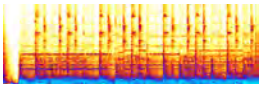
MOORE THEOLOGICAL COLLEGE

Acoustic Amenity Report for Concept Plan

Issued

September 2009



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1 Introduction

Moore Theological College proposes to redevelop its Newtown Campus located at the intersection of King Street and Carillon Avenue, Newtown. The Moore College site is currently occupied by diverse allotments including educational, residential and administration buildings of varying architectural styles and ages.

The Moore College redevelopment project has been categorised as a Major Project to be determined under Part 3A of the Environmental Planning & Assessment Act 1979, and as such Project Application Director-General's Requirements have been issued for the preparation of an Environmental Assessment to accompany the Concept Plan and Stage 1 Project Application for the proposed development.

This amenity acoustic report has been prepared in support of the Concept Plan for the proposal, and considers the acoustic impacts of the entire project. The acoustic report is to be lodged for approval to the Department of Planning together with the rest of the Concept Plan documentation.

The amenity acoustic report for the Concept Plan assesses the likely impact of noise on the proposed development from existing activity in the area, together with the likely noise impact of the development on existing nearby residences, both within and adjacent to the site.

This report presents the findings of the acoustic assessment. It includes measured environmental noise survey data and environmental noise limits, based on the measured noise levels in the area. Compliance with these limits will ensure that any noise from the overall development (e.g. mechanical services noise, and noise from associated plant and equipment) will not impact negatively on the nearest existing residences. The report also provides recommendations for appropriate internal noise level criteria for the new facility.

Further to the Concept Plan acoustic study, Acoustic Studio has also assessed the acoustic issues related to:

- Stage 1 Project Application: refer to "Moore Theological College – Project Application Acoustic Report", dated September 2009.
- Construction of proposed development: refer to "Moore Theological College – Construction Noise and Vibration Management Plan", dated September 2009.

The abovementioned documents are to complement the present Concept Plan acoustic report and can be read in conjunction, if required.

2 Description of Proposal

2.1 Project Background

The Moore Theological College has been operating in NSW since 1856 and in Newtown since 1891 providing educational services to the Anglican Diocese of Sydney as well as students from other parts of Australia and the world. Since the late 1950's there has been a significant expansion of the Newtown College campus, including the growth of a major theological library on the site.

Apart from its academic function, the College has traditionally provided housing for married students and faculty staff.

Currently there are 318 full-time students and 171 part-time at Moore College. In order to meet its future needs, it is proposed to redevelop its campus to provide in the order of 30,000 m^2 of new and refurbished floor space to cater for up to 600 students and their families in 2020. The proposed campus renovation/expansion will consist of:

- A new library and learning centre.
- A new teaching and administration floor space.
- New student and teaching staff accommodation.
- 340 car parking spaces provided both at grade and within basement parking.

2.2 Site Location

The site is a 2.2 ha wedge-shaped site located west of the intersection of King Street and Carillon Avenue, Newtown. Both pedestrian and traffic access to the site is from Carillon Avenue. Figure 1 shows the location of the Project and the surrounding area.

Figure 1: Locality Plan

The overall Concept Plan of the development is shown below in Figure 2.

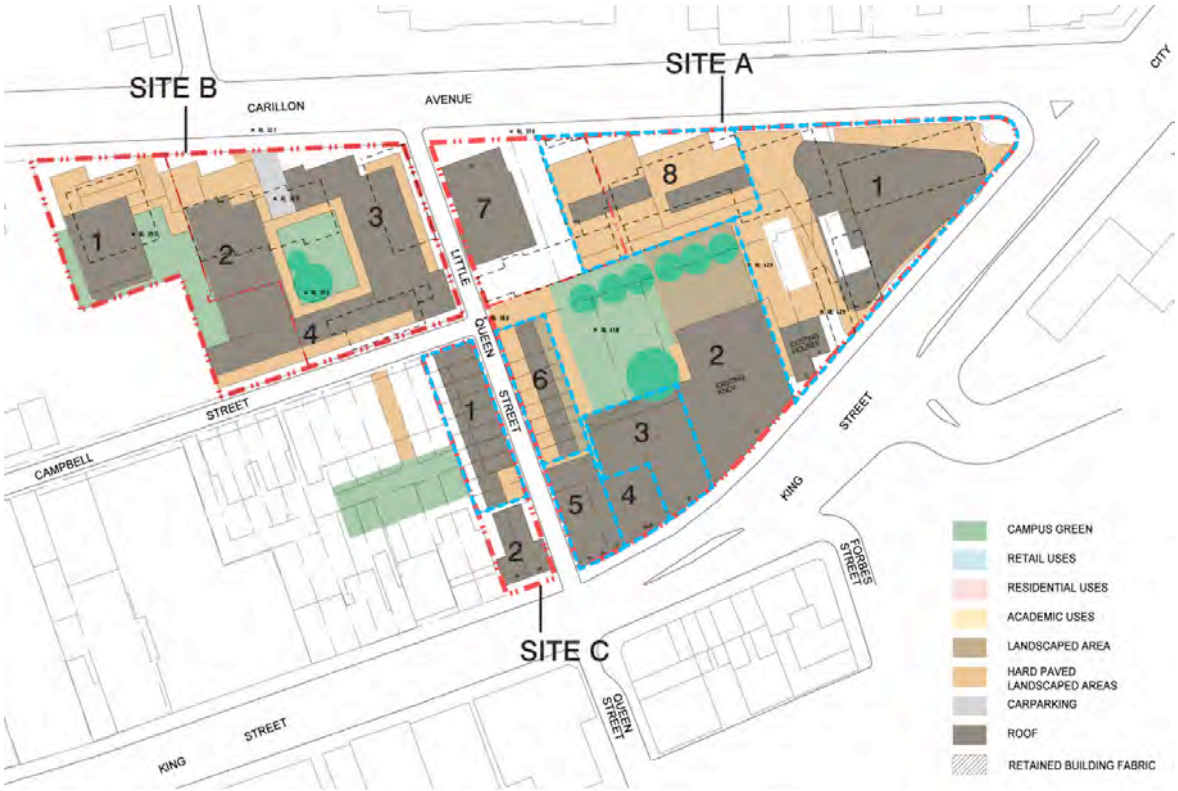


Figure 2: Concept Plan of overall site

2.3 Components of development

Library and Learning Centre

The Library and Learning Centre building is to be sited on the eastern corner of the Moore College campus site, adjacent to the intersection of King Street and Carillon Avenue.

The Library and Learning Centre building will consist of seven (7) levels above ground and two (2) underground basement levels below. It will provide for a main library space occupying most of the six (6) upper levels of the building, plus teaching spaces, administration offices and other common use areas, such as lobby, atrium and terraces.

The basement levels will be mainly occupied by storage areas and the plant room; but also partially by the underground car parking to be built on site.

The Library and Learning Centre building facilities will be air-conditioned.

Student and Teaching Staff Accommodation

The Student and Teaching Staff accommodation will be housed in separate buildings of diverse heights to the north of the campus site facing Carillon Avenue both sides of Little Queen Street. The buildings will also include common use areas, such as kitchen and dining areas, and will also provide two (2) levels of underground car parking spaces.

Residential units have the potential to be air-conditioned.

2.4 Neighbouring properties

Figure 3 shows the development and the context of the surrounding area. The buildings surrounding the development site are:

- Sydney University educational and residential premises to the north and to the east.
- A mix of commercial, retail and residential dwellings to the south across King Street and to the south west along Campbell Street.
- Newtown Primary School to the west.

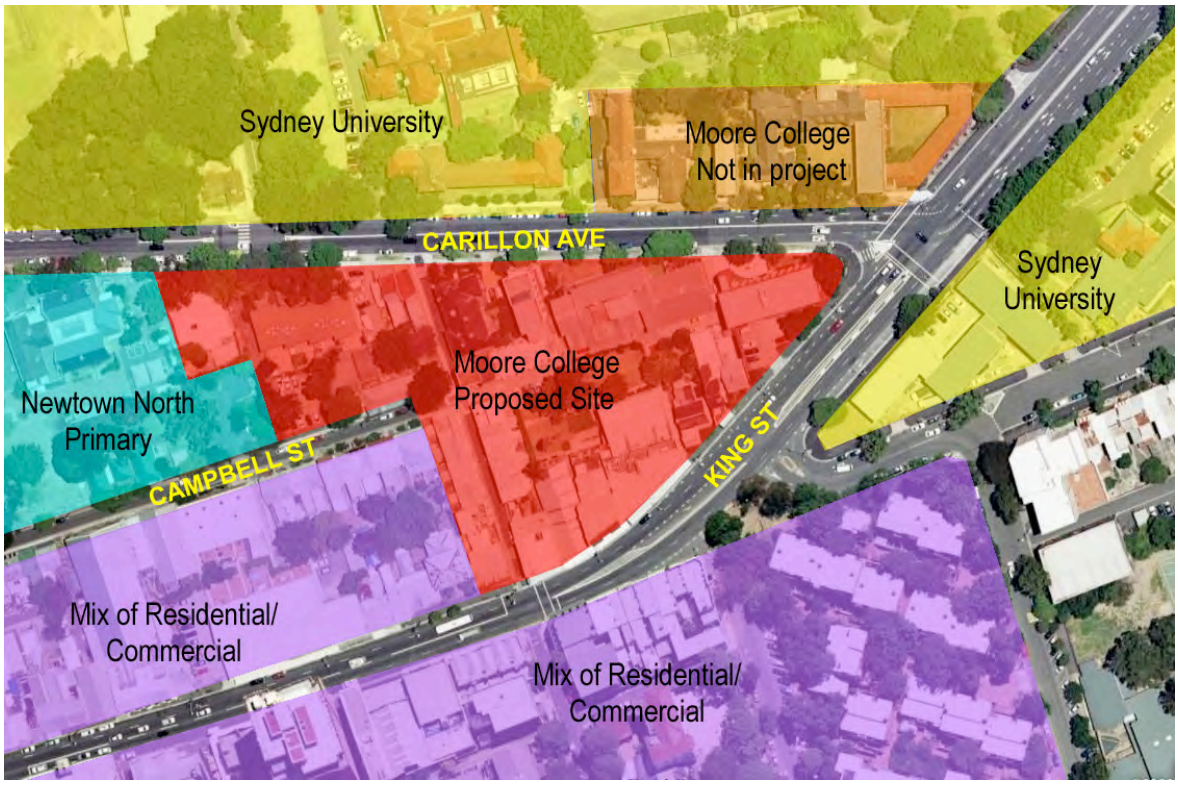


Figure 3: The development site and the context of the surrounding area.

3 Acoustic Issues

The following acoustic issues are addressed as part of the Concept Plan Development Application.

- The impact of noise produced by the development on surrounding residential buildings.

  The development will contribute noise to the future ambient noise environment. Typically, this will result from steady noise from proposed air-conditioning systems associated with the buildings (generally noise emitted by externally located plant, or air intakes or discharge zones on the building façades, such as fresh air intakes, etc).

  It is not anticipated that any other activities associated with the operation of the Facility will generate sound levels that may result in any noise impact at the neighbouring residences.

  Design noise limits have been set for the project. These limits are reported in Section 5 of this report.

- The impact of existing ambient noise on the Facility.

  The ambient noise environment of the site is dominated by steady noise from traffic travelling along King Street and Carillon Avenue.

  The existing noise environment has been established with noise surveys carried out during typical day-time and night-time periods. The impacts of these measured levels on the proposed development have been assessed and are reported in Section 6 of this report.

- The compliance of the proposed development with the Building Code of Australia (BCA).

  The development is expected to comply with all the requirements included in the Building Code of Australia and the discussion of the BCA components are summarised in the Section 7 of this report.

- The impact of noise generated by vehicle movements associated with the Facility on existing traffic noise levels.

  The traffic levels generated by the development will be very low compared to the existing high traffic flows of King Street and Carillon Avenue. It is assumed that there will be no increase in the overall traffic noise levels of the area as a consequence of the impact of traffic noise resulting from vehicle movements associated with the Facility and no further assessment of this aspect is required.

4 Existing Noise Environment

4.1 General survey information

Survey of the existing noise environment around the Moore College campus was conducted by setting up an unattended noise monitor in order to record the noise levels around the site continuously. Long term noise monitoring was carried out for the week from 11th to 17th June 2009 to establish the range of ambient noise levels of the Moore College campus and surrounds.

Long term noise monitoring was carried out with an RTA Technology Environmental Noise Logger Type 02. The calibration of the logger was checked before and after use and no variation was noted.

Operator attended short term monitoring was carried out between 11.00am and 12.00noon on Monday 21st September 2009 in order to confirm the validity of the long term data across the site.

