

Report

Acoustic Services – Secretary's Environmental Assessment Requirements (SEAR)

NEW WESTERN SYDNEY UNIVERSITY BANKSTOWN CITY CAMPUS
Western Sydney University

Report

CONFIDENTIAL

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1 EXECUTIVE SUMMARY

1.1 Purpose

NDY have been engaged by Western Sydney University to complete the Acoustics Report associated with the new Western Sydney University (WSU) Bankstown City Campus development in Bankstown, Sydney. This report has been prepared for submission as part of the Secretary's Environmental Assessment Requirements (SEAR) SSD9831.

This report outlines the outcomes of initial Authority consultation, to determine the capacities of existing services and utilities available for the proposed development. This document is intended to provide sufficient information to demonstrate servicing can be provided to support the proposed development.

1.2 Revision History

Rev	Date Issued	Comment
1.0	05 June 2019	Initial Issue
2.0	18 July 2019	Draft Issue
3.0	22 July 2019	Final Issue
4.0	28 August 2019	Final Issue

1.3 Professional Accreditation

The assessment and reporting have been undertaken by acoustic consultant Akil Lau and David Luck of Norman Disney & Young. Both Akil Lau and David Luck are certified members of the Australian Acoustical Society (M.A.A.S).

Additionally, NDY Acoustics Sydney is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

1.4 Information Sources

- NSW Noise Policy for Industry 2017
- NSW Interim Construction Noise Guideline 2009
- NSW Road Noise Policy 2011
- Assessing Vibration: A Technical Guideline 2006
- Vibrations in Buildings, DIN4150.3-1999
- Development near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)



2 PROJECT INFORMATION

2.1 Project Site

The Bankstown City Campus Development (BCCD) is a key component of Western Sydney University's Western Growth Program. The project, entailing a stand-alone vertical campus on an undeveloped site in Bankstown Central Business District, will facilitate the relocation of most programs from the existing campus at Milperra into new facilities that support new modes of working, learning and research, with scope to accommodate future growth.

The project site includes 74 Rickard Road (being Lot 5 DP 777510) and a portion of 375 Chapel Street (being part Lot 6 DP 777510). In addition, public domain works are proposed to Rickard Road, 70 Rickard Road (being part Lot 7 DP 777510) and access is proposed via 80 Rickard Road (being Lot 12 DP 566924). The site is within the Civic Precinct, located next to Council office and chambers, Bankstown Knowledge Hub and the Bryan Brown Theatre, and Paul Keating Park. On the east side of the site The Appian Way, a partially pedestrianised roadway, links from Rickard Road south to Bankstown Railway Station.

Project Description:

The building characteristics are as noted below:

- **Basement:** The Bankstown City Campus development has two levels of basement, accommodating carparking, loading & delivery, building management office, end of trip facilities and building services plant.
- **Ground Level:** The Ground Level concept is to create a porous building, connected to its external context, drawing both landscape and visitors into the Ground Level, and continuing through to the levels above. Key entry points provided at the centre of the Rickard Road and Paul Keating Park frontages, connected by an internal 'University Street', punctuated by an atria and escalator route that provided a visual and physical connection that extends to high student use spaces above. The ground level also contains 3 retail tenancies which are proposed to food and beverage tenancies.
- **Levels 1 & 2:** Level 1 & 2 are the largest floor plates of the Bankstown City Campus Development with Net Lettable Area each of approximately 2,300m². A greater floor to floor height has been provided to both these levels of 4.32m, offering a flexible expansive floor for range learning programmes, particularly to the north where the column spacing extends to 12m.
- **Level 3:** Situated between high occupancy levels above and below, including the Library, Level 3 has been identified as a real destination space within the building for students and visitors. It's proposed that level will accommodate the Student Hub and provide valuable breakout and study space between classes for students.
- **Levels 4-6:** Levels 4 to 6 are proposed to house a variety of University Workspace, Research and Learning accommodation, including the Library at Level 4, situated directly above the Student Hub below. The levels are served by escalators, as well as lifts. The large rectangular flexible floor plate allows for a range of learning accommodation, including larger rooms to the north, where the column spans are at their greatest.
- **Level 7:** Levels 7 is the final level served by the escalators. The Collaborative Space is envisaged as another destination hub, facilitating spaces designed to foster a strong cross disciplinary collaboration and learning culture between University Staff and students partnerships.
- **Levels 8-12:** Levels 8 to 12 form the mid-tower, with access via the passenger lifts. The levels are expected to accommodate a variety of University Workspace and Learning Spaces. A series of balconies

are provided at each floor the south-west façade allowing for external study and breakout areas from the main floorplate.

- **Level 13:** Level 13 had been designed to accommodate a conference facility for the University, catering for up to 300 persons. A generous floor to floor height in excess of 5m has been provided, allowing for large conference rooms with increased ceiling heights along the northern boundary.
- **Levels 14-18:** Upper tower levels form the cantilevered form of the building. These levels allow future growth opportunities for the University as the campus develops. The floors will be constructed with fit-out to accommodate University growth needs. Terraces are provided to Level 16 and Level 18 overlooking Bankstown CBD to the south, as well as Level 17 to the north. The north-east corner of the Level 18 floor plate accommodates the majority of the 'roof' services plant, including building back-up generator, hydraulics plant, and external cooling towers. Additional smaller plant rooms are located at Level 14, 15 and 17, accommodating AHU and stair pressurisation plant.

Figure 1 shows the project site and Figure 2 shows the Bankstown Area zoning in accordance with Bankstown Local Environmental Plan 2015, Land Zoning Map.



Figure 1: Site Layout

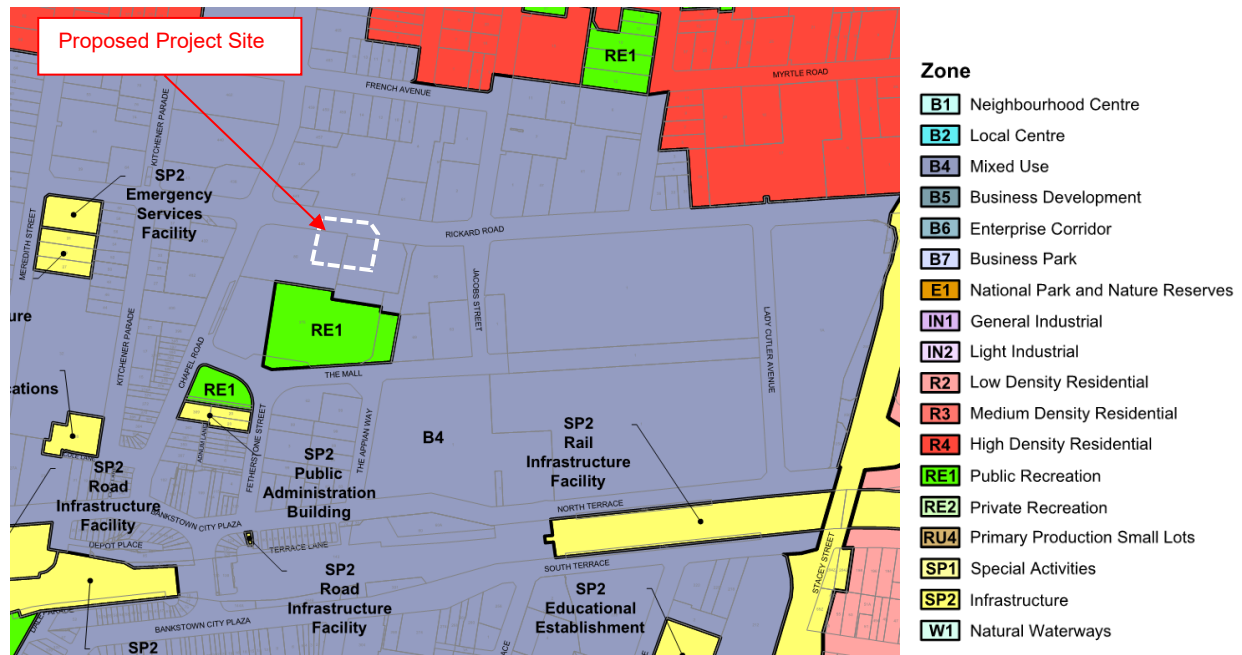


Figure 2: Bankstown Local Environmental Plan 2015 Land Zoning Map

3 ACOUSTIC SURVEY OF THE EXISTING ENVIRONMENT

3.1 Methodology

Noise survey and site inspection were conducted to determine the existing background/ ambient noise levels at the nearest sensitive receivers. The noise survey was carried out over a period of 8 days, between the 16th May and 24th May 2019.

The noise measurements locations are shown in **Figure 3**.



Figure 3: Noise Logging and Receiver Locations

3.2 Instrumentation

Noise levels were measured using the Noise Loggers listed in Table 1.

Noise Logger	Type	Serial Number	Date of Calibration
Ngara	Class 1	8780C7	23.09.2018
Ngara	Class 1	8780FB	23.09.2018
B&K 2270 Sound Level Meter	Class 1	2650622	06.12.2018

Table 1: Noise Logger Information

The equipment calibration was checked prior to, and after the noise survey using a 94dB external calibration tone at 1 kHz. No significant drift was noted during the calibration procedure (i.e. less than 0.5dB).

The noise logger was configured to record all relevant noise parameters including background noise (L_{A90}) and equivalent continuous noise levels L_{Aeq} . Samples were recorded at 15-minute A-weighted continuous intervals. The noise monitor responses were set to *fast* response.

3.3 Meteorological Data

In order to verify that the noise data was obtained during suitable meteorological conditions, weather data such as rain and wind speed was obtained from the Bureau of Meteorology Bankstown Airport AWS weather station (Station ID 066137) as a representative site.

Noise data is excluded (as per the NSW NPFI methodology) from the results in case of:

- Rain observed during any 15-minute noise measurement period and/or.
- Wind speeds exceeded 5 m/s during any 15-minute noise measuring period.¹

3.4 Sensitive Receivers

Table 2 shows the assessed sensitive receivers in close proximity to the site, please also refer to **Figure 3** for a mark-up of the receiver locations.

