.

In addition, the following noise management levels are applicable for other receivers

- Education premises* – 55 dBA external windows open – 65 dBA external windows closed
- Student Services in the Arc building 70 dBA.
- Open common space to the West. 65 dBA

* Based on a 10 dBA reduction from inside to outside with windows open and a 20 dBA reduction with windows closed.

4.3 Vibration Criteria

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document *Assessing Vibration: A Technical Guideline* (2006) produced by the NSW DECCW.

Acceptable values of human exposure to continuous vibration, such as that associated with drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence, or a vibration-critical area). Guidance on criteria for continuous vibration is set out in Table 4-3.

Table 4-3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (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

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV) and are presented in Table 4-4.

Table 4-4 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events, and their duration in the relevant time period.

4.4 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *"Explosives – Storage and Use – Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"*, as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4-5.

Table 4-5 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

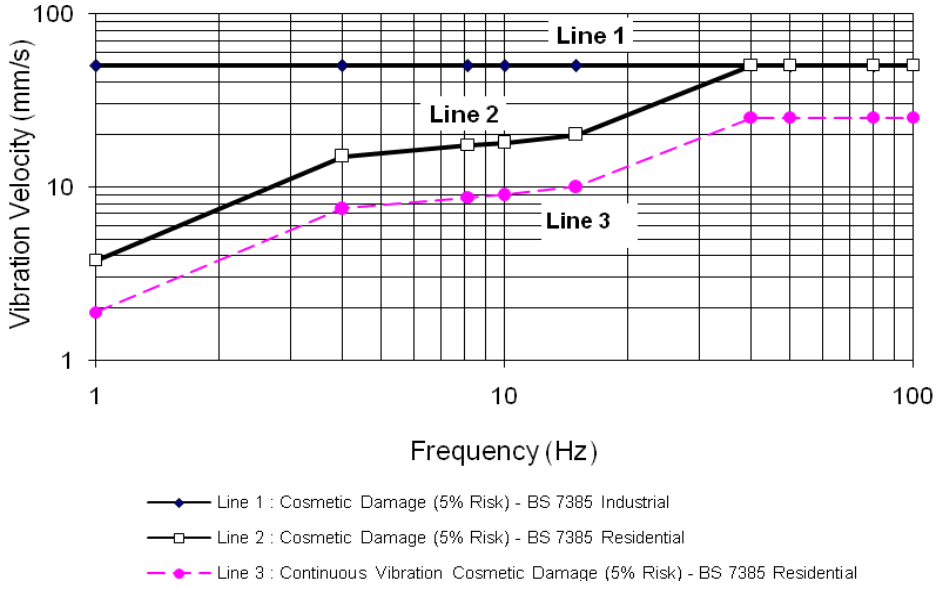
Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Table 4-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Note that rock breaking / hammering, and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

Figure 4-1 Graph of Transient Vibration Guide Values for Cosmetic Damage



In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *Structural Vibration Part 3 – Effects of Vibration on Structures*. Table 4-6 details these recommendations for heritage buildings.

Table 4-6 DIN 4150 recommended PPV Vibration Level for Heritage Buildings

Guideline Values for Velocity – mm/s		
1-10 Hz	10 to 15 Hz	40 to 50 Hz
3	3 to 8	8-10

4.5 Traffic Noise Criteria

Noise Criteria for assessment of road traffic noise are set out in the NSW Government's *NSW Road Noise Policy (RNP)*. Table 4-7 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

Table 4-7 Traffic Noise Criteria extracted from the NSW *RNP*

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (15\ hour)}$ 55 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

In summary, the noise level goals at the residential receivers, for this project, based on the *RNP* are:

- $L_{Aeq,1hr}$ day 55dBA; and
- $L_{Aeq,1hr}$ night 50dBA

In addition, where the above criteria are already exceeded as a result of existing traffic the policy notes:

> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.*

4.6 Construction Equipment & Noise Source Levels

Sound Power Levels (SWLs) for typical C1 construction plant are identified in Table 4-8. These SWLs have been measured at other similar construction sites. The table gives both Sound Power Level and Sound Pressure Levels (SPL) at 7m for the equipment. Sound Power Level is independent of measurement position.