Short term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2446899). The calibration of the analyser was checked before and after the survey and no variation in level occurred.

Weather conditions were calm and dry during the survey.

A windshield was used to protect the microphone of the logger.

Peter Griffiths and Laura Lapena of Acoustic Studio Pty Ltd carried out the surveys.

4.2 Monitoring locations

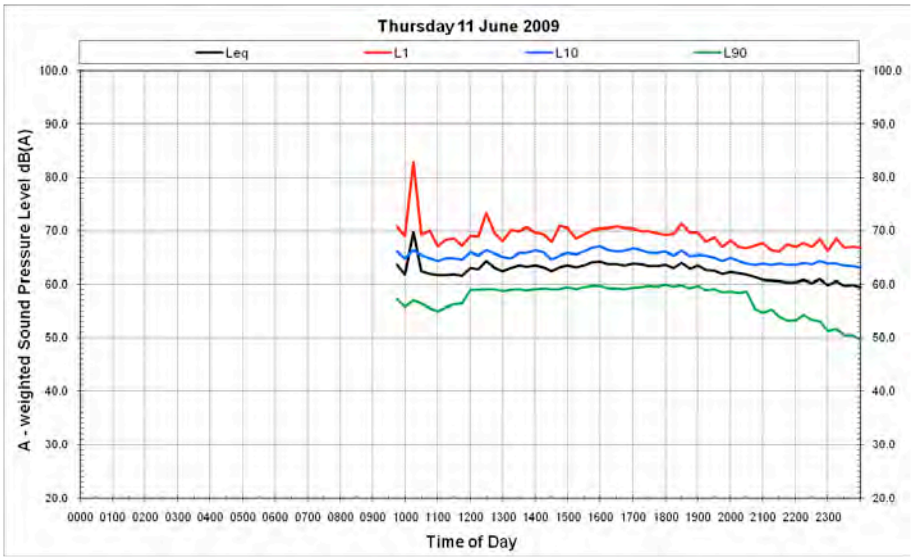
The noise monitoring locations are shown in Figure 4.

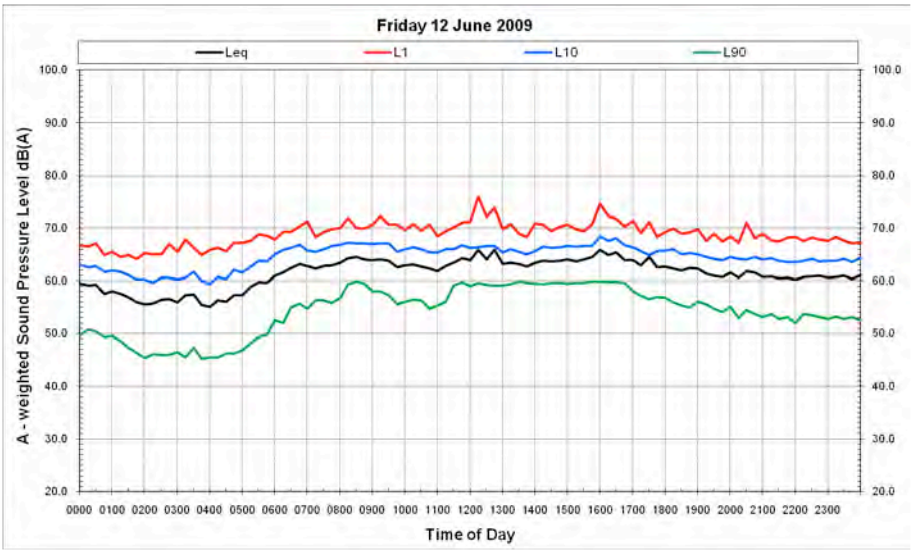
Figure 4: Ambient noise monitoring location.

4.3 Long term noise monitoring

The long term noise monitoring position was a secure location at the south-eastern corner of the rooftop of the 3-storey administration building sited at the corner of King Street and Carillon Avenue. The noise monitor was set up in the free-field (i.e. away from reflective surfaces). This location was found representative of the ambient and background noise environment around the proposed Moore College site.

The results of the long term noise monitoring at Location L1 are shown graphically below.

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Leq
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A - weighted Sound Pressure Level dB(A)
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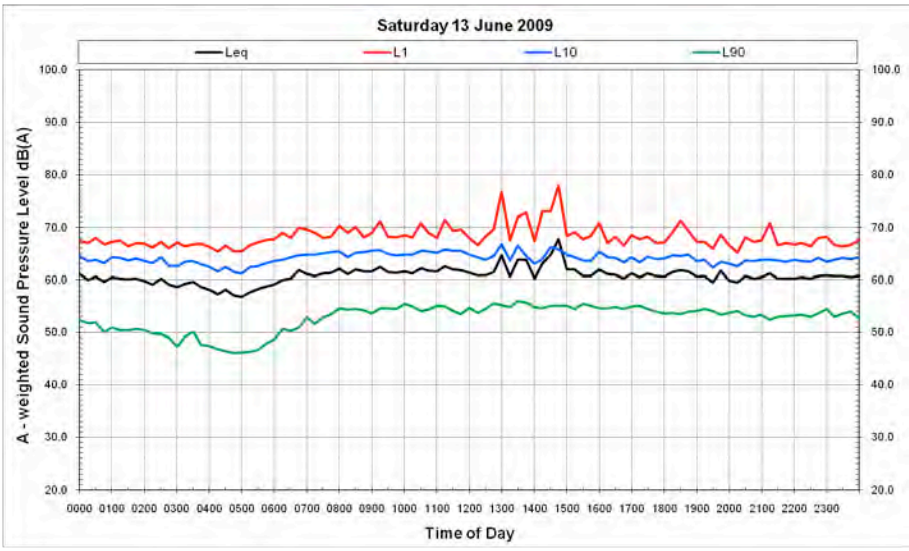
Time of Day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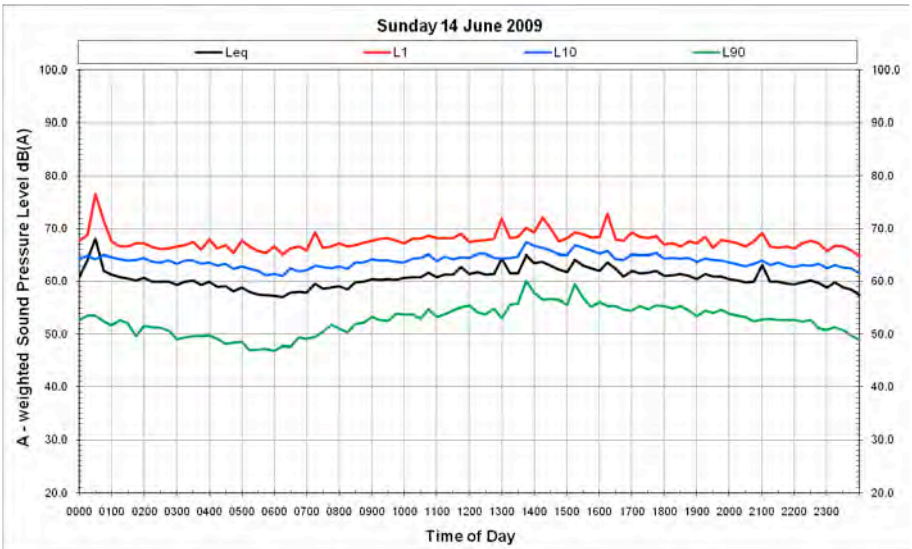
Time of Day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A - weighted Sound Pressure Level dB(A)
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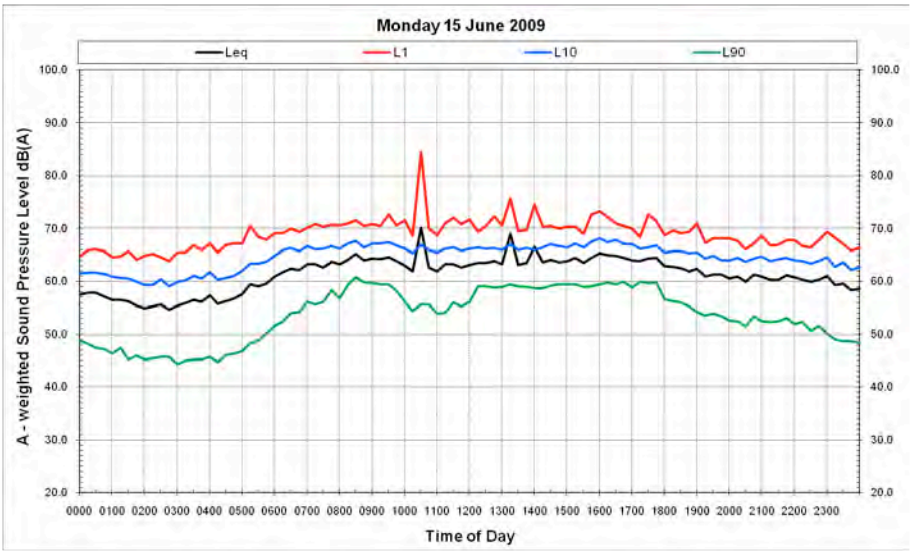
Time of Day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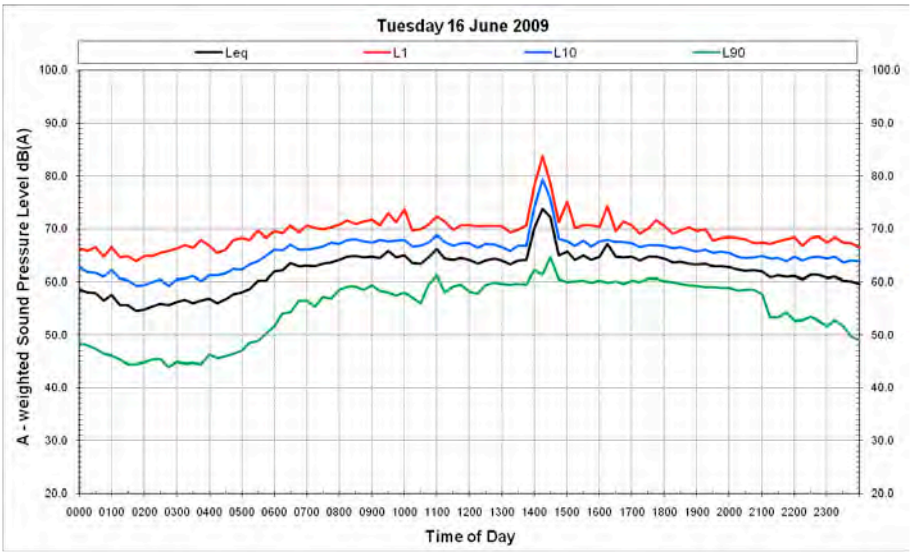
Time of Day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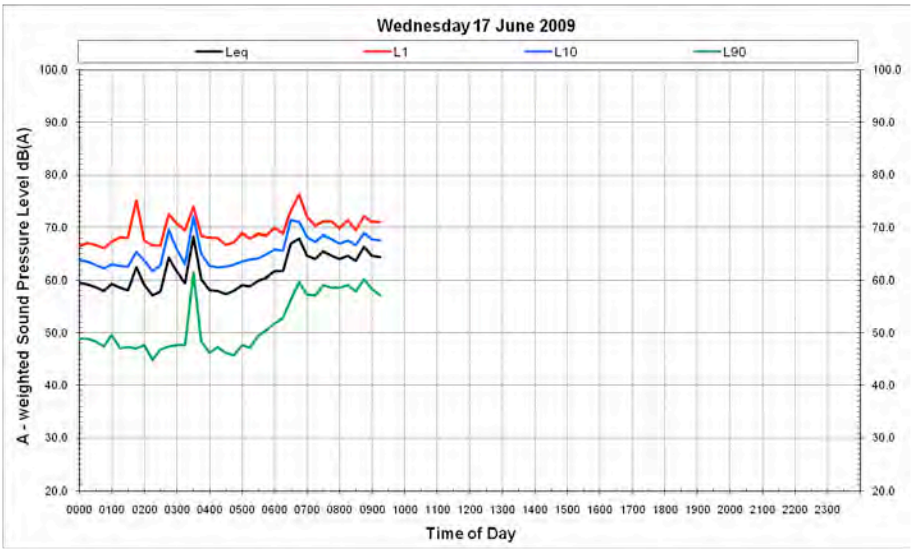
A - weighted Sound Pressure Level dB(A)
Time of Day


Wednesday 17 June 2009
Leq
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L90
A - weighted Sound Pressure Level dB(A)
Time of Day

4.4 Short term noise monitoring

Two (2) short term noise monitoring locations were chosen as representative of the nearest locations of the closest affected residences within and outside the boundaries of the proposed Moore College site:

- Short term Location L2 was on the southern boundary of the Moore College campus site directly in front the proposed new Library building.
- Short term Location L3 was on the northern boundary of the Moore College campus directly adjacent to the proposed students and staff accommodation buildings.