Item	Receivers	Representative property for monitoring	Distance (approximate)	Zoning as per LEP 2014
R1	Residential properties on Rickard Road	61 – 63 Rickard Road Bankstown NSW	25m North of site	B4 – Mixed use with Residential
R2	Residential properties on Chapel Road	400 Chapel Road N Bankstown NSW	100m South West of site	B4 – Mixed use with Residential
R3	Passive Recreational	Paul Keating Park	20m South of site	RE1 – Public Recreation
R4	Commercial properties	Bankstown Community Services/ Bankstown Library and Knowledge Centre	20m West of site	B4 – Mixed use

Table 2: Sensitive Receivers and zoning

¹ The wind noise data has been corrected for the height difference between the meteorological station (33m) and the measurement position (1.5m) as per AS1170.2-1989. The procedure has been outlined and validated in "CONVERTING BUREAU OF METEOROLOGY WIND SPEED DATA TO LOCAL WIND SPEEDS AT 1.5m ABOVE GROUND LEVEL" by Tracy Gowen, Peter Karantonis, and Tony Rofail.



4 ACOUSTIC CRITERIA

4.1 SEARS Requirements

Critical State significant infrastructure (CSSI) projects are high priority infrastructure projects that are essential to the State for economic, social or environmental reasons. The CSSI process involves a declaration by the Minister for Planning that a State significant infrastructure project is critical.

When an application for approval of a declared CSSI project is made, the Secretary of the Department of Planning and Environment is required to issue environmental assessment requirements (SEARs). The Secretary is also required to consult with relevant government agencies in preparing the SEARs. Community consultation during preparation of the SEARs may also be undertaken if deemed necessary by Minister.

Project-specific SEARs was prepared to deal with specific issues associated with a project that are not adequately covered in the standard SEARs. Below is extract from the project specific SEARs for this project.

10. Noise and Vibration

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

4.2 Operational Noise Criteria

4.2.1 NSW Noise Policy for Industry 2017

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs.
- Evening: 1800 to 2200 hrs.
- Night-time: 2200 to 0700 hrs.

The measured background (L_{A90}) and equivalent continuous (L_{Aeq}) noise levels during these defined time periods are presented in Table 3.

The L_{A90} noise levels presented are *Rating Background Levels* (RBLs), being the median of the background L_{A90} (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24-hour period during the noise survey.

The L_{Aeq} noise levels presented are the logarithmic average of all the L_{Aeq} samples taken in each of the daytime, evening and night-time periods.

Table 3 shows the existing ambient and background noise levels at the closest residential boundary (Location 1 in Figure 3), Appendix A shows the graphical data results for the monitoring location.

Table 3: Existing Ambient Noise Levels, dBA

Location	Noise Index	Noise Level, dB re 20 μ Pa		
		Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
L1 – 1-5 Jacobs Street, Bankstown NSW	L_{A90} (RBL)	54	54	41
	$L_{Aeq,period}$	65	65	60
L2 – 402-410 Chapel Road Bankstown NSW	L_{A90} (RBL)	54	51	42
	$L_{Aeq,period}$	64	63	61

4.2.1.1 Amenity and Intrusiveness Criteria

Based on the unattended noise survey discussed in Section 3 of this report, the external noise level criteria for the receiver location has been derived in accordance with the NSW Noise Policy for Industry (NSW NPfI).

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW. The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background (L_{A90}) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5 dB.
- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equalled to recommended amenity noise level minus 5dB(A). A +3dB(A) to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The closest *residential* receivers are located on Rickard Road and Chapel Road which has been assessed based on the urban noise criteria given in the NPfI.

The NPfI recommends “Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2, only the amenity levels apply.” The project amenity and intrusive noise levels are listed in Table 4.



Table 4: NPfI Project Intrusiveness and Amenity Noise Criteria

Type of Receiver	Noise Level $L_{eq,15min}$ [dBA]		
	Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
Commercial Premises (Southern site Boundary)	Project Amenity Assessment		
	63 (when in use)		
Passive recreational (Southern boundary, Paul Keating Park)	Project Amenity Assessment		
	55 (when in use)		
Residential properties (on Rickard Road)	Project Intrusiveness Assessment		
	59	59	46
	Project Amenity Assessment		
	58	55	50
Residential properties (on Chapel Road)	Project Intrusiveness Assessment		
	59	56	47
	Project Amenity Assessment		
	58	53	51

4.2.1.2 'Modifying factor' Adjustments

Penalties may be applied if the noise from the development "... contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."

To take into account the potential annoying character of the noise an adjustment of +2dB(A) or +5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), may be added to the measured value to penalise the noise for its potential greater annoyance aspect.

Table C1 of the NSW NPfI provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

4.2.2 Project Trigger Noise Levels for Operational Noise Sources

The project trigger noise levels are the most stringent noise levels of the NSW NPfI project intrusiveness and project amenity noise levels for day, evening and night time periods and are project specific. Table 5 below presents the project trigger noise level (PTNL) for the closest receivers.



Table 5: External Project Trigger Noise Levels (PTNL) operation noise

Location	Time	Descriptor	External PTNL [dBA]
Commercial Premises (Southern Site Boundary)	When in use	$L_{eq, 15min}$	63
Passive Recreational (Southern boundary, Paul Keating Park)	When in use	$L_{eq, 15min}$	55
Residential properties (on Rickard Road)	0700 to 1800	$L_{eq, 15min, day}$	58
	1800 to 2200	$L_{eq, 15min, evening}$	55
	2200 to 0700	$L_{eq, 15min, night}$	46
Residential properties (on Chapel Road)	0700 to 1800	$L_{eq, 15min, day}$	58
	1800 to 2200	$L_{eq, 15min, evening}$	53
	2200 to 0700	$L_{eq, 15min, night}$	47

4.2.3 Project Trigger Noise Levels for Emergency Equipment

There is no specific guideline related to noise criteria specific to emergency equipment (e.g. Generators, fire pumps, etc.). State Environment Protection Policy (SEPP), VIC 1989, have specific noise guidelines for standby generators² which states that noise limit shall be increased by 10dB for a day period and by 5 dB for all other periods. Based on the best practice for state of Victoria, we have developed external noise criteria for emergency equipment which is to increase the PTNL by 10 dB for all periods. Table 6 summarises the noise criteria for emergency equipment.

Table 6: External Project Trigger Noise Levels (PTNL) for emergency equipment

Location	Time	Descriptor	External PTNL [dBA]
Commercial Premises (Southern Site Boundary)	When in use	$L_{eq, 15min}$	73
Passive Recreational (Southern boundary, Paul Keating Park)	When in use	$L_{eq, 15min}$	65
Residential properties (on Rickard Road)	0700 to 1800	$L_{eq, 15min, day}$	68
	1800 to 2200	$L_{eq, 15min, evening}$	65
	2200 to 0700	$L_{eq, 15min, night}$	56
Residential properties (on Chapel Road)	0700 to 1800	$L_{eq, 15min, day}$	68
	1800 to 2200	$L_{eq, 15min, evening}$	63
	2200 to 0700	$L_{eq, 15min, night}$	57

² A standby generator means a generator of electrical power used as an alternative to the main supply in emergencies or for a maximum period of 4 hours per month for maintenance purposes.

4.2.3.1 Sleep Disturbance Noise Limits

In accordance with NSW NPfI 2017, the potential for sleep disturbance from maximum noise level events from premises during the night time period needs to be considered. Sleep disturbance is both awakenings and disturbance to sleep stages.

“Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.”

Table 7 details the sleep disturbance noise limits for the nearest residential receivers adjacent to the proposed development.

Table 7: Sleep Disturbance Noise Limits

Location	Descriptor	Given Noise Limits [dBA]	Limits based on RBL* [dBA]	Project Noise Levels [dBA]
Residential properties (on Rickard Road)	$L_{eq,15mins, night}$	40	46	46
	$L_{Fmax, night}$	52	56	56
Residential properties (on Chapel Road)	$L_{eq,15mins, night}$	40	47	47
	$L_{Fmax, night}$	52	57	57

4.3 Construction Noise and Vibration Criteria

4.3.1 Interim Construction Noise Guideline

The NSW Interim Construction Noise Guideline was developed by the NSW-Department of Environment & Climate Change DECC, NSW which incorporates the EPA. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

The guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

It is expected that the length of the construction works associated with the development would be more than 3 weeks and therefore a quantitative method has been used for this assessment.

Table 8 and Table 9 set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the ‘highly noise affected management level’ which is >75dBA. Affected properties above 75 dBA will require community consultation and a Construction Noise & Vibration Management Plan (CNVMP).



Table 8: Noise at Residence using Quantitative Assessment

Recommended Hours	Time of Day	External Management Level $L_{eq,15min}$ [dBA]
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise Affected RBL + 10
		Highly noise affected 75
Outside recommended standard hours	Any time other than the recommended standard hours	Noise Affected RBL + 5

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

Table 9: Noise at Sensitive Land Use (other than residence)

Land Use	External Management Level, $L_{eq,15min}$ [dBA] (applies when properties are being used)
Commercial premises	70
Passive Recreation area (Paul Keating Park)	60

4.3.2 Noise Management Level

Noise Management Levels (NML) associated with the construction works on the project site are presented in Table 10.



Table 10: Construction Noise Management Levels

Receivers	Recommended Hours	Period	RBL $L_{A90,15mins}$ [dBA]	External Noise Management Level [dBA]
Commercial premises	All Hours (Standard Construction Hours + Outside Standard Construction Hours)	When in use	n/a	70 $L_{eq,15mins}$
Passive Recreation area (Paul Keating Park)	All Hours (Standard Construction Hours + Outside Standard Construction Hours)	When in use	n/a	60 $L_{eq,15mins}$
Residential properties on Rickard Road (North of the site boundary)	Standard Construction Hours	Day	54	64 $L_{eq,15mins}$
	Outside Standard Construction Hours	Day	54	59 $L_{eq,15mins}$
		Evening	54	59 $L_{eq,15mins}$
		Night	41	46 $L_{eq,15mins}$
Residential properties on Chapel Road (West of the site)	Standard Construction Hours	Day	54	64 $L_{eq,15mins}$
	Outside Standard Construction Hours	Day	54	59 $L_{eq,15mins}$
		Evening	51	56 $L_{eq,15mins}$
		Night	42	47 $L_{eq,15mins}$

4.3.3 Construction Vibration Criteria

The effects of construction vibration upon buildings can be separated into three main categories:

1. Perceptibility of the occupants to the vibration and the possibility of them being disturbed or annoyed.
2. Vulnerability of the building structures to vibration induced damaged.
3. Vulnerability of the contents of the building that includes types of equipment, activities and processes.