Table 4-8 Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Bored Pile Rig	112	87
Mobile Crane	104	79
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump – 120 mm diameter / 50 bar	112	87
Concrete Saw	116	91
Mobile Crane	98	73
Tower Crane	104	79
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Front End Loader	112	87
Excavator	107	82
Hand Tools	90	65

4.7 Construction Noise Predictions

Assessment of likely construction noise at surrounding educational, commercial, and residential receivers has been assessed for D14 construction works.

Site-related noise emissions were modeled with the "CadnaA" noise prediction program, using the ISO 9613 noise prediction algorithms. Factors that are addressed in the noise modeling are:

- equipment sound level emissions and location;
- screening effects from buildings;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

Modelling has been conducted for three significant construction scenarios, summarised in Table 4-9.

Table 4-9 Construction Scenarios for C1 Construction Works

Scenario	Description	Works
A	Foundations	This includes site preparation and foundation piling. This included a front-end loader and bored piling rig.
B	Building Construction	This scenario includes concreting and lifting. 2 concrete pumps, 2 forklifts, 2 compressors, 1 tower crane, a boom truck and lift are assumed to operate in 15-minutes. Also, concrete trucks and normal delivery trucks assumed to be 2 movements in 15-minutes.
C	Facade	In the event that the construction of the façade occurs in isolation. Forklift, cranes, and power tools assumed. 2 truck movements in 15-minutes assumed.

Noise modelling has been conducted for each of the above scenarios, with plant located across the construction site as follows.

Line Noise Source – Truck routes are modelled as line noise sources with the number of trucks on the haulage route in a 15-minute period applied to these sources.

Point Noise Sources – Fixed plant and equipment are modelled as point sources.

The modelling assumes a "typical worst case" scenario whereby all plant, is running continuously. As such the modelling represents likely noise levels that would occur during intensive periods of construction. Therefore, the presented noise levels can be considered in the upper range of noise levels that can be expected at surrounding receivers when the various construction scenarios occur.

Once noise sources have been applied to the model, the resultant noise levels at identified surrounding receivers are predicted. These results are then compared with established site-specific noise criteria.

The following tables detail results of noise modelling for each scenario.

Table 4-10 Predicted Construction Noise Levels at Receivers – $L_{Aeq(15\ min)}$ – dBA

Receiver	Predicted Noise Level	NML	Exceedance Level
Scenario A – Foundations			
UNSW Hall	73	63	10
UNSW Village	66	63	3
Colombo House	60	63	0
Education	66	55/65	11 / 1
Student Services	61	70	0
Open common space	58	65	0
Scenario B – Building Construction			
UNSW Hall	68	63	5
UNSW Village	66	63	3
Colombo House	57	63	0
Education	70	55/65	15 / 5
Student Services	58	70	0
Open common space	61	65	0
Scenario C – Facade			
UNSW Hall	59	63	0
UNSW Village	53	63	0
Colombo House	50	63	0
Education	59	55/65	4 / 0
Student Services	52	70	0
Open common space	49	65	0

A review of results indicates that exceedance of noise management levels are predicted at the nearest residential accommodation at UNSW Hall by up to 10 dBA during foundations and to a lesser degree, 5 dBA, during construction.

In the case of education building exceedances of up to 15 dBA can be expected should windows remain open. When closed more manageable exceedances (< 5 dBA) are predicted

4.8 Discussion of Results

It is noted that construction noise from the proposed D14 works will generate exceedance of noise management levels at surrounding noise sensitive receivers. Typically, the greatest exceedances at residential accommodation will occur during the installation of the foundations were improved amenity can be achieved by closing of windows should occupants require.

In the same manner it is likely that the windows of education buildings will need to be closed at times to ensure acceptable internal amenity is achieved.

Further it is noted that exceedances of these magnitude are typical of construction sites in Sydney were receivers are in close proximity to residences and other uses. These emissions have been successfully managed by the implement of noise management procedures detailed in following sections.

It is also noted that there is no major excavation is associated with this development and therefore the intensive noise typically associated with this activity will not occur at the D14 site.

4.9 Construction Vibration Assessment

Table 4-11 sets out the typical ground vibration levels at various distances for safe working distances.

