Cessnock Correctional Centre Upgrade
Review of Environmental Factors
Acoustic Assessment

Report Date: Friday, 19 August 16
Reference: S16392RP1, Revision A

Document Information

Project	Cessnock Correctional Centre Upgrade – Review of Environmental Factors	
Client	Umow Lai	
Report title	Acoustic Assessment	
Project Number	S16392	
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Revision Table

Report revision	Date	Comments
0	10 August 2016	Draft Issue
A	19 August 2016	For Issue

Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	A-Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
ICNG	New South Wales *Interim Construction Noise Guideline*,
INP	New South Wales *Industrial Noise Policy*, 2000.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally a residential premises boundary) is greater than 5 dB above the background noise level.
L_{90}	Noise level exceeded for 90 % of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum noise level measured in a defined time period.
mm/s	Units of vibration velocity.
$m/s^{1.75}$	Units of VDV.
Night-time	Between 10.00 p.m. on one day and 7.00 a.m. on the following day as defined in the INP.
NML	Noise Management Level—Level above which construction noise management measures should be considered as defined by the ICNG.
PPV	Peak Particle Velocity—peak vibration level in a particular direction.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (day/evening/night). For the short-term method, the RBL is simply the measured L90,15min noise level. For the long-term method it is the median value of all measured background levels during the relevant assessment period.

RNP	New South Wales *Road Noise Policy*, 2011.
Standard working hours	7 am to 6 pm Mondays to Fridays 7 am to 1 pm Saturdays No work on Sundays or Public Holidays.
VDV	Vibration Dose Value – measure of the vibration received at an assessment position over a day or night time period.

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1 Introduction

This report presents a planning stage acoustic assessment of the proposed Cessnock Correctional Centre Upgrade at Cessnock, New South Wales.

The main elements of the Upgrade consist of:

- an additional 320 maximum security beds in four two-storey accommodation buildings (320-bed facility)
- an additional 280 minimum security bed facility in four two-storey accommodation buildings (280-bed facility)
- 500 additional staff and visitor car parking spaces
- a new Rapid Build Prison (RBP) with four accommodation pods that can house up to 100 inmates each.

The site is surrounded by suburban residential land uses to the south, more isolated residences to the north and a retirement community to the east. However, these noise sensitive land uses are a considerable distance from the Centre and the proposed upgrade areas.

This report presents a description of the proposal, relevant noise criteria, assessment and planning stage acoustic advice. The principal purposes of report are to:

- Measure and document existing noise levels to establish noise criteria for the site for both the operational and construction phases.
- To provide comment on and predict noise emission from the operational site to existing noise sensitive land uses adjacent to the site, and to identify any mitigation requirements that will be required for the future design of the site.
- To provide comment on potential construction noise and vibration impacts.

2 Project description

New South Wales' prison population is steadily increasing and existing correctional centres are close to capacity. To address this the NSW Department of Justice is expanding the Cessnock Correctional Centre, by building new facilities.

Cessnock Correctional Centre is a minimum and maximum security prison with a current capacity of about 800 inmates. The Centre is dedicated to keeping the community safe and reducing reoffending, through measures including education and vocational training. It has a large industries complex employing and training inmates in a variety of jobs including engineering, and food services.

The proposed expansion works include:

- Site preparation, vegetation removal, bulk earthworks and the provision of utilities and services.
- An additional 320 maximum security beds in four two-storey accommodation buildings including
  - industries such as kitchen, education and laundry for the maximum security inmates
  - program and education spaces
  - playing field and walking tracks
  - movement control and administration facilities.
- An additional 280 minimum security bed facility in four two-storey accommodation buildings including
  - a programs building and secure entry and visits building for the minimum security inmates
  - movement control and administration facilities
  - playing field with a double tennis court.
- A new 400 bed Rapid Build Prison (RBP) to be constructed to the south-west of the existing CCC. The RBP will be a maximum security facility that will include:
  - four accommodation pods that can house up to 100 inmates each
  - industries buildings containing: Kitchen; Education; and Laundry
  - secure fencing
  - a new gate house and administration building
  - parking for 160 staff and visitor cars
  - new services compound for generators, substations, water tanks and other services.
- Changes to existing buildings, including:
  - changes to the existing reception and visits buildings
  - changes and upgrades to existing 3 story accommodation blocks
  - changes to fencing to integrate the new 320 and 280 complexes with the existing
  - changes to existing movement control paths within the site.
- Changes to site infrastructure, including
  - 500 additional staff and visitor parking spaces;
  - a modified road layout to include a new main entrance that would connect Lindsay street with the main gatehouse.
  - A new administration and visitor processing building.
- Landscaping.
- Stormwater management.
- Demolition of buildings as required.

The works would be undertaken in accordance with the *State Environmental Planning Policy (Infrastructure) 2007* and would be undertaken in stages to facilitate the continued operation of the Centre.

The proposed locations of the various facilities are shown on Figure 1.