4.3.3.1 Human Response to Vibration

Humans are very sensitive to vibration, and they can be disturbed, annoyed and have their work activities interfered with if the levels are too high. The Interim Construction Noise Guideline references “*Assessing Vibration: a technical guideline*” (Vibration Guideline) issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration. The Vibration Guideline provides vibration criteria for continuous, impulsive and intermittent vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The criteria are discussed in more detail in the following sections.

4.3.3.2 Continuous and impulsive vibration (1-80 Hz)

According to the Vibration Guideline for continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted root-mean-square acceleration values and results are to be compared against the following preferred and maximum values given for each orthogonal axis. The frequency weightings as per BS6841:1987 (reproduced in Appendix B3 of the guideline) are to be applied to the RMS measurement values (1-80Hz). The criteria in the Vibration Guideline are derived from the limiting values of the assessment curves and multiplying factors from BS 6472:1992 (the curves are no longer referenced in the superseded version of the standard BS 6472:2008). We have assumed hotels will be assessed as per the criteria for residences.

Table 2.2 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s²) 1–80 Hz

Location	Assessment period ¹	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas ²	Day- or night-time	0.0050	0.0036	0.010	0.0072
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
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas ²	Day- or night-time	0.0050	0.0036	0.010	0.0072
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

¹ Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

² Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

The Vibration Guideline notes “Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project.”

4.3.3.3 Intermittent vibration (1-80 Hz)

According to the Vibration Guideline for intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV). Acceptable values of vibration dose are given as follows. We have assumed hotels will be assessed as per the criteria for residences.

Table 2.4 Acceptable vibration dose values for intermittent vibration ($\text{m/s}^{1.75}$)

Location	Daytime ¹		Night-time ¹	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas ²	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

¹ Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

² Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Source: BS 6472-1992

4.3.3.4 Structural Response to Vibration - German Standard DIN 4150-3:1999

The German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

The response of a building to vibration is affected by several factors that include its type of foundation, the underlying ground conditions, its construction and the state of the building. Please note the construction vibration limits are designed to ensure the structural integrity of nearby buildings and are not for human comfort. the limits are well above perceptibility.

According to DIN 4150 short term vibration refers to vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated. Long-term vibration refers to all types of vibration not covered by the definition of 'short-term vibration'. The criteria for short-term and long-term vibration are listed in the following.

4.3.3.5 Guideline Values for evaluation of short-term vibration - DIN 4150-3:1999

The vibration limits of table 1 in DIN 4150-3:1999 (replicated in **Table 11** below) refer to the evaluation of the effects of short-term vibration on structures.

The criteria are the peak particle velocities (ppv) measured on any foundation or uppermost full storey of any building not related to the site and are listed in the Table 11 below.

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, however, further investigations are necessary. And on the other hand, exceeding the limits does not necessarily lead to damage.

Table 11: DIN 4150-3 Construction Vibration Limits – Short Term

Type of Structures	Guideline values for vibration velocity (mm/s)			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50 Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, Industrial building and building of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

4.3.3.6 Guideline Values for evaluation of long-term vibration - DIN 4150-3:1999

The vibration limits of table 3 in DIN 4150-3:1999 refer to the evaluation of the effects of long-term vibration on structures.

The criteria are the peak particle velocities measured on the uppermost full storey of any building not related to the site and are listed in Table 12 below.

According to the standard, *exceeding the values listed below does not necessarily lead to damage*.

If a building is subject to harmonic vibration, then maximum values can occur in floors other than the top floor, or in the foundation. The values given also apply in these cases.

Table 12: DIN 4150-3 Construction Vibration Limits – Long Term

Type of Structures	Guideline values for velocity, v_i , in mm/s of vibration in horizontal plane of highest floor, at all frequencies
Buildings for commercial purposes, Industrial building and building of similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	2.5



5 OPERATIONAL NOISE IMPACT ASSESSMENT

5.1 Building Services Plant Noise

It is understood that the development will include mechanical plant and HVAC equipment. At this stage, the detailed design and selection of mechanical plant is still underway. Preliminary assessment based on initial equipment selection is summarised below.

5.1.1 Load Bank

Based on the preliminary design of load bank, it is understood that 1 x Load Bank (Model BL12V1200MC, with 1200KW) with Sound Pressure Level of 91 dBA at 1m is proposed at Level 18 on the northern side. We have assumed a solid noise barrier on the northern façade to reduce the noise from the load bank reaching the apartments on Rickard Road. Load Bank will be used during a emergency scenario or during testing of a generator (once in 3 months). Worst case noise during night time (with attenuation from noise barrier) will comply with the project specific noise levels for emergency scenario of 56 dBA at the boundary of nearest residential apartments on Rickard Road.

5.1.2 Emergency Generator Assessment

The detailed design of the generator rooms and selection of the plant will still need to be confirmed. Refer to **Table 6** for external noise criteria specific to emergency generators. Based on preliminary selection it is understood that CAT C32 Diesel Generator set (1500 KVA) will be installed inside the generator room on Level 18 with Sound Pressure Levels of 80dBA at 1m. It is expected to require the following acoustic treatment to achieve boundary noise compliance:

- Heavy construction to acoustic enclosure walls and ceiling
- Acoustic attenuators to intake, outlet and exhaust

The emergency generator noise emissions from the development will be designed to satisfy the boundary noise requirements of the NPfI. Treatment requirements will be reviewed in detail as the design of the development progresses. Based on the information provided the emergency generator will comply with the project specific noise levels for emergency scenario of 56 dBA at the boundary of nearest residential apartments on Rickard Road.

5.1.3 Generic Recommendations

For other HVAC equipment, these can be treated using a combination of any of the following options:

- Selection of low noise units.
- Strategic location of equipment away from most sensitive receivers.
- Duct internal acoustic lining (where appropriate).
- Acoustic attenuators (where appropriate).
- Acoustic louvres.
- Acoustic barriers (if exceed the above recommendations).

All mechanical services noise emissions from the development will be designed to satisfy the boundary noise requirements of the NPfI. These will be reviewed in detail as the design of the development progresses.

5.1.4 Operational Vibration Impact

All operational activities expected to occur on this site are likely to have negligible impact on the surrounding buildings with respect to vibration and are expected to comply with the stipulated vibration limits.



5.1.5 Building envelope

The building envelope, internal partitions and building services equipment will be designed in general accordance with recommended internal design sound levels as per AS/NZS2107:2016 and Development Near Rail Corridors and Busy Roads – Interim Guideline.



6 CONSTRUCTION ASSESSMENT

6.1 Preliminary Noise Assessment

The following has been assumed in regards to noise intensive equipment/activities:

- Excavations may be undertaken.
- Rock breaking activities may be performed.
- Loading and unloading will be part of general construction activities.

For the assessment reference sound levels for representative equipment have been taken from the DEFRA, BS5228 and AS2436 databases. The documents include extensive databases of sound data covering trucks, excavators, hand tools and all manner of other construction equipment and activities. The ratings listed are for individual pieces of equipment at constant operation.

Table 13: Typical External Noise Levels of Demolition and Construction Machinery/Activity

Item #	Activity /Machinery	Source	Leq Sound Pressure Level at 10m (dBA)
Demolition Activities			
1	Tracked excavator, breaking up brick foundation (121kW, 15t)	DEFRA	90
2	Jack hammers	AS2436	93
3	Hand-held hydraulic breaker 20kg / 69bar	DEFRA	93
4	Backhoe mounted hydraulic breaker, breaking road surface (67kW)	DEFRA	88
5	Tracked excavator, loading dump truck	DEFRA	85
Earthworks			
6	Tracked Excavator, Ground Excavation Works (25t, 125kW)	DEFRA	77
Piling (bored piling)			
7	Crane mounted Auger	DEFRA	79
General Construction			
8	Electric tower crane, lifting	DEFRA	77
9	Hand-held Circular Saw (Petrol - Cutting Concrete Blocks), 3kW, 9kg	DEFRA	79
10	Generator, Power for Site Cabins (3kW)	DEFRA	65
11	Truck (>20 tonne)	AS2436	79
Noisy Activities when Building is Enclosed			
12	screw guns	BS5228	73
13	tile cutting	BS5228	81

6.1.1 Construction Activities and Mitigation

The following has been assumed in regards to vibration intensive equipment/activities:

- Ground rock breaking activities may be required.
- Drum roller are expected to be non-vibratory.

- Any excavations on the site are expected using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment.

The following general construction noise source control measures may be required:

- Site access for construction vehicles to be set up away from the Northern boundary.
- During extended construction hours, less intrusive works will be scheduled to be carried out and/or works will be carried out away from sensitive receivers.
- Activities that approach the highly noise affected criteria for the residential receivers to be carried out during times where receivers are less sensitive to noise.
- Avoid unnecessary revving of engines and turn off plant that is not being used/required.
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
- Where possible, avoid using tonal reverse alarm outside standard construction hours.
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to day period.
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors.
- Use less noise intensive equipment where reasonable and feasible.
- Where practical fixed plant should be positioned as far as possible from the sensitive receivers.
- Use temporary site buildings and material stockpile as noise barrier.
- Employ the use of solid barrier plywood hoardings if required.
- Where practical, a partial enclosure shall be used to minimise noise levels.