The results of the short term background and ambient noise monitoring are shown in the table below.

Location	$L_{A90,15min}$ Background Noise Level, in dB(A)	$L_{Aeq,15min}$ Ambient Noise Level, in dB(A)
L2 – King Street (ground level)	59	70
L3 – Carillon Avenue (ground level)	51	67

Table 1: Short-term background and ambient noise levels measured around Moore College site

4.5 Noise levels for assessment purposes

Background and ambient noise levels

All the educational activities of the new complex will mainly occur on weekdays and during daytime hours. However, due to the mixed uses of the college, it is considered that some minor impacts might also occur during the evening or early night period related with its residential use or when some occasional night time activities might occur (e.g. a function in the College site).

The background noise levels (for assessment purposes) have been established in general accordance with the methodology described in the NSW Industrial Noise Policy, i.e. the 10^{th} percentile background noise level is established for each period for each day of the ambient noise survey. The median of these levels is then used as the background noise level for each period and they are shown in the Table 2 below together with the L_{Aeq} ambient noise levels measured for each period. Any noise data points that are obviously extraneous to the typical background noise levels monitored during the survey have been excluded from this calculation.

Location	L_{A90} Background Noise Levels, in dB(A)			L_{Aeq} Background Noise Levels, in dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1 – Admin Building (Rooftop Level)	55	53	46	63	62	60
L2 – King Street (Ground level)[1]	59	57	50	70	69	67
L3 – Carillon Avenue (Ground level) [1]	51	49	42	67	65	64

Note 1: Noise levels over the complete time period for short term measurements locations L2 and L3 have been estimated by correlation with long term measurement results at location L1.

Table 2: Background and ambient noise levels measured around Moore College site

Traffic noise levels

Both the analysis of the long and short term surveyed noise data and the observations made during our site visits indicate that noise levels in the area under study were dominated by traffic noise from King Street and Carillon Avenue.

Table 3 below shows the results of traffic noise level monitoring. These values include a 2.5 dB allowance for noise reflected from the façade, in accordance with the requirements of the NSW Environmental Criteria for Road Traffic Noise.

Location	L_{Aeq} Traffic Noise Levels, in dB(A)	
	Day (7am-10pm)	Night (10pm-7am)
L1 – Admin Building (Rooftop Level)	65	62
L2 – King Street (Ground level)[1]	72	70
L3 – Carillon Avenue (Ground level) [1]	69	66

Note 1: Noise levels over the complete time period for short term measurements locations L2 and L3 have been estimated by correlation with long term measurement results at location L1.

Table 3: Traffic noise levels measured around Moore College site

5 Noise Impacts from the Facility

5.1 Potential noise sources

It is not expected that the activities occurring as part of the day-to-day operation of the proposed Facility will create any significant noise impact on the surrounding area.

The only potential noise sources will be mechanical systems associated with cooling and heating systems for the buildings.

5.2 Environmental noise limits

Environmental noise is generally assessed by comparing the new potentially intrusive noise against a criterion based on the pre-existing background noise level. Where the intrusive noise is greater than the pre-existing background noise level, the potential exists for disturbance and annoyance. However, the impact is considered marginal if the difference between the pre-existing background noise level and the equivalent continuous sound pressure level of the intrusive noise is 5dB or less. This concept has resulted in the commonly used criterion of the equivalent continuous noise level (L_{eq}) of the intrusive noise being equal to or less than the existing background noise level (L_{90}) + 5 dB.

This principle is used as the basis of the noise assessment methodology described in the NSW Industrial Noise Policy (INP) published by the NSW Department of Environment and Conservation. Whilst this policy is intended for use with large-scale industrial developments, the general noise assessment methodology can be applied in principle to the type of nose likely to be emitted by the mechanical services of a development such as that proposed for Moore College redevelopment.

The INP methodology defines two criteria; an intrusiveness criterion, and an amenity criterion. The project noise rating is the lower of the two criteria.

Intrusiveness criterion

The intrusiveness criterion relates the L_{Aeq} emitted by the facility, and is equal to the lowest background noise level plus 5 dB(A). For this project the intrusiveness criteria (for noise emissions from the mechanical services of the project) are shown in Table 4 for each period.

Location	Time of Day	Existing L_{A90}, in dB(A)	Intrusiveness criteria, in dB(A)
Moore College centre of site	Day	55	60
	Evening	53	58
	Night	46	51
Residences along King Street	Day	59	64
	Evening	57	62
	Night	50	55
Residences along Carillon Avenue	Day	51	56
	Evening	49	54
	Night	42	47

Table 4: Intrusiveness criteria for proposed site and surrounds

Amenity criterion

The amenity criterion is designed to limit continuing increases in community noise levels by restricting overall L_{Aeq} values to a recommended noise level based on land use.

As an urban noise amenity area, the recommended L_{Aeq} levels for the Moore College site and surrounds are shown in the Table 5 below.

Type of Receiver	Time of Day	Recommended L_{Aeq} Noise Level, in dB(A)	
		Acceptable	Maximum
Residence - Urban	Day	60	65
	Evening	50	55
	Night	45	50
School classroom - Internal	Noisiest 1hr period	35	40
Place of worship - Internal	When in use	40	45
Commercial premises	When in use	65	70

Table 5: Amenity criteria - Recommended L_{Aeq} noise levels from industrial noise sources

It is observed that external ambient noise levels measured on site already exceed the recommended noise levels presented in the amenity criteria values shown in the table above. This is due to the fact that ambient noise levels in the area are dominated by high traffic noise. In such cases, the amenity criterion for noise from industrial noise becomes the $L_{Aeq, period(traffic)}$ minus 10 dB. This criterion replaces the amenity criterion in Table 5.

Corrected amenity criteria values for the project are shown in the table below. Note that the amenity criteria relate to the L_{Aeq} for the entire period (day, evening or night) whereas the intrusiveness criteria relate to a 15 minute L_{Aeq}.

Location	Time of Day	Existing L_{A90}, in dB(A)	Intrusiveness criteria, in dB(A)
Moore College – Centre of site	Day	63	53
	Evening	62	52
	Night	60	50
Residences along King Street	Day	70	60
	Evening	69	59
	Night	67	57
Residences along Carillon Avenue	Day	67	57
	Evening	65	55
	Night	64	54

Table 6: Amenity criteria for proposed site and surrounds

Project specific rating level

The project specific rating level is the lower of the two criteria above. In this case it is the amenity criterion at any residential boundary to the Facility.

5.3 Control of mechanical services plant noise

Appropriate noise control measures will be included in the design of the mechanical services within the Moore College redevelopment proposal to ensure that the noise limits established in Table 6 are met at the nearest residential boundaries. These control measures could include any or all of the following:

- Selection of appropriate quiet equipment.
- Strategically locating noisy equipment away from sensitive areas.
- Use of noise barriers, shielding or construction of acoustic enclosures.
- Provide for in-duct noise attenuation.
- Plant rooms to be of masonry construction with internal sound absorptive treatment as required.

6 Noise Impacts on the Facility

6.1 Potential noise sources

As a part of the Princes Highway, King Street is an arterial road providing for a connection route between the City of Sydney and the southern suburbs. Vehicle movements along the section of King Street adjacent to the Moore College campus are high, especially during peak hours, and include a high percentage of heavy vehicles. A number of bus routes run along this section of King Street and there is a bus stop in front of the proposed Library building site.

Carillon Avenue is a local collector road that links King Street with other local collector roads leading to Parramatta Road and the Great Western Highway. Traffic volumes along the section of Carillon Avenue under study are anticipated to be medium-high. There are no bus routes in the section around the Moore College site.

6.2 Traffic noise criteria

The appropriate traffic noise criteria are those set in the publication *The Environmental Criteria for Road Traffic Noise* (ECRTN), May 1999, published by the Environmental Protection Authority (EPA) of NSW (now the NSW Department of Environment, Climate Change and Water).

This publication sets road traffic noise criteria for a number of road/land use scenarios. In the case of the Moore College redevelopment, the relevant scenario is that of residential facilities affected by traffic noise from an existing arterial/collector road. For this type of development, the nominated external criteria are as follows:

- Day (7 am – 10 pm) $L_{Aeq(15hr)}$ 60 dB (external)
- Night (10 pm – 7 am) $L_{Aeq(9hr)}$ 55 dB (external)

These criteria refer to the L_{Aeq} (the A-weighted equivalent continuous noise level) occurring when measured 1m from the façade of the building. The criteria include a 2.5 dB allowance for noise reflected from the façade.

Furthermore, the proposed campus site of Moore College will include a mix of residential and educational spaces, which are categorised as “sensitive” to traffic noise. Therefore and additionally to the criteria presented above, the following internal noise levels, extracted from the Australian Standard AS/NZS 2107.2000 *“Acoustics—Recommended design*

sound levels and reverberation times for building interiors" are established as criteria in order to ensure an appropriate internal sound level is achieved within all internal spaces within the proposed Moore College site:

Type of Building	Type of Occupancy		Recommended L_{Aeq}, in dB(A)	Maximum L_{Aeq}, in dB(A)
Educational	Library	- General Areas	40	50
		- Reading Areas	40	45
	Teaching Spaces		35	45
	Office Areas		40	45
Residential (near major roads)	Living Areas		35	45
	Sleeping areas		30	40

Table 7: Recommended internal noise levels criteria for proposed site

6.3 Control of traffic noise impact

Traffic noise levels around Moore College campus have been presented in Section 4.5 of this Report. A comparison of the surveyed external noise levels around the proposed site and the recommended external noise levels from the ECRTN presented in the previous section shows that existing traffic noise levels are already exceeding the recommended noise levels for residential premises adjacent to existing arterial roads.

It has also been stated that the current ambient noise around the Moore College campus is dominated by traffic noise from adjacent roads, namely King Street and Carillon Avenue. Especially significant is the impact of King Street, which is a major road that carries high volumes of traffic, including light and heavy vehicles and diverse bus routes, and it implies a substantial noise impact in the already existing facilities of Moore Theological College.

As the NSW ECRTN states, the "in-source" reduction of traffic noise impacts may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage. Those methods are not under the control of the proponent and, as such, are not a part of the current acoustic assessment.

However, reducing noise levels via transmission through the building envelope can also control internal traffic noise impacts. Consequently, the redevelopment of the Moore College Newtown site provides for an opportunity to address and reduce traffic noise impacts inside the College facilities if suitable traffic noise control measures are incorporated in the final architectural design.

In order to comply with the recommended noise levels at the Moore College site facilities, the following noise control measures “at the receiver” are proposed:

- Optimise architectural layout by strategically locating noise sensitive areas away from traffic noise sources.
- Design and specification of the building envelope to provide the required attenuation to achieve the internal design sound levels.
- Provide for mechanical ventilation to enable windows and doors of noise sensitive spaces to be closed.
- Provide for acoustic perimeter seals for windows and doors in noise sensitive spaces.
- Use of noise barriers around terraces and open spaces.

It is anticipated that, with traffic noise mitigation measures incorporated in the detail design stage of the development, there will be no adverse noise impact on the Facility from existing traffic noise levels.

7 Building Code of Australia Compliance

The section F5 of the Building Code of Australia (BCA) defines sound transmission and noise insulation requirements. Those requirements apply only to residential developments and are therefore only applicable to the students/staff residential premises within the proposed Moore College site.

The sound insulation requirements of the BCA were amended on 1 May 2004, in response to increasing evidence that the previous BCA sound insulation requirements were not meeting community expectations. Of relevance to the proposed development at Moore College Campus, Newtown, the scope of the changes includes:

- The addition of a spectrum adaptation factor (C_{tr}) for walls and floors to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others. The C_{tr} factor takes into account lower frequency sounds.
- An increase in the levels for airborne sound insulation for walls and floors.
- The quantification of floor impact sound insulation ratings.

Compliance with the BCA sound insulation requirements is now possible via a number of options. The simplest form of compliance for the residential component of Moore College redevelopment project is to adopt wall and floor construction solutions that are nominated in the BCA as “deemed to comply”.

8 Summary and Conclusions

A noise assessment has been carried out on the potential noise impact of the proposed renovation/expansion Concept Plan for Moore Theological College in Newtown. An assessment has also been carried out on the potential impact of existing noise sources on the proposed development.

Long and short term noise monitoring has been carried out to establish the existing background, ambient and traffic noise levels around the proposed campus site.

Appropriate noise limits have been developed to control noise impacts from the development on the neighbouring residences.

