Level 5, 73 Miller Street
North Sydney, NSW 2060
1800 478 573

Madeleine Lloyd
Town Planner

Walker Corporation
Level 21, Governor Macquarie Tower
1 Farrer Place
Sydney NSW 2000

9 November, 2021

Dear Madeleine,

Response to Feedback by NSW Department of Planning, Industry & Environment Regarding EIS Acoustic Assessment Report

We are writing to address the feedback provided by the NSW Department of Planning, Industry & Environment (NSW DPI&E) in their letter titled *"Macarthur Medical Research Centre SSD-17491477, Review of environmental impact statement"* (dated 4 November 2021), regarding the submitted acoustic report titled *"Lang Walker AO Medical Research Centre – Macarthur, Environmental Impact Statement – Acoustic Assessment"*, dated 29 October 2021 (referred herein as the EIS Acoustic Assessment Report).

We respond to the NSW DPI&E comments as follows:

NSW DPI&E: Noise monitoring cannot rely solely on past data from the Stage 2 Campbelltown Hospital redevelopment and the Acoustic Report must be updated to include more recent testing both within the hospital campus and at the closest residential receivers to the west and south of the proposal site.

The reasons for considering the measurements discussed in the report titled *"Campbelltown Hospital Redevelopment Stage 2 – SSDA Acoustic Assessment Report"* (referred herein as the CHRS2-SSDA Acoustic Report, dated 27 July 2018, issued by Arup), are the following:

- During the implementation of COVID-19 lockdown restrictions, vehicular traffic flows had reduced significantly. Ambient noise levels are dominated by local road traffic, and more distant traffic on a major road corridor (i.e. Appin Road) which is located in the vicinity of the project site.
  Consequently, it is our opinion that ambient noise levels during the lockdown were reduced to levels which were not representative of typical operational conditions (i.e. those that occur when the restrictions are lifted).
  Hence, if a noise survey were to be conducted during the lockdown, the measured noise levels would also be non-typical and significantly lower that would otherwise be expected.
- If an unattended noise survey was to be conducted now that the restrictions have been lifted, it is likely this would be affected by noise emissions from construction activities currently being

undertaken within the hospital campus (for the daytime period). Hence, the measurements from this survey would also be considered non-representative of typical operational conditions. Furthermore, if representative noise measurements were to be obtained in the absence of construction noise emissions, a request to stop all construction activities would be required for the duration of the survey. This exercise is considered to be impractical and not feasible.

- Measurements discussed in the CHRS2-SSDA Acoustic Report were undertaken before the restrictions and in the absence of construction noise emissions. Therefore, these levels are considered to be more representative of typical operational conditions; and as a result, they have been used in our assessment.

Finally, please note that an unattended noise survey was conducted on site. The aim of this survey, however, was to quantify façade incident noise levels rather than to obtain a measurement of the ambient noise level. Since the hospital was operational during the COVID-19 lockdown periods, and local roads surrounding the MMRC are dominated by hospital traffic, a survey to quantify façade L_{Aeq} noise levels was considered worthwhile. The survey was conducted just before the full implementation of lockdown restrictions.

NSW DPI&E: ***Particularly, noting the need to consider the current noise environment resulting from the ongoing construction of the Stage 2 redevelopment and the requirement to assess cumulative acoustic impacts throughout the locality in accordance with the SEARs.***

We have amended the EIS Acoustic Assessment Report to consider the aggregate of noise contributions from the subject development (i.e. Macarthur Medical Research Centre), as well as from Stage 2 redevelopment works at Campbelltown Hospital. This updated report is included in Appendix A to this letter.

Consequently, specific operational acoustic criteria have been nominated for the Macarthur Medical Research Centre so that contributions from this development is considered in terms of its cumulative noise impacts. Refer to discussion in Section 4.1.3 of updated EIS Acoustic Assessment Report.

We are also of the opinion that undertaking a further noise survey to assist in determining the cumulative acoustic impacts would not be of value at this stage, since the current ambient noise levels are being affected by construction noise from the hospital campus.

We expect that construction works at Campbelltown Hospital will continue into 2022, by which time, construction works are expected to start at the Macarthur Medical Research Centre. Major construction works for these two separate projects are not expected to occur concurrently. We do not, therefore, consider it necessary to adjust the construction noise assessment criteria as has been done for the operational noise criteria.

Nevertheless, as part of the construction noise and vibration management plan, we recommend that confirmation be obtained that major works will not be undertaken simultaneously; and if that is not the case, then construction noise assessment level (i.e. noise management levels) should be adjusted accordingly (refer to discussion in Section 7.4.1).

We trust this letter addresses the aforementioned concerns.

If you have any further questions, please do not hesitate to contact us.

Kind regards

Renzo Arango
Pulse White Noise Acoustics

Appendix A: Updated EIS - Acoustic Assessment Report

Lang Walker AO Medical Research Building - Macarthur

Environmental Impact Statement – Acoustic Assessment

Western Sydney University
Penrith NSW 2751.

Report number: 210196_WSU MMRC_EIS Acoustic Assessment_Rev 8.0.docx
Date: 9 November 2021
Version: For Issue

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DOCUMENT CONTROL

Project Name	Lang Walker AO Medical Research Building - Macarthur
Project Number	210196
Report Reference	210196_WSU MMRC_EIS Acoustic Assessment
Client:	Western Sydney University Penrith NSW 2751.

Revision	Description	Reference	Date	Prepared	Checked	Authorised
1	Draft	210196_WSU MMRC_EIS Acoustic Assessment	16 July 2021	Renzo Arango	-	Matthew Harrison
2	Draft	210196_WSU MMRC_EIS Acoustic Assessment	6 August 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
3	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	27 August 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
4	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	1 October 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
5	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	7 October 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
6	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	7 October 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
7	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	14 October 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
8	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	29 October 2021	Renzo Arango	Matthew Harrison	Matthew Harrison
9	For Issue	210196_WSU MMRC_EIS Acoustic Assessment	9 November 2021	Renzo Arango	Matthew Harrison	Matthew Harrison

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1 EXECUTIVE SUMMARY

A new research centre for Western Sydney University (WSU) is proposed at Campbelltown Hospital, NSW. This new research centre is known as the Macarthur Medical Research Centre (WSU MMRC).

As part of the conditions discussed the Secretary's Environmental Assessment Requirements (SEARs), an acoustic assessment is required.

Consequently, this report discusses the methodology which has been adopted to determine the assessment criteria. These criteria are used to undertake the following:

- An operational acoustic assessment; and
- An indicative assessment of potential construction activities.

Regarding the operational acoustic assessment, conceptual treatments have been provided to address the impact generated by mechanical services. This impact includes external noise emissions, internal noise emissions and internal vibration levels.

Also, performance requirements have been provided for building envelope constructions. These requirements are aimed to mitigate noise intrusion from external noise sources, such as local road traffic. Additionally, operational procedures have been advised for the use of the loading dock, so related noise emissions are minimised.

Noise emissions from vehicular activities on local roads, which are related to the use of the development, are found to be compliant with the relevant noise criteria for local roads.

In relation to the stand-by generator, performance requirements have been nominated for the acoustic enclosure. Additionally, operational procedures for maintenance operations, and architectural treatments are also recommended.

In relation to construction activities, it is recommended that a construction noise and vibration management plan (CNVMP) should be implemented to manage the noise and vibration impact onto the nearest affected premises. As part of this CNVMP, trial acoustic testing should be undertaken prior to starting vibration intensive tasks and construction activities. This testing should include noise and vibration measurements within the nearest impacted premises (most likely to be WSU Macarthur Clinical School and Hospital Building D). The testing should be conducted to validate safe working distances, acoustic impact and mitigation procedures that can be implemented in the CNVMP.

Finally, we conclude that the proposed development can achieve compliance with the acoustic conditions required in the SEARs.

2 INTRODUCTION

The WSU MMRC will be located at the location of the existing helipad (which will be relocated), between the WSU Macarthur Clinical School (WSU MCS) and Hospital Building D. As part of the response to the Secretary's Environmental Assessment Requirements (SEARs) in relation to this new development, an acoustic assessment is required. Pulse White Noise Acoustics (PWNA) has been engaged to undertake this acoustic assessment.

This report discusses the findings obtained from the acoustic assessment. This assessment addresses the impacts from typical operational activities and construction activities.

A list of acoustic terminology used in this report is included in Appendix A of this report.

2.1 Project Description

As previously mentioned, it is proposed to locate the WSU MMRC to the site where the helipad is currently situated: along Parkside Crescent, between the WSU MCS and Hospital Building D. To vacate the site for the WSU MMRC, the helipad will be relocated to the top of the new hospital building which is part of the Stage 2 Redevelopment works for Campbelltown Hospital.

The WSU MMRC will comprise the following facilities as summarised in Table 1 below. It is expected the development will accommodate 82 staff.

The WSU MMRC also includes an "amphitheatre" space which extends vertically between Lower Ground 1 to Level 0. It is intended to use this space for informal activities such as meetings and tutorials.

The development does not include a carpark. Instead, the following is proposed in providing access to the development:

- A new drop-off zone along Parkside Crescent (refer to Figure 1).

Finally, to allow for the disposal of waste, the loading strategy shown in Figure 1 below is proposed.

Operational times for the WSU MMRC extend from 7:30 am to 5:00 pm.

Table 1 Summary of facilities within the WSU MMRC

Floor Level	Entry / Shared Public	Clinical Research	Research Assessment	Dry Research	Logistics / Support	Core/Plant
Lower Ground 2	Corridors	-	-	-	Storage	Plant rooms
Lower Ground 1	Seminar rooms Amenities Storage Amphitheatre	-	-	Workspaces Meeting room Quiet room Storage	Cleaner room	Plant rooms
Level 0	Amenities Waiting areas Parents room Retreat spaces Terraces Amphitheatre	Consultation rooms Treatment rooms Interview rooms Workroom Reception Waiting/Play area Utility rooms Amenities	-	Incubator rooms Workspaces Quiet rooms Focus rooms Breakout area Maker space Storage	Cleaner room	Comms room Services shafts
Level 1	Amenities Waiting/breakout areas	Consultation rooms Treatment rooms Interview rooms Reception Utility rooms Storage Waiting areas Amenities	Physiology Room GAIT Room Ultrasound Grinding/Plaster room Storage, dirty utility Group research room PEA BOD room BOD POD room DEXA room Lab Proc. Medication room Storage	Meeting rooms Workspaces Focus rooms Quiet room Collab space Utilities	Cleaner room	Comms room Services shafts
Level 2	Amenities Waiting areas Terraces	Consultation rooms Interview rooms Reception Utility rooms Clinical workroom Amenities Storage Waiting areas	-	Meeting rooms Workspaces Focus rooms Quiet room Collab spaces Utilities	-	Plant rooms Comms room Services shafts

Figure 1 Loading strategy and location of drop-off zone

2.2 Site Layout

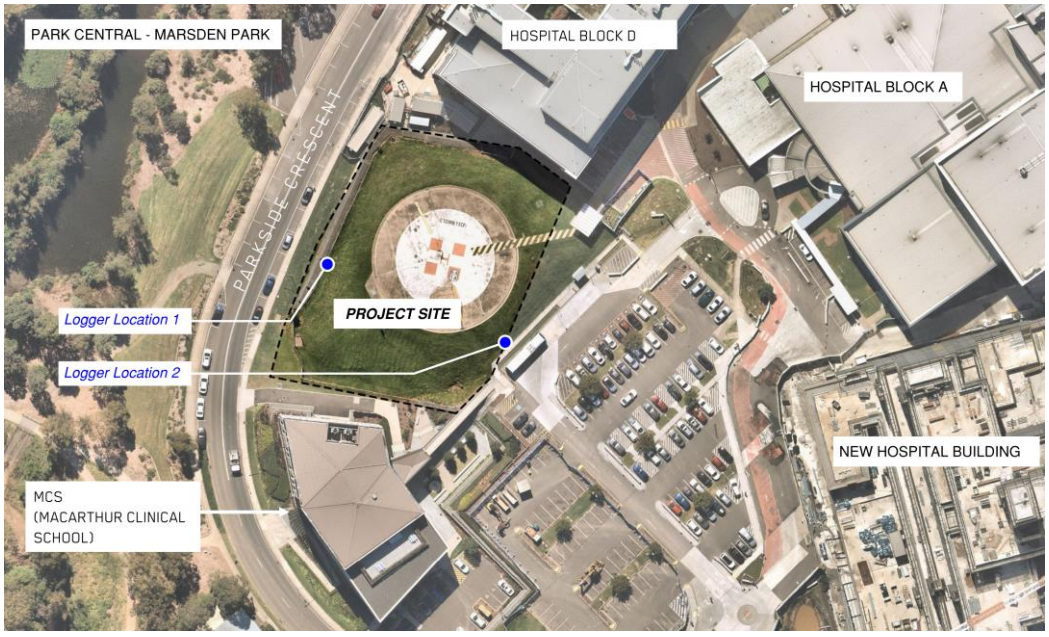
The WSU MMRC is surrounded by the following noise sensitive receivers (refer to Figure 2 and Figure 3):

- Residences along Parkside Crescent, approximately 135m east from the project site.
- Park Central, also known as Marsden Park, is located between the WSU MMRC and the residences mentioned above. This is classified as a passive recreational space.
- Residences along Therry Road, approximately 235m south from the project site.
- Along northern property boundary: Building D which is part of Campbelltown Hospital.
- Along southern property boundary: the WSU MCS which is an educational facility.
- New hospital building (part of Stage 2 Redevelopment works for Campbelltown Hospital), located at approximately 70m east from the project site. Carpark spaces and a bus stop are located between the project site and the new hospital building. This bus stop will be relocated to south of new hospital building as part of the hospital redevelopment works.