Table 14: Construction Noise Mitigation Measures

Item #	Activity /Machinery	Typical Construction Noise Mitigation Measures
Demolition Activities		
1	Tracked excavator, breaking up brick foundation	Localized barriers with acoustic absorption and overhang to be setup as close to the breaking source the breaking source, time management, activities to be carried out during less sensitive time during the day, to be carried out during standard hours
2	Jack hammers	
3	Hand-held hydraulic breaker	
4	Backhoe mounted hydraulic breaker, breaking road surface	
5	Tracked excavator, loading dump truck	Site access for trucks to be away from sensitive receiver, location of truck loading to be as far away from sensitive receiver as practical, time management, noisy loading activities to be carried out during standard hours
Earthworks		



Item #	Activity /Machinery	Typical Construction Noise Mitigation Measures
6	Tracked Excavator, Ground Excavation Works	Minimal excavation expected to be required. Time management, to be carried out during standard hours (Monday to Sunday 07:00-20:00)
Piling (bored piling)		
7	Crane mounted Auger	Time management, to be carried out during standard hours
Construction		
8	Electric tower crane, lifting	Location of crane to be as far away from sensitive receiver as practical, if crane needs to be set-up near the receiver noisy activities will need to be time managed, to be carried out during standard hours
9	Hand-held Circular Saw (Petrol - Cutting Concrete Blocks)	To be set up away from the sensitive receiver, if required adjacent the boundary or a barrier to shield the noise emissions may be required (building façade may be used as a barrier during later stages of the construction)
10	Generator, Power for Site Cabins	To be set up away from the sensitive receiver, if required adjacent the boundary a barrier to shield the noise emissions may be required outside standard construction hours
11	Truck (>20 tonne)	Site access for trucks to be away from sensitive receiver
12	Screw guns	Compliance expected if carried out within enclosed building
13	Tile cutting	Compliance expected if carried out within enclosed building

6.2 Preliminary Vibration Assessment

Based on the information available at this stage, the construction activities expected to occur on the site are likely to have little to no impact on the surrounding buildings on a vibration basis. Compliance with vibration limits is expected based on ensuring ground compacting equipment is selected to adhere to minimum safe working distances.

It is important to note that construction vibration levels depend on several factors. These include the activity, the machine, the geology of the ground and the distance between the building and the source. Surface works are expected to have a lower vibration impact than ground compacting/breaking works.

NSW RMS provides safe operating distances as per the *CNVG* for cosmetic damage to the building and for human response to vibration which has been used as a guideline at this stage. Table 15 below lists minimum safe working distances for critical equipment.

Table 15: RMS Safe Operating Distances - Construction Noise and Vibration Guideline 2016

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline - AVaTG)
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
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
Jackhammer	Hand held	1 m (nominal)	2 m

6.3 Construction noise and vibration mitigation measures

6.3.1 General/Site Management Issues

- As the construction methodology of the proposed development is yet to be finalised, NDY has provided a general recommendation to manage the construction noise and vibration in the section below. A detailed construction noise and vibration management plan and a quantitative construction noise assessment will be developed in the later stage of the project with the consultant team and contractor and it will be finalised prior to issuing a construction certificate in accordance with AS2436-2010 and other relevant Australian Guidelines.
- All employees, contractors and subcontractors are to receive an environmental induction and should instruct all persons at the site with regard to all relevant project specific and standard noise mitigation measures, including but not limited to permissible hours or work, limitation of high noise generating activities, location of nearest affected noise receivers, construction employee parking areas, designated loading/unloading areas and procedures, site opening/closing times (including deliveries) and environmental incident procedures.
- A dedicated person will form a point of contact for dissemination of general information regarding site operations. Contact persons will also be defined to receive comment or complaints from the community.

6.3.2 Hours of Work/Respite Periods

- Typical standard construction hours are 07:00 – 18:00 Monday – Friday and 08:00 – 13:00 Saturday. If works are required to be undertaken outside standard construction hours, additional approval must be sought from the Management prior to commencing works.
- Respite periods will be provided in the later stage of the project if it is deemed necessary.



6.3.3 Consultation

Notification to residents of proposed works:

- A letter to be distributed to neighbouring sites/residents in advance of the works to notify them of the nature and estimated timescales for completion of the proposed works.

Project info-line and construction response line:

- A 24-hour contact point shall be provided for any complaints regarding the construction works and a project representative shall respond to all compliant as soon as possible.

6.3.4 Noise Source Controls

General/ Work Practices:

- Avoid unnecessary revving of engines and turn off plant that is not being used/required.
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
- Where possible, avoid using tonal reverse alarm outside standard construction hours.
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to day time period.
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors.
- Use less noise intensive equipment where reasonable and feasible.

Use and siting of equipment/activities:

- Where practical fixed plant should be positioned as far as possible from the sensitive receivers.

Enclosures:

- Use temporary site buildings and material stockpile as noise barrier.
- Employ the use of solid barrier plywood hoardings if required.
- Where practical, a partial enclosure shall be used to minimise noise levels.

6.3.5 Vibration

Structural Damage:

- Use lower impact or low tonnage equipment.
- Maintain safety distance between construction plant and building, to be determined during detailed design stage.

Human Annoyance:

- Scheduling the use of vibration causing equipment at the least sensitive time of the day.
- Sequencing operations so that high vibration causing activities do not occur simultaneously.

6.3.6 Complaints Management

To facilitate in managing noise and vibration complaints, clearly visible signage specifying any security measures and key contact details will be erected on the perimeter of the building site.

A 24-hour contact name, phone number and email address will be provided for the resident to contact. The signage will indicate *"For any enquiry, complaint or emergency relating to this site at any time please contact..."*.

In addition, a log sheet will be kept by the contractor to record information about each complaint associated with the works.

The contents of the log sheet will include:

- The Name Address of the Complainant.
- Time and Date of the Complaint.
- The Nature of the Complaint.
- Subsequent Details.
- Remedial Action Undertaken.

The contents of the log sheet will be regularly maintained and updated, as soon as a complaint is made.

6.3.7 Noise and Vibration Monitoring

Where required, the developer will engage a qualified Acoustical Consultant to assess noise and ground borne vibration levels at agreed sensitive locations at agreed intervals. Monitoring periods will need to be determined as required by the Council. It is proposed that the results of the monitoring program are prepared by the Acoustical Consultant and contractor into monitoring reports, summarising construction noise and vibration results over the subject period. These reports will be made available to council as required.

Monitoring Reports should:

- Include a representative sample of typical site activities likely to occur on a day to day basis, activities causing complaints and/or any activity nominated in writing by the Council.
- outline activities, noise levels and remedial measures undertaken.
- make recommendations on control measures available where noise or vibration levels are found to exceed the guideline prescribed limits and describe the methods to be employed to ensure ongoing compliance, such as:
 - restricted times of operation of certain noisy activities (such as pile driving) including scheduling of noisy activities to less sensitive times.
 - the use of low noise techniques, such as Pressure or Bored Piling instead of the impact driven pre-cast pile techniques.
 - provision of sound attenuating barriers, fences or acoustic enclosures.
- Define the permissible noise levels at all relevant sensitive zones.



7 CONCLUSIONS

The following conclusions are based on the noise data and assumptions outlined in in this report.

7.1 Noise and vibration criteria

Noise and vibration criteria have been developed in accordance with the Australian Standards and stipulated NSW guidelines. Background and Ambient noise monitoring was conducted near the site and results summarised in this report.

7.2 Building Services Plant Noise

All mechanical services noise emissions from the development will be designed to satisfy the boundary noise requirements of the NPfl e.g. using internally lined ductwork, attenuators and/or barriers where required. These will be reviewed in detail as the design of the development progresses.

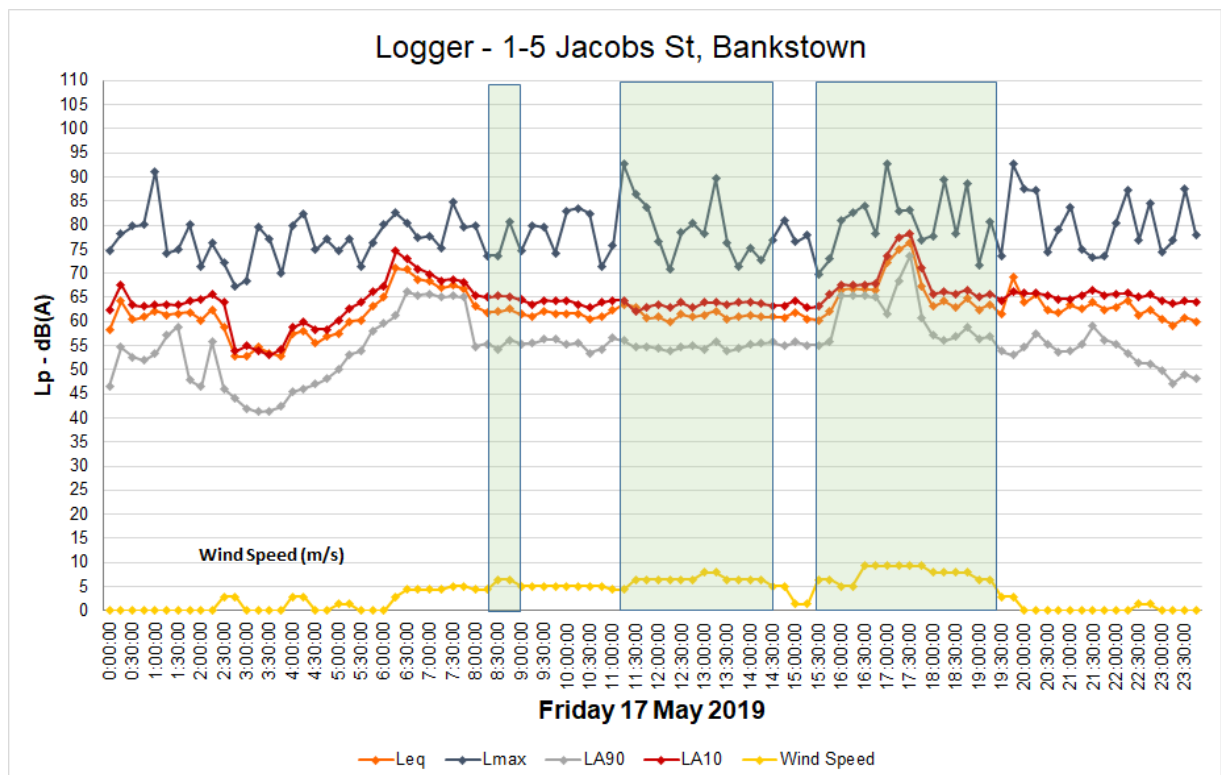
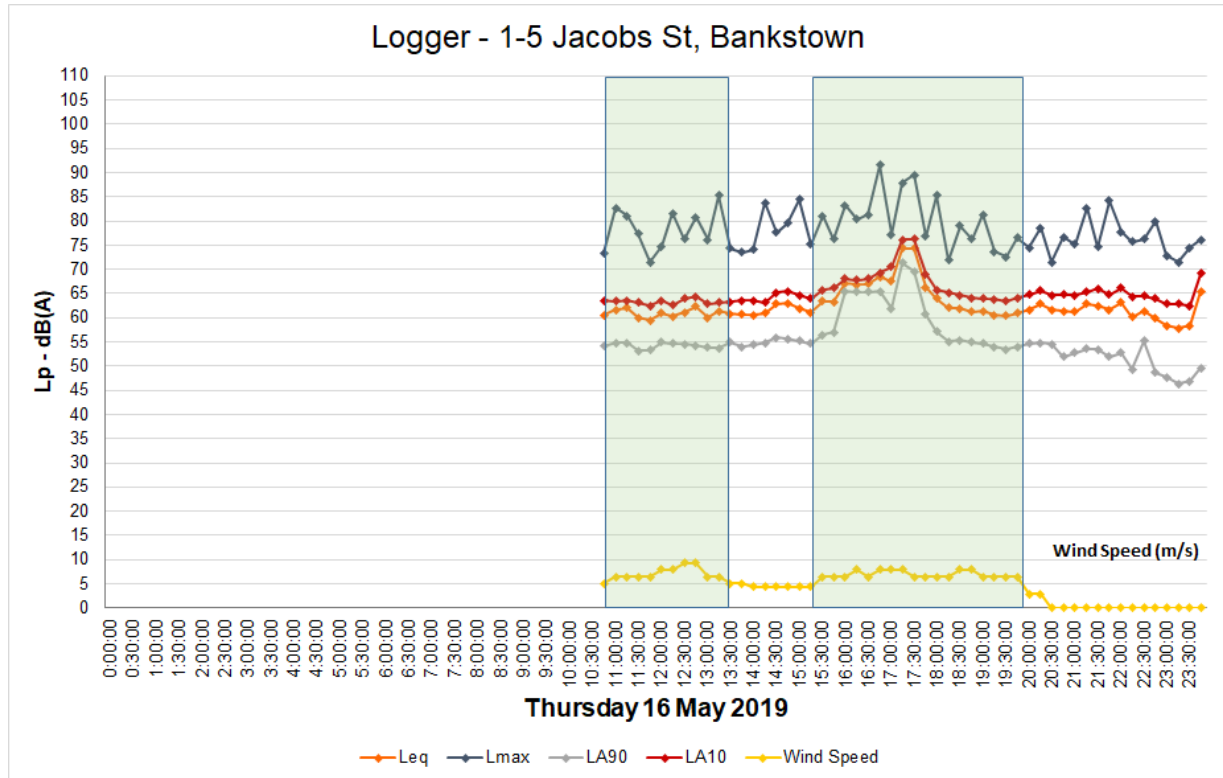
7.3 Construction Noise and Vibration