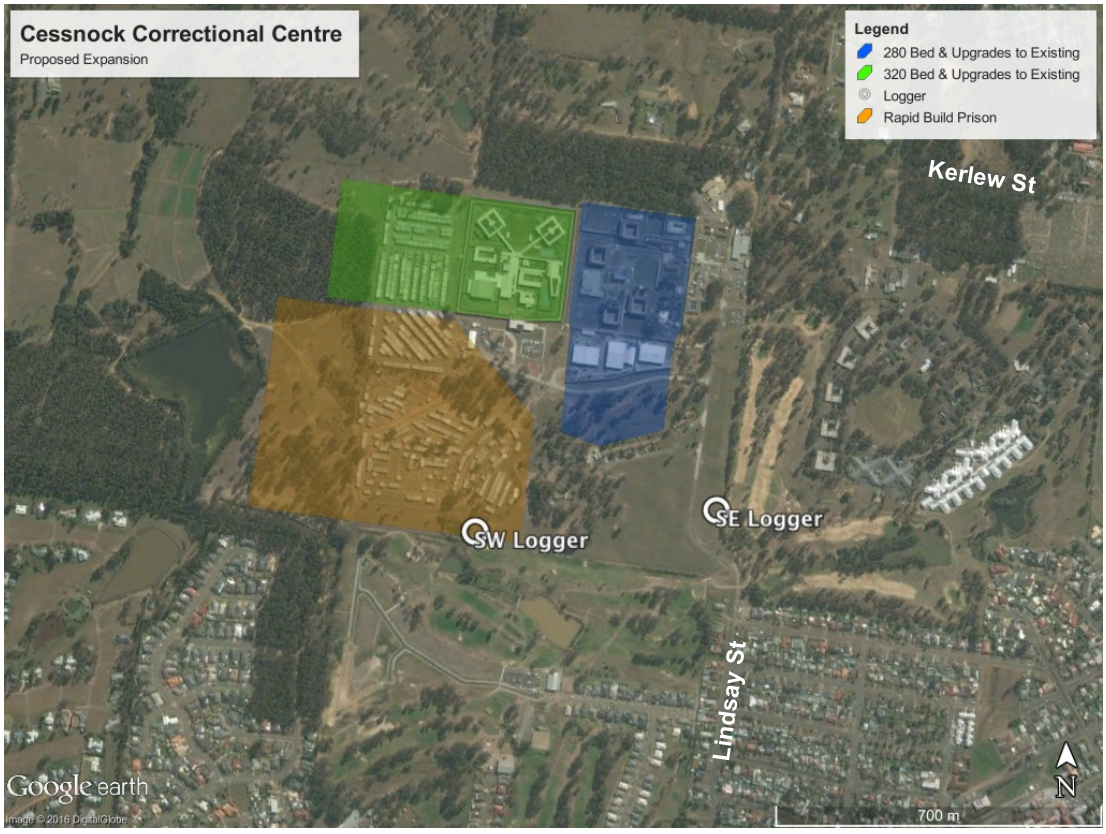

Figure 1 Cessnock Correctional Centre Upgrade location plan

Access to the Cessnock Correctional Centre is via Lindsay Street to the southeast. However, during construction a temporary access road would connect the site to Kerlew Street to the north and be used for construction traffic (e.g. heavy vehicles).

Noise sensitive land uses around the site include:

- residential areas to the southwest, south and southeast of the site
- isolated residences to the north of the site
- Calvary Cessnock Retirement Community to the east of the site.

The surrounding noise sensitive areas are typically located a minimum of 150 m from the boundary of the proposed expansion areas, with major areas of the Upgrade generally 300 m or further away from residential areas. The closest residences are those positioned to the southwest on Mount Pleasant Grove, which are approximately 150 m away from the nearest building at the RBP. The residences to the southeast and the retirement community to the east are over 300 m away from the proposed works areas, and the nearest residence to the north is over 200 m away.

3 Assessment criteria

The Cessnock Correctional Centre is located within the Cessnock local government area. The Cessnock City Council *Development Control Plan 2010* requires developments within the Cessnock area to have regard to potential noise impacts. To address this, this assessment has regard to:

- the NSW Environment Protection Authority (EPA) *Industrial Noise Policy* (INP) for operational noise
- the NSW EPA *Road Noise Policy* (RNP) for operational traffic noise generated as a result of the development
- the NSW EPA *Interim Construction Noise Guideline* (ICNG) for the management of construction noise
- the NSW EPA's *Assessing Vibration: A Technical Guideline* for the management of construction vibration.

3.1 Existing noise survey

A noise survey to establish existing conditions at the area surrounding the Cessnock Correctional Centre was undertaken from 21 to 27 July 2016. The results of this noise survey are presented in Appendix A.

3.2 Operational phase

Operational noise criteria – normal operation

This report uses the INP to establish assessment criteria for noise from operations at Cessnock Correctional Centre, including noise generated by external mechanical plant. The criteria apply at the boundary of the nearest affected residential premises or 30 m from the premises if the boundary is more than 30 m from the premises.

INP criteria for noise emission have been derived from unattended noise measurements taken on site between 21 to 27 July 2016 (discussed in detail in Appendix A) and are presented in Table 1.

Table 1 Noise emission criteria

Location	Noise emission criteria, dB(A) $L_{eq,15min}$		
	Daytime 7 am – 6 pm	Evening 6 pm – 10 pm	Night-time 10 pm – 7 am
Residences to the southeast and north, and retirement village to the east	47	40	37
Residences to the south and southwest	43	42	40

Operational noise criteria – emergency operation

For emergency equipment sources (for example backup power generators) that operate up to a maximum of one hour in either the daytime or evening period, a noise increase of 5 dB above the intrusive criteria is permitted, as presented in Table 4.2 in the INP.

For the Cessnock Correctional Centre, it is proposed that backup power generators will be installed at the RBP, the 280-bed facility and the 320-bed facility. If these predominantly operate only during the daytime and evening period, and typically only for a period of one hour or less, than a 5 dB increase in the noise emission criteria may be allowable for these items of plant.

Road traffic noise

Criteria for road traffic noise impacts associated with the project are derived from the NSW Road Noise Policy (RNP).

Table 3 of the RNP provides road traffic noise assessment criteria for residential land uses. The relevant criteria for the Cessnock Correctional Centre expansion are for the Local Road category (when considering the residences on surrounding streets) and the type of project is 'Existing residences affected by additional traffic on existing local roads generated by land use developments'.