It has been noted that existing traffic noise levels are above the criteria recommended in *The Environmental Criteria for Road Traffic Noise*, May 1999, published by the Environmental Protection Authority (EPA) of NSW (now the NSW Department of Environment, Climate Change and Water). Consequently, traffic noise impact needs to be addressed by the Facility and a general strategy for reducing internal traffic noise levels has been given.

It is considered that:

- The proposed development will not have any adverse acoustic impact on the existing environment including the surrounding residences.
- There will be no adverse noise impact on the development due to existing traffic noise levels with appropriate noise control measures being implemented and incorporated in the design of the buildings.
- Compliance with the Building Code of Australia regarding noise insulation requirements for residential premises will be achieved with the adoption of “deemed to comply” constructions for internal partitions, floors/ceilings, and services risers, etc, in the architectural design.

MOORE THEOLOGICAL COLLEGE

Project Application Acoustic Report for Library Building

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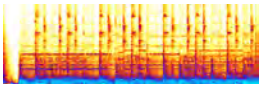

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1 Introduction

Moore Theological College proposes to redevelop its Newtown Campus located at the intersection of King Street and Carillon Avenue, Newtown. The Moore College site is currently occupied by diverse allotments including educational, residential and administration buildings of varying architectural styles and ages.

The Moore College redevelopment project has been categorised as a Major Project to be determined under Part 3A of the Environmental Planning & Assessment Act 1979, and as such Project Application Director-General's Requirements have been issued for the preparation of an Environmental Assessment to accompany the Concept Plan and Stage 1 Project Application for the proposed development.

Currently, the Moore College redevelopment project for the whole campus site is in Concept Plan stage. However, Stage 1 consisting of the new Library Building to be constructed within the subject site is subject to its own Project Application requirements.

This acoustic report has been prepared in support of the Stage 1 Project Application for the abovementioned Library building, and considers only the acoustic impacts of its operation within the Moore College campus. The acoustic report is to be lodged for approval to the Department of Planning together with the rest of the Project Application documentation.

The acoustic report for the Project Application assesses the likely impact of noise on the proposed Library Building from existing activity in the area, together with the likely noise impact of the development on existing nearby residences, both within and adjacent to the site.

This report presents the findings of the acoustic assessment. It includes measured environmental noise survey data and environmental noise limits, based on the measured noise levels in the area. Compliance with these limits will ensure that any noise from the overall development (e.g. mechanical services noise, and noise from associated plant and equipment) will not impact negatively on the nearest existing residences. The report also provides recommendations for appropriate internal noise level criteria for the new facility.

Further to the Project Application acoustic study, Acoustic Studio has also assessed the acoustic issues related to:

- Concept Plan: refer to "Moore Theological College – Acoustic Amenity Report for Concept Plan", dated September 2009.
- Construction of proposed development: refer to "Moore Theological College – Construction Noise and Vibration Management Plan", dated September 2009.

The abovementioned documents complement this Stage 1 Project Application acoustic report and can be read in conjunction, if required.

2 Description of Proposal

2.1 Project Background

The Moore Theological College has been operating in NSW since 1856 and in Newtown since 1891 providing educational services to the Anglican Diocese of Sydney as well as students from other parts of Australia and the world. Since the late 1950's there has been a significant expansion of the Newtown College campus, including the growth of a major theological library on the site.

Currently there are 318 full-time students and 171 part-time at Moore College. In order to meet its future needs, it is proposed to redevelop its campus to provide 30,000 m^2 of new and refurbished floor space to cater for up to 600 students in 2020.

The Stage 1 Project Application for Moore College campus redevelopment includes the construction of a new Library Building and Learning Centre within its premises. The site of the new Library is referred to as Site A.

The Library and Learning Centre building will consist of seven (7) levels above ground and two (2) underground basement levels below. It will provide for a main library space occupying most of the six (6) upper levels of the building, plus teaching spaces, administration offices and other common use areas, such as lobby, atrium and terraces.

The basement levels will be mainly occupied by storage areas and the plant room; but also partially by the underground car parking to be built on site.

Initially car parking will be provided in an above ground car park on Site B of the overall site. The underground basement car parking areas of the library (included in this project application) will be constructed at a future time after the construction of the library building.

The Library and Learning Centre building facilities will be air-conditioned.

2.2 Site Location

The Library Building and Learning Centre is to be located to the north-eastern corner of the current campus site, adjacent to the intersection of King Street and Carillon Avenue. Figure 1 shows the location of the proposed Library building (highlighted in red) within the Moore College campus site and the surrounding area.

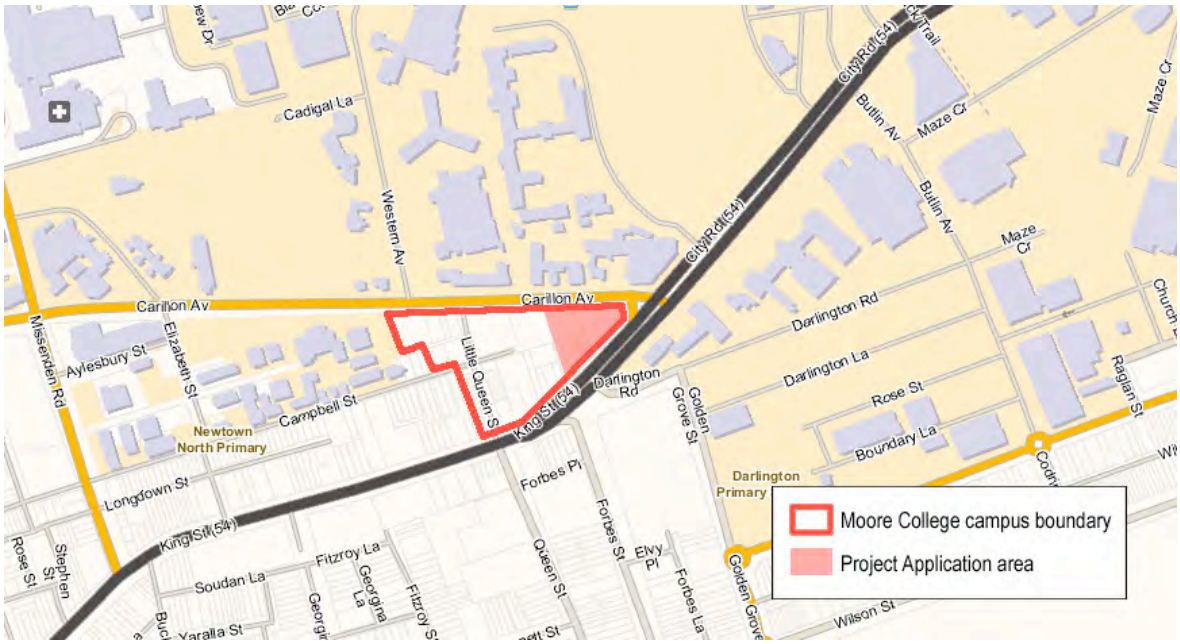


Figure 1: Locality Plan

The Project is within the Moore Theological College campus. Figure 2 below shows (highlighted in yellow) the location of the proposed Library building within the Project plan.

Figure 2: Ground Level Plan of Library Building

2.3 Neighbouring properties

Figure 3 below shows the proposed Library Building site (highlighted in red) within Moore College campus (highlighted in orange) and the context of the surrounding area.

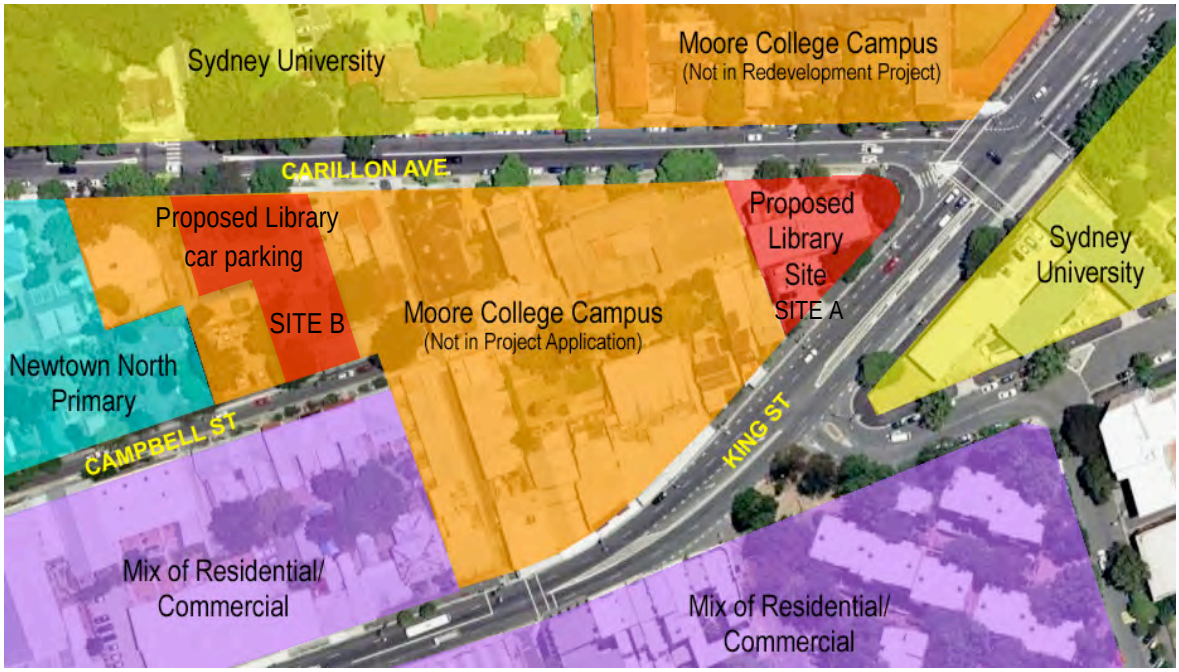


Figure 3: Proposed Library Building site, library car parking, and the context of the surrounding area.

The nearest receivers surrounding the subject site are:

- Moore College educational and residential premises to the north and to the west.
- Sydney University educational and residential premises to the north-west and to the east.
- A mix of commercial, retail and residential dwellings to the south across King Street.

3 Acoustic Issues

The following acoustic issues exist for this Project Application proposal:

- The impact of noise produced by the Library operation on the surrounding educational, residential and commercial premises, both within Moore College campus site and outside its boundaries.
- The impact of existing ambient noise on the project.
- Internal sound insulation and speech privacy.
- Internal room acoustics.
- Quiet building services noise levels inside the building.

3.1 The makeup of the existing ambient noise

The ambient noise environment of the site is made up of the following:

- Steady noise from traffic along King Street and Carillon Avenue, including bus movements on King Street.
- Steady noise from externally located air-conditioning plant in surrounding buildings.
- General street noise (people moving around the campus).

In order to determine the existing noise environment around the proposed Library building a noise survey was carried out on-site. The findings of the noise survey have then been assessed and reported in Section 4 below.

3.2 The make up of noise produced by the Project

The new Library building will contribute with noise to the future ambient noise environment. Typically, this noise will result from steady noise from the proposed air-conditioning systems of the building (generally noise emitted by externally located plant, or air intakes or discharge zones on the building façade, such as fresh air intakes, etc).

Where appropriate, design noise limits have been set for the project. These limits are reported in Section 5 below.

4 Existing Noise Environment

4.1 General survey information

Survey of the existing noise environment around the Moore College campus was conducted by setting up an unattended noise monitor in order to record the noise levels around the site continuously. Long term noise monitoring was carried out for the week from 11th to 17th June 2009 to establish the range of ambient noise levels of the Moore College campus and surrounds.

Long term noise monitoring was carried out with an RTA Technology Environmental Noise Logger Type 02. The calibration of the logger was checked before and after use and no variation was noted.

Operator attended short term monitoring was carried out between 11.00am and 12.00noon on Monday 21st September 2009 in order to confirm the validity of the long term data across the site.

Short term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2446899). The calibration of the analyser was checked before and after the survey and no variation in level occurred.

Weather conditions were calm and dry during the survey.

A windshield was used to protect the microphone of the logger.

Peter Griffiths and Laura Lapena of Acoustic Studio Pty Ltd carried out the surveys.