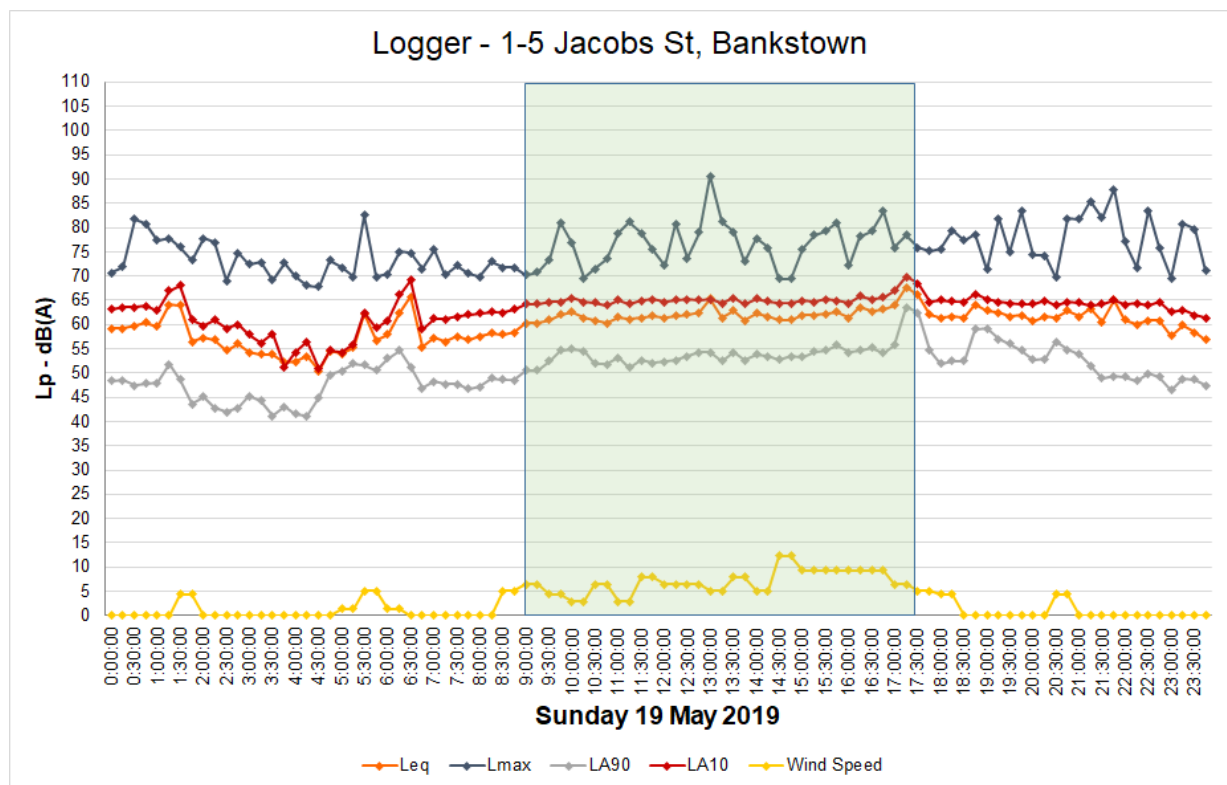
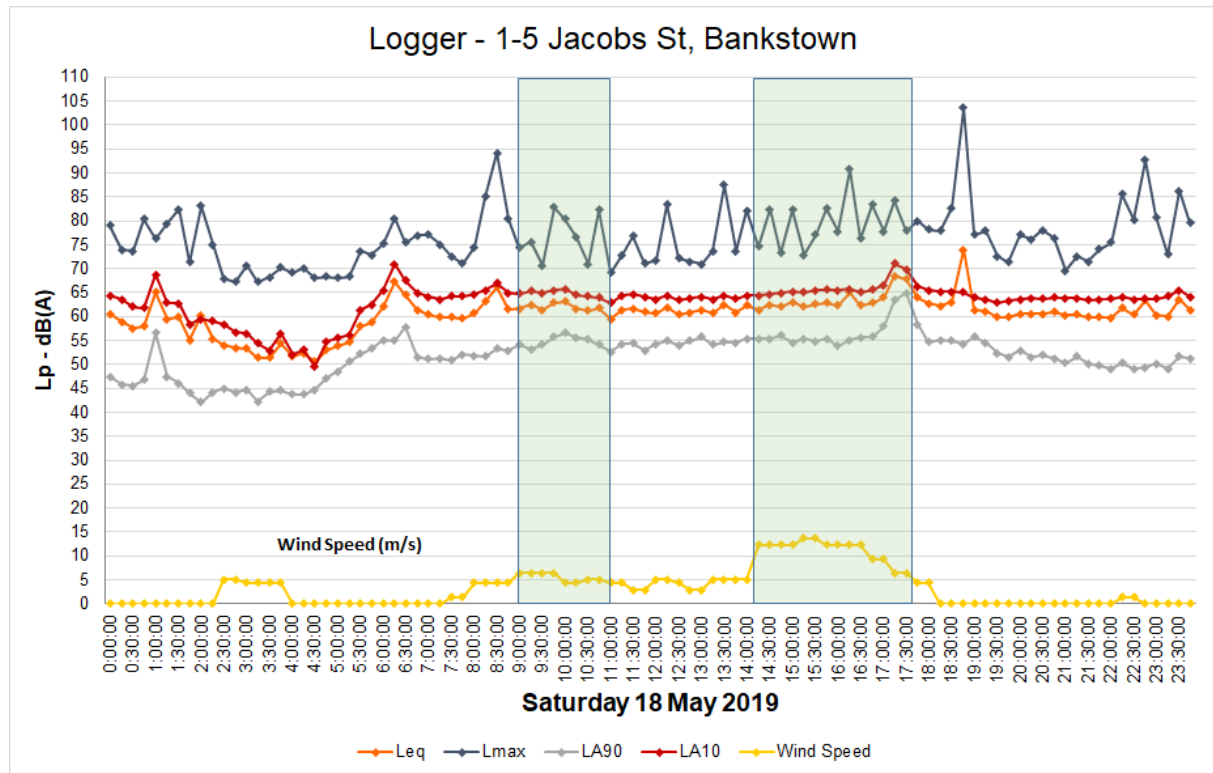
Noise and vibration impact during the construction phase is proposed to be managed through the implementation of a Noise and Vibration Management plan. This will require the contractor to undertake a range of measures to ensure that noise and vibration impacts are minimised and comply with the relevant construction noise and vibration standards during the construction phase. NDY has provided general recommendations to manage the construction noise and vibration in the Section 6 of this report. A detailed construction noise and vibration management plan and a quantitative construction noise assessment will need to be developed in the later stage of the project with the consultant team and contractor and will need to be finalised prior to issuing a construction certificate.