The assessment criteria are:

- 55 dB(A) $L_{eq,1h}$ daytime (7 am to 10 pm)
- 50 dB(A) $L_{eq,1h}$ night-time (10 pm to 7 am).

The RNP also provides a relative increase criterion, being that the increase over existing road traffic noise levels shall be controlled to within 2 dB of the 'no build option'.

3.3 Construction phase

Construction noise

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise, and has therefore been adopted for this construction noise assessment.

The ICNG prescribes $L_{eq,15min}$ noise management levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceed these management levels, then all feasible and reasonable work practices should be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

The ICNG recommends standard working hours for construction sites of:

- between 7 am and 6 pm, Mondays to Fridays inclusive
- between 8 am and 1 pm, Saturdays
- no work on Sundays or Public Holidays.

Residential land uses

The noise management levels prescribed for residential land uses by the ICNG are presented in Table 2. The noise management levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level.

Table 2 Noise management levels for residential land uses

Time of day	Noise Management Level, $L_{eq,15min}$	Application notes
Recommended standard hours	Noise affected: RBL + 10 dB	May be some community reaction to noise. • Where the predicted or measured construction noise level exceeds the noise affected level, all feasible and reasonable work practices should be applied to meet the noise affected level. • All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details.
	Highly noise affected: >75 dB(A)	May be strong community reaction to noise. • Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur. • Respite activities would be determined taking into account times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods.

Time of day	Noise Management Level, $L_{eq,15min}$	Application notes
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 affected noise level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the affected noise level, the proponent should negotiate with the affected community.

Non-residential land uses

Non-residential land uses that may be noise affected by works at the Cessnock Correctional Centre include the Calvary Cessnock Retirement Community and areas of the Cessnock Correctional Centre itself.

For the Retirement Community, the residential NMLs are considered appropriate given the use of the community is predominantly residential in nature. For the Correctional Centre, NSW Department of Justice will consider noise impacts on a case-by-case basis as works progress around the site. Generally, if external noise levels at the Correctional Centre from construction works can be controlled to 65 dB(A) L_{eq}, no significant impacts are expected on the basis that there is typically an outdoor-to-indoor noise reduction of 25 dB across a closed façade.

Sleep disturbance

In accordance with the ICNG, sleep disturbance should be assessed for night time construction works longer than two consecutive nights in duration. The ICNG references the sleep disturbance assessment method defined in NSW *Environmental Criteria for Road Traffic Noise* (EPA, 1999) (ECRTN). Although the ECRTN has now been superseded by the *Road Noise Policy*, the sleep disturbance assessment methodology in the ECRTN is still recommended for use.

The ECRTN describes two methods for the assessment of sleep disturbance:

- A screening criterion based on determining the predicted $L_{A1\ (1min)}$ level from construction works and the number of times that this level is predicted to exceed the background level by more than 15 dB(A). Conservatively, this is equivalent to the night time NML + 10 dB(A). Where this is screening criterion exceeded then further analysis is recommended.
- The EPA's advice that '*Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions*'. Based on a typical 10 dB reduction through an open window, it is therefore reasonable to assume that external levels of 60-65 dB(A) L_{max} are unlikely to result in awakening reactions.

Project-specific NMLs

The project-specific NMLs for residences as part of the Cessnock Correctional Centre Upgrade are presented in Table 3.

Table 3 Project-specific NMLs for residences

Receiver type	Period	NML, dB(A) $L_{eq,15min}$
Residences to the southeast and north, and retirement village to the east	Standard work hours	52
	Daytime (outside of standard hours)	47
	Evening	40
	Night time	37
Residences to the south and southwest	Standard work hours	48
	Daytime (outside of standard hours)	43
	Evening	42
	Night time	42

Construction vibration

Assessing Vibration: A Technical Guideline (the Guideline) provides guidance on acceptable levels of vibration for maintaining human comfort and preventing cosmetic or structural damage to buildings during construction works.

Human comfort

Vibration criteria for human comfort are more stringent than vibration criteria for building structural and cosmetic damage. The vibration assessment criteria for human comfort defined in the Guideline represent goals that, where predicted or measured to be exceeded, require the application of all reasonable and feasible mitigation measures. Where the maximum value cannot reasonably and/or feasibly be achieved, the operator would need to negotiate directly with the affected community.

The Guideline defines vibration assessment criteria for maintaining human comfort during continuous, impulsive and intermittent vibration. Vibration generated by the construction works as part of the Cessnock Correctional Centre Upgrade would be expected to be intermittent in nature, as they would involve short periods of continuous vibration, such as vibratory compaction works.

For intermittent vibration, the Vibration Dose Value (VDV) is used as the metric for assessment as it accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are presented in Table 4.

Table 4 VDV management levels for intermittent vibration

Receiver	VDV – intermittent vibration, $m/s^{1.75}$	
	Preferred	Maximum
Residences – daytime	0.2	0.4
Residences – night time	0.13	0.26
Offices, schools, places of worship	0.4	0.8
Workshops	0.8	1.6

Building damage

The risk of building damage as a result of construction works typically only arises at significantly higher levels of vibration than those which can cause human disturbance. That is, building occupants will tend to perceive vibration strongly before a risk of cosmetic or structural damage to the building arises.

There is no Australian Standard for the assessment of building damage from ground vibration and therefore reference has been made to German Standard DIN 4150-1999, *Part 3 – Structural vibration – Effects of vibration on structures* (DIN 4150-3) for the assessment of potential effects vibration from construction work on buildings.