Table 4-11 Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	(300kg – 5 to 12t Excavator)	2m	7m
Medium Hydraulic Hammer	(900kg – 12 to 18t Excavator)	7m	23m
Large Hydraulic Hammer	(1600kg – 18 to 34t Excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

- Construction Noise Strategy, 2012, Transportation Construction Authority

The highest vibration levels will occur when construction equipment is located on the northern side of the site university accommodation when piling occurs.

A review of the site plant and surrounding receivers indicates that the minimum distance between the vibration generating activities and surrounding buildings will be in the order of 8 metres. Therefore, the use of pile boring (the proposed activity that will generate the highest levels) will be acceptable and unlikely to lead to adverse reactions.

The risk of structural damage, even cosmetic from the piling works is considered negligible.

4.10 Construction Noise & Vibration Mitigation Measures

Without mitigation, noise levels from construction activities have been predicted to exceed the noise management levels nominated in the guidelines at some surrounding receivers. Therefore, noise control measures are recommended to ensure that noise is reduced where reasonable and feasible.

The following project specific mitigation measures are recommended;

- Notification of works to nearby impacted receivers;
- Installation a 2.4 metre plywood hoarding around the construction site;
- Scheduling foundation works during university holidays or in consultant with nearest impacted receivers (where feasible);

- Selection of quietest feasible construction equipment; and
- Localised treatment such as barriers, shrouds, and the like around fixed plant such as pumps, generators, and concrete pumps.
- UNSW to be aware that Construction noise exceedance at surrounding noise sensitive receivers both residential accommodation and educational facilities. UNSW may need to manage communications to affected students.

In addition, the following measures should be included in a Noise and Vibration Management Plan.

- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures, and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.

The adoption of the above measures are aimed at working towards achieving the noise management levels established at surrounding receivers.

4.11 Noise & Vibration Management Plan

A Construction Noise and Vibration Management Plan for the site is recommended which should be prepared by the successful contractor. The plan should reference the findings of this assessment. Areas that should be addressed in the plan (as a minimum) include:

- noise and vibration mitigation measures;
- noise and vibration monitoring;
- response to complaints**;**
- responsibilities;
- monitoring of noise emissions from plant items;
- reporting and record keeping;
- non-compliance and corrective action; and
- community consultation and complaint handling.

4.12 Construction Traffic Noise

Based on similar projects it is likely that the development would generate up to six heavy vehicle movements per hour during the construction phase.

As traffic will enter and leave by High Street then onto Anzac Parade the contribution to existing traffic volumes will be negligible.

5 OPERATIONAL NOISE & VIBRATION

Operational noise from the proposed facilities will be from activities within the new building as well as mechanical plant located predominantly on the roof plantroom.

5.1 Operational Noise Criteria

The NSW *NPfI* provides a framework and process for deriving noise criteria for consents and licences that enable the EPA and others to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997. Whilst specifically aimed at assessment and control of noise from industrial premises regulated by the EPA, the policy is also appropriate for use by the DP&E when assessing major development proposals.

Having been designed for large industrial and agricultural sources, the monitoring and assessment procedures may not be applicable to the smaller developments and noise sources regulated by local government. It is recognised however, that Councils may find the policy to be of assistance in noise assessment and land-use planning.

The *NPfI* documents a procedure for assessment and management of industrial noise which involves the following steps:

- Determining the project noise trigger levels for a development. The project noise trigger level is a benchmark level above which noise management measures are required to be considered. They are derived by considering short-term intrusiveness due to changes in the existing noise environment (applicable to residential receivers only) and maintaining noise level amenity for particular land uses for residents and other sensitive receivers;
- Predicting or measuring noise produced by the development (having regard to any associated annoying characteristics and prevailing meteorological effects);
- Comparing the predicted or measured noise level with the project noise trigger level and assessing impacts and the need for noise mitigation and management measures;
- Considering any residual noise impacts following the application of feasible and reasonable noise mitigation measures;
- Setting statutory compliance levels that reflect the best achievable and agreed noise limits for development; and
- Monitoring and reporting environmental noise levels from the development.

The project noise trigger level represents the level that, if exceeded, may indicate a potential noise impact upon a community. It is a benchmark or objective and is not intended for use as a mandatory requirement.

Intrusiveness Noise Level

For assessing intrusiveness, the background noise level (L_{A90}) is measured and the Rating Background Level (RBL) determined. The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous noise level (L_{Aeq}) of the source (measured over a 15-minute period) does not exceed the background noise level (RBL) by more than 5dBA.