4.2 Monitoring locations

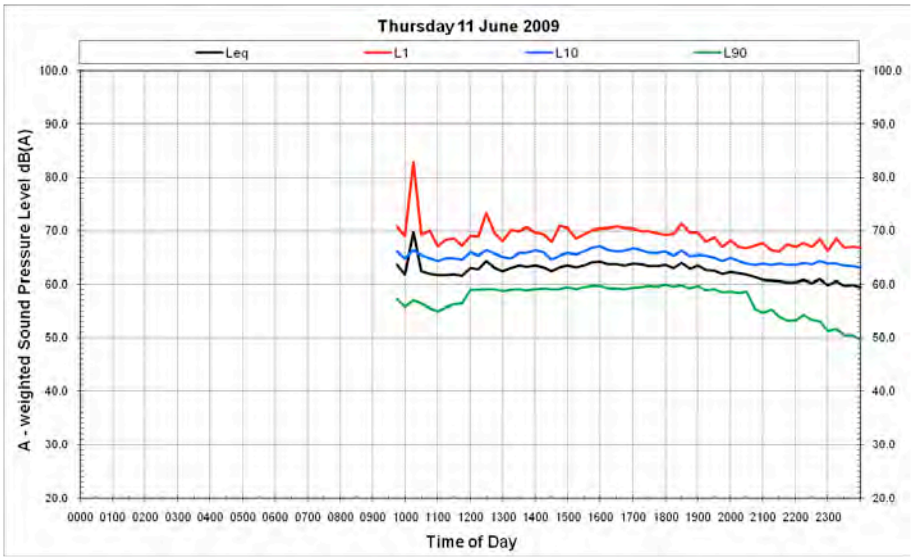
The noise monitoring locations are shown in Figure 4.

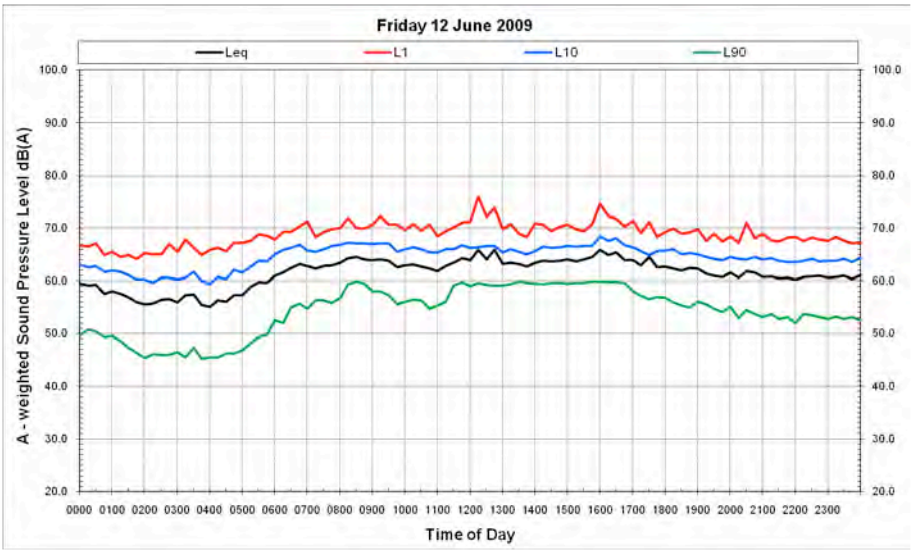
Figure 4: Ambient noise monitoring location.

4.3 Long term noise monitoring

The long term noise monitoring position was a secure location at the south-eastern corner of the rooftop of the 3-storey administration building currently sited at the corner of King Street and Carillon Avenue. The noise monitor was set up in the free-field (i.e. away from reflective surfaces). This location was found representative of the ambient and background noise environment around the proposed Moore College site.

The results of the long term noise monitoring at Location L1 are shown graphically below.

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Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
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90.0
80.0
70.0
60.0
50.0
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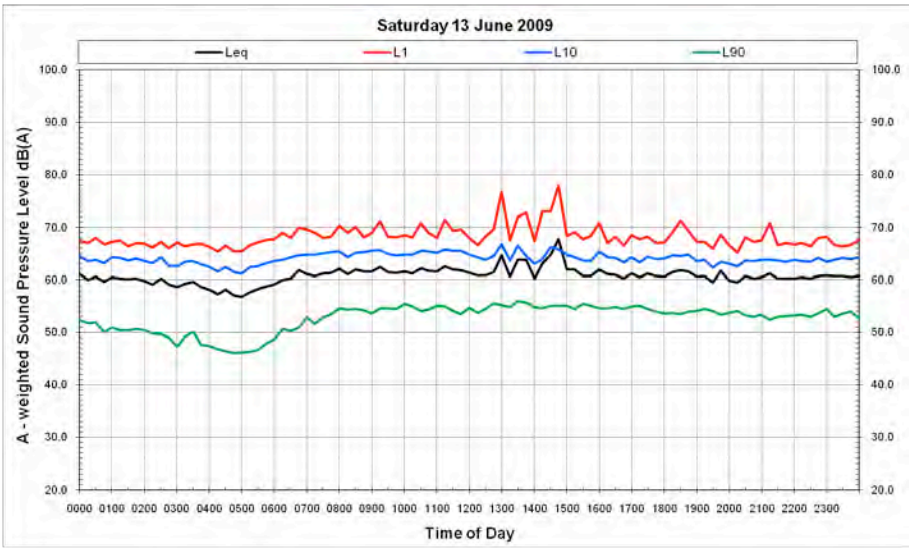
Time of Day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Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
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80.0
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50.0
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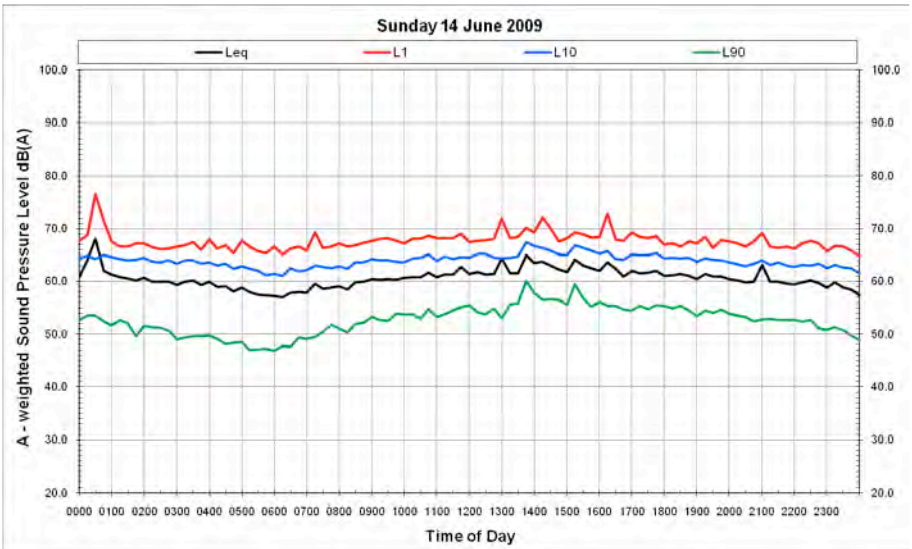
Time of Day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L1
L10
L90
A - weighted Sound Pressure Level dB(A)
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90.0
80.0
70.0
60.0
50.0
40.0
30.0
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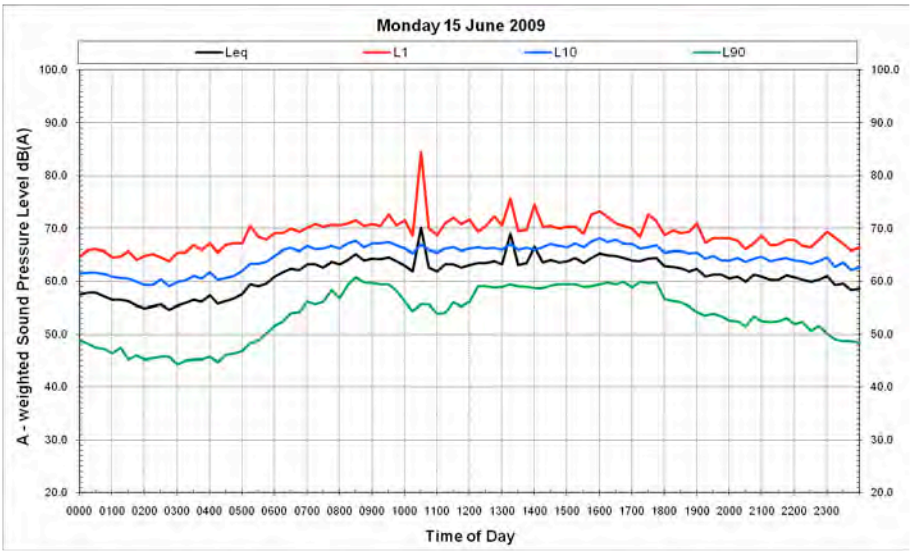
Time of Day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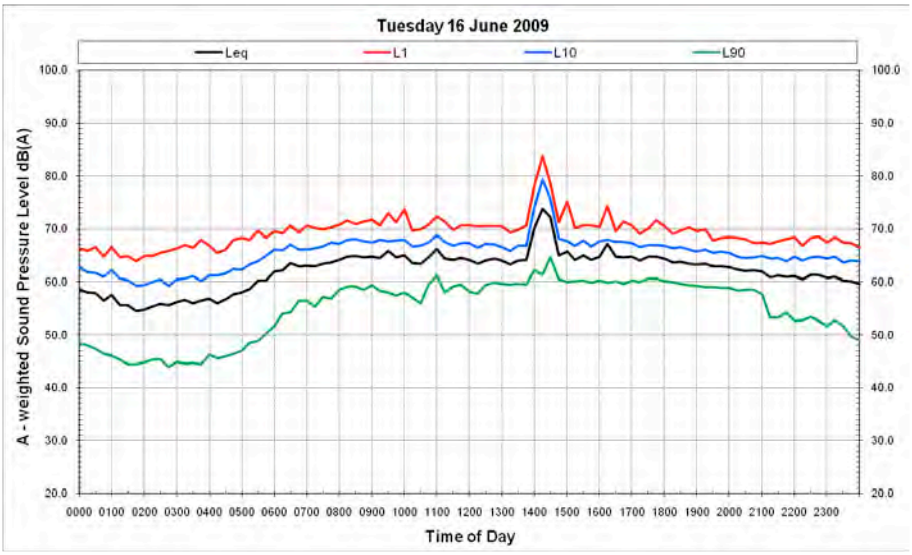
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day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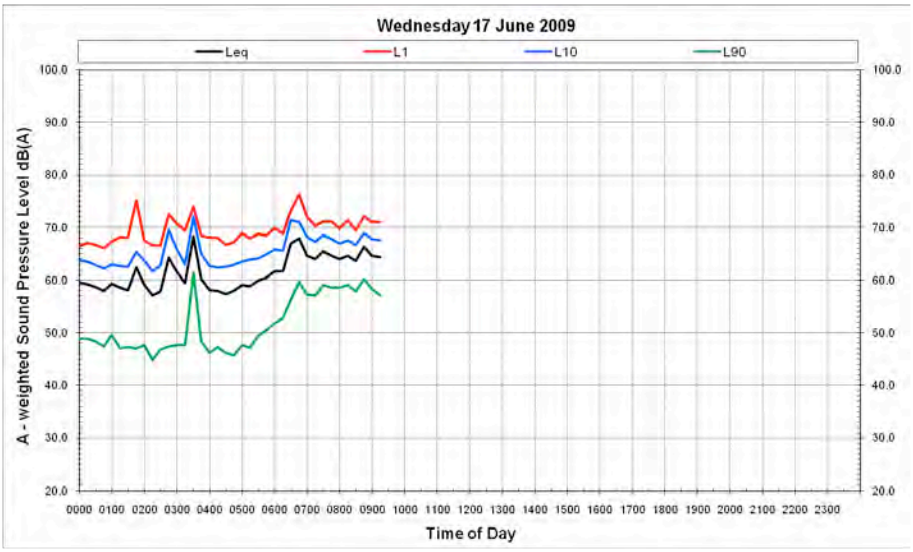
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day


Wednesday 17 June 2009
Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

4.4 Short term noise monitoring

Two (2) short term noise monitoring locations were chosen as representative of the nearest locations of the closest affected residences within and outside the boundaries of the proposed Moore College site:

- Short term Location L2 was on the southern boundary of the Moore College campus site directly in front the proposed new Library building.
- Short term Location L3 was on the northern boundary of the Moore College campus directly adjacent to the proposed students and staff accommodation buildings.

The results of the short term background and ambient noise monitoring are shown in the table below.

Location	$L_{A90,15min}$ Background Noise Level, in dB(A)	$L_{Aeq,15min}$ Ambient Noise Level, in dB(A)
L2 – King Street (ground level)	59	70
L3 – Carillon Avenue (ground level)	51	67

Table 1: Short-term background and ambient noise levels measured around Moore College site

4.5 Noise levels for assessment purposes

Background and ambient noise levels

The background noise levels (for assessment purposes) have been established in general accordance with the methodology described in the NSW Industrial Noise Policy, i.e. the 10^{th} percentile background noise level is established for each period for each day of the ambient noise survey. The median of these levels is then used as the background noise level for each period and they are shown in the Table 2 below together with the L_{Aeq} ambient noise levels measured for each period. Any noise data points that are obviously extraneous to the typical background noise levels monitored during the survey have been excluded from this calculation.