Since the receivers listed above are found to be the nearest potentially affected receivers, the acoustic assessment discussed in this report is undertaken at these receiver locations.

Figure 2 Site layout

Figure 3 Site layout and noise logger locations



2.3 Planning Secretary's Environmental Assessment Requirements (SEARs)

The sections of the SEARs which are relevant to the acoustic assessment are the following:

10. *Noise and Vibration*

- *Provide a noise and vibration impact assessment that:*
    - *includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.*
    - *details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours.*
    - *includes a quantitative assessment of the main sources of operational noise, including consideration of any mechanical services (e.g. air conditioning plant).*
    - *outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.*
    - *considers sources of external noise intrusion in proximity to the site (including, road, rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards.*
    - *demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development.*

Relevant policies and guidelines:

- *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA)*
- *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)*
- *Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006)*
- *Development Near Rail Corridors and Busy Roads - Interim Guideline (Department of Planning, 2008).*
- *Australian Standard 2363 Acoustics - Measurement of noise from helicopter operations (AS 2363).*

These requirements are addressed as follows in this report:

- The criteria used for the assessment of construction activities are discussed in Section 5. These criteria are derived in accordance with the *Interim Construction Noise Guideline.* The assessment of these construction activities and relevant outcomes are discussed in Section 7.
- For typical operational activities, the assessment criteria are summarised in Section 4. These criteria are obtained according to the *NSW Noise Policy for Industry 2017*. *Development Near Rail Corridors and Busy Roads - Interim Guideline*, and other relevant statutory requirements. The assessment of typical operational activities and relevant outcomes are discussed in Section 6.
- The requirements discussed in the document titled *Assessing Vibration: A Technical Guideline 2006* are considered for the operational acoustic assessment, as well as the assessment of construction vibration.
- Standard AS 2363-1999 is a withdrawn standard which addresses the methodology to conduct noise measurements of helicopter flight activities. The standard does not provide criteria for the assessment of noise impacts by such helicopter activities. Therefore, this report does not address the noise assessment related to helicopter flight activities according to this Standard. Nonetheless, it is stated that the sound insulation performance of the building envelope should account for helicopter noise impacts. This will be further considered as part of the detailed design development. (refer to further discussion in Section 6.3.2).

3 EXISTING ACOUSTIC ENVIRONMENT

To establish the existing background noise levels on site and at the nearest affected receivers, the following information has been considered:

- To determine existing ambient noise levels at the nearest affected receivers, the measured noise levels documented in the report titled *"Campbelltown Hospital Redevelopment Stage 2 – SSDA Acoustic Assessment Report"* (referred herein as the *CHRS2-SSDA Acoustic Report*, dated 27 July 2018, issued by Arup), were used for our assessment.

  The measurements discussed in the Arup report were undertaken prior to the COVID-19 restrictions being implemented. It is noted that vehicular traffic flows have reduced significantly since the implementation of these restrictions. Consequently, ambient noise levels have also reduced and are not considered typical. Therefore, the measured noise levels documented in the Arup report have been used to establish the noise criteria for our assessment at the nearest affected receivers.

  A summary of these measured noise levels is discussed in Section 3.2.

- To determine incident road traffic noise levels onto the building envelope of the WSU MMRC, two noise loggers were deployed on site. These measurements were conducted prior to latest COVID-19 restrictions being implemented.

  A summary of the measured noise levels obtained on site, is discussed in Section 3.3.

3.1 Unattended Noise Monitoring

An unattended noise survey was conducted between 21 June and 29 June 2021, at the following locations shown in Figure 3:

- Location 1: In proximity to western property boundary, facing Parkside Crescent.

- Location 2: Along eastern property boundary, facing hospital carpark.

As previously mentioned, this survey was conducted to determine the incident noise levels onto the building envelope of the WSU MMRC.

Instrumentation for the survey comprised two Rion NL-42 noise loggers (serial numbers 00998081 for Logger Location 1, and 00396931 for Logger Location 2). Calibration of the loggers was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Measurement data has been filtered to remove periods affected during adverse weather conditions based on weather information obtained from Campbelltown (Mount Annan) weather station (ID 068257); as well construction noise from adjacent sites within the hospital premises.

3.2 Measured Road Traffic Noise Levels

From measurements at Logger Locations 1 and 2, road traffic noise levels incident onto the project site have been determined. This information has been processed into the time periods discussed in the NSW Road Noise Policy (NSW RNP). The results are presented in Table 2 below.

Table 2 Measured noise levels for assessment of noise intrusion – Locations 1 & 2

Logger Location	Period	Measured Noise Levels (dBA)	
		Daytime/Night Time Periods	Max. 1 Hour Levels
Location 1	**Daytime: 7:00 am – 10:00 pm**	57 L_{Aeq} (15 hrs)	59 L_{Aeq} (1 hr)
	Night time: 10:00pm – 7:00 am	53 L_{Aeq} (9 hrs)	56 L_{Aeq} (1 hr)
Location 2	**Daytime: 7:00 am – 10:00 pm**	61 L_{Aeq} (15 hrs)	64 L_{Aeq} (1 hr)
	Night time: 10:00pm – 7:00 am	54 L_{Aeq} (9 hrs)	58 L_{Aeq} (1 hr)

The $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ descriptors represent the logarithmic average noise energy during the measurement period. The "15 hour" represents the daytime period between 7:00 am to 10:00 pm and the "9 hour" represents the night-time period between 10:00 pm to 7:00 am.

3.3 Measured Background Noise Levels

To determine background noise levels at nearest affected receivers, measured noise levels discussed in the *CHRS2-SSDA Acoustic Report* are used. These measurements were conducted to establish operational external noise level criteria for the Campbelltown Hospital Stage 2 Redevelopment project.

From the measurement locations used for the hospital redevelopment, two locations are found to be relevant to our project (refer to Figure 4):

- ML4: Unit 4/31-33 Georgiana Crescent, Campbelltown.
- ML5: 22 Parkside Crescent, Campbelltown.

A summary of the measured noise levels is presented in Table 3. These correspond to the residential location identified in Section 2.2.

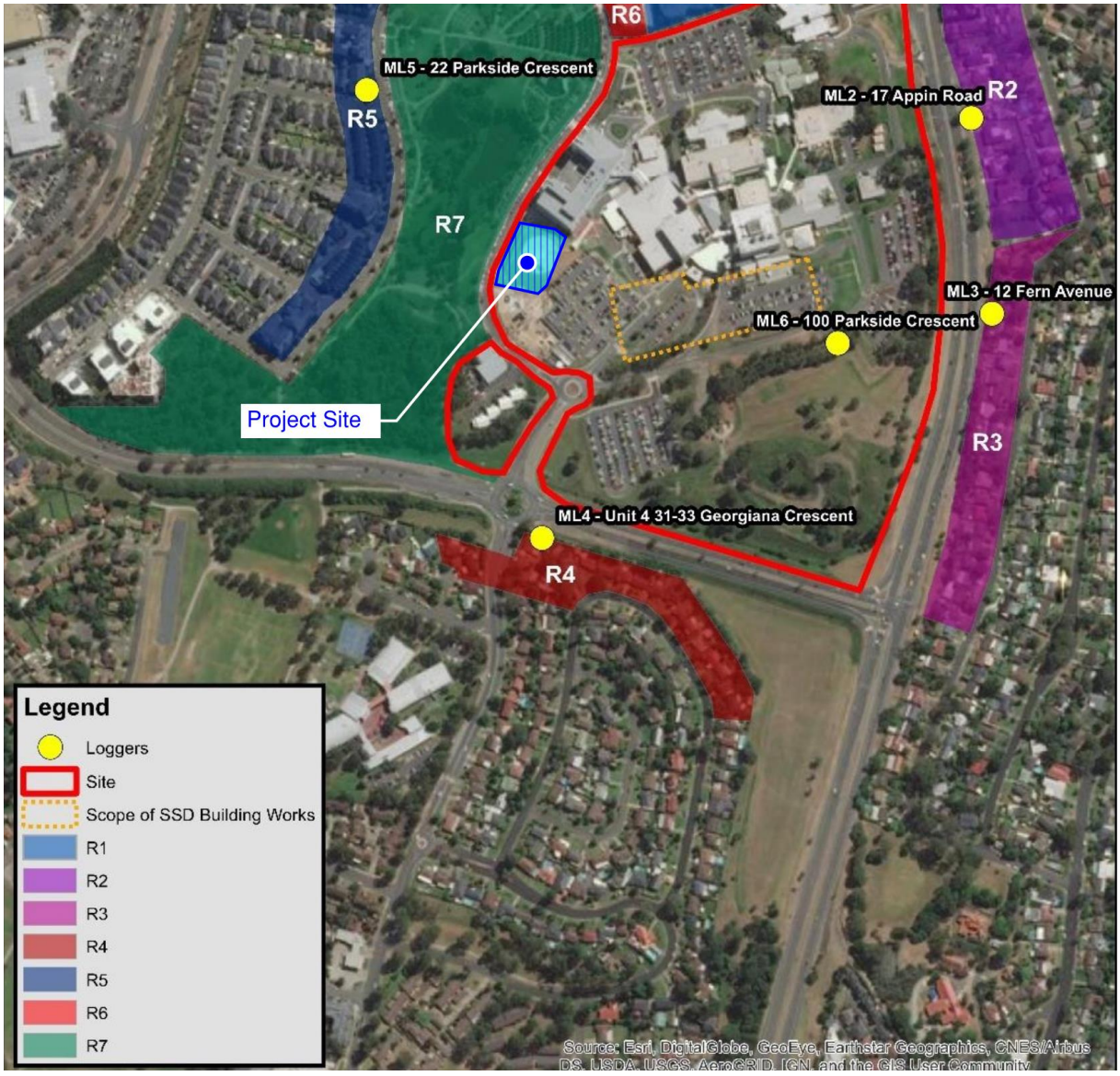
Table 3 Summary of measured ambient noise levels (from Table 4 of the CHRS2-SSDA Acoustic Report)

Measurement Location	Daytime 7:00 am to 6:00 pm		Evening 6:00 pm to 10:00 pm		Night Time 10:00 pm to 7:00 am	
	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
ML4: Unit 4/31-33 Georgiana Crescent, Campbelltown	51 dBA	61 dBA	47 dBA	57 dBA	42 dBA	55 dBA
ML5: 22 Parkside Crescent, Campbelltown	46 dBA	57 dBA	44 dBA	57 dBA	40 dBA	55 dBA

Notes:

1. *For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am*
2. *The L_{A90} noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level*
3. *The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.*