Amenity Noise Level

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5 dBA below the recommended amenity nose level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 15 dBA.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10 dB or lower than the existing industrial noise level, the project amenity noise level can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

An extract from the NSW *NPfI* that relates to the amenity noise levels for surrounding receivers is given in Table 5-1.

Table 5-1 Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level L_{Aeq} (dBA)
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1: Daytime 7.00am–6.00pm; Evening 6.00pm–10.00pm; Night 10.00pm-7.00am.

5.2 Maximum Noise Level Events

Noise sources of short duration and high level that may cause disturbance to sleep if occurring during the night time need to be considered.

The approach recommended by the *NPfI* is to apply the following initial screening noise levels:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL + 5 dB, whichever is the greater; and/or
- L_{AFmax} 52 dBA or the prevailing RBL + 15 dB, whichever is the greater.

The sleep disturbance screening noise levels apply outside bedroom windows during the night time period.

Where the screening noise levels cannot be met, a detailed maximum noise level event assessment should be undertaken. It may also be appropriate to consider other guidelines including the NSW *Road Noise Policy (RNP)* which contains additional guidance relating to potential sleep disturbance impacts.

A review of research on sleep disturbance in the *RNP* indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on currently available research results, the *RNP* concludes that:

- "Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions."
- "One or two noise events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly."

5.3 Project Noise Trigger Levels

The amenity and intrusiveness noise levels and resulting project trigger levels (shown in **bold**) applicable to sources of continuous operational noise associated with the project (i.e. mechanical plant and equipment) are shown in Table 5-2.

Table 5-2 Project Noise Trigger Levels

Receiver	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
UNSW Accommodation	Day	**58**	**58**
	Evening	57	**48**
	Night	56	**43**

Note 1: Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL +5.
Note 2: Project amenity noise level (ANL) is suburban ANL minus 5dBA plus 3 dBA to convert from a period level to a 15-minute level.

For maximum noise level events (night time period only), the following screening noise levels apply.

Table 5-3 Sleep Disturbance Trigger Levels

Receiver	$L_{Aeq,15min}$	L_{AFmax}
UNSW Accommodation	56	71

5.4 Mechanical Services

The major mechanical noise sources associated with the development will be chillers, cooling towers, air handling units, and fans that will be located on the roof of the new building in a plant room. These that have yet to be detailed.

Noise from most major plant will be contained in the roof plantroom. Detailed specifications of mechanical services equipment that would otherwise allow an acoustic assessment of noise emissions from the site are not available at this stage of the project as selection and design is conducted after project approval.

In line with the approvals for other developments, detailed assessment of operational noise emission should form a conditional requirement of the development, to be satisfied by the PCA, prior to the issue of the construction certificate.

To mitigate noise from mechanical plant, it is likely the some or all of the following noise control measures may need to be adopted at the design stage to meet noise objectives:

- Equipment selection;
- Silencers on carpark and other fans,
- Acoustic louvres,
- Noise barriers, and;
- Variable speed controls on fans.

The mechanical plant will be designed to meet the criteria presented in Table 5-2 at the identified nearby receivers.

5.5 D14 Noise Emissions

The proposed use of the D14 Building is for classes and administration offices and, as such, noise generated within this area is expected to be general classroom noise which will be adequately contained by the facade of the building.

No specific measures are required to protect the acoustic amenity of nearby residents.

6 CONCLUSION

A noise and vibration review of the D14 educational development has been conducted for the University of NSW site. Site-specific noise criteria that are applicable to this project have been presented. These have been determined for surrounding receivers to be applied on all state significant development applications.

A noise assessment has been conducted of the proposed activities associated with the construction of the D14 building to determine the potential for noise impact at surrounding receivers. An exceedance of up to 10 dBA is predicted at nearest residential accommodation immediately to the north of the site (within the University Campus). Exceedances up to 15 dBA are predicted educational facilities. Accordingly, closure of windows to achieve improved acoustic amenity along with noise mitigation measures should be adopted on site.

The nearest receivers off-site are of a significant distance and shielded and no specific mitigation is necessary.

In the stage when the façade has been installed noise from fit out works will be contained in the building were noise will not adversely impact on surrounding receivers any time of the day provided no external activities occur in the evening / night periods.