The 'safe limits' specified by DIN 4150-3 are summarised in Table 5. The values are specified as maximum levels measured in any direction at the foundation, and are not to be exceeded during construction works.

Table 5 Structural and cosmetic damage criteria

Group	Type of structure	Vibration velocity (PPV) in mm/s			
		At foundation, at a frequency of:			Vibration at horizontal plane of highest floor
		<10 Hz	10 – 50 Hz	50 – 100 Hz	
1	Commercial and industrial buildings	20	20 to 40	40 to 50	40
2	Residential buildings	5	5 to 15	15 to 20	15
3	Particularly sensitive buildings (e.g. heritage-listed)	3	3 to 8	8 to 10	8

Note: For frequencies above 100 Hz, the higher values in the 50 – 100 Hz column should be used.

A search of the NSW heritage database indicates no heritage-listed structures in the immediate vicinity of the Cessnock Correctional Centre. Based on this, the residential criteria from Table 5 (Group 2 criteria) are most relevant to the assessment of potential structural and cosmetic damage due to construction vibration.

DIN 4150-3 recommends these values as maximum levels of short-term construction vibration, at which experience has shown that damage that reduces the serviceability of structures will not occur due to vibration effects. A reduction in serviceability of the structure is deemed to have occurred if:

- cracks form in plastered surfaces of walls
- existing cracks in the building are enlarged
- partitions become detached from loadbearing walls or floors.

4 Operational assessment

4.1 Mechanical plant

The mechanical plant design for the Cessnock Correctional Centre Upgrade has not been finalised at this stage of the project and we understand that equipment selections have not been made. The major items of outdoor mechanical plant at the site, with respect to noise generation, are likely to include:

- outdoor split system condenser units
- kitchen and toilet exhaust fans
- backup generators to be installed at the 280-bed facility, 320-bed facility and the RBP.

Given the distances involved to the nearest noise sensitive land uses (greater than 300 m from the likely mechanical plant areas) and the typical sound power levels associated with condenser units and exhaust fans, it is expected that the most stringent INP night time criterion of 37 dB(A) will be able to be readily achieved at the nearest noise sensitive locations. During detailed design, due consideration should be given to noise mitigation principles for condenser units and exhaust fans such as:

- selecting the quietest condenser units and exhaust fans capable of achieving the mechanical design requirements
- locating outdoor condenser units on the sides of buildings facing away from the surrounding residential land uses
- installing sufficient ductwork after the exhaust fans and directing the exhaust away from residential land uses.

With respect to the backup generators, they will be located approximately 400 m or further from the nearest noise sensitive land uses surrounding the site:

- the generators for the new 320-bed and 280-bed sites will be 320 kVA generators installed within an acoustic enclosure adjacent to the new Main Switch room
- the proposed generator location at the RBP is to the northern end of that site, away from the residences.

To ensure compliance with the most stringent INP night time criterion of 37 dB(A) at the nearest noise sensitive locations given the proposed generator locations, it will be necessary to select generators with an acoustic enclosure that achieves a sound pressure level of no more than 80 dB(A) at 1 m. Alternatively, higher noise generators could be considered if they are located within a solid concrete building with acoustically treated doors and openings.

If the generators will only operate in emergency situations, and predominantly during the daytime, then it may be reasonable to consider increasing the allowable noise emissions from the generators in accordance with the INP approach to short-term noise sources.

4.2 Industries buildings

Industries buildings are proposed for each of the three proposed sites:

- An industries building will be located at the southern part of the 320-bed site adjacent to the western boundary of the existing maximum security facility.
- New industries buildings will be located as part of the refurbishment of the existing area to the north of the new 280-bed site.
- Two new industries buildings will be located to the western boundary of the RBP.

We understand that the industries buildings will be primarily used for Kitchen, Laundry and Education activities and have assumed that they would typically only operate during the daytime and evening periods defined in the INP. Current internal industry activities at the Cessnock Correctional Centre include light fabrication works, furniture manufacture and we have assumed that these may also occur within the industries buildings.

Assuming a typical worst-case internal reverberant sound pressure level of 75 dB(A) within the industries building during noisy activities, the following minimum constructions are recommended to ensure that noise from the industries buildings achieves compliance with the worst-case INP evening criterion of 40 dB(A) $L_{eq,15min}$:

- External wall construction achieving a minimum R_W 40 rating – this can be achieved through the use of either lightweight or masonry constructions.
- External glazing to be minimum 10.38 mm thick laminated glass or double glazing comprising of minimum 6/12/6 construction. Openable windows should be fitted with rubber compression seals or acoustic equivalent.
- External doors facing towards residential areas to be minimum 40 mm thick solid core doors and fitted with rubber or silicone acoustic seals to the head, jambs and base.
- Roof construction to achieve a minimum R_W 23 rating – this can generally be achieved through the use of metal deck roofing with insulation.

4.3 Activity areas

Outdoor activity areas are proposed for each of the Upgrade sites:

- An oval and three walking tracks are proposed for the 320-bed site. The oval is located approximately 500 m from the nearest noise sensitive location to the north.
- A playing field and double tennis court is to be located within the 280-bed site, approximately 400 m from the retirement village to the east.
- An exercise yard is proposed at the southeast corner of the RBP site, approximately 400 m from the nearest residences to the south.

To assess noise from the outdoor activity areas, we have assumed a crowd of approximately 80 men, with 30% speaking in a raised voice continuously during a 15-minute period and 10% shouting. Based on typical voice sound power levels, this results in an overall sound power level for the outdoor activity areas of 97 dB(A) L_W. It has also been assumed that the activity areas would be used during the daytime period only.

Based on the nearest outdoor activity area at the 280-bed site, this results in a predicted noise level of 33 dB(A) $L_{eq,15min}$ at the retirement village. This predicted noise level readily complies with the most stringent daytime INP criterion of 43 dB(A).

4.4 Road traffic noise

The proposed Cessnock Correctional Centre Upgrade will include 660 additional staff and visitor car spaces, with access to the Centre to continue to be via Lindsay Street.

The Traffic and Transport report prepared for the Review of Environmental Factors[1] identifies that:

- The evening peak period occurs between 4 pm and 5 pm and would increase in number from 245 staff (current number) to 501 staff with all facilities operating at the Centre. This corresponds to staff leaving at the completion of the main 6 am to 4 pm shift.
- The morning peak period would occur between 5 am and 6 am and would involve the same number of vehicles (245 existing, 501 in future) arriving for the main 6 am to 4 pm shift.

Based on the proposed movements and the typical distances to residences on Lindsay Street, the predicted existing and future peak hourly road traffic noise level are shown in Table 6.

Table 6 Predicted worst case operational road traffic noise levels

Period	Predicted road traffic noise level, dB(A) $L_{eq,1h}$		Change, dB
	Existing	Future	
Morning peak hour	56	59	+3.1
Evening peak hour	56	59	+3.1

It should be noted that the overall levels presented in Table 6 are conservative as they assume that all staff will enter/exit via Lindsay Street when some are likely to take Mavis Street or other local roads. The worst case change in road traffic noise levels resulting from the project marginally exceeds the +2 dB criterion from the RNP. In practice, the difference between a 2 dB and 3 dB increase is not expected to be noticeable.

We also note that the above predicted road traffic noise levels are limited to the hour before and hour after the main shift ends, and changes to traffic flows during other hours of the day will be significantly less than these peak periods. The three other work shifts have significantly lower staff numbers (less than 100 total with existing staff and the proposed upgrade) and therefore traffic noise levels at residences on Lindsay Street from movements associated with the Centre at all other times of day will be significantly lower.

Given the relatively small exceedance of the RNP criteria, the limited periods of the day for which these traffic noise levels apply and the lack of other viable access routes to the Cessnock Correctional Centre, no specific mitigation for road traffic noise is proposed as part of the development.

[1] Jacobs, *Cessnock Correctional Centre Redevelopment, Review of Environmental Factors – Traffic, Transport and Access*, 19 August 2016.

5 Construction assessment

5.1 Proposed working hours

We understand that construction works for the Cessnock Correctional Centre Upgrade are proposed to occur between 6 am and 6 pm, 7 days per week. Works between 6 am and 7 am will generally involve quieter preparatory works but noisier works will need to occur on Saturday afternoons and Sundays to ensure that the construction works can be completed efficiently and safely. Therefore, noisy works will need to occur outside of the standard work hours, albeit generally during daytime hours (7 am to 6 pm).

5.2 Construction activities

Table 7 presents the typical construction phases expected for the project, and the typical expected worst-case sound power levels for each stage based on normal operating scenarios. Sound power levels for individual items of plant and equipment are included in Appendix B.

Table 7 Typical construction phases

Stage	Description	Typical worst case L_W, dB(A)
Site establishment	Fences, erosion and sediment controls, etc. Construction of site access tracks.	110
Early works	Demolition works and bulk excavation works.	112
Structure	Construction of structure including steelwork. Commencing post-bulk excavation.	113
Internal works and fitout	Internal fitout works within the new buildings.	114 (internal)
Landscaping	External hard and soft landscaping works.	107

5.3 Construction noise assessment

Table 8 presents typical worst-case construction noise levels at distances from the works that are representative of the nearest noise sensitive land uses. The predicted noise levels are conservative as they assume that the construction works are operating continuously at the typical worst case sound power levels presented in Table 7, and that there is no shielding of the construction noise over the transmission path to the nearest residences. A 10 dB reduction has been applied to the internal works and fitout phase as these works will generally be attenuated by the building structure.

The predicted noise levels indicate that the standard hours NMLs of 52 dB(A) and 48 dB(A) may potentially be exceeded at distances of up to 300 m from the works during the noisiest activities as part of the earthworks and structure phases. However, as these typical worst case predictions generally only exceed the NMLs by approximately 5 dB, it is likely that there will be extended periods of construction where noise levels at noise sensitive receivers remain below the standard NMLs, particularly where works are occurring more than 500 m from residential land uses. No noise sensitive land uses are predicted to be highly noise affected during the works.

Table 8 Typical construction noise levels at distance

Stage	Typical worst case noise level with distance			
	150 m	200 m	300 m	400 m
Site establishment	55	52	49	46
Early works	57	54	52	48
Structure	58	55	52	49
Internal works and fitout	49	46	43	40
Landscaping	52	49	46	43

The predictions also indicate that there is the potential for construction noise to exceed the daytime out of hours works NMLs at distances of over 400 m for works on Saturday afternoons and Sundays. The evening and night time NMLs could also be exceeded if works occur during these periods.

A discussion of potential management and mitigation measures for construction noise is provided in Section 5.6.

5.4 Construction vibration assessment

Transport for NSW provides guidelines for safe working distances for intensive activities in the document *'Transport for NSW Construction Noise Strategy'*. Vibration levels for typical construction activities have been published along with the safe working distances for cosmetic damage and human comfort. Table 10 presents the recommended safe working distances for vibration intensive plant.

Table 10 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe Working Distance – Cosmetic Damage	Safe Working Distance – Human Response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2 m	7 m

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

All items in the table above with the exception of a vibratory roller have a safe working distance of no greater than 100 m. Given the significant distance between the site and the nearest residences (at least 150 m), it is not expected that vibration from construction works will impact on adjacent land uses. Vibration impacts from works in close proximity to prison areas may require consideration but will be managed by NSW Department of Justice from time-to-time, but it is generally considered that any vibration impacts on existing prison areas will be minor given the likely time of works and the general distance between work areas and occupied areas.

5.5 Construction traffic noise

At times during construction, it is likely that traffic volumes on Kerlew Street will increase at times due to light construction vehicles and trucks accessing the site. Although the RNP does not provide guidance on noise generated by traffic from construction works, it is considered reasonable to compare the construction noise impact against the same criteria as for operational traffic.

The *Traffic, Transport and Access* Report estimates:

- a maximum of 315 additional light vehicles during morning and evening peak hours during any stage of construction
- a maximum of 60 heavy vehicle movements during the same peak hour.

Based on the proposed movements and the typical distances to residences on Kerlew Street, the predicted peak hourly road traffic noise level during construction is 55 dB(A) $L_{eq,1h}$. This is a worst case road traffic noise level based on major construction phases for the various facilities occurring simultaneously.

The predicted worst-case construction road traffic noise level complies with the daytime RNP criterion of 55 dB(A) $L_{eq,1h}$ and therefore daytime construction road traffic noise impacts are not considered to be significant given the construction of the access road via Kerlew Street. If these morning peak hour movements occurred during the hours of 6 am to 7 am (considered night time under the RNP) then the predicted road traffic noise level at houses on Kerlew Street would potentially exceed the night time RNP criterion of 50 dB(A) $L_{eq,1h}$ for limited periods.

Therefore, where reasonable and feasible, consideration should be given to restricting heavy vehicle access to the site prior to 7 am, such that the majority of heavy vehicles arrive after 7 am. We note that occasional heavy vehicle movements between 6 am and 7 am are not expected to result in significant road traffic noise impacts at residences on Kerlew Street.

5.6 Management measures

As the noise management levels are predicted to be exceeded at the nearest sensitive receivers at times during the construction phase, construction noise and vibration management measures will need to be implemented in accordance with the ICNG.

Where sensitive receivers are predicted (or measured) to be noise or vibration affected during construction works, all feasible and reasonable work practices should be implemented to reduce construction noise and/or vibration. In relation to the implementation of management measures, feasibility addresses engineering consideration regarding what is practical to build. Reasonableness relates to the application of judgment in arriving at a decision, taking into account the following factors:

- noise or vibration reduction achieved
- number of receivers who benefit
- cost of the mitigation measure
- delay to schedule and whether the measure will prolong exposure to noise/vibration
- community views
- pre-construction noise and vibration levels at receivers.

The following sections outline typical noise management and mitigation measures that could be considered to assist with construction noise management from the site.

Construction Noise and Vibration Management Plan

The appointed construction contractor should be requested to develop and implement a Construction Noise and Vibration Management Plan (CNVMP) detailing how construction noise and vibration will be managed during the construction phase in accordance with the ICNG. If work outside of standard hours are proposed, then the CNVMP should detail a process for assessing these out of hours works given the greater potential for construction noise disturbance during works outside of standard hours.

Working hours

Where reasonable and feasible, noisy construction works should not be conducted between 6 am and 7 am.

Where noisy work must occur outside of the daytime hours for reasons of safety, operational reasons at the Cessnock Correctional Centre and/or practicability, then works should be concentrated to the evening, rather than night time, hours where possible (i.e. it is preferable to conduct noisy works between 6 and 10 pm rather than at night time).

Site management

- Site access routes should be located as far away from noise sensitive receivers as feasible.
- Equipment should be located to take advantage of the barriers provided by existing site structures.
- Noisy plant should be located as far away from noise sensitive receptors as possible whilst still allowing efficient and safe completion of the work.

- Plant known to emit noise strongly in one direction should be orientated so that the noise is directed away from the nearest noise sensitive areas.
- Machines that are used intermittently should be shut down in the intervening periods between works or throttled down to a minimum.
- The reversing of vehicles should be minimised to reduce the noise from reversing signals.
- Vehicle warning devices such as horns should not be used as signalling devices.
- Two way radios should be used at the minimum effective volume.
- When work is complete, the noise of packing up plant and equipment and departing from the site should be minimised.

Equipment management

- Selection of lower-noise and vibration plant, equipment and processed (e.g. bored piling rather than impact piling).
- Equipment should have quality mufflers installed.
- All plant should be well maintained.
- Equipment not in use should be shut down and only equipment of the necessary power/duty should be used to complete the task.

6 Conclusion

This report presents a planning stage acoustic assessment of the proposed Cessnock Correctional Centre Upgrade at Cessnock, New South Wales, including an assessment of:

- operational noise (generated by the site through mechanical plant, industry activities and outdoor activity) against the requirements of the *Industrial Noise Policy*
- road traffic noise generated by the site against the recommendations of the *Road Noise Policy*
- likely construction noise and vibration generated by the construction phase against the *Interim Construction Noise Guideline*.

Based on the current information for the site, it is expected that noise levels generated by operation of the site will be able to comply with the relevant noise emission criteria with appropriate selection and design of mechanical plant, including emergency generators, and appropriate design of industries buildings.

Noise generated by the construction phase could have the potential to exceed the Noise Management Levels defined by the *Interim Construction Noise Guideline* during noisy works periods and therefore construction noise management measures will need to be implemented on site. Due to the significant distance to neighbouring land uses, construction vibration impacts are not expected.

Appendix A—Noise survey and derivation of noise criteria

Unattended noise logging

Unattended noise measurements ('logging') have been conducted during the period Thursday 21 July to Wednesday 27 July 2016 The logging was conducted at two locations on the southern boundary of the site, representative of the nearest residential areas to the expansion site. The two logging locations are shown in Figure 1.

During the site visit to deploy and recover the noise loggers, noise emissions from existing operations at the Cessnock Correctional Centre were not audible at either noise logging location. The noise environment was controlled by wind in the trees, bird noise and distant traffic.

Equipment

The equipment used was one Rion NL-21 (serial number 888253) and one Rion NL-22 environmental noise logger (serial number 00862918). The logger calibration was checked prior to, and after noise measurements, and calibration drift did not exceed 0.5 dB.

The noise logger was configured to record all relevant noise indices including background noise (L_{90}) and equivalent continuous noise levels (L_{eq}). Samples were accumulated at 15-minute intervals. The time response of the logger was set to 'fast'.

Weather conditions

In order to verify that noise data was obtained during suitable meteorological conditions, half-hourly weather data was obtained from the Bureau of Meteorology (BOM) Automatic Weather Station (AWS) 061260 at Cessnock Airport.

Noise data has been excluded from the processed results if:

- Rain was observed during a measurement period OR
- Wind speed exceeded 5 m/s (18 km/h) at the measurement height of 1.5 m above ground. Wind data obtained from the BOM is presented as the value at 10 m above ground, and these values are halved for the purpose of assessing wind speed at 1.5 m above ground.

While no periods of rain were recorded during the noise monitoring period, meteorological data shows the wind speed exceeded 5 m/s on occasion, and consequently some noise data has been removed due to being wind-affected.

Measured noise levels

For reference, a weekly chart showing the graphed noise logging results is shown in Figure A1 for the southeast location and in Figure A2 for the southwest location. The graphs indicate periods that were excluded due to rain recorded at the BOM station.

It can be seen that noise levels are generally higher during the day, decreasing markedly during the evening before reaching a minimum at night-time. This is considered indicative of a suburban environment.

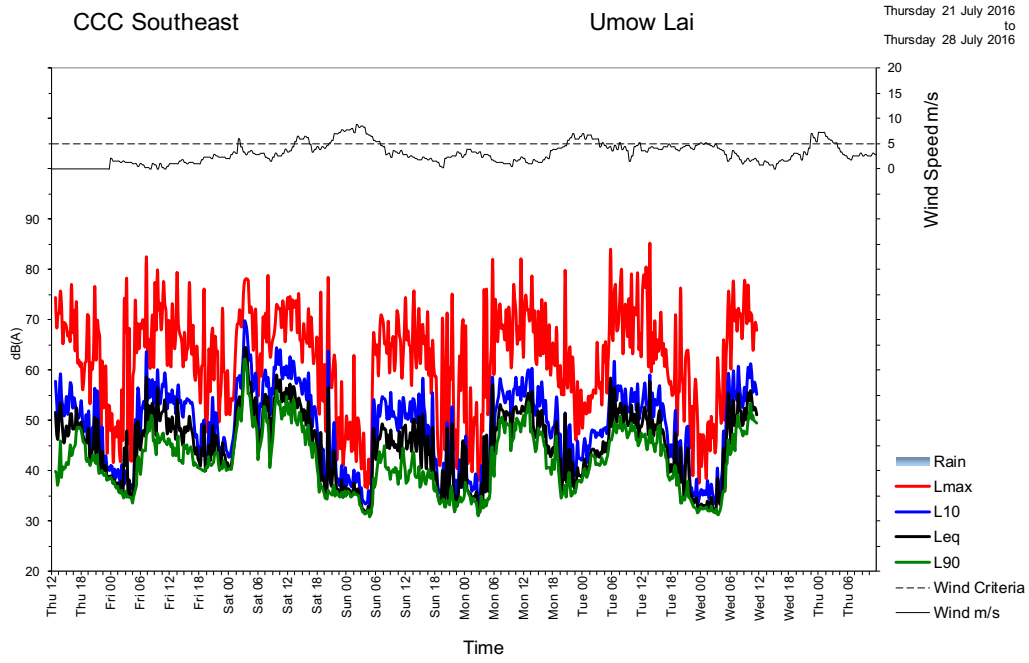

Figure A1 Graphed noise logging data for southeast location

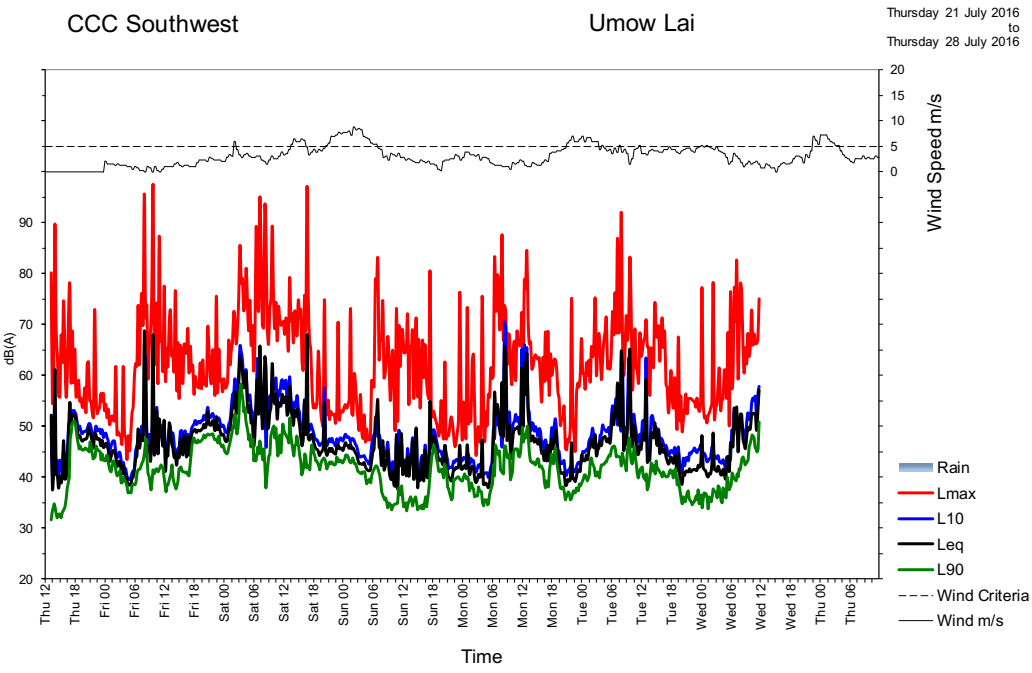

Figure A2 Graphed noise logging data for southwest location

Data processing for noise emission criteria

The INP has been used to derive objective noise criteria for each of the following times of day:

- Daytime: 07:00 to 18:00
- Evening: 18:00 to 22:00
- Night-time: 22:00 to 07:00

We have used the procedures in the NSW INP to derive a representative background noise level (a Rating Background Level or RBL) for the daytime, evening and night-time periods based on the measurements conducted on site. An RBL is the median of the lowest 10th percentile of the background L_{A90} samples in each daytime, evening and night-time measurement period. The RBL for each of these periods has been calculated for each 24 hour period during the noise survey.

We have also determined representative L_{eq} (energy average) noise levels according the INP procedures. Noise levels during the INP defined time periods are presented in Table A1.

Table A1 Measured noise levels at Cessnock Correctional Centre

Location	Metric	Noise level during period, dB(A)		
		Daytime	Evening	Night-time
Southeast	L_{90} / RBL / Background noise level	42	35	32
	L_{eq} / Energy average noise level	51	44	45
Southwest	L_{90} / RBL / Background noise level	38	37	37
	L_{eq} / Energy average noise level	55	46	46

Derivation of noise emission criteria

In consideration of the above, project specific criteria have been established in accordance with the NSW INP. Criteria for continuously operational mechanical services and other site noise sources at the proposed development site are shown in bold in Table A2 for residential locations to the southeast and north, and for the retirement village to the east, and in Table A3 for residential locations to the south / southwest. For the purpose of determining amenity criteria at this site, the nearby residentially zoned land is considered to be located in a 'suburban' noise environment as defined in the NSW INP.

Table A2 Noise emission criteria – residential receivers to the southeast and east (and north)

Location	Noise Emission (L_{eq}) criteria, dB(A)		
Southeast and east of CCC	**Daytime**	**Evening**	**Night-time**
Rating Background Level (RBL)	42	35	32
Intrusive criterion (RBL + 5 dB)	47	40	37
Amenity Criterion (Suburban)	55	45	40
Project specific criteria	**47**	**40**	**37**

Table A3 Noise emission criteria – residential receivers to the south and southwest

Location	**Noise Emission (L_{eq}) criteria, dB(A)**		
South and southwest of CCC	**Daytime**	**Evening**	**Night-time**
Rating Background Level (RBL)	38	37	37
Intrusive criterion (RBL + 5 dB)	43	42	42
Amenity Criterion (Suburban)	55	45	40
Project specific criteria	**43**	**42**	**40**(1)

(1) Amenity criterion applies for this time period.

Appendix B—Typical construction sound power levels

Typical plant and equipment sound power levels (L_w)

The following table presents typical sound power levels for equipment that would be expected during the construction phase of the Cessnock Correctional Centre Upgrade. The levels are based on measurements previously conducted by Resonate Acoustics and on the database published by the UK Department for Environmental, Food and Rural Affairs (DEFRA). A typical overall range of sound power levels for each stage is also presented based on typical operating scenarios, and including any tonal or impulsive penalties considered applicable. Note that the typical overall sound power level is not necessarily the sum of all the individual sound power levels but corresponds to a typical worst-case sound power level for that phase over a 15-minute period.

Activity	Typical equipment used	Typical L_W dB(A)
Site establishment	**Typical L_W**	**110**
	Mobile crane	100
	Light delivery vehicle	90
	Material and delivery truck	99
	Water cart	98
	Generator	94
	Excavator	106
	Concrete saw cutting	114
	Water pump	96
Early works	**Typical L_W**	**112**
	Flatbed truck with crane	97
	Light delivery vehicle	90
	Mobile crane	100
	Material and delivery truck	99
	Large excavator	106
	Rock-breaker	113
	Grader	108
	Dump truck	97
	Water cart	98
	Vibratory roller	104
	Jackhammer	112
	Concrete saw cutting	114

Activity	Typical equipment used	Typical L_W dB(A)
Structure	**Typical L_W**	**113**
	Generator	94
	Large excavator	106
	Mobile crane	100
	Concrete pump	103
	Concrete mixer	101
	Concrete truck	106
	Mobile electric welding set	101
	Electric hand tool	108
	Water pump	96
	Jackhammer	112
	Concrete saw cutting	114
Internal works and fitout	**Typical L_W**	**114**
	Generator	94
	Mobile electric welding set	101
	Electric hand tool	108
	Jackhammer	112
	Concrete saw cutting	114
	Light delivery vehicle	90
	Material and delivery truck	99
Landscaping	**Typical L_W**	**107**
	Generator	94
	Large excavator	106
	Light delivery vehicle	90
	Material and delivery truck	99
	Dump truck	97
	Water cart	98
	Paver	105
	Vibratory roller	104
	Grader	108