Figure 4 Site monitoring locations (from Figure 3 of the CHRS2-SSDA Acoustic Report)



4 OPERATIONAL ACOUSTIC CRITERIA

4.1 NSW Noise Policy for Industry

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

Consequently, the NSW EPA has prepared a document titled Noise Policy for Industry (NSW NPI) which provides a framework and process for determining external noise criteria and subsequent assessments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other noise sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

4.1.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minutes period, does not exceed the background noise level measured in the absence of the source by more than 5 dBA. This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

4.1.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

4.1.2.1 Area Classification

The NSW NPI characterises the "Urban" noise environment as an area with an acoustical environment that:

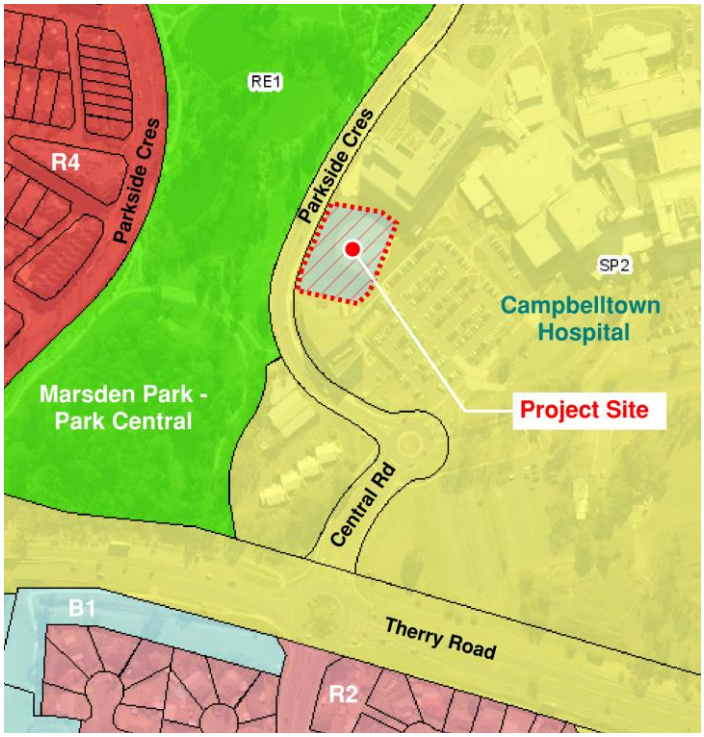
- Is dominated by "urban hum" or industrial noise source
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods
- Is near commercial or industrial districts
- Has any combination of the above

…where "urban hum" means the aggregate unidentifiable sound of man and mostly due to traffic-related sound sources.

Residences along Therry Road are zoned as R2 (refer to Figure 5). This zoning corresponds to a "suburban residential" classification in accordance with Table 2.3 of the NSW NPI. Nevertheless, the measured background noise levels (listed as location ML4 in Table 3) are more representative of an "urban residential" zone (also refer to Table 2.3 of the NSW NPI). Therefore, these residences are considered as such for the purpose of our assessment.

Residences along Parkside Crescent are also considered as "urban residential". This concurs with the zoning shown in Figure 5 (i.e. R4) and measured background noise levels (listed as location ML5 in Table 3).

Figure 5 Zoning around project site



For urban residences and non-residential receivers, the recommended amenity criteria are shown in Table 4 below.

Table 4 NSW NPI – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2]
Residence	Urban	Day	60
		Evening	50
		Night	45
Hospital wards, external	All	Noisiest 1 hour	50
Educational facilities, external [3]	All	Noisiest 1 hour, when in use	45
Passive recreation areas	All	When in use	50

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Note 3: To convert external noise levels from internal noise levels, a noise reduction of 10 dB has been assumed for open windows

4.1.3 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions derived from the measured data are presented in Table 5. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the commercial components of the development to potentially affected noise sensitive receivers.

These criteria are considered to be the overall external noise level criteria for the assessment of noise contributions from both the Stage 2 redevelopment works at Campbelltown Hospital, and the WSU MMRC.

In order to determine specific criteria for the WSU MMRC which account for the cumulative noise impact of all new developments in the hospital campus (namely Stage 2 redevelopment works for Campbelltown Hospital, and the WSU MMRC); and prevent a background noise creep; correction factors have been applied to the overall external noise level criteria. These correction factor have been implemented as follows:

- For residences along Therry Road: These residences will be equally exposed to noise emissions from the hospital redevelopment works and the WSU MMRC. Therefore a -3 dB correction is applied to the overall criteria.

- For residences along Parkside Crescent: Due to the implementation of the WSU MMRC building, these residences will be screened from most of the noise emissions by the hospital redevelopment works (i.e. no line of sight to the new hospital infrastructure). Instead, these will be exposed to noise emissions from the WSU MMRC. Therefore a 0 dB correction is applied to the overall criteria.

- Existing hospital and educational facilities (i.e. WSU MCS): These premises will be equally exposed to noise emissions from the hospital redevelopment works and the WSU MMRC. Therefore a -3 dB correction is applied to the overall criteria.

- For passive recreation areas (i.e. Park Central): These areas will be mostly exposed to noise emissions from the WSU MMRC, but screened from noise emissions by the new hospital infrastructure. Therefore a 0 dB correction is applied to the overall criteria.

It is noted in Section 2.1 that operational times for the WSU MMRC are between 7:30 am to 5:00 pm. Therefore, for residences, the only relevant assessment period is that corresponding to the daytime period; and provisionally for the evening period.

For each assessment period, the lower (i.e. the more stringent) of the amenity or intrusive criteria are adopted. These are shown in bold text in Table 5.

Table 5 External noise level criteria in accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Measured $L_{Aeq, period}$ Noise Level (dBA)	Overall External Noise Level Criteria		Correction for Cumulative Noise Impact	Criteria Including Correction for Cumulative Noise Impact	
					Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [4]		Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [4]
R2 Residences along Therry Road	Day	55	51	61	56	58	-3	**53**	55
	Evening	45	47	57	52	50	-3	49	**47**
	Night	40	42	55	47	48	N/A	-	-
R4 Residences along Parkside Crescent	Day	55	46	57	51	58	0	**51**	58
	Evening	45	44	57	49	50	0	**49**	50
	Night	40	40	55	45	48	N/A	-	-
Hospital Wards: Hospital Building D New hospital building (part of Stage 2 hospital redevelopment)	Noisiest 1 hour	50	-	-	-	53	-3	-	**50**
Educational Facilities: WSU MCS	Noisiest 1 hour, when in use	45	-	-	-	48	-3	-	**45**
Passive Recreation Areas: Park Central	When in use	50	-	-	-	53	0	-	**53**

Note 1: Project Amenity Noise Levels corresponding to "Urban" areas, equivalent to the Recommended Amenity Noise Levels (Table 4) minus 5 dBA
Note 2: L_{A90} Background Noise or Rating Background Level
Note 3: Project Noise Trigger Levels are shown in bold
Note 4: This is based on the assumption that the existing noise levels are unlikely to decrease in the future
Note 5: Minimum project intrusiveness noise level as per Table 2.1 of the NSW NPI

4.1.4 Sleep Disturbance

In accordance with the NSW NPI, sleep disturbance is to be assesses in two stages addressing the likelihood of sleep disturbance and sleep awakening.

For the criterion addressing the likelihood of sleep disturbance, the NSW NPI recommends that the maximum noise level event should not exceed the following:

- 40 dB $L_{Aeq,\ 15\ minutes}$ or the prevailing RBL plus 5 dB, whichever is the greater; and / or
- 52 dB L_{AFmax} or the prevailing RBL plus 15 dB, whichever is the greater

As a result, the following criteria are adopted as the criterion for the likelihood of sleep disturbance:

- For residences along Therry Road: 57 dB L_{Amax}.
- For residences along Parkside Crescent: 55 dB L_{Amax}.

Regarding sleep awakening, ongoing research is still being undertaken to quantify an appropriate criterion. The NSW Road Noise Policy (NSW RNP) provides guidelines and a summary of current research being undertaken on this topic. According to the NSW RNP, an accurate representation of sleep disturbance impacts on a community from a noise source is particularly difficult to quantify mainly due to differing responses of individuals to sleep disturbance – this is found even within a single subject monitored at different stages of a single night's sleep or during different periods of sleep.

In addition, the differing grades of sleep state make a definitive definition difficult, and even where sleep disturbance is not noted by the subject, factors such as heart rate, mood and performance can still be negatively affected.

An assessment of sleep disturbance should consider the maximum noise level or $L_{A1(1\ minute)}$, and the extent to which the maximum noise level exceeds the background level and the number of times this may happen during the night-time period. Factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10.00pm and 7.00am); and
- Whether there are times of day when there is a clear change in the existing noise environment (such as during early morning shoulder periods).

Currently the information relating to sleep disturbance impacts indicates that:

- Maximum internal noise levels below 50–55 dBA are unlikely to cause an awakening from a sleep state.
- One or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to affect health and wellbeing significantly.

As a result, the adopted sleep awakening criterion for the project is an internal noise level of 50 - 55 dB L_{AFmax}. This criterion is applicable for noise emissions generated by short term events occurring during the night time period. Therefore, allowing for a 10 dB noise reduction for open windows, it is proposed that the noise screening criterion for sleep awakening should be 60 - 65 dB L_{AFmax} external noise level at residential properties.

4.1.5 Emergency Plant

For emergency plant, such as stand-by generators, which only operate occasionally (such as emergencies and maintenance operations), the NSW NPI allows for modifying factors that can be subtracted from the predicted noise levels. These modifying factors should be applied prior to assessing against the external noise level criteria. These duration modifying factors are summarised in Table 6 below.

Table 6 Modifying factors for duration

Allowable Duration of Noise (one event in any 24 hour period)	Allowable Exceedance at Receiver for the Period of Noise Event	
	Daytime and Evening (7am – 10pm)	Night time (10pm – 7am)
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

Note: Where the duration of the noise event is smaller than the duration of the project trigger noise level (PNTL), that is, less than 15 minutes, the allowable adjusted project noise trigger level (APNTL) is derived as follows:

$$APNTL = 10\log((10^{\frac{PNTL}{10}}\ x\ (\frac{900 - duration}{900})) + (10^{\frac{PNTL+allowable\ exceedance\ in\ table\ above}{10}}\ x\ duration))$$

4.2 Internal Noise Level Criteria

4.2.1 The State Environmental Planning Policy (Infrastructure) 2007

The State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) was introduced to assist the delivery of necessary infrastructure by improving regulatory certainty and efficiency. The Infrastructure SEPP has specific planning provisions and development controls for various types of infrastructure, and also for developments located adjacent to infrastructure. In order to provide guidelines for this type of assessment (noise intrusion from road and rail traffic noise), the Department of Planning of the NSW Government has prepared a document titled *"Developments Near Rail Corridors and Busy Roads – Interim Guideline"* (DNRC & BR-IG).

According to Clause 102 of the Infrastructure SEPP, the DNRC & BR-IG applies to educational developments adjacent to rail corridors and busy roads. According to the DNRC & BR-IG, busy roads are defined as follows:

- Roads specified in Clause 102 of the Infrastructure SEPP: Freeway, tollway or a transitway or any other road with an average annual daily traffic (AADT) volume of more than 40,000 vehicles.
- Any other road is defined as roads with an average annual daily traffic (AADT) volume of more than 20,000 vehicles
- Any other road with a high level of truck movements or bus traffic.

According to Section 3.6 and Table 3.1 of the DNRC & BR-IG, the noise intrusion criterion for educational institutions is 40 dB L_{Aeq}. It is our understanding that this criterion applies to teaching spaces, such as Seminar Rooms.

4.2.2 Project Quality Requirements

Noise from air-conditioning plant and traffic noise intrusion are generally the principal contributors to the overall internal noise levels. Therefore, it is important that an appropriate ambient noise level is established in an educational development.

A reduced level of ambient noise is required in certain spaces to achieve good communication throughout the space. A higher level of ambient noise is generally preferable in open plan spaces to ensure a moderate level of acoustic privacy between workstations. Too loud a background noise level may, however, lead to communication difficulties and fatigue.