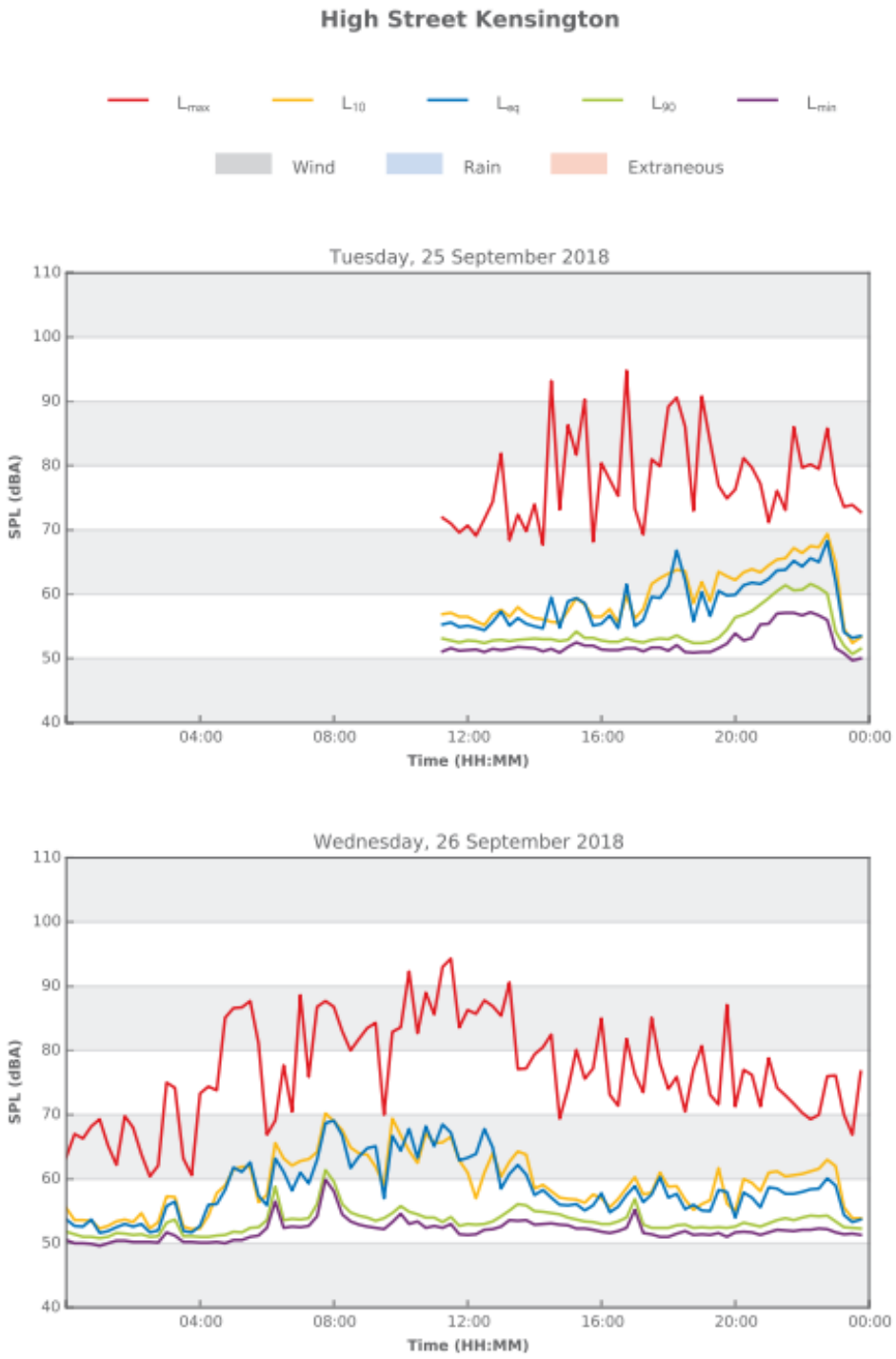
Vibration associated with on-site construction activities is negligible. No specific management and mitigation measures to reduce noise impact at receivers have been identified beyond the normal measures.

A Noise & Vibration Management Plan will be prepared by Lend Lease in managing the environmental issues associated with this project.