Location	L_{A90} Background Noise Levels, in dB(A)			L_{Aeq} Background Noise Levels, in dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am

L1 – Admin Building (Rooftop Level)	55	53	46	63	62	60
L2 – King Street (Ground level)[1]	59	57	50	70	69	67
L3 – Carillon Avenue (Ground level) [1]	51	49	42	67	65	64

Note 1: Noise levels over the complete time period for short term measurements locations L2 and L3 have been estimated by correlation with long term measurement results at location L1.

Table 2: Background and ambient noise levels measured around Moore College site

Traffic noise levels

Both the analysis of the long and short term surveyed noise data and the observations made during our site visits indicate that noise levels in the area under study were dominated by traffic noise from King Street and Carillon Avenue.

Table 3 below shows the results of traffic noise level monitoring. These values include a 2.5 dB allowance for noise reflected from the façade, in accordance with the requirements of the NSW Environmental Criteria for Road Traffic Noise.

Location	L_{Aeq} Traffic Noise Levels, in dB(A)	
	Day (7am-10pm)	Night (10pm-7am)
L1 – Admin Building (Rooftop Level)	65	62
L2 – King Street (Ground level)[1]	72	70
L3 – Carillon Avenue (Ground level) [1]	69	66

Note 1: Noise levels over the complete time period for short term measurements locations L2 and L3 have been estimated by correlation with long term measurement results at location L1.

Table 3: Traffic noise levels measured around Moore College site

5 Noise Impacts from the Facility

5.1 Potential noise sources

By the nature of its usage, it is not expected that the operation of the proposed Library building will create any significant noise impact on the surrounding area.

The above ground car park (Site B) will provide spaces for 38 cars. Because of the distance to the nearest residences (Moore College educational and residential premises to the north and to the west and Sydney University educational and residential premises to the north-west and to the east) and the existing high ambient noise levels generated by traffic in Carillon Avenue and King Street, noise from vehicles moving within the car park, car doors closing, and people conversation will be inaudible at the nearest residential boundaries. It is not expected that the above ground car park will cause any significant noise impact on the surrounding area.

The only potential noise sources will be mechanical plant and equipment associated with cooling and heating systems for the building and extract fan systems for the bathroom and toilet areas.

5.2 Environmental noise limits

Environmental noise is generally assessed by comparing the new potentially intrusive noise against a criterion based on the pre-existing background noise level. Where the intrusive noise is greater than the pre-existing background noise level, the potential exists for disturbance and annoyance. However, the impact is considered marginal if the difference between the pre-existing background noise level and the equivalent continuous sound pressure level of the intrusive noise is 5dB or less. This concept has resulted in the commonly used criterion of the equivalent continuous noise level (L_{eq}) of the intrusive noise being equal to or less than the existing background noise level (L_{90}) + 5 dB.

This principle is used as the basis of the noise assessment methodology described in the NSW Industrial Noise Policy (INP) published by the NSW Department of Environment and Conservation. Whilst this policy is intended for use with large-scale industrial developments, the general noise assessment methodology can be applied in principle to the type of nose likely to be emitted by the mechanical services of a development such as that proposed for Moore College redevelopment.

The INP methodology defines two criteria; an intrusiveness criterion, and an amenity criterion. The project noise rating is the lower of the two criteria.

Intrusiveness criterion

The intrusiveness criterion relates the L_{Aeq} emitted by the facility, and is equal to the lowest background noise level plus 5 dB(A). For this project the intrusiveness criteria (for noise emissions from the mechanical services of the project) are shown in Table 4 for each period.

Location	Time of Day	Existing L_{A90}, in dB(A)	Intrusiveness criteria, in dB(A)
Residences within Moore College campus	Day	55	60
	Evening	53	58
	Night	46	51
Residences along King Street	Day	59	64
	Evening	57	62
	Night	50	55
Residences along Carillon Avenue	Day	51	56
	Evening	49	54
	Night	42	47

Table 4: Intrusiveness criteria for proposed site and surrounds

Amenity criterion

The amenity criterion is designed to limit continuing increases in community noise levels by restricting overall L_{Aeq} values to a recommended noise level based on land use.

As an urban noise amenity area, the recommended L_{Aeq} levels for the Moore College site and surrounds are shown in the Table 5 below.

Type of Receiver	Time of Day	Recommended L_{Aeq} Noise Level, in dB(A)	
		Acceptable	Maximum
Residence - Urban	Day	60	65
	Evening	50	55
	Night	45	50
School classroom - Internal	Noisiest 1hr period	35	40
Place of worship - Internal	When in use	40	45
Commercial premises	When in use	65	70

Table 5: Amenity criteria - Recommended L_{Aeq} noise levels from industrial noise sources

It is observed that external ambient noise levels measured on site already exceed the recommended noise levels presented in the amenity criteria values shown in the table above. This is due to the fact that ambient noise levels in the area are dominated by high traffic noise. In such cases, the amenity criterion for noise from industrial noise becomes the $L_{Aeq, period(traffic)}$ minus 10 dB. This criterion replaces the amenity criterion in Table 5.

Corrected amenity criteria values for the project are shown in the table below. Note that the amenity criteria relate to the L_{Aeq} for the entire period (day, evening or night) whereas the intrusiveness criteria relate to a 15 minute L_{Aeq}.

Location	Time of Day	Existing L_{A90}, in dB(A)	Intrusiveness criteria, in dB(A)
Residences within Moore College campus	Day	63	53
	Evening	62	52
	Night	60	50
Residences along King Street	Day	70	60
	Evening	69	59
	Night	67	57
Residences along Carillon Avenue	Day	67	57
	Evening	65	55
	Night	64	54

Table 6: Amenity criteria for proposed site and surrounds

Project specific rating level

The project specific rating level is the lower of the two criteria above. In this case it is the amenity criterion at any residential boundary to the Facility.

6 Noise Impacts on the Facility

6.1 Potential noise sources

The Moore College campus and the future Library building will be located in an area dominated by significant traffic noise levels from nearby roads. King Street is an arterial road providing for a connection route between the City of Sydney and the southern suburbs. Vehicle movements are high, especially during peak hours, and include a high percentage of heavy vehicles. A number of bus routes run along this section of King Street and there is a bus stop in front of the proposed Library building site.

Carillon Avenue is a local collector road that links King Street with other local collector roads leading to Parramatta Road and the Great Western Highway. Traffic volumes along Carillon Avenue are anticipated to be medium-high. There are no bus routes in the section around the Moore College site.

Plant noise from adjacent buildings will also contribute to general ambient noise levels around the site.

6.2 External traffic noise criteria

The appropriate traffic noise criteria are those set in the publication *The Environmental Criteria for Road Traffic Noise* (ECRTN), May 1999, published by the Environmental Protection Authority (EPA) of NSW (now the NSW Department of Environment, Climate Change and Water).

This publication sets road traffic noise criteria for a number of road/land use scenarios. In the case of the Moore College redevelopment, the relevant scenario is that of residential facilities affected by traffic noise from an existing arterial/collector road. For this type of development, the nominated external criteria are as follows:

- Day (7 am – 10 pm) $L_{Aeq(15hr)}$ 60 dB (external)
- Night (10 pm – 7 am) $L_{Aeq(9hr)}$ 55 dB (external)

These criteria refer to the L_{Aeq} (the A-weighted equivalent continuous noise level) occurring when measured 1m from the façade of the building. The criteria include a 2.5 dB allowance for noise reflected from the façade.

6.3 Internal noise level limits

The internal noise level within a space (in the absence of occupational noise i.e. people, music, etc) is generated by:

- The level of external noise that breaks in to the space through the building façade.
- The level of noise from the air-conditioning systems within the building.

Therefore when designing to specific noise levels within a space account must be made of these two factors.

Australian Standard AS2107:2000[1] recommends design noise levels within occupied spaces for a large range of building and occupancy types. The noise levels recommended take into account the function of the area(s) and apply to the noise level measured within the space unoccupied but fully fitted-out and ready for occupancy.

The Standard applies to steady-state or quasi-steady-state sounds (e.g. air-conditioning noise - "steady-state", and continuous traffic noise - "quasi-steady-state").

The Standard recommends varying design sound levels specifically for educational buildings, such as the Moore College Library under study, depending on their usage. These would include the following:

Type of Building	Type of Occupancy	Recommended L_{Aeq}, in dB(A)	Maximum L_{Aeq}, in dB(A)
Educational	Library - General Areas	40	50
	- Reading Areas	40	45
	Teaching Spaces	35	45
	Office Areas	40	45

Note: The lower of the two numbers is generally taken as the design target, the upper number being the 'just acceptable' limit.

Table 7: Recommended internal noise levels criteria for proposed site

Detailed internal noise level limits will be developed for all the spaces within the Library building as the project progresses. These limits will apply to both external noise and air-conditioning noise. Limits will be met through appropriate design of the façade and the use of appropriate noise control mechanisms for the mechanical equipment as detailed in Section 7 below.

[1] Standards Australia *Australian Standard AS/NZS2107:2000 Acoustics – recommended design sound levels and reverberation times for building interiors,* 2000

7 Acoustic Design Strategy

7.1 Control of external mechanical services plant noise

Appropriate noise control measures will be included in the design of the mechanical services within the Library building design proposal to ensure that the noise limits established in Table 6 are met at the nearest residential boundaries. These control measures could include any or all of the following:

- Selection of appropriate quiet equipment.
- Strategically locating noisy equipment away from sensitive areas.
- Use of noise barriers, shielding or construction of acoustic enclosures.
- Provide for in-duct noise attenuation.
- Plant rooms to be of masonry construction with internal sound absorptive treatment as required.

7.2 Control of internal noise levels

Appropriate internal noise level limits will be set for the different spaces within the library in order to provide an appropriate acoustic environment for the users. The control of internal noise levels will include can be achieved by applying the recommendations outlined below.

Noise Controls for Building Façade

In order to minimise the impact of traffic noise from King Street and Carillon Avenue over the internal spaces of the Library building, the following noise controls for the building façade are recommended:

- The Library building will have a composite façade consisting of masonry and glazing. A minimum acoustic performance of R_w 45 dB is recommended for the combined façade structure.

  It is noted that the minimum R_w for the composite façade is to be reviewed when the architectural detail design of the Library building is finalised.

- Provide mechanical ventilation in the Library building to enable windows and doors facing noisy roads to be closed.
- Provide for acoustic absorption to be applied to the ceiling and soffits of outdoors terraces.

Acoustic Design of Internal Spaces

An appropriate acoustic design of internal spaces of the Library building shall be completed during the detail design stage of the project. The detailed acoustic design would include:

- Control of room to room noise transfer between adjacent spaces by choosing the adequate R_w for dividing elements, including dividing walls, doors, windows and ceilings.

  It is noted that the minimum R_w for the dividing elements is to be defined when the architectural detail design of the Library building is finalised.

- Control of reverberation times inside spaces by choosing the appropriate internal materials linings. The Australian Standard AS2107:2000[2] presents recommended reverberation times for educational spaces and they are show in the table below.

Type of Building	Type of Occupancy	Recommended Reverberation Time (T), in seconds
Educational	Library - General Areas	0.4 to 0.6
	- Reading Areas	0.4 to 0.6
	Teaching Spaces	0.5 to 0.6
	Office Areas	0.4 to 0.6
	Corridors and Lobbies	0.6 to 0.8

Table 8: Recommended internal reverberation times for proposed site

Control of mechanical services plant noise

External noise control measures for air-conditioning systems and mechanical plant have been already presented in Clause 7.1, and are also applicable to the internal noise control related to the mechanical ventilation system.

[2] Standards Australia *Australian Standard AS/NZS2107:2000 Acoustics – recommended design sound levels and reverberation times for building interiors,* 2000

8 Summary and Conclusions

A noise assessment has been carried out on the potential noise impact of the proposed new Library Project at Moore Theological College. An assessment has also been carried out on the potential impact of existing noise sources on the proposed Library building.

Ambient noise monitoring has been carried out to establish the existing background, ambient and traffic noise levels within the area.

Appropriate noise limits have been developed to control noise impacts from the development on the surrounding existing educational, residential and commercial buildings. It is considered that the proposed Library will not have any adverse acoustic impact on the existing environment.

Initial internal noise design levels for the Library building have been discussed and will be developed further as the architectural project progresses. An acoustic strategy has been outlined in order to guarantee the acoustic comfort inside the Library building.