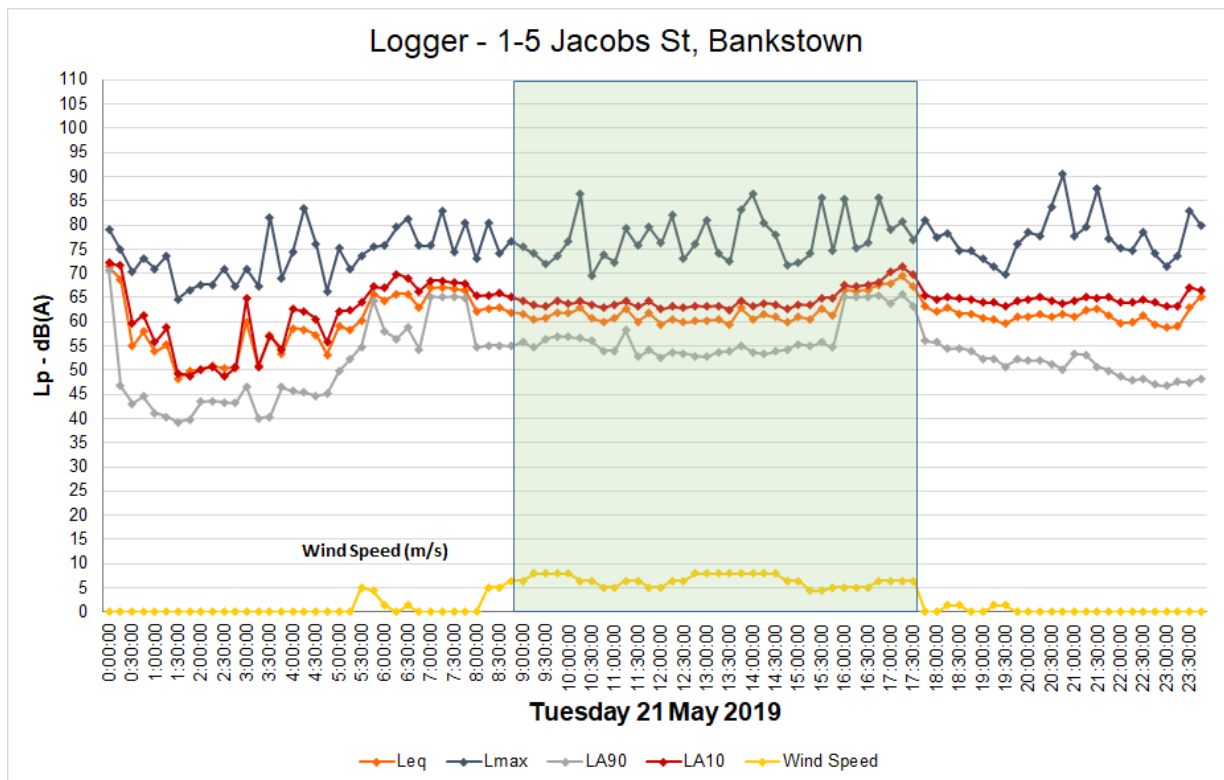
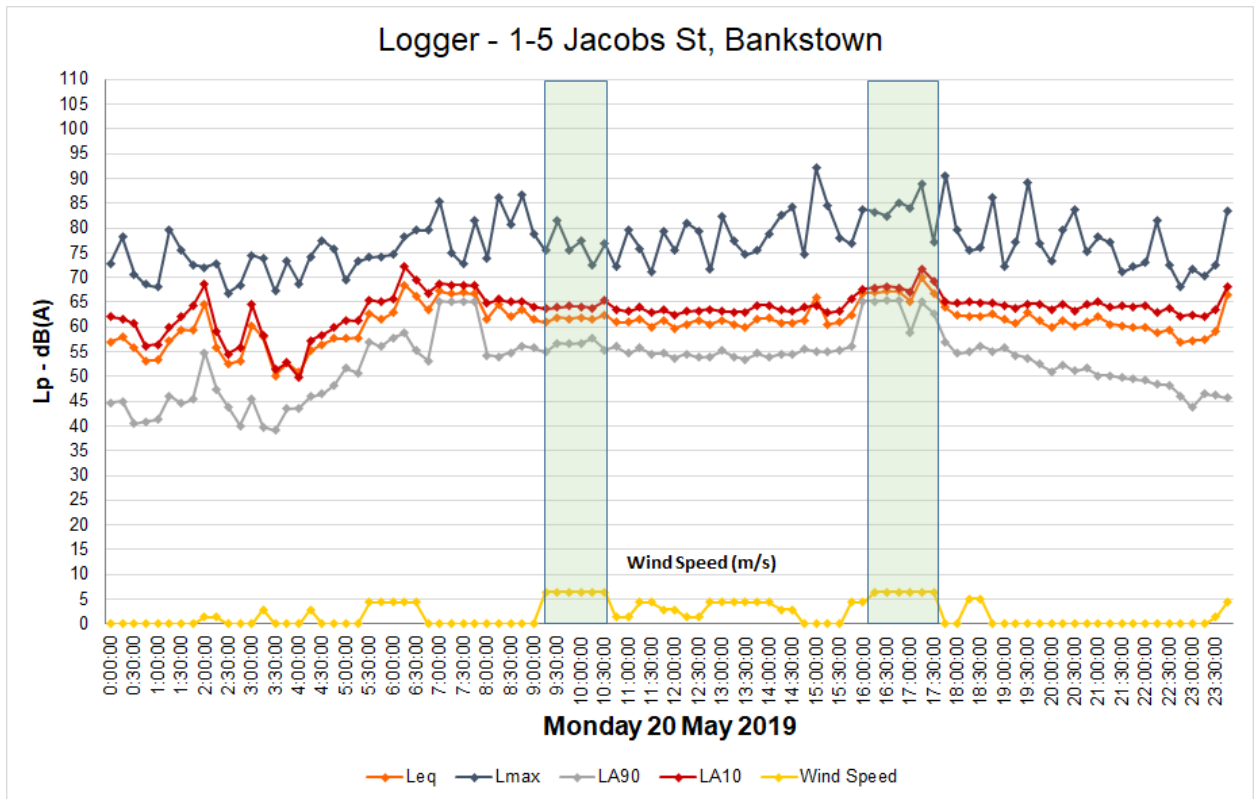


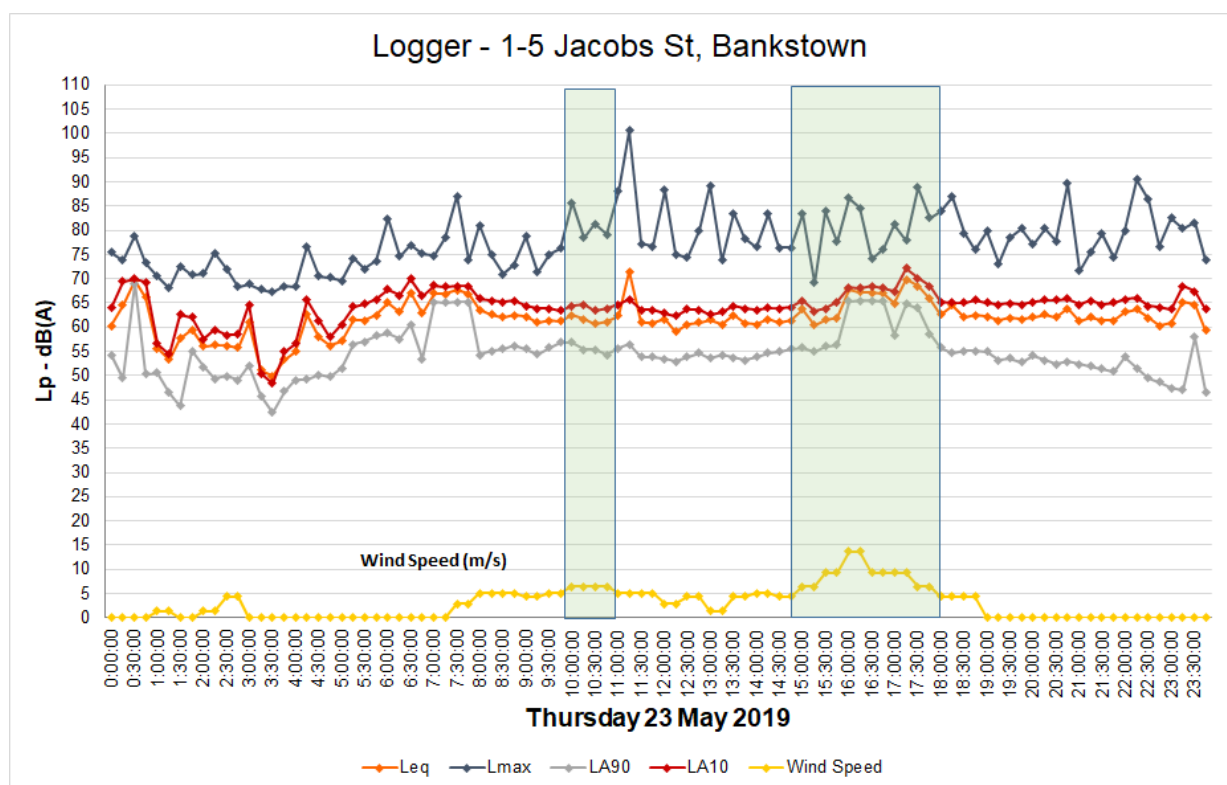
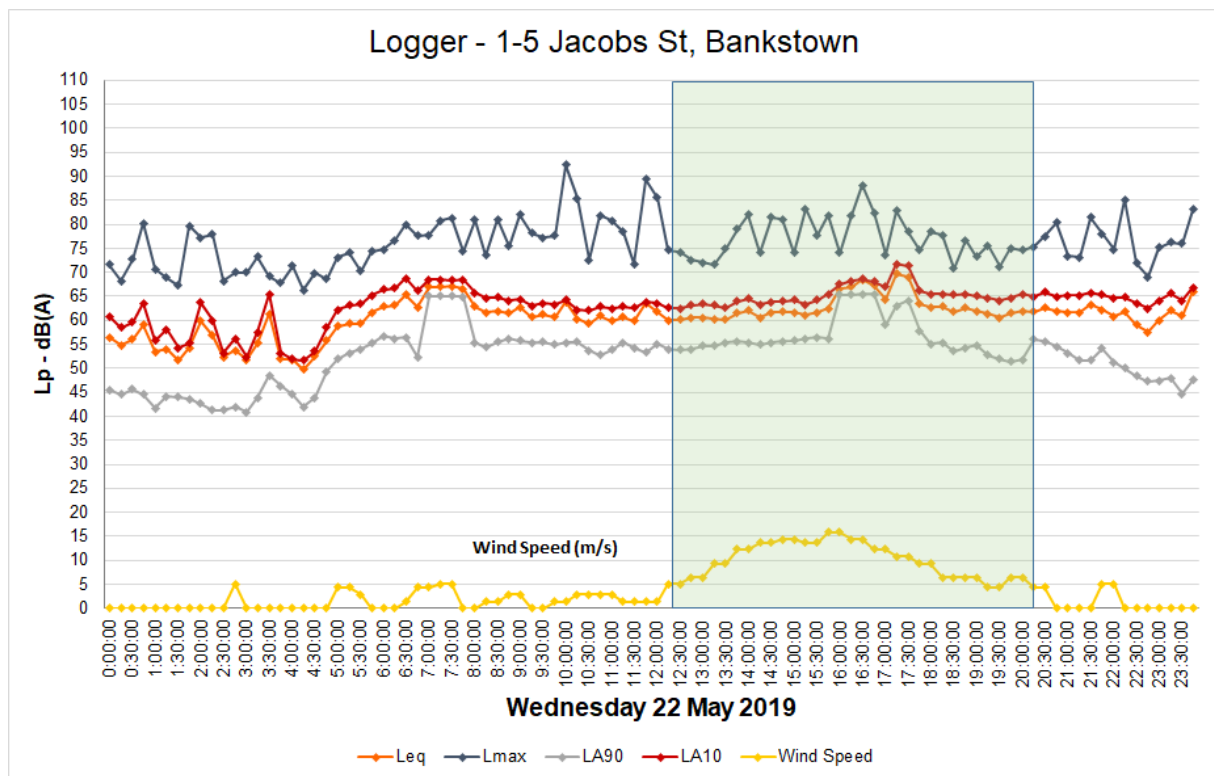
8 APPENDIX A - GRAPHICAL DATA FOR NOISE MONITORING LOCATIONS