Site specific operational noise criteria has been determined for the project based on ambient noise monitoring. By satisfying the relevant criteria at the subject site, compliance will readily be achieved at surrounding noise sensitive receptors. Noise emission from the D14 site will be addressed during the detailed design phase.

APPENDIX A

NOISE MEASUREMENT RESULTS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L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Tuesday, 25 September 2018
SPL (dBA)
110
100
90
80
70
60
50
40
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
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SPL (dBA)
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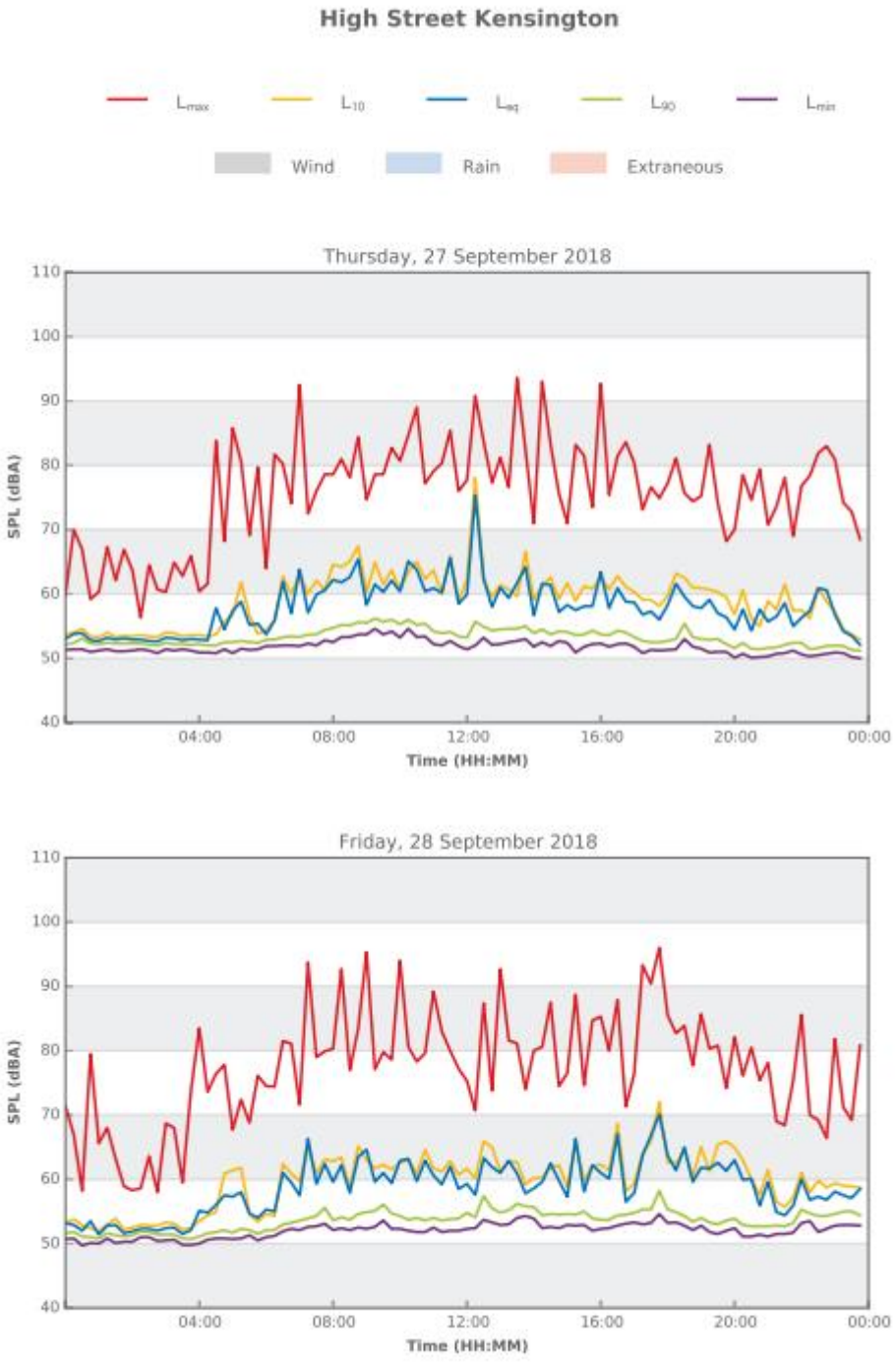
Time (HH:MM)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L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
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90
80
70
60
50
40
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
Friday, 28 September 2018
SPL (dBA)
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04:00
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16:00
20:00
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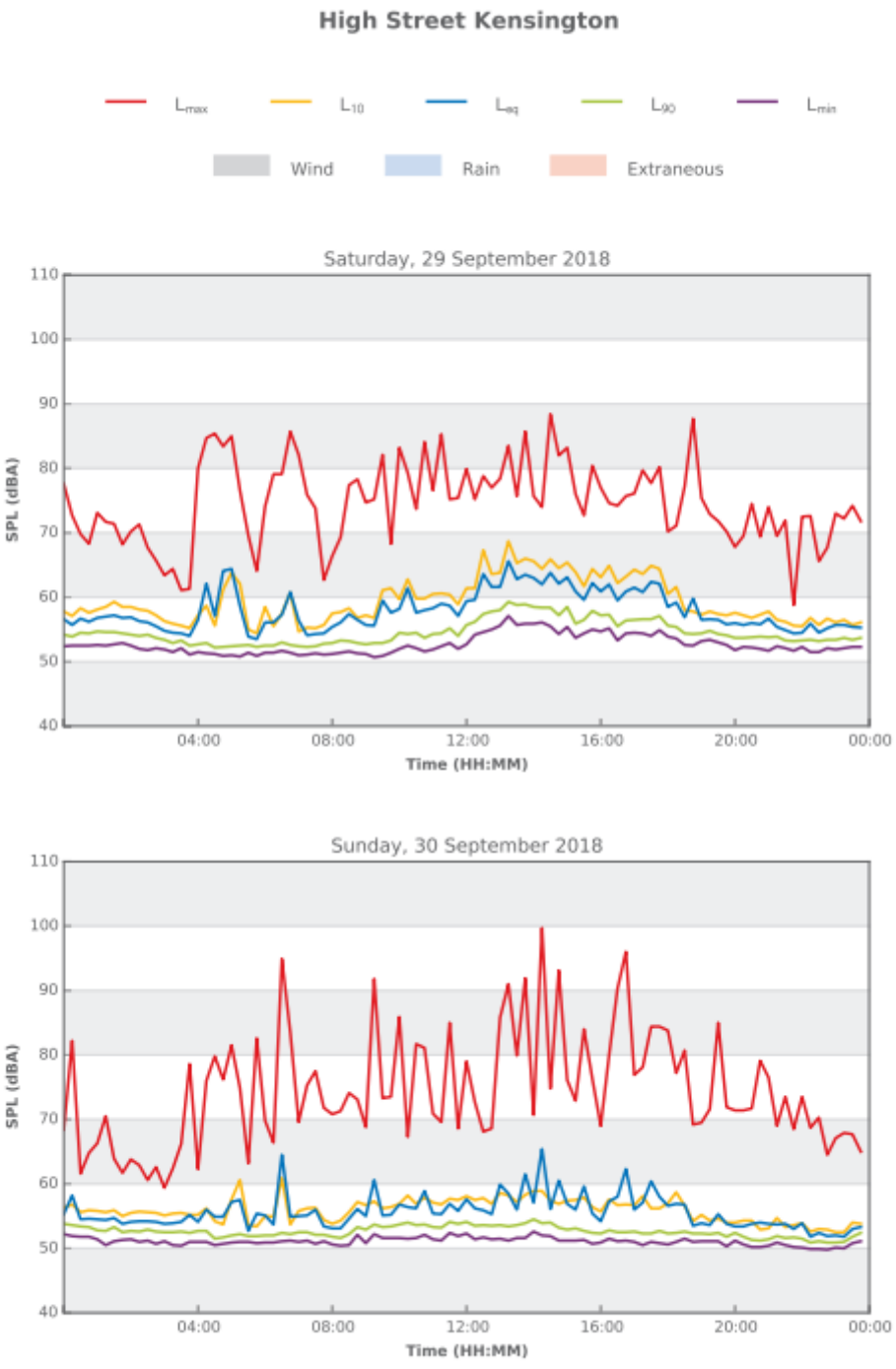
Time (HH:MM)