Project quality requirements for internal noise levels have been obtained from the following guidelines which are relevant to the WSU MMRC:

- Condition 10 - Acoustic Comfort, which is part of the Green Star – Design & As Built v1.3 rating scheme.
- Internal noise level criteria discussed in standard AS/NZS 2107:2016
- Western Sydney University, Capital Works & Facilities, Mechanical Services Design Standards (WSU CW&F MSDS), version 16.

Table 7 below summarised the internal noise level criteria from these project specific requirements.

Table 7 Summary of internal noise level criteria

Room	Internal Noise Level Criteria (dB L_{Aeq}) for Green Star Condition 10.1	Internal Noise Level Criteria (dB L_{Aeq}) based on standard AS/NZS 2107:2016	WSU CW&F Mechanical Services Design Standards v16.0 (dB L_{Aeq})	
			Satisfactory	Maximum
Seminar rooms	Max 40	35 - 45	30	35
Individual Offices (2P max capacity): Consultation rooms Treatment rooms Interview rooms Quiet rooms Focus areas (enclosed offices) Clinical workrooms	Max 45	40 - 45	35	40
Treatment Rooms: PEA BOD room BOD POD room DEXA room Ultrasound Physiology / Gait Lab Labs Proc. Room Med. Room	Max 45	40 - 45	-	-
Meeting rooms	Max 40	35 - 40	35	40
Open Office Areas: Workspaces Group research room Incubator rooms Focus areas (open offices)	Max 45	40 - 45	40	45

Room	Internal Noise Level Criteria (dB L_{Aeq}) for Green Star Condition 10.1	Internal Noise Level Criteria (dB L_{Aeq}) based on standard AS/NZS 2107:2016	WSU CW&F Mechanical Services Design Standards v16.0 (dB L_{Aeq})	
			Satisfactory	Maximum
Laboratory (working): Grinding Makerspace	Max 45	40 - 50	40	50
Breakout areas	Max 45	40 - 45	-	-
Amphitheatre Waiting areas	Max 45	40 - 45	45	50
Reception	Max 45	40 - 45	-	-
Amenities / toilets	Max 50	45 - 55	45	55
Corridors & lobbies	Max 50	45 - 50	45	50
Storage areas	-	-	45	50

4.2.3 Internal Noise Level Criteria – Operational Conditions

Based on the criteria and guidelines discussed in Sections 4.2.1 and 4.2.2, we conclude the following:

- Statutory criterion of 40 dB L_{Aeq} applies to educational spaces such as the Seminar Rooms.
- For all other internal spaces, the internal noise level criteria are not defined by certain local statutory conditions, but by quality requirements which are specific to the WSU MMRC. Subsequently, compliance with recommended internal design noise levels will be addressed as part of the assessment process to confirm fulfillment with these project specific requirements.

  These project specific requirements are listed in Table 7.

4.2.4 Emergency Operations: Standard AS/NZS 1668.1:2015

According to standard AS/NZS 1668.1:2015, internal noise levels generated by smoke control systems should comply with the following:

> *The noise level in occupied spaces during operation of the smoke control systems (including smoke exhaust fans and air pressurization fans) shall not exceed 65 dBA. Where the internal occupied ambient noise levels exceed 60 dBA, the smoke control systems shall not exceed 5 dBA above the internal occupied ambient noise levels, to a maximum level of 80 dBA.*
>
> *Noise levels in fire-isolated exits and car parks, as well as and smoke control zones served by hot layer smoke control systems shall not exceed 80 dBA.*

4.3 Noise Impact on Local Roads

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (NSW RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person

4.4 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration - from uninterrupted sources (refer to Table 8).
- Impulsive vibration - up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 9).
- Intermittent vibration - such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 10).

Table 8 Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions, and places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 9 Impulsive vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions, and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 10 Intermittent vibration impacts criteria (m/s$^{1.75}$) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

5 CONSTRUCTION NOISE & VIBRATION CRITERIA

5.1 Construction Noise Criteria

5.1.1 Interim Construction Noise Guideline

Noise criteria for construction and demolition activities are discussed in the *Interim Construction Noise Guideline* (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in Table 11 below.

Specific non-residential receivers in the vicinity of the proposed construction site, and their recommended 'management levels', are presented in Table 12.

Based on the measured background noise levels summarised in Section 3, the NMLs to be used in this assessment are listed in Table 13.

It is our understanding that construction works will be conducted under typical standard construction hours.

Finally, it is noted that construction of the main clinical services building at Campbelltown Hospital (part of Stage 2 redevelopment works) will be completed in early 2022. According to the preliminary construction program for the WSU MMRC (shown in Appendix B), construction works will start in mid-2022. Therefore, it is unlikely major construction works for the separate developments will occur concurrently. Consequently, we are of the opinion that there is no need for adjusting the construction noise criteria as it has been implemented for the operational noise criteria (refer to discussion in Section 4.1.3).

Nevertheless, it is advised that this is confirmed as part of the construction noise and vibration management plan (refer to Section 7.4.1).

Table 11 NMLs for quantitative assessment at residences (from ICNG)

Time of Day	Noise Management Level $L_{Aeq(15minute)}$[1,2]	How to Apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1 *Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

Note 2 *The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).*

Table 12 NMLs for quantitative assessment at non-residential receivers

Land Use	$L_{Aeq(15minute)}$ Construction NML
Hospital wards, external: [1] Hospital Building D New hospital building (part of Stage 2 hospital redevelopment)	External noise level 55 dBA
Educational facilities, external: [1] WSU MCS	External noise level 55 dBA
Passive recreation areas: Park Central	External noise level 60 dBA
Note 1: External noise level criterion estimated from internal noise level criterion assuming a 10 dB noise level difference for open windows	

Table 13 NMLs as basis for the acoustic assessment

Receiver Types	NML, dB $L_{Aeq(15minute)}$	
	Standard Hours **Monday to Friday: 7 am to 6 pm** **Saturday: 8 am to 1 pm**	**Outside Standard Hours**
R2 Residences along Therry Road	61	N/A
R4 Residences along Parkside Crescent	56	N/A
Hospital wards, external: [1] Hospital Building D New hospital building (part of Stage 2 hospital redevelopment)	55 (external)	N/A
Educational facilities, external: [1] WSU MCS	55 (external)	N/A
Passive recreation areas: Park Central	60 (external)	N/A

5.1.2 Sleep Disturbance

As discussed in Section 5.1.1, it is noted that construction works will be undertaken during standard construction hours. These standard hours are only part of the daytime period. Therefore, a sleep disturbance assessment is not required.

5.2 Construction Traffic Noise Criteria

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (NSW RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

5.3 Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed. Refer to further discussion in Section 4.4
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 5.3.1
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 5.3.1
- Effects on scientific and medical equipment – where vibration can have an impact on the functionality of scientific and medical equipment. Refer to discussion in Section 5.3.2

5.3.1 Vibration Criteria – Building Contents & Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration"* (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999).

5.3.1.1 Standard BS 7385 Part 2 – 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 14 and illustrated in Figure 6.

Table 14 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 6	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in Table 14 relate to transient vibration which does not cause resonant responses in buildings.

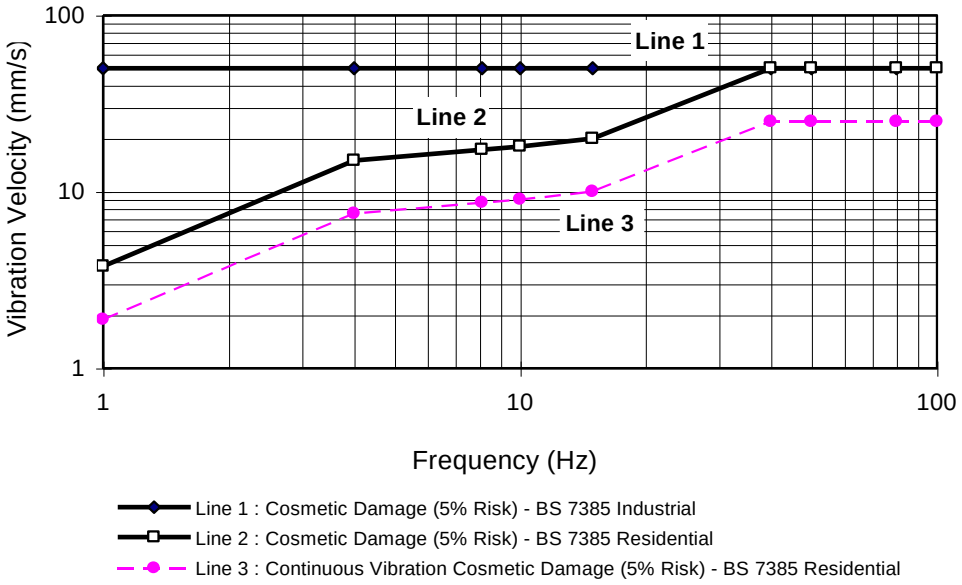
Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 14 may need to be reduced by up to 50% (refer to Line 3 in Figure 6).

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 14, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 14 should not be reduced for fatigue considerations.

Figure 6 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



5.3.1.2 Standard DIN 4150 Part 3 – 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 15. The criteria are frequency dependent and specific to particular categories of structures.

Table 15 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
Note 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.				

5.3.2 Scientific and Medical Equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

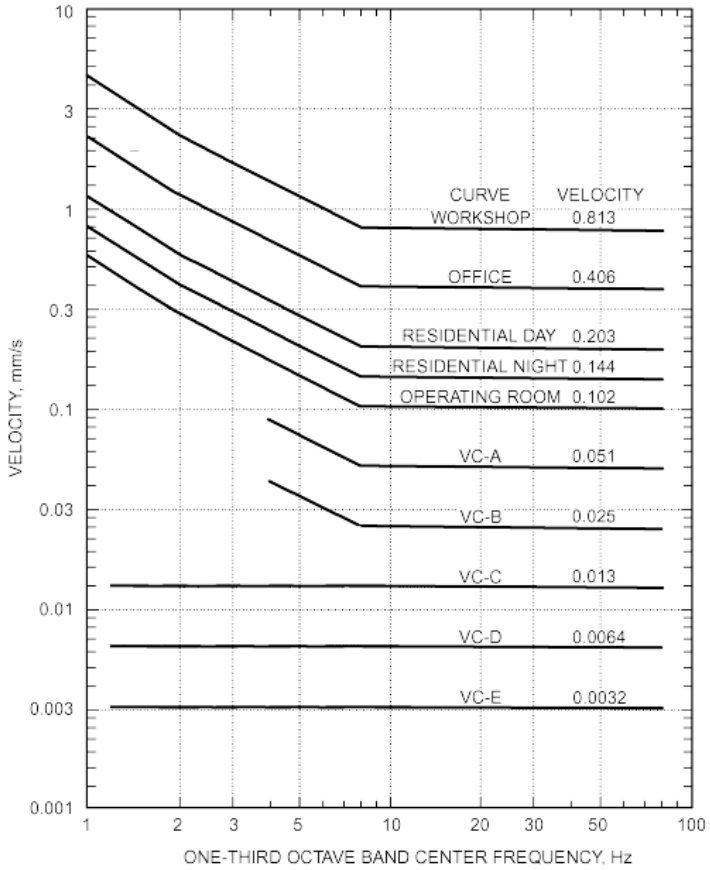
Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use at the nearest existing hospital buildings, objectives for the satisfactory operation of the instrument should be sourced from manufacturer's data.

Where manufacturer's data is not available, generic vibration criterion (VC) curves may be adopted as vibration goals. These generic VC curves are presented below in Table 16 and Figure 7.