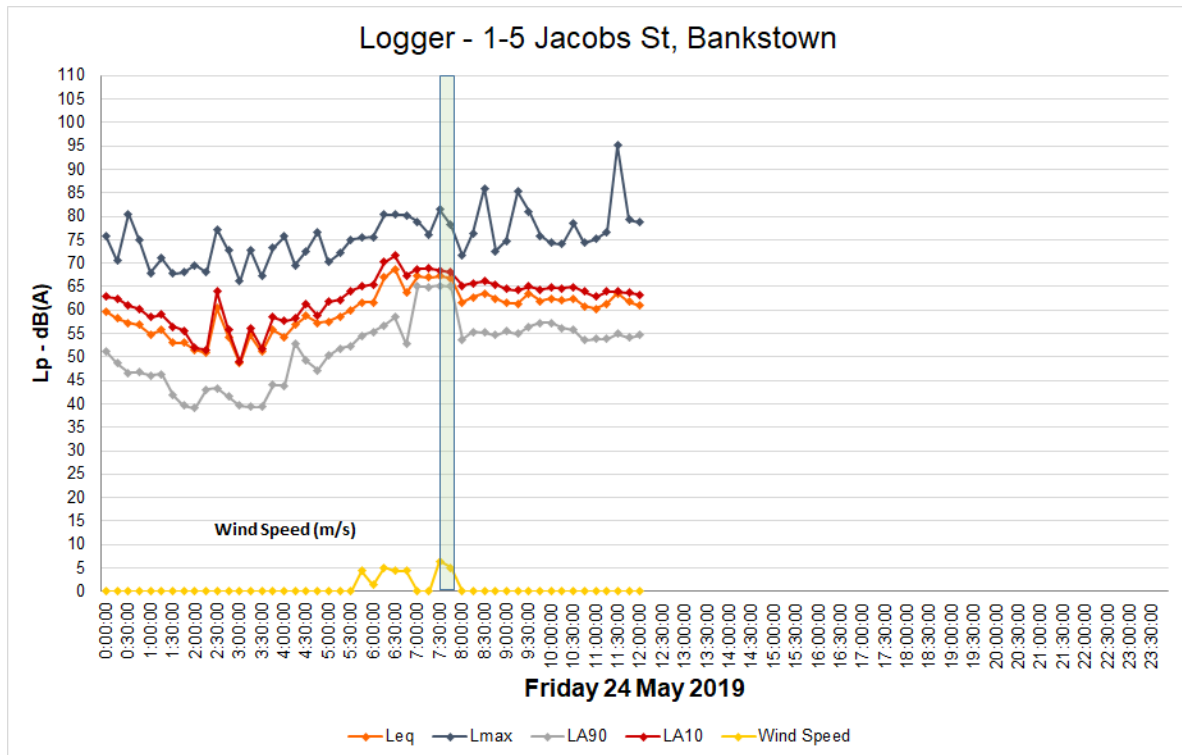
1-5 Jacobs Street Bankstown NSW - unattended measured noise levels, Wednesday 16 May to Thursday 24 May 2019. NB: There was no rain during the monitoring period and the bands indicate wind speeds in excess of 5 m/s:





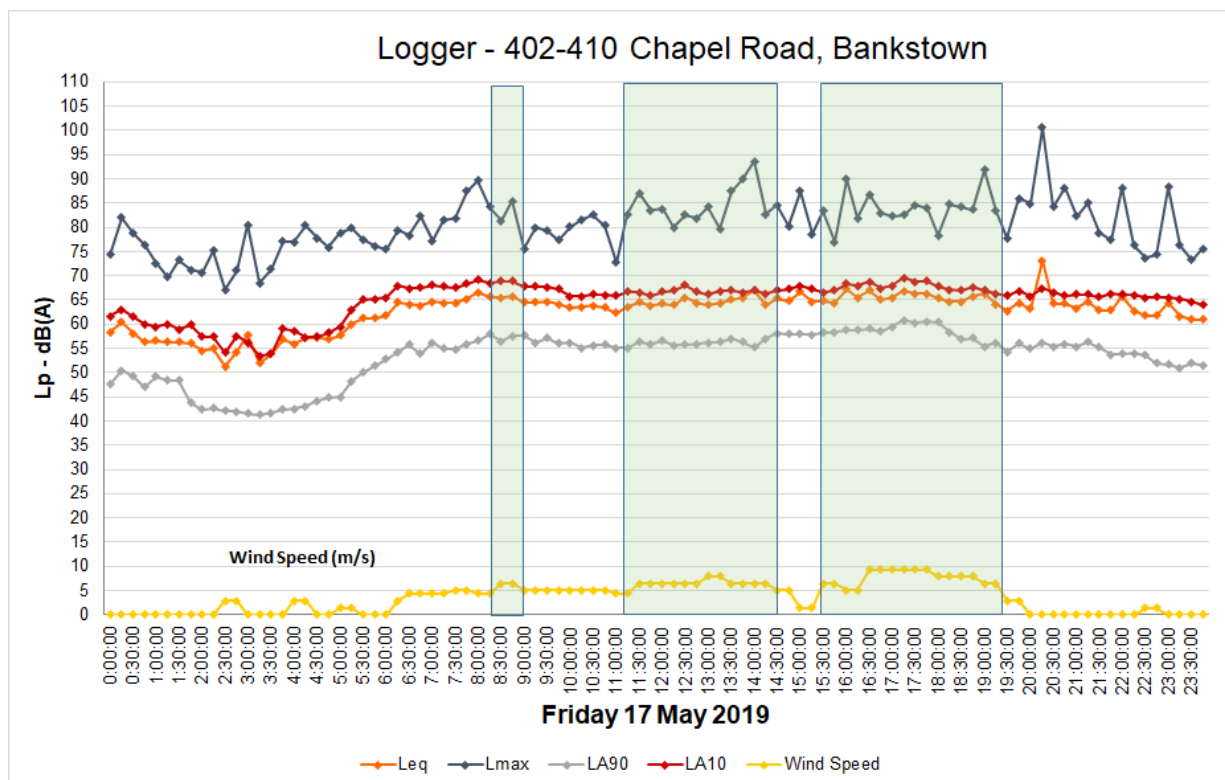
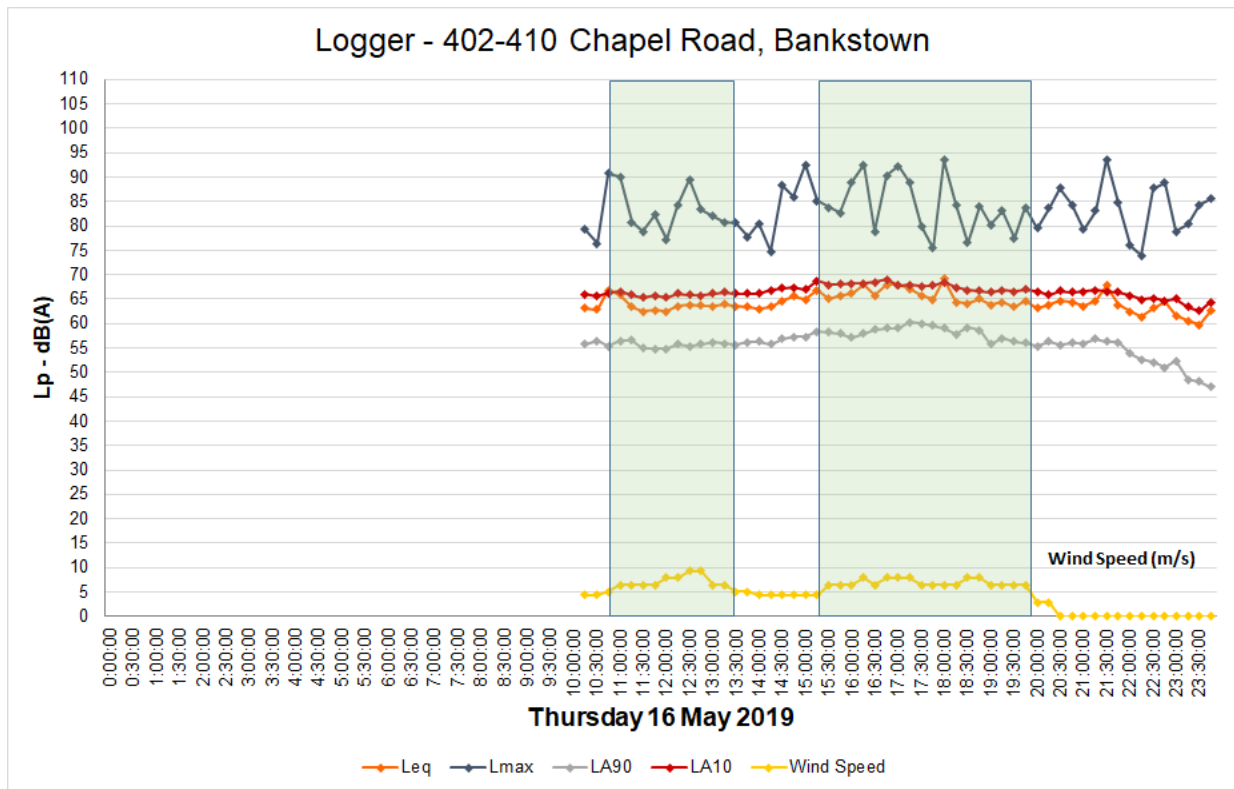


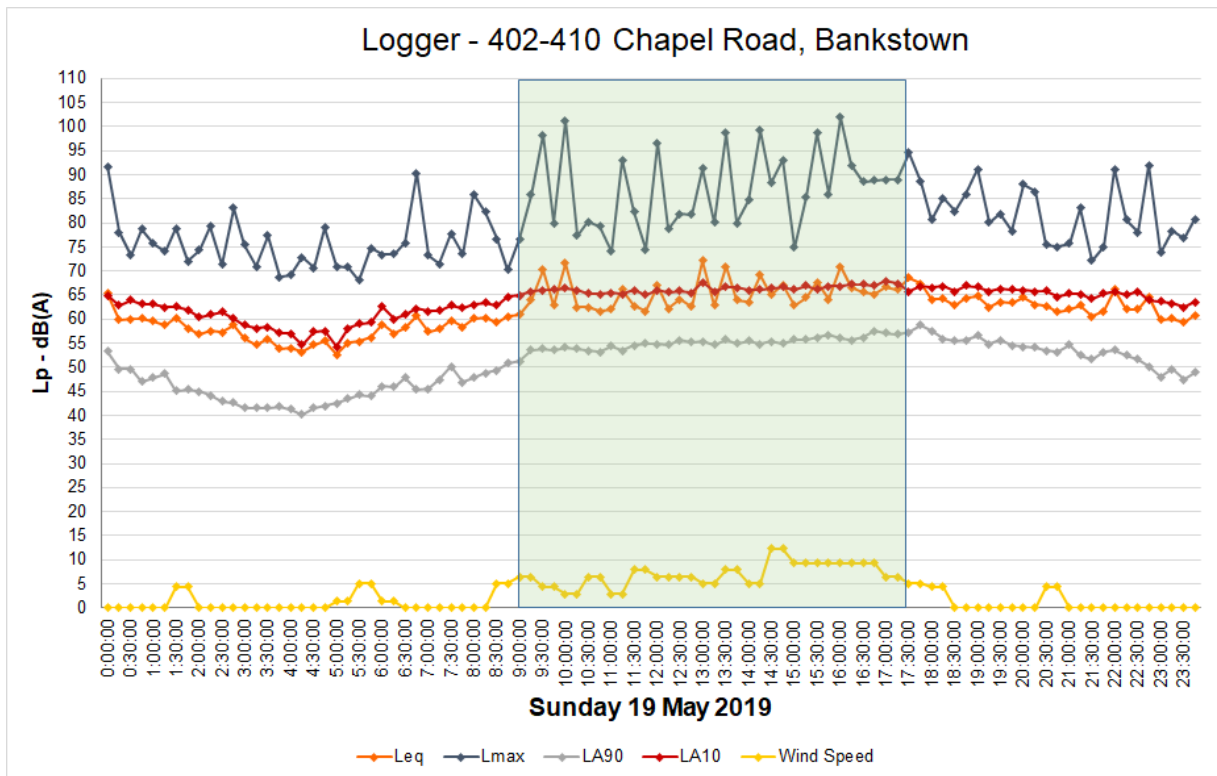
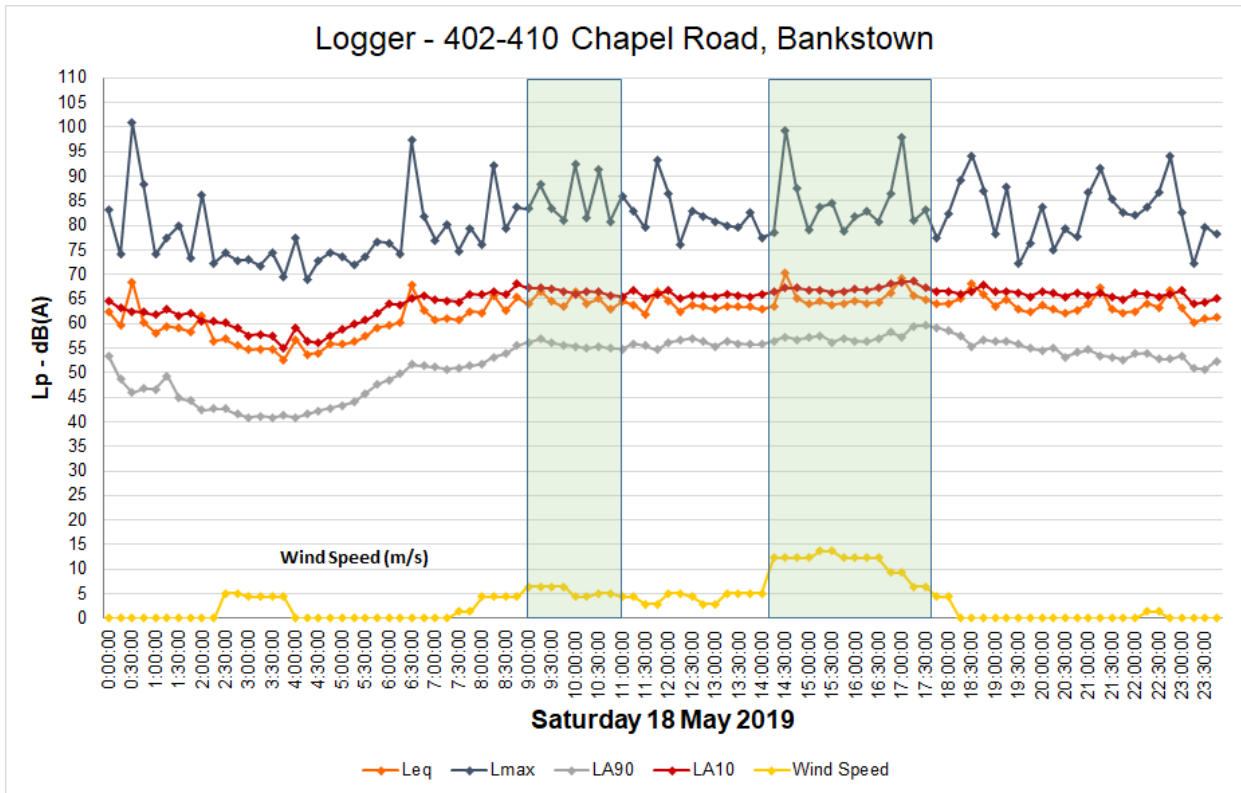


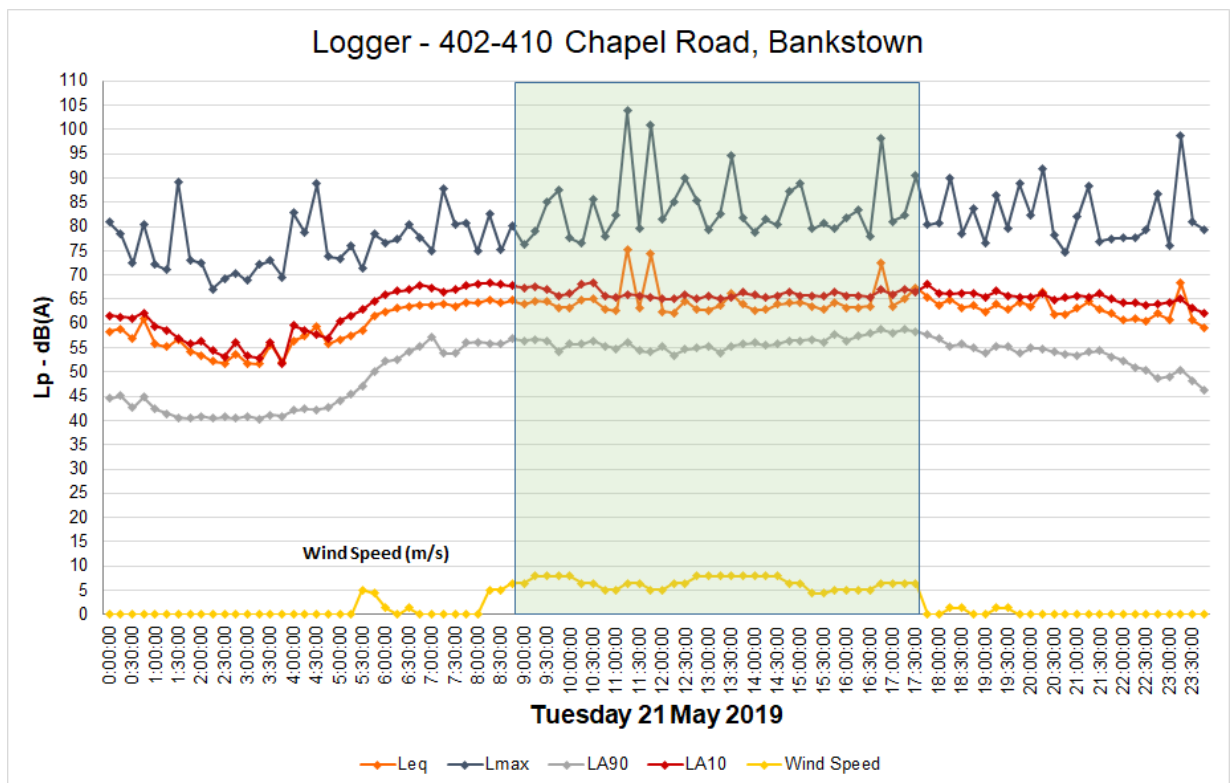