High Street Kensington
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L_{10}
L_{eq}
L_{90}
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Wind
Rain
Extraneous
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60
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40
04:00
08:00
12:00
16:00
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00:00
Time (HH:MM)
Sunday, 30 September 2018
SPL (dBA)
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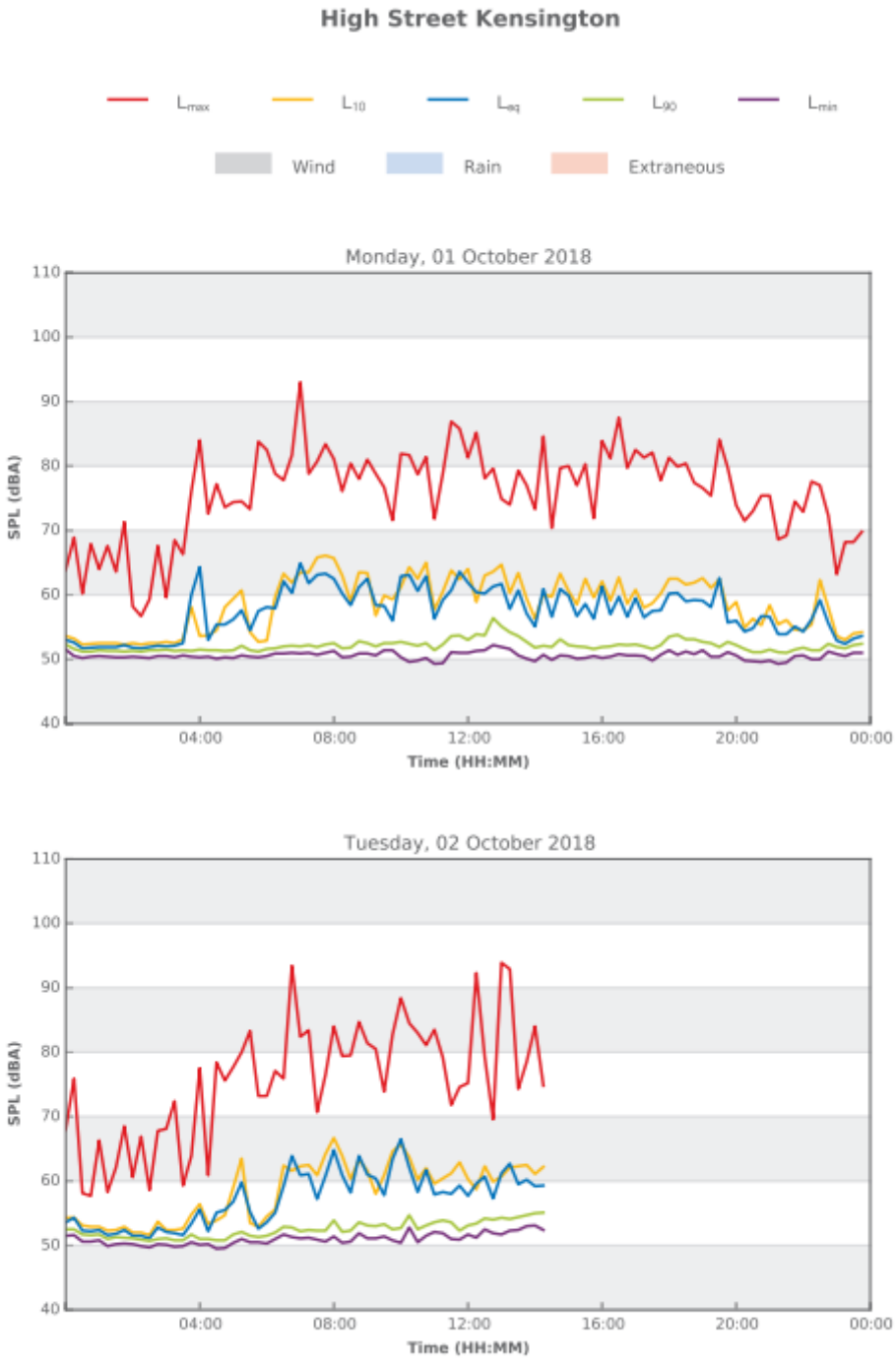
High Street Kensington
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L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
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08:00
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16:00
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00:00
Time (HH:MM)
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