MOORE THEOLOGICAL COLLEGE

Construction Noise and Vibration Management Plan

Issued

September 2009

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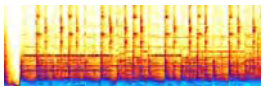

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1 Introduction

1.1 Purpose

To control noise and vibration levels generated during the redevelopment/expansion of the Moore Theological College at its Newtown campus in accordance with identified legislation, codes and standards, namely:

- The Department of Environment, Climate Change and Water (DECCW) Interim Construction Noise Guideline 2009.
- The Environmental Protection Authority (EPA) Environmental Noise Control Manual 1994.
- Australian Standard AS 2436-1981, *Guide to Noise Control on Construction, Maintenance & Demolition Sites.*
- Australian Standard AS 2670.2-1990, *Evaluation of human exposure to whole-body vibration Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz).*

1.2 Scope

This procedure is applicable to all demolition, excavation and construction works for the Project.

1.3 Definitions

dB(A)

Refers to the sound pressure level that is weighted to approximately conform to the human perception of loudness.

$L_{Aeq,T}$

Refers to the the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a duration interval.

For the purpose of assessment of compliance with this plan the duration interval (T) shall be 15 minutes.

1.4 Responsibilities

The Contractor shall be responsible for ensuring all works are undertaken in strict accordance with the requirements of the contract documents and this Plan.

The Contractor shall be responsible for ensuring all project personnel and sub-contractors employed are aware of their responsibilities in regard to the management of noise and vibration during construction and assume the responsibilities assigned to them within this Plan.

The Contractor shall be responsible for measuring and managing all noise and vibration impacts on receivers in accordance with the statutory requirements listed in Section 1 above.

2 Project Description

The proposed development will be constructed within the existing Newtown campus areas of Moore Theological College, at the corner of King Street and Carillon Avenue, Newtown.

Existing University of Sydney and Newtown North Primary School premises are in close proximity to the site. Also, commercial and residential buildings share common boundaries with the proposed site.

Furthermore, Moore College includes residential accommodation for its students and staff within its precinct.

The proximity of these noise and vibration sensitive receivers will determine the extent of the noise and vibration control measures required during the redevelopment/expansion of the Moore College campus.

In terms of construction noise and vibration generation, it is anticipated there will be three general stages of the project:

- Demolition of existing structures not to be retained.
- Bulk excavation.
- Construction of new buildings / renovation of retained dwellings.

Currently the Moore College renovation/expansion project is at a preliminary design stage. Therefore, the duration, description and staging of construction works is not defined at this stage. Therefore, this Construction Noise and Vibration Management Plan provides general recommendations only and indicates best noise and vibration control practices to be observed during the Moore College construction project.

2.1 Activities, noise sources, and duration

The anticipated activities, noise sources and duration of these activities are shown below in Table 1.

Stage	Activities	Significant Noise Sources
Demolition	• Demolition • Removal of excavated material	• Bulldozers • Excavators • Trucks
Bulk excavation	• Excavation • Rock sawing • Rock breaking • Removal of excavated material	• Excavators • Rock saws • Rock breaker • Trucks
Construction/Renovation	• Concrete delivery and pouring • Material delivery (steelwork, etc) • Transport of materials on site.	• Concrete mixers • Concrete pumps • Trucks • Cranes

Table 1: Summary of major activities and noise sources

2.2 Anticipated airborne noise levels of plant

The anticipated airborne noise levels for the above noise sources are shown in Table 2.

Noise Source/Plant	Sound Power Level, dB(A)
Concrete pump	100 to 110
Concrete mixer	90 to 120
Crane	100 to 115
Truck	100 to 120
Excavator/Bulldozer	110 to 120
Rock saws	105 to 125
Rock breaker	110 to 125

Table 2: Anticipated airborne noise levels for major noise sources/plant

3 Noise and Vibration Sensitive Receivers

The nearest noise and vibration sensitive receivers to the development are shown in Figure 1. They include:

- Existing Moore College buildings including educational and residential uses.
- Sydney University and associated Colleges premises along Carillon Avenue and King Street to the north and east of the proposed site.
- Newtown North Primary in Carillon Avenue to the west of the proposed site.
- Residential / commercial premises along King Street and Campbell Street to the south and west of the proposed site.

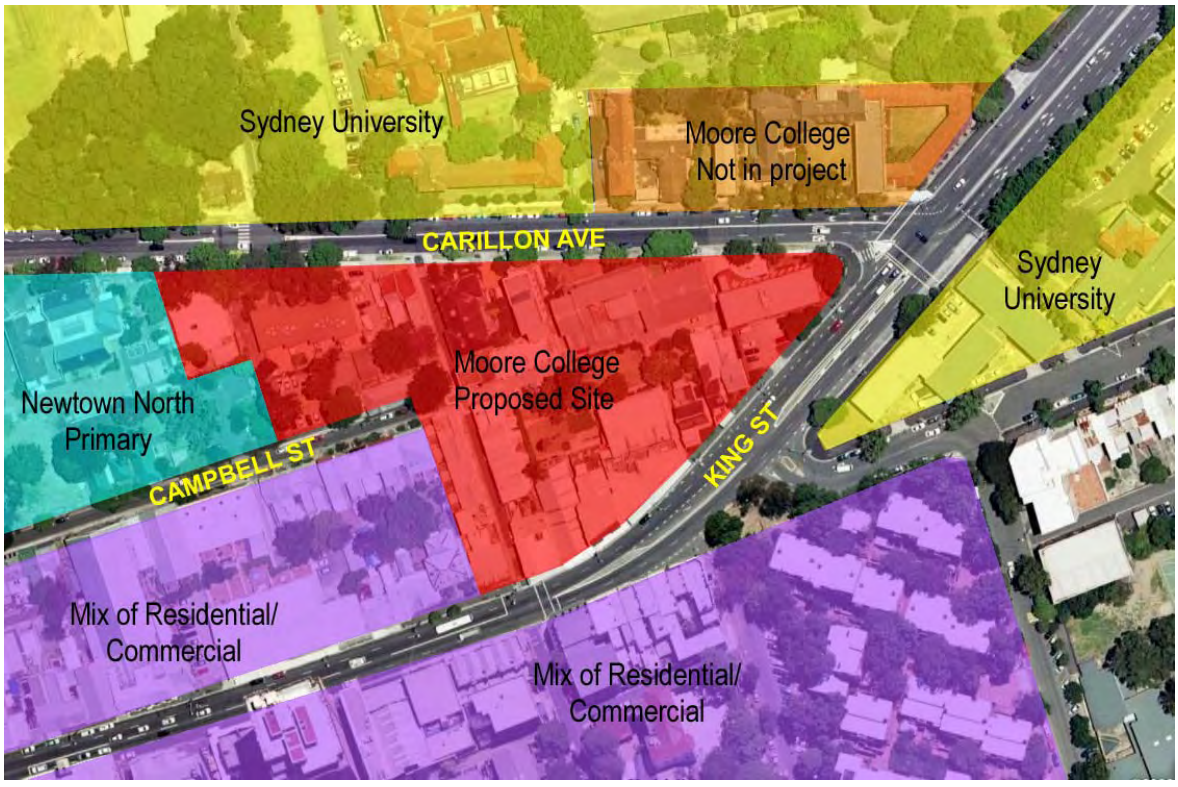


Figure 1: The development site and the context of the surrounding area.

4 Noise Management

4.1 Control elements

As a general rule, prevention should be applied as universal work practice at any time of day, but especially if any construction works are to be undertaken at critical times outside normal daytime/weekday periods. It is noted that the reduction of the noise at the source and the control of transmission path between the construction site and the receiver are the preferred options for noise minimisation. Providing treatments at the affected residences or other sensitive land uses should only be at a last resort.

Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Maintain equipment regularly.
- On site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
  - Schedule activities to minimise noise impacts.
  - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
  - Keep truck drivers informed of designated routes, parking locations and delivery hours.

4.2 Working Hours

Working hours shall be limited at least to those set out as recommended standard hours of work in the DECCW *Interim Construction Noise Guideline* as follows:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- Sundays and Public Holidays No excavation or construction work

4.3 Noise Criteria/Site Operational Noise Level Limits

The noise criteria and operational levels presented in this section are for guidance only and do not form part of any legal obligation on the part of the project proponent. However, compliance with these criteria/limits is considered best practice.

Within all existing Moore College buildings and classrooms

It is critical that the occupants of the existing classrooms, administrative offices and residential areas of Moore Theological College be protected from disturbance resulting from construction noise.

The overall noise levels ($L_{Aeq,\ 15\ minutes}$) from all construction activities occurring during periods when the educational/residential premises are in use shall not exceed the internal background sound level of any acoustically sensitive space by more than 5 dB.

An acoustically sensitive space shall include:

- All teaching spaces including classrooms, library areas and any other space used for educational purposes.
- All administration areas including private offices and general office areas, and meeting rooms.
- All students and staff residential spaces, including sleeping and living areas.

The internal background sound levels shall be assumed to be “Satisfactory” recommended design sound levels listed in Table 1 of Australian Standard 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

At nearest residential dwellings

The DECCW in its ‘Interim Construction Noise Guideline’ suggests construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receptors. These are as follows:

- Within recommended standard hours.

  The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background level by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

  However, in the case of a highly noise affected area, the construction noise level at the most exposed boundary of any affected residential receiver when the construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

- Outside recommended standard hours.

  The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background level by more than 5 dB(A).

  It is noted that a strong justification would be required for works outside the recommended standard hours.

Apart from the external construction noise management levels presented above, the DECCW guideline also recommends internal ground-borne noise maximum levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise. The ground-borne noise levels presented below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening: $L_{Aeq,15min}$ 40 dB(A) (internal)
- Night: $L_{Aeq,15min}$ 35 dB(A) (internal)

The internal noise levels are to be assessed at the centre of the most affected habitable room. It is noted that a strong justification would be required for works outside the recommended standard hours.

At nearest commercial dwellings

DECCW's 'Interim Construction Noise Guideline' also suggests construction noise management levels for commercial and industrial premises surrounding construction sites. These levels are to applicable levels to the retail premises surrounding the currently Moore College campus, such as the shops and garage along King Street, and are as follows:

- Industrial premises: $L_{Aeq,15min}$ 75 dB(A) (external)
- Offices and retail premises: $L_{Aeq,15min}$ 70 dB(A) (external)

4.4 Plant noise levels

The Contractor shall test all plant/equipment and trucks for compliance in accordance with the Flow Chart in Appendix A.

The exit ramps to the street and all internal haul roads shall be at the lowest grade practicable.

The number of trucks on site at the commencement of site activities shall be kept to the minimum required by the loading facilities on site.

4.5 Noise Monitoring

The Contractor shall implement environmental noise monitoring at the locations described below.

- Boundary of Moore Theological College and the residential dwellings located along Campbell Street.
- Boundary of nearest residential receivers facing Moore Theological College campus across King Street and Carillon Avenue.
- Locations within the existing Moore Theological College buildings as directed by the Project Manager.

An allowance of 1.5 days per week shall be dedicated to monitoring of noise and vibration for the first four weeks of demolition and construction. Further monitoring shall be reviewed after this time or sooner should it be deemed necessary by the Acoustic Consultant and the Project Manager. This shall take place mainly at the above locations although other locations and plant and equipment monitoring shall take place as and when necessary.

4.6 Reporting

The Contractor shall prepare a noise monitoring report shall each month for review by the Project Manager. The reports shall summarise and interpret the results of the noise monitoring carried out during the past month.

4.7 Communication and complaints

The Contractor shall establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition the following procedures shall be adopted specifically for complaints relating to noise.

Upon receipt of a complaint The Contractor shall:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.
- If the activity is occurring outside normal working hours, the General Foreman shall immediately stop the activity. Where stopping the activity would create a safety issue the activity shall be permitted to continue only as long as is necessary to make the area safe. The activity shall then be directed to cease.
- Any activity which is directed to cease due to excessive noise may not recommence until the Project Manager is satisfied that the requirements of the “Code” can be met and has given permission to recommence the activity.
- The Site Supervisor shall ensure that a report of any incident is provided to the Project Manager.
- The Project Manager shall provide a report on the incident to the relevant stakeholders.
- The Contractor shall will provide a 24 hour telephone contact number and this number will be prominently displayed on the site.

4.8 Safety

Personnel involved in operations will be issued with ear plugs or ear muffs which must be used whenever noise levels interfere with normal speech when individuals are standing at a

distance of 1m from each other, or when the eight hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8H}$ measured with a properly calibrated sound level meter exceeds 85 dB.

Signs shall be erected and made visible at the entry to all areas where noise levels will exceed 85 dB(A).

4.9 Non-compliances

Non-compliance reports shall be used as appropriate to deal with failures to meet the requirements of this plan.