Table 16 Criteria for vibration sensitive equipment

Equipment	Curve
Bench microscopes up to 100× magnification; laboratory robots	0.102 mm/s
Bench microscopes up to 400× magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators; microelectronics manufacturing equipment; proximity and projection aligners, etc.	0.051 mm/s VC-A
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400×; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3 mm line widths	0.025 mm/s VC-B
Electron microscopes up to 30 000× magnification; microtomes; magnetic resonance imagers; microelectronics manufacturing equipment, such as lithography and inspection equipment to 1 mm detail size	0.013 mm/s VC-C
Electron microscopes at magnification greater than 30 000×; mass spectrometers; cell implant equipment; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of 1/2 µm; includes electron beam systems	0.0054 mm/s VC-D
Non-isolated laser and optical research systems; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of 1/4 µm; includes electron beam systems	0.0032 mm/s VC-E

Figure 7 Criteria for vibration sensitive equipment (ASHRAE 2007, HVAC Applications, Chapter 47 "Sound and Vibration Control")



5.4 Ground-Borne Noise Criteria

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. The following ground-borne limits for residences are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels 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 (6 pm to 10 pm) - Internal: 40 dB $L_{Aeq\ (15\ min)}$
- Night-time (10 pm to 7 am) - Internal: 35 dB $L_{Aeq\ (15\ min)}$

Mitigation options to deal with ground-borne noise may include extensive community consultation to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours.

It is noted that no construction works are currently proposed for the evening and night-time periods, therefore, an assessment of ground-borne is not currently required for this development.

6 OPERATIONAL ACOUSTIC ASSESSMENT

6.1 External Noise Emissions - Building Services

New mechanical plant will be implemented as part of the WSU MMRC development. At the time of issuing this report, no noise data or technical information has been provided regarding these proposed building services.

Therefore, the mechanical plant design and equipment selection should be made so that the aggregate noise level from all external emissions, comply with the external noise level criteria discussed in Section 4.1.

This should be conducted as part of the detailed assessment of mechanical noise emissions which is required to be undertaken during t the later design stages.

The following design measures could be considered as part of the detailed design stage in order to achieve compliance:

- Mechanical plant installation locations and the positioning of external air duct paths (such as inlets and outlets) near the property boundary should be limited, as far as practicable.
- Plant room walls should achieve a minimum airborne sound insulation performance of Rw 45 -50. Whenever possible, the plant rooms should only be accessible from inside the building.
- If airflow paths are required to/from outside (such as outside air, exhaust air, relief air, etc) these paths should be fully ducted and include minimum 50 mm thick internal insulation; and / or include acoustic louvres. When the extent of ductwork is not sufficient for treatment, then rectangular silencers may be required (this especially applies to fans and AHUs).
- Ornamental louvres should generally only be considered if they are blanked off with FC sheeting or plant room external walls (subject to further Detailed Design acoustic assessment).
- All plant room walls and roof / ceiling to be internally lined with insulation, which in combination with insulation facing, should achieve a minimum noise reduction coefficient (NRC) rating of 0.8.
- AHUs and FCUs should include return air / outside air plenums which are in internally lined with minimum 50 mm thick insulation.
- Variable speed drives should be implemented whenever possible.
- Reduce the number of operational plant items between 6:00 pm and 7:00 am (and during the night-time period generally).
- Outdoor units and other plant items to be screened from direct line of sight to the affected residences (depending on their locations).

The above recommendations should be considered as in-principle, best practice acoustic treatment that will need to be confirmed during detailed design stages.

Finally, the following is recommended regarding the installation of air-cooled chillers that are to be located in the Level 2 roof plant room:

- Each chiller should not exceed a maximum case radiated sound power level of 72 dBA. If this recommended sound power level is not a feasible measure to be obtained, then further acoustic treatments are to be considered such as solid screen barriers and acoustic louvres.
- Chillers should be located at a minimum distance of 15 m from nearest façade of the WSU MCS.
- Noise emissions from the chillers, in conjunction with noise emissions from other plant items, should not exceed external noise level criteria discussed in Section 4.1.

6.2 Internal Noise Emissions – Building Services

As discussed in Section 6.1, the mechanical ventilation design is still ongoing at the time of issuing this report. Nevertheless, it is advised that this should be designed to achieve the internal noise level criteria discussed in Section 4.2.

All emergency plant (such smoke exhaust fans, smoke spill air fans and stair pressurisation fans) should comply with the criteria discussed in standard AS/NZS 1668.1:2015 (refer to Section 4.2.4).

Mechanical plant should be resiliently mounted. Vibration isolation mounts and supports should be designed to achieve compliance with vibration criteria discussed in Section 4.4.

6.3 Architectural Treatment (Building Envelope)

6.3.1 Preliminary Assessment – Rail Corridors

Section 3.5.1 of the DNRC & BR-IG provides a guide to the level of assessment required based on distances from the rail corridor. These are illustrated in Figure 8 and Figure 9 below.

In relation to Figure 8, developments located within Zone A require a full acoustic assessment. For developments within Zone B, standard acoustic mitigation measures are advised.

Regarding Figure 9, the WSU MMRC is referred as "other vibration sensitive building". Hence, this development would only require a rail vibration assessment (according DNRC & BR-IG) if it is situated within 60 m from the rail corridor.

Figure 8 Preliminary assessment for rail noise (Figure 3.1 of the DNRC & BR – IG)

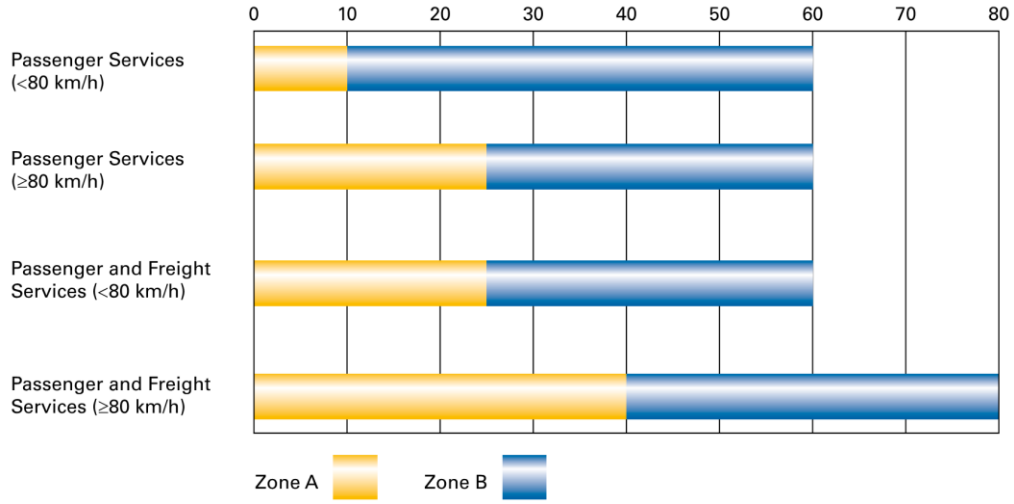


Figure 3.1: Acoustic Assessment Zones based on distance (m) of noise-sensitive development from operational track (not corridor)

Figure 9 Preliminary assessment for rail vibration (Figure 3.2 of the DNRC & BR – IG)

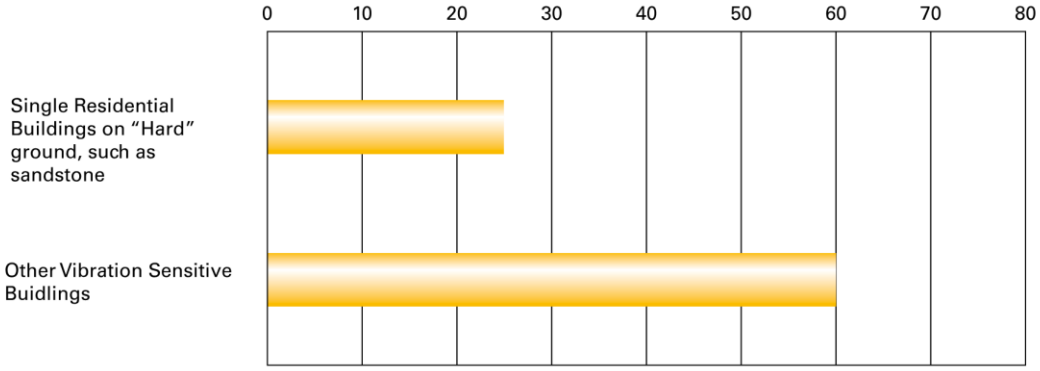


Figure 3.2: Distance from the nearest operational track (m)

The nearest rail corridor to the site is part of the Main Southern Railway. At its closest, the rail corridor is located at approximately 750 m. Therefore, based on this distance, an assessment for rail noise and vibration is not required.

6.3.2 Building Envelope Assessment

According to flowchart shown in Section 3.5 of the DNRC & BR-IG, an acoustic assessment is still recommended because the WSU MMRC is not a residential development. It is noted from site measurements that the dominant external noise sources comprise local road traffic. Existing ambient noise levels have been determined through the noise survey undertaken on site. These noise levels have been summarised in Section 3.2, and are used in our conceptual assessment of the building envelope.

Therefore, to achieve compliance with the internal noise level criteria discussed in Section 4.2, it is advised that all glazed façade constructions should achieve the minimum sound insulation performances tabulated in Table 17 below.

Table 17 Required minimum sound insulation performances for glazed façade constructions

Room	Façade Location	Overall Sound Insulation Performance Rw (C; Ctr)	Min. Sound Insulation Performance in Octave Band Centre Frequencies							
			63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz
Seminar rooms	Southern facade	Rw 38 (-1; -3)	24	27	31	35	36	41	50	46
Meeting rooms Quiet rooms	Southern & eastern facade	Rw 37 (-1; -3)	24	27	31	35	35	40	49	46
	Northern & western facade	Rw 36 (-1; -3)	23	25	29	33	36	37	47	46
Consultation rooms Interview rooms	Northern & western facade	Rw 36 (-1; -3)	23	25	29	33	36	37	47	46
Open office areas Workspaces Treatment Rooms	All facades	Rw 35 (-1; -3)	21	23	27	32	35	36	44	46

Additionally, all external doors (including sliding doors) should achieve a minimum sound insulation performance of Rw 35.

Please note sound insulation performance of windows is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is advised window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track.

As per the windows, the performance of sliding doors is not only subject to the glass selection, but also to the door frame construction and frame seals. Therefore, it is recommended that the door manufacturer confirms that the door system achieves the required performance. Typically, these doors should include fin rubber seals and Q-Lon seals, with deep C channels as part of the door track and laminated glass panels.

Non-glazed components should achieve a minimum sound insulation performance of Rw 45 – 50.

It is advised that the performances listed in Table 17 should be further revised during detailed design stages. This revision during detailed design stages should also consider the noise impact by helicopter flight activities.

It is noted that the existing helipad which occupies the project site will be relocated to the top of the new hospital building which is part of the Stage 2 Redevelopment works at Campbelltown Hospital. At this new location, the flight paths for the new helipad do not extend over the project site, as shown in Figure 10 (provided by Avipro via email on 9 July 2021).

Figure 10 Flight paths for new helipad as part of Stage 2 Redevelopment works at Campbelltown Hospital

6.4 Loading Dock for Waste Collection

6.4.1 Methodology

As shown in Figure 1, the waste collection area is accessible from Parkside Crescent. It is assumed collection will be conducted by a front loaded or rear loaded, heavy rigid, waste collection truck.

For our assessment, the sound power levels summarised in Table 18 are considered. It is also assumed that the garbage truck operates at a maximum speed of 35 km/hour when arriving or departing from site.

Table 18 Sound power levels for garbage truck movements and activities

Vehicular Activity	Sound Power Level (dB re 1pW) [1]
Garbage truck pass-by	104 dB L_{Amax}
Truck door closing [2]	99 dB L_{Amax}
Engine start	94 dB L_{Amax}
Beeping alarm	100 dB L_{Amax}

Note 1: Noise information used for the prediction of $L_{Aeq,15\ minutes}$ noise levels

Vehicle movements were modelled as line sources with sound power levels corrected for length, assessment time (i.e. 15 minutes), and number of movements. Hence, the following equation has been used:

SWL line source = SWL base sound power level + 10 log (t event / t assessment period) + 10 log (N)

Where:

SWL line source:	Sound power level of line source
SWL base sound power level:	Base sound power levels as listed in Table 18
t event:	Duration of individual event in seconds
t assessment period:	Assessment period in seconds (900 seconds which corresponds to 15 minutes)
N:	Number of events

Also, it is noted that for light vehicle movements, engine noise was modelled at an elevation of 1m above ground level.

6.4.2 Predicted Noise Levels

Table 19 and Table 20 summarise the predicted noise levels related to the use of the loading dock for waste collection. These noise levels have been estimated at the nearest affected receivers.

Please note that for the sleep disturbance assessment, Building D (part of Campbelltown Hospital), has been included since it is noted that ward areas and bedrooms are located along its southern façade.

Table 19 Predicted L_{Aeq} noise levels and subsequent assessment

Receiver	Predicted Noise Levels (dB $L_{Aeq,\ 15\ minutes}$)	Noise Emission Criteria (dB $L_{Aeq,\ 15\ minutes}$)	Assessment Outcomes
Residential: 12 Parkside Crescent, Campbelltown	30 - 35	Day: 51 Evening: 49 Night: 45	Compliance
Campbelltown Hospital, Building D	Less than 30	53	Compliance
WSU Macarthur Clinical School (WSU MCS)	55 - 60	48	Non-compliance

Note 1: Exceedances of 1-2 dB are considered to be marginal since these are found to be subjectively imperceivable

Note 2: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 amzz

Table 20 Predicted L_{Amax} noise levels and subsequent assessment

Receiver	Predicted Noise Levels (dB L_{Amax})	Noise Emission Criteria (dB L_{Amax})	Assessment Outcomes
Residential: 12 Parkside Crescent, Campbelltown	50	Sleep disturbance: 55 Sleep awakening: 60-65	Sleep disturbance & awakening unlikely to occur
Campbelltown Hospital, Building D	40	Sleep disturbance: 55 Sleep awakening: 60-65	Sleep disturbance & awakening unlikely to occur

Note 1: Exceedances of 1-2 dB are considered to be marginal since these are found to be subjectively imperceivable

From Table 19 and Table 20, the following is observed:

- Compliance is achieved with L_{Aeq} noise levels except at the WSU MCS. This noise impact at WSU MCS could become more crucial since it is noted that a lecture theatre is located along its northern façade (this facade is adjacent to the arrival path proposed for the loading dock, refer to Figure 1).

- Compliance is achieved with L_{Amax} noise levels. Therefore, it is unlikely that sleep disturbance and sleep awakening events will occur at nearest impacted residences and Building D.

Therefore, based on the assessment outcomes summarised above, it is advised that the waste disposal and use of the loading dock should be undertaken outside the operational times proposed for the WSU MMRC and the WSU MCS (it is verbally confirmed that both operational times are similar).

6.5 Noise Impact on Local Roads

To induce a 2 dB increase in existing traffic noise levels, the vehicular traffic generated by the WSU MMRC would need to result in a 60% increase in the existing traffic volumes.

As discussed in Section 2.1, the development will accommodate 82 staff and approximately 85 clients. For comparison purposes, please note that only the seven-storey carpark building at Campbelltown Hospital provides 1032 car spaces. This excludes the additional carpark spaces available throughout the hospital campus. Therefore, the traffic generated by the WSU MMRC represents much less than 60% of the existing vehicular traffic generated by the hospital.

Furthermore, Appin Road has an existing annual average daily traffic (AADT) volume of between 20,000 and 40,000 vehicles. Therefore, the traffic generated by the WSU MMRC also represents less than 60% of the existing traffic volume along Appin Road.

Consequently, based on the observations above, it is not expected that the vehicular traffic related to the WSU MMRC will have a noise impact on local roads. Additionally, the allocation of carpark spaces for the use of WSU MMRC staff and patrons within the hospital campus, is also not expected to cause a noise impact within the hospital or at nearest noise affected receivers.

6.6 Stand-by Generator

One stand-by generators is to be installed on the Level 2 roof plant room (refer to Figure 11). Therefore, the following sub-sections discuss the conceptual treatments recommended to achieve compliance with the external noise emission criteria discussed in Section 4.1 (by also considering modifying factors for duration).

Figure 11 Proposed location for stand-by generator (Level 2 roof plant room)

6.6.1 Acoustic Performance & Requirements

Stand-by generator should be installed within an acoustic enclosure / canopy. Air intake and discharge should comprise acoustic louvres or silencers to achieve compliance with the maximum noise level requirement stated below. Likewise, the exhaust system should include mufflers which should be selected to achieve compliance with the recommended maximum noise level requirement.

External noise emissions for the generator, when contained within the manufacturer's acoustic canopy, should not exceed a maximum sound pressure level of **61 dBA at 7 m** from the containerised unit, on any direction around the unit. These measurements should be undertaken under free field conditions and without wall reflections.

Therefore, please note, this maximum noise level requirement is not a spatial average of noise measurements obtained around the containerised unit; but the maximum sound pressure level that should not be exceeded when measured at any location around the unit, at 7 m from the generator.

The sound pressure level from the generator plant room at 7 m should include (but not be limited to) the noise contributions generated by the exhaust system, air inlet, air outlets; as well as the noise break-out from the walls, doors and roof of the acoustic container.

Stand-by generator should be resiliently mounted.

6.6.2 Operational Procedures for Maintenance Operations

It is our understanding that maintenance operation for the stand-by generators will be undertaken once a month for a maximum period of 1 hour. Therefore, the following is recommended in relation to procedures for maintenance operations:

- Only one stand-by generator should be operated at a time (regardless if the generator is part of the base building or tenancy infrastructure).
- Instead of load banks, the load provided by the building should be used as part of the maintenance operations.
- Maintenance operations should only be conducted between 7:00 am and 6:00 pm; and outside business hours.
- Each maintenance operation should only be undertaken for a maximum period of 1 hour.
- Only one maintenance operation can be conducted in any 24-hour period.

6.6.3 Architectural Treatments

It is advised that the containerised generator should be installed at a minimum distance of 22 m from the nearest façade of the WSU MCS.

7 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

7.1 Construction Noise Assessment

An interim high-level construction program has been provided in the report titled *"Construction Management Plan, Macarthur Medical Research Centre"* (dated July 2021, issued by CPM Consulting, referred herein as the *CMP Report*). From this high-level program and the CMP Report, construction and demolition tasks have been assumed for our assessment. These are summarised in Table 21 below, along with the equipment likely to be used in each task and their sound power levels.

The high-level program obtained from the CMP Report, is included in Appendix B of this report.

Table 21 Summary of sound power levels

Tasks	Equipment	Max. Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Site establishment	Excavator (approx. 20 tonne)	107	114
	Mobile crane	110	
	Power hand tool (electric)	103	
	Forklift	106	
	Semi - trailer (idle)	102	
Site clearance, demolition & bulk earthworks	Dump truck	109	124
	Skid steer	110	
	Compactor	107	
	Forklift	106	
	Hand-held jackhammer (for pile trimming)	116	
	Concrete pump	103	
	Concrete truck	107	
	Piling rig	113	
	Mini grader	108	
	Rock hammer (mounted to excavator)	122	
	Excavator (approx. 20 tonne)	107	
Structure	Concrete pump	103	115
	Concrete truck	107	
	Delivery truck (idle)	106	
	Concrete vibrator	103	
	Mobile crane	110	
	Power hand tool (electric)	103	
	Forklift	106	
	Elevating work platform	105	
	Welder	101	

Tasks	Equipment	Max. Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Façade & fitout	Delivery truck (idle)	106	121
	Mobile crane	110	
	Power hand tool (electric)	103	
	Forklift	106	
	Elevating work platform	105	
	Angle grinder	102	
	Core drill	113	
	Concrete saw	119	
	Welder	101	
	Nail gun	103	
External works	Welder	101	120
	Concrete saw	119	
	Delivery truck (idle)	106	
	Mobile crane	110	
	Power hand tool (electric)	103	
	Elevating work platform	105	
	Forklift	106	
	Blower	98	

For this assessment, the nearest affected receivers on which our assessment is conducted, are listed in Table 22 below.

Based on the equipment sound power levels given in Table 21, noise levels have been predicted at these nearest affected properties for each construction scenario (where each construction scenario comprises two or more construction tasks). These predicted noise levels are summarised in Table 23.

These predicted noise levels have been assessed against the construction noise criteria discussed in Section 5.1. The outcomes of this assessment are summarised in Table 24.

Table 22 Receiver IDs for assessment purposes

Receiver ID	Noise Sensitive Locations	Type
RE01	12 Parkside Crescent, Campbelltown	Residential
RE02	35 Georgiana Crescent, Ambervale	Residential
ED01	WSU Macarthur Clinical School (WSU MCS)	Educational
ME01	Campbelltown Hospital, Building D	Hospital
PR01	Park Central – Marsden Park	Passive Recreation Area

Table 23 Predicted external $L_{Aeq\ (15\ minutes)}$ noise levels at residential receivers

Scenario	Tasks	Aggregate Sound Power Level per Scenario (dBA re 1pW)	Predicted $L_{Aeq,\ 15min}$ Noise Levels, dBA				
			RE01	RE02	ED01	ME01	PR01
1	Site establishment	114	57-60	50-55	65-80	65-90	65-75
2	Site clearance & bulk earthworks	124	66-70	60-65	75-90	75-95	75-85
3	Structure	115	60-65	55-60	65-85	65-90	70-80
4	Structure, façade & fitout, external works	125	70-75	63-68	70-90	70-95	75-85
5	Façade & fitout, external works	125	70-75	63-68	70-90	70-95	75-85

Table 24 Summary of assessment outcomes and exceedances based on the ICNG criteria

Scenario	Parameter	Assessment Outcome				
		RE01	RE02	ED01	ME01	PR01
1	*Predicted Noise Levels, dBA*	*57-60*	*50-55*	*65-80*	*65-90*	*65-75*
	Within standard construction hours					
	Exceedance over NML, dB	1-4	0	10-25	10-35	5-15
2	*Predicted Noise Levels, dBA*	*66-70*	*60-65*	*75-90*	*75-95*	*75-85*
	Within standard construction hours					
	Exceedance over NML, dB	10-14	4	20-35	20-40	15-25
3	*Predicted Noise Levels, dBA*	*60-65*	*55-60*	*65-85*	*65-90*	*70-80*
	Within standard construction hours					
	Exceedance over NML, dB	4-9	0	10-30	10-35	10-20
4	*Predicted Noise Levels, dBA*	*70-75*	*63-68*	*70-90*	*70-95*	*75-85*
	Within standard construction hours					
	Exceedance over NML, dB	14-19	2-7	15-35	15-40	15-25
5	*Predicted Noise Levels, dBA*	*70-75*	*63-68*	*70-90*	*70-95*	*75-85*
	Within standard construction hours					
	Exceedance over NML, dB	14-19	2-7	15-35	15-40	15-25

*Note 1: Nil exceedances (i.e. 0 dB shown with **green** font) indicate compliance. Exceedances shown with **orange** font indicate noise affected receivers. Exceedances shown with **red** font indicate highly noise affected receivers*

Consequently, from the assessment summarised in Table 24, the following is noted:

- All assessed residential receivers are likely to be noise affected by construction activities.
- The WSU MCS and Building D which is part of Campbelltown Hospital, are likely to be affected or highly affected by construction activities. Due to the nature of the construction works and site conditions, it is difficult to predict the internal acoustic impact within these buildings, except to note that there will be internal spaces which will be highly impacted. Therefore, as part of the construction management procedures, it is advised that trial acoustic testing should be undertaken prior to the start of construction and demolition works. This is recommended in order to properly determine the impact on users and instrumentation (refer to Section 7.4).

- Passive recreation areas at Park Central, are likely to be noise affected during construction works.

Therefore, based on these findings, the conceptual management procedures discussed in Section 7.4 are recommended.

7.2 Construction Traffic Noise Assessment

No information regarding vehicular traffic movements related to construction activities; is available at this stage. Nevertheless, it is noted that vehicle numbers on surrounding roads would need to increase by around 60% from existing traffic flows, for a 2 dB increase in road traffic noise to occur.

7.3 Vibration Assessment

To retain compliance with the human comfort vibration criteria discussed in Section 5.3, it is recommended that the indicative safe distances listed in Table 25 should be maintained. These indicative safe distances should be validated prior to the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

Since the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort, vibration validating measurements should be conducted at each site to determine the vibration level and potential impact onto this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 5.3. This information should also be included as part of the construction noise and vibration management plan (CNVMP).

Table 25 Recommended indicative safe working distances for vibration intensive plant

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage (BS 7385: Part 2 DIN 4150: Part 3)	Human Comfort (AVTG)
Vibratory roller	< 50 kN (Typically 1 – 2 tonnes)	5	15 – 20
	< 100 kN (Typically 2 – 4 tonnes)	6	20
	< 200 kN (Typically 4 – 6 tonnes)	12	40
	< 300 kN (Typically 7 – 13 tonnes)	15	100
	> 300 kN (Typically more than 13 tonnes)	20	100
Small hydraulic hammer	300 kg, typically 5 – 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg, typically 12 – 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg, typically 18 – 34 tonnes excavator	22	73
Vibratory pile driver	Sheet piles	2 – 20	20
Jackhammer	Hand held	1	Avoid contact with structure and steel reinforcements

7.4 Noise & Vibration Management Procedures

The contractor should develop a construction noise and vibration management plan (CNVMP) in order to implement mitigation measures to manage the noise and vibration impact onto the potentially affected receivers.

The following sub-sections discuss the issues and measures that can be considered as part of this CNVMP.

For any management procedures and measures to control noise and vibration impact onto WSU MCS and within the premises of Campbelltown Hospital (including Building D), it is advised that the contractor coordinate these procedures and measures in consultation with Western Sydney University and NSW Health Infrastructure.

Noise and vibration management procedures discussed herein should be consider in conjunction with recommendations discussed in Section 4.7.2 of the CMP Report.

7.4.1 Confirmation of Simultaneous Construction Works

As discussed in Section 5.1.1, it is envisaged that major construction from the Stage 2 redevelopment works will not occur concurrently with those programmed for the WSU MMRC. However, due to unforeseen delays caused by the lockdown restrictions, there might be unexpected extensions to the construction programs.

Therefore, as part of the CNVMP, it is advised to confirm not major works will be conducted simultaneously for these separate projects. However, if that occurs, the NMLs should be adjusted accordingly to prevent a creep of overall construction noise emissions.

7.4.2 Noise Mitigation Measures

A detailed construction program should be provided which should include the following:

- Schedule of construction activities (classified into scenarios if applicable)
- List of construction equipment per activity
- Location of construction equipment
- Duration of construction activities, as well as proposed construction hours

This construction program should be issued to assist on the prediction of the noise impact and to develop mitigation measures that can ameliorate this impact. A 3D computer noise model can be produced to conduct the noise level predictions and undertake the relevant assessment. The outcomes of this assessment should be discussed in the CNVMP.

The contractor should, where reasonable and feasible, apply best practice noise mitigation measures. These measures include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

To minimise noise impacts during the works, the contractor should take all reasonable and feasible measures to attenuate the noise impact. Hence it is advised that on-site monitoring be conducted to attest this impact and propose mitigation measures as construction activities develop.

The contractor should also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

A potential approach would be to schedule a respite period after continuous construction activity, or undertaking high noise generating works to less sensitive times.

Finally, undertake an assessment of road traffic noise generated by light and heavy vehicle movements which are associated with the development construction. For this purpose, request a traffic study report to determine the relevant traffic flows and assess the predicted road traffic noise levels in accordance with the criteria discussed in Section 5.2.

7.4.3 Vibration Mitigation Measures

The following vibration mitigation measures are recommended to be considered as part of a CNVMP:

- Any vibration generating plant and equipment is to be located in areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Identify of other vibration sensitive structures such as tunnels, gas pipelines, fibre optic cables, Sydney Water retention basins. Specific vibration goals should be determined on a case-by-case basis by an acoustic consultant which is to be engaged by the construction contractor.
- Identify heritage structures as well as vibration sensitive premises (such as those containing scientific and surgery equipment). Safe working distances from vibration generating equipment should be established in order to achieve compliance with the criteria discussed in Section 5.3.

  Hence, it is advised to conduct attended measurements of vibration generating plant at commencement of works to confirm compliance with vibration criteria discussed in Section 5.3. Measurements should be conducted at the nearest affected property boundary. If possible, measurements will also be used to validate the safe working distances advised in Table 25 and to establish safe working distances suitable to the project.

  Trial measurements should especially consider the impact onto the WSU MCS and Building D which is part of Campbelltown Hospital.
- Use lower vibration generating items of construction plant and equipment, that is, smaller capacity plant.
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Schedule a minimum respite period prior to long continuous activities.
- Use only dampened rock breakers and/or "city" rock breakers to minimise the impacts associated with rock breaking works.

7.4.4 Miscellaneous Measures

Deliveries should be undertaken, where possible, during standard construction hours.

Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles on site; and monitor the profiles in use.

It is advised that mobile plant and trucks operating on site for a significant portion of the project are to have reversing alarm noise emissions minimised. Broadband "quacker" reversing alarms should be used in preference to tonal alarms. This is to be implemented subject to recognising the need to maintain occupational safety standards.

No public address system should be used on site.

A complaint response procedure should be implemented. Information to be gathered as part of this process should include location of complainant, time/s of occurrence of alleged noise or vibration impacts (including nature of impact particularly with respect to vibration), perceived source, prevailing weather conditions and similar details that could be utilised to assist in the investigation of the complaint. All resident complaints will be responded to in the required timeframe and action taken recorded.

8 CONCLUSIONS

Pulse White Noise Acoustics (PWNA) has been engaged to undertake an acoustic assessment for a new research centre for Western Sydney University (WSU), namely the Macarthur Medical Research Centre (WSU MMRC). The WSU MMRC will be located within the campus of Campbelltown Hospital, along Parkside Crescent; between the WSU Macarthur Clinical School (WSU MCS) and Hospital Building D. The site is currently occupied by the hospital helipad which will be relocated as part of the Stage 2 Redevelopment works for Campbelltown Hospital.

This assessment is prepared to address the acoustic conditions included in the Secretary's Environmental Assessment Requirements (SEARs) related to this new development.

The following sub-sections summarise the outcomes of this assessment.

8.1 Operational Acoustic Assessment

8.1.1 External & Internal Noise Emissions – Building Services

It is advised that the mechanical services should be designed to comply with the operational external noise level criteria discussed in Section 4.1. Hence conceptual treatments have been provided for further consideration during detailed design stages; as well as limiting sound power levels for the air-cooled chillers. These treatments are discussed in Section 6.1.

Additionally, it is also advised that the mechanical / AC ventilation system should be designed to achieve the internal noise level criteria discussed in Section 4.2.

Emergency plant should be designed to comply with the internal noise level criteria discussed in standard AS/NZS 1668.1:2015 (refer to Section 4.2.4).

Mechanical plant should be resiliently mounted. Vibration isolation mounts and supports should be designed to achieve compliance with vibration criteria discussed in Section 4.4.

8.1.2 Building Envelope Constructions

To achieve compliance with the operational criteria discussed in Section 4.2, conceptual treatments and performance requirements for building envelope constructions have been provided in Section 6.3.

These conceptual treatments are to be further developed during the detailed design stages; and should consider the noise impact by helicopter flight activities.

8.1.3 Loading Dock For Waste Collection

It is advised that the waste disposal and use of the loading dock should be undertaken outside the operational times proposed for the WSU MMRC and the WSU MCS (it is verbally confirmed that both operational times are similar).

8.1.4 Noise Impact on Local Roads

The noise emissions from vehicular activities on local roads, which are related to the use of the development, are found to be compliant with the relevant noise criteria for local roads.

8.1.5 Stand-by Generator

It is advised that the stand-by generator should be enclosed within an acoustic canopy or enclosure which achieves a nominated sound level performance at 7m from the unit when measured under free field conditions (i.e. 61 dBA at 7m).

Additionally, operational procedures for maintenance operations, and architectural treatments are recommended in Section 6.6.

8.2 Construction Noise & Vibration Assessment

The preliminary construction noise and vibration assessment has determined that the nearest receivers will be affected or highly affected by construction activities. This is particularly noted for the WSU MCS and Hospital Building D.

As a result, conceptual management procedures have been advised in Section 7.4 which should be considered and further developed into a detailed construction noise and vibration management plan (CNVMP).

Also, noise generated by road traffic related to construction activities, should be assessed against the criterion discussed in Section 7.2. This assessment can be conducted as part of the construction traffic management plan and/or the CNVMP.

Finally, the CNVMP should also consider the noise and vibration impact onto the WSU MCS and Hospital Building D. Hence vibration mitigation measures are discussed in Section 7.4.3, which includes the validation of safe working distances prior to starting vibration intensive tasks and construction activities. This validation should be undertaken in the form of trial vibration measurements. This validation survey should also include noise measurements within hospital premises.

8.3 Final Remarks

Based on the findings from the acoustic assessment, it is our opinion that the proposed development can achieve compliance with the operational acoustic criteria required by local authorities, provided the conceptual recommendations discussed herein are implemented and developed at the later detailed design stages.

APPENDIX A: ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ambient sound	The all-encompassing sound at a point composed of sound from all sources near and far.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Reverberation	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
Air-borne sound	The sound emitted directly from a source into the surrounding air, such as speech, television or music
Impact sound	The sound emitted from force of one object hitting another such as footfalls and slamming cupboards.
Air-borne sound isolation	The reduction of airborne sound between two rooms.
Sound Reduction Index [R] (Sound Transmission Loss)	The ratio the sound incident on a partition to the sound transmitted by the partition.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
Level difference [D]	The difference in sound pressure level between two rooms.

Normalised level difference [D_n]	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
Standardised level difference [D_{nT}]	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
Weighted standardised level difference [$D_{nT,w}$]	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
Impact sound isolation	The resistance of a floor or wall to transmit impact sound.
Impact sound pressure level [L_i]	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
Normalised impact sound pressure level [L_n]	The impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level [$L_{n,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
Weighted standardised impact sound pressure level [$L'_{nT,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in situ on site.
C_I	A value added to an L_{nW} or $L'_{nT,w}$ value to account for variations in the spectrum.
Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level [$L_{Ax,T}$]	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*

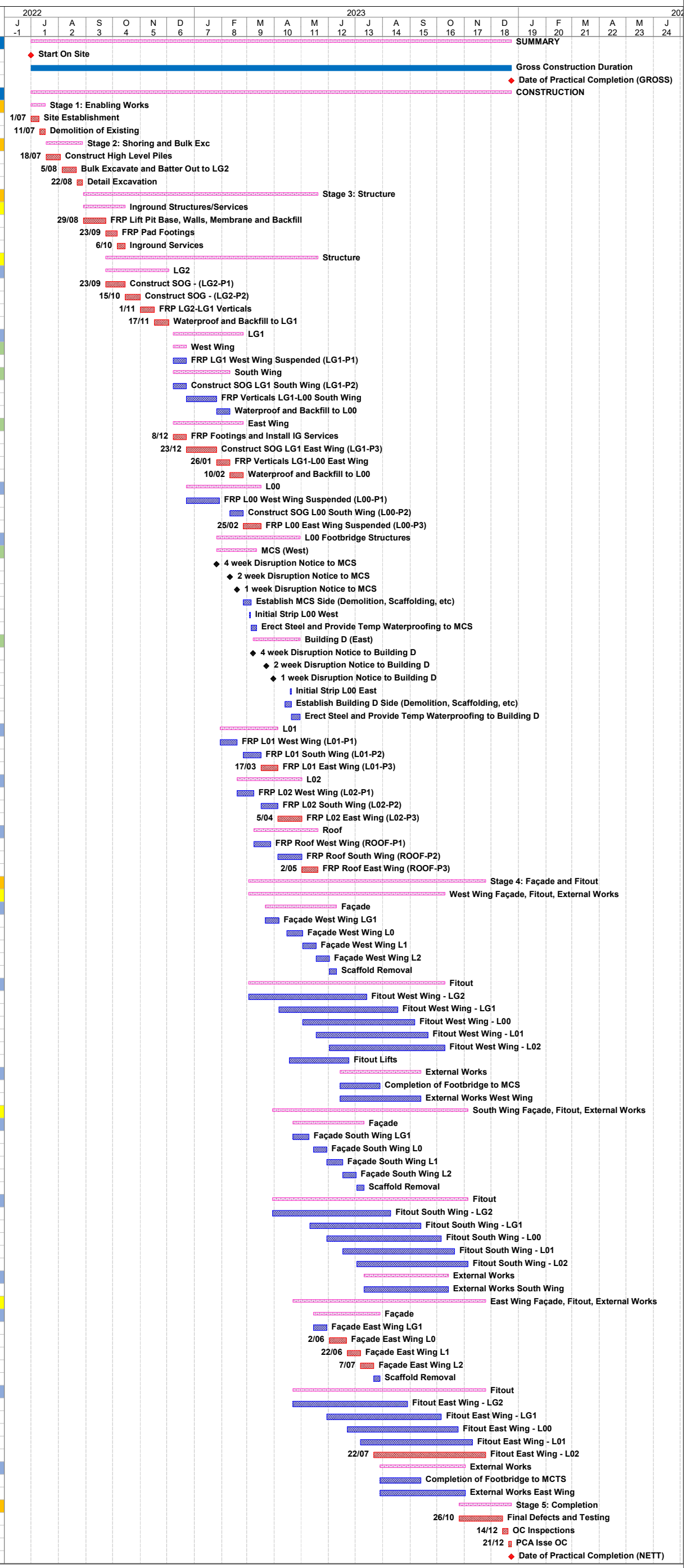
APPENDIX B: HIGH-LEVEL CONSTRUCTION PROGRAM

MACARTHUR MEDICAL RESEARCH CENTRE
HIGH LEVEL PROGRAMME

walker

cpm consulting

ID	Task Name	Duration	Start	Finish
1	**SUMMARY**	**378 days**	**1 Jul '22**	**23 Dec '23**
2	Start On Site	0 days	1 Jul '22	1 Jul '22
3	Gross Construction Duration	378 days	1 Jul '22	23 Dec '23
6	Date of Practical Completion (GROSS)	0 days	23 Dec '23	23 Dec '23
7	**CONSTRUCTION**	**378 days**	**1 Jul '22**	**23 Dec '23**
8	**Stage 1: Enabling Works**	**12 days**	**1 Jul '22**	**16 Jul '22**
9	Site Establishment	6 days	1 Jul '22	9 Jul '22
10	Demolition of Existing	6 days	11 Jul '22	16 Jul '22
11	**Stage 2: Shoring and Bulk Exc**	**30 days**	**18 Jul '22**	**27 Aug '22**
12	Construct High Level Piles	12 days	18 Jul '22	2 Aug '22
13	Bulk Excavate and Batter Out to LG2	12 days	5 Aug '22	20 Aug '22
14	Detail Excavation	6 days	22 Aug '22	27 Aug '22
15	**Stage 3: Structure**	**174 days**	**29 Aug '22**	**19 May '23**
16	**Inground Structures/Services**	**30 days**	**29 Aug '22**	**14 Oct '22**
17	FRP Lift Pit Base, Walls, Membrane and Backfill	18 days	29 Aug '22	22 Sep '22
18	FRP Pad Footings	6 days	23 Sep '22	5 Oct '22
19	Inground Services	6 days	6 Oct '22	14 Oct '22
20	**Structure**	**156 days**	**23 Sep '22**	**19 May '23**
21	**LG2**	**48 days**	**23 Sep '22**	**2 Dec '22**
22	Construct SOG - (LG2-P1)	12 days	23 Sep '22	14 Oct '22
23	Construct SOG - (LG2-P2)	12 days	15 Oct '22	31 Oct '22
24	FRP LG2-LG1 Verticals	12 days	1 Nov '22	16 Nov '22
25	Waterproof and Backfill to LG1	12 days	17 Nov '22	2 Dec '22
26	**LG1**	**48 days**	**8 Dec '22**	**24 Feb '23**
27	**West Wing**	**12 days**	**8 Dec '22**	**22 Dec '22**
28	FRP LG1 West Wing Suspended (LG1-P1)	12 days	8 Dec '22	22 Dec '22
29	**South Wing**	**36 days**	**8 Dec '22**	**9 Feb '23**
30	Construct SOG LG1 South Wing (LG1-P2)	12 days	8 Dec '22	22 Dec '22
31	FRP Verticals LG1-L00 South Wing	12 days	23 Dec '22	25 Jan '23
32	Waterproof and Backfill to L00	12 days	26 Jan '23	9 Feb '23
33	**East Wing**	**48 days**	**8 Dec '22**	**24 Feb '23**
34	FRP Footings and Install IG Services	12 days	8 Dec '22	22 Dec '22
35	Construct SOG LG1 East Wing (LG1-P3)	12 days	23 Dec '22	25 Jan '23
36	FRP Verticals LG1-L00 East Wing	12 days	26 Jan '23	9 Feb '23
37	Waterproof and Backfill to L00	12 days	10 Feb '23	24 Feb '23
38	**L00**	**51 days**	**23 Dec '22**	**16 Mar '23**
39	FRP L00 West Wing Suspended (L00-P1)	15 days	23 Dec '22	28 Jan '23
40	Construct SOG L00 South Wing (L00-P2)	12 days	10 Feb '23	24 Feb '23
41	FRP L00 East Wing Suspended (L00-P3)	15 days	25 Feb '23	16 Mar '23
42	**L00 Footbridge Structures**	**68 days**	**26 Jan '23**	**29 Apr '23**
43	**MCS (West)**	**36 days**	**26 Jan '23**	**11 Mar '23**
44	4 week Disruption Notice to MCS	0 days	26 Jan '23	26 Jan '23
45	2 week Disruption Notice to MCS	0 days	10 Feb '23	10 Feb '23
46	1 week Disruption Notice to MCS	0 days	18 Feb '23	18 Feb '23
47	Establish MCS Side (Demolition, Scaffolding, etc)	6 days	25 Feb '23	6 Mar '23
48	Initial Strip L00 West	1 day	4 Mar '23	4 Mar '23
49	Erect Steel and Provide Temp Waterproofing to MCS	6 days	6 Mar '23	11 Mar '23
50	**Building D (East)**	**36 days**	**8 Mar '23**	**29 Apr '23**
51	4 week Disruption Notice to Building D	0 days	8 Mar '23	8 Mar '23
52	2 week Disruption Notice to Building D	0 days	23 Mar '23	23 Mar '23
53	1 week Disruption Notice to Building D	0 days	31 Mar '23	31 Mar '23
54	Initial Strip L00 East	1 day	19 Apr '23	19 Apr '23
55	Establish Building D Side (Demolition, Scaffolding, etc)	6 days	13 Apr '23	20 Apr '23
56	Erect Steel and Provide Temp Waterproofing to Building	6 days	20 Apr '23	29 Apr '23
57	**L01**	**51 days**	**30 Jan '23**	**4 Apr '23**
58	FRP L01 West Wing (L01-P1)	15 days	30 Jan '23	17 Feb '23
59	FRP L01 South Wing (L01-P2)	15 days	25 Feb '23	16 Mar '23
60	FRP L01 East Wing (L01-P3)	15 days	17 Mar '23	4 Apr '23
61	**L02**	**51 days**	**18 Feb '23**	**1 May '23**
62	FRP L02 West Wing (L02-P1)	15 days	18 Feb '23	8 Mar '23
63	FRP L02 South Wing (L02-P2)	15 days	17 Mar '23	4 Apr '23
64	FRP L02 East Wing (L02-P3)	15 days	5 Apr '23	1 May '23
65	**Roof**	**51 days**	**9 Mar '23**	**19 May '23**
66	FRP Roof West Wing (ROOF-P1)	15 days	9 Mar '23	27 Mar '23
67	FRP Roof South Wing (ROOF-P2)	15 days	5 Apr '23	1 May '23
68	FRP Roof East Wing (ROOF-P3)	15 days	2 May '23	19 May '23
69	**Stage 4: Façade and Fitout**	**198 days**	**3 Mar '23**	**24 Nov '23**
70	**West Wing Façade, Fitout, External Works**	**162 days**	**3 Mar '23**	**9 Oct '23**
71	**Façade**	**57 days**	**22 Mar '23**	**9 Jun '23**
72	Façade West Wing LG1	12 days	22 Mar '23	5 Apr '23
73	Façade West Wing L0	12 days	15 Apr '23	2 May '23
74	Façade West Wing L1	12 days	3 May '23	17 May '23
75	Façade West Wing L2	12 days	18 May '23	1 Jun '23
76	Scaffold Removal	6 days	2 Jun '23	9 Jun '23
77	**Fitout**	**162 days**	**3 Mar '23**	**9 Oct '23**
78	Fitout West Wing - LG2	96 days	3 Mar '23	13 Jul '23
79	Fitout West Wing - LG1	96 days	6 Apr '23	17 Aug '23
80	Fitout West Wing - L00	96 days	3 May '23	5 Sep '23
81	Fitout West Wing - L01	96 days	18 May '23	20 Sep '23
82	Fitout West Wing - L02	96 days	2 Jun '23	9 Oct '23
83	Fitout Lifts	48 days	18 Apr '23	23 Jun '23
84	**External Works**	**72 days**	**14 Jun '23**	**12 Sep '23**
85	Completion of Footbridge to MCS	36 days	14 Jun '23	28 Jul '23
86	External Works West Wing	72 days	14 Jun '23	12 Sep '23
87	**South Wing Façade, Fitout, External Works**	**162 days**	**30 Mar '23**	**4 Nov '23**
88	**Façade**	**57 days**	**22 Apr '23**	**10 Jul '23**
89	Façade South Wing LG1	12 days	22 Apr '23	9 May '23
90	Façade South Wing L0	12 days	15 May '23	29 May '23
91	Façade South Wing L1	12 days	30 May '23	16 Jun '23
92	Façade South Wing L2	12 days	17 Jun '23	1 Jul '23
93	Scaffold Removal	6 days	3 Jul '23	10 Jul '23
94	**Fitout**	**162 days**	**30 Mar '23**	**4 Nov '23**
95	Fitout South Wing - LG2	96 days	30 Mar '23	9 Aug '23
96	Fitout South Wing - LG1	96 days	11 May '23	12 Sep '23
97	Fitout South Wing - L00	96 days	30 May '23	5 Oct '23
98	Fitout South Wing - L01	96 days	17 Jun '23	20 Oct '23
99	Fitout South Wing - L02	96 days	3 Jul '23	4 Nov '23
100	**External Works**	**72 days**	**11 Jul '23**	**13 Oct '23**
101	External Works South Wing	72 days	11 Jul '23	13 Oct '23
102	**East Wing Façade, Fitout, External Works**	**162 days**	**22 Apr '23**	**24 Nov '23**
103	**Façade**	**57 days**	**15 May '23**	**28 Jul '23**
104	Façade East Wing LG1	12 days	15 May '23	29 May '23
105	Façade East Wing L0	12 days	2 Jun '23	20 Jun '23
106	Façade East Wing L1	12 days	22 Jun '23	6 Jul '23
107	Façade East Wing L2	12 days	7 Jul '23	21 Jul '23
108	Scaffold Removal	6 days	22 Jul '23	28 Jul '23
109	**Fitout**	**162 days**	**22 Apr '23**	**24 Nov '23**
110	Fitout East Wing - LG2	96 days	22 Apr '23	28 Aug '23
111	Fitout East Wing - LG1	96 days	30 May '23	5 Oct '23
112	Fitout East Wing - L00	96 days	22 Jun '23	24 Oct '23
113	Fitout East Wing - L01	96 days	7 Jul '23	9 Nov '23
114	Fitout East Wing - L02	96 days	22 Jul '23	24 Nov '23
115	**External Works**	**72 days**	**29 Jul '23**	**1 Nov '23**
116	Completion of Footbridge to MCTS	36 days	29 Jul '23	12 Sep '23
117	External Works East Wing	72 days	29 Jul '23	1 Nov '23
118	**Stage 5: Completion**	**44 days**	**26 Oct '23**	**23 Dec '23**
119	Final Defects and Testing	36 days	26 Oct '23	13 Dec '23
120	OC Inspections	5 days	14 Dec '23	19 Dec '23
121	PCA Isse OC	3 days	21 Dec '23	23 Dec '23
122	Date of Practical Completion (NETT)	0 days	23 Dec '23	23 Dec '23



Date : 13 Aug '21