5 Vibration Management

This section of the construction noise and vibration management plan includes general procedures to be followed, vibration surveys and monitoring to be carried out and vibration criteria to ensure human comfort and prevent building damage and prevent disruption to equipment, processes and in particular artefacts in the Australian Museum.

On-site measurements will be necessary at the commencement of each key construction process to determine the level of vibration generated by the particular equipment used.

This document discusses general guidelines for the management strategy of vibration arising from the construction works in relation to this project. Criteria to ensure human comfort and prevent building damage and disruption to equipment and processes are discussed in Appendix B.

5.1 Vibration Sensitive Receivers

The main vibration sensitive receivers are:

- Students and staff of Moore Theological College when in use.
- Occupants of Sydney University and associated Colleges located along Carillon Avenue and King Street when in use.
- Students and staff of Newtown North Primary during school hours.
- Residents of dwellings nearby the site along Campbell Street, King Street and Carillon Avenue 24 hours a day, 7 days a week.
- Staff and patrons of retail/commercial premises adjacent to the site along King Street, when in use.
- Moore Theological College structures, when in use 24 hours a day, 7 days a week.
- Nearby residential, educational and commercial structures surrounding the Moore College campus 24 hours a day, 7 days a week.

5.2 Control Elements

The Contractor shall carry out a preliminary assessment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation would involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels would then be put in place. Vibration mitigation measures and a review of vibration criteria may then be necessary.

5.3 General Procedures

All practical means shall be used to minimise impact on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- The layout of the site, including the location of static sources of vibration.
- Techniques used in construction to minimise generated vibration levels.
- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

5.4 Vibration Criteria

The DECCW relevant documentation to construction issues does not include any discussion of vibration criteria and, therefore, cannot be referred to for any appropriate criteria.

Relevant Australian and international vibration criteria to ensure human comfort, prevent building damage and prevent disruption to equipment and processes are discussed in Appendix B.

Vibration limits for building damage are less stringent than limits for human comfort, and both are relevant to this plan, as follows.

Human comfort

- Students and staff of Moore Theological College when in use.
- Occupants of Sydney University and associated Colleges located along Carillon Avenue and King Street when in use.
- Students and staff of Newtown North Primary during school hours.

- Residents of dwellings nearby the site along Campbell Street, King Street and Carillon Avenue 24 hours a day, 7 days a week.
- Staff and patrons of retail/commercial premises adjacent to the site along King Street, when in use.

Building damage

- Moore Theological College structures, when in use 24 hours a day, 7 days a week.
- Nearby residential, educational and commercial structures surrounding the Moore College campus 24 hours a day, 7 days a week.

Vibration Criteria for Human Comfort

Vibration levels arising from demolition, excavation and construction activities shall not exceed the following limits:

Location	Continuous Vibration (r.m.s.), mm/s	Intermittent Vibration (r.m.s.), mm/s
In any residence adjacent to Moore College campus along King and Campbell Streets and Carillon Avenue	Curve 2 in Figure 5b, AS2670.2:1990	Curve 60 in Figure 5b, AS2670.2:1990
In any residence within Moore College campus	Curve 2 in Figure 5b, AS2670.2:1990	Curve 60 in Figure 5b, AS2670.2:1990
Within any teaching space of Moore College campus	Curve 2 in Figure 5b, AS2670.2:1990	Curve 60 in Figure 5b, AS2670.2:1990
Within any staff/administrative areas within Moore College campus	Curve 4 in Figure 5b, AS2670.2:1990	Curve 128 in Figure 5b, AS2670.2:1990
Within any teaching space of Newtown North Primary	Curve 2 in Figure 5b, AS2670.2:1990	Curve 60 in Figure 5b, AS2670.2:1990
Within any staff/administrative areas within Newtown North Primary	Curve 4 in Figure 5b, AS2670.2:1990	Curve 128 in Figure 5b, AS2670.2:1990
Within any commercial premise adjacent to Moore College campus along King and Campbell Streets and Carillon Avenue	Curve 4 in Figure 5b, AS2670.2:1990	Curve 128 in Figure 5b, AS2670.2:1990

Table 3: Vibration criteria for human comfort

Vibration Criteria for Damage

The criteria given in Table 3 (Human Comfort) shall generally form the limiting vibration criteria for the project.

For unoccupied buildings, or during periods when the buildings are unoccupied (e.g. University holidays), the criteria for building damage suggested by Australian Standard AS2187-1993 of 5 mm/s shall be adopted.

5.5 Vibration Surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks shall be carried out on site at the outset of each key vibration generating activity.

Shortly before the commencement of each activity the background vibration level will be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process shall be re-assessed.

5.6 Vibration Monitoring

A vibration monitoring system shall be implemented. This system shall monitor vibration levels when there is potential for them to change. This can happen in various situations, such as, changes in equipment and activities or changes to work procedures that may affect existing vibration control measures. The monitoring procedure shall be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding allowable limits appropriate action, as described in Clause 5.7 shall be taken.

5.7 Control of Vibration

If measured vibration levels exceed the appropriate criteria; one or more of the following measures shall be taken:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria shall be undertaken and the vibration management strategy amended.

5.8 Sources of Vibration

Potential sources of perceptible vibration include:

- Demolition and excavation plant including rock-breakers, jack hammers.
- Truck movements on site.
- Installation of structural steel work.
- Grinding, cutting and drilling of existing building structures.

The Contractor shall carry out a review of vibration generated by construction activities. The levels of vibration generated will be site specific and will depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties.

The Contractor shall carry out a preliminary vibration survey will determine whether a means of vibration mitigation will be necessary on the site.

5.9 Non Compliances

Non-compliance reports shall be used as appropriate to deal with failures to meet the requirements of this plan. The Project Manager shall issue non-compliance reports.

6 Conclusion

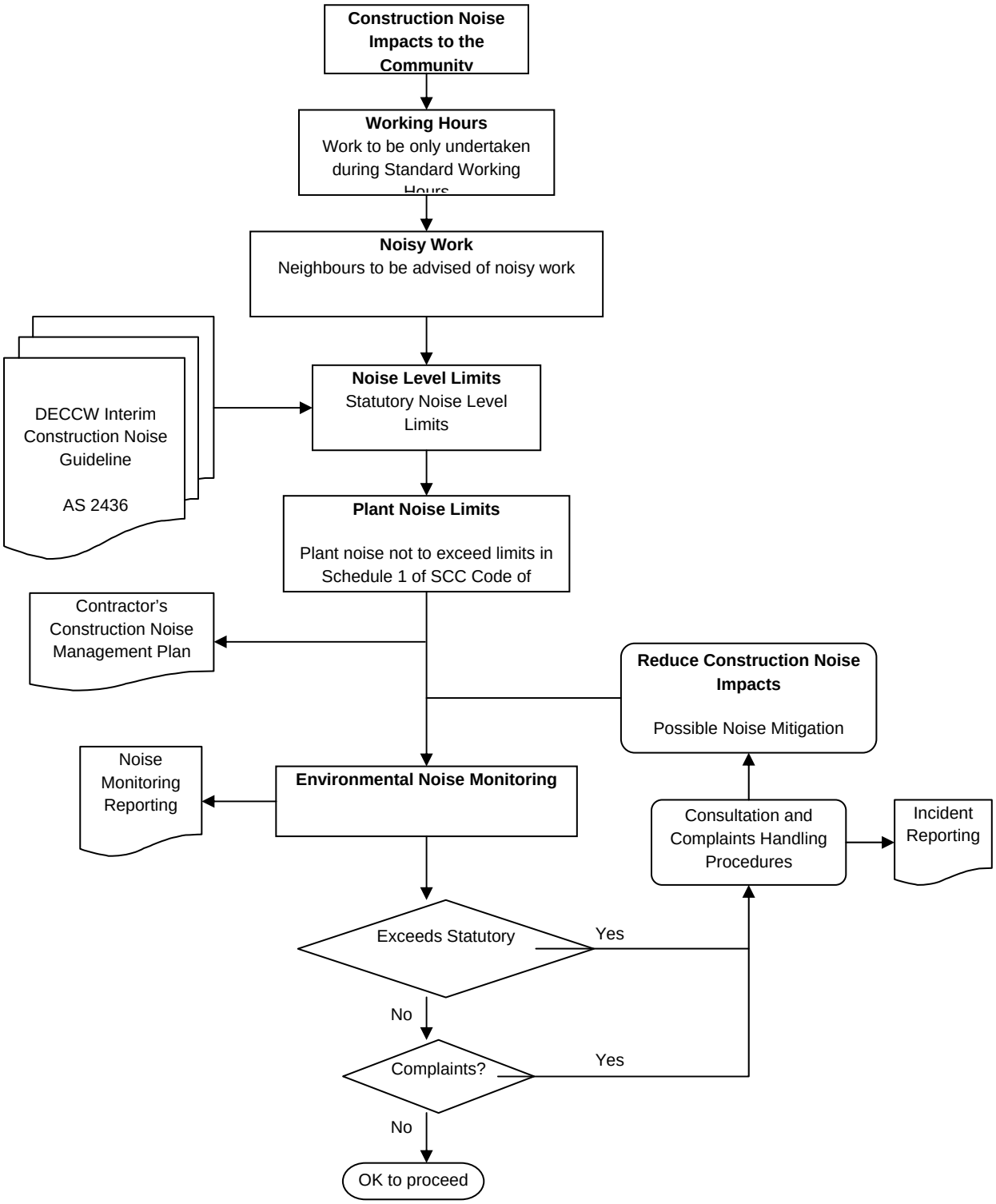
This general construction noise and vibration management plan has been devised for construction works associated with the proposed renovation / expansion of Moore Theological College campus in Newtown. Criteria for both noise and vibration have been discussed and set according to established guidelines and standards.

To ensure adverse effects are avoided at all receivers, monitoring of noise and vibration levels shall be carried out and should the criteria be exceeded the offending activities shall be stopped, providing it is safe to do so, and action shall be taken to ensure compliance. Care shall also be taken to ensure that any complaints received will be resolved to the satisfaction of all parties involved.

Appendices

Appendix A

Flow chart showing the management of construction noise impacts on the community



Appendix B

Vibration Criteria

Human Comfort

The Environmental Noise Control Manual, Chapter 174, issued by the Environmental Protection Authority (EPA), contains guidelines to limit vibration levels generated by activities on construction sites.

Guidelines are given in terms of satisfactory vibration levels related to the minimum adverse comment level by building occupants. Table A1 gives the vibration limits for both continuous and intermittent vibration to prevent adverse comment in various working areas. Daytime is between 7am and 10pm and night-time is between 10pm and 7am. These limits apply at the site boundary.

Space	Time	Continuous Vibration (mm/s)	Intermittent Vibration (mm/s)
Residential	Day	0.2	6.0
	Night	0.14	2.0
Office	Day	0.4	12.7
	Night	0.4	12.7
Workshops	Day	0.8	12.7
	Night	0.8	12.7
Precision Laboratories	Day	0.1	0.1
	Night	0.1	0.1

Table A1: Vibration Criteria to Ensure Human Comfort

Where measured vibration levels exceed those permitted for continuous vibration given in Table A1 the offending activities can be rescheduled for out of office or school hours hence removing the sensitive receivers.

Building Damage

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage[1]. This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there are still no International Organisation for Standardisation (ISO) guidance limits.

There are however several standards that can be referred to.

German Standard

The relevant German standard is DIN 4150: Part 3: 19862. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table A2: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

The guidelines state that:

Experience to date has shown that, provided the values given in Table A2 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of table A2 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.

Swiss Standard

The relevant Swiss standard is SN 640 312:1978. For steady state vibration, form machines, traffic and construction in buildings the following limits are given:

[1] Building Research Establishment (1995), 'Damage to Structures from Ground-borne Vibration', *BRE Digest*

Structural type	Vibration Velocity, v_i, in mm/s	
	Foundation	
	10 to 30 Hz	30 to 60 Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table A3: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Steady State Vibration

British Standard

The relevant standard is BS7385: Part 2: 1993[2]. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

Table A4: Transient Vibration Guide Values for Cosmetic Damage

The standard states in Annex A, that … *the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance.* It is recommended that buildings of

[2] BS 7385: Part 2: 1993 Evaluation and Measurement for vibration in Buildings, Guide to damage levels from groundborne vibration

importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that should be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report should be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993[3], which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

Summary

Table A5 gives a summary of recommended vibration limits for buildings to prevent damage. The most stringent limit recommended in the German and Swiss standards is 3 mm/s. However, this criterion is applicable to particularly sensitive constructions such as heritage buildings. Therefore, the next most stringent level of 5 mm/s has been conservatively chosen as an appropriate limit whilst the construction work is carried out. This limit should be met across the full frequency range of relevance i.e. typically 4 Hz – 250 Hz encountered in building construction.

[3] AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

Table A5: Summary of International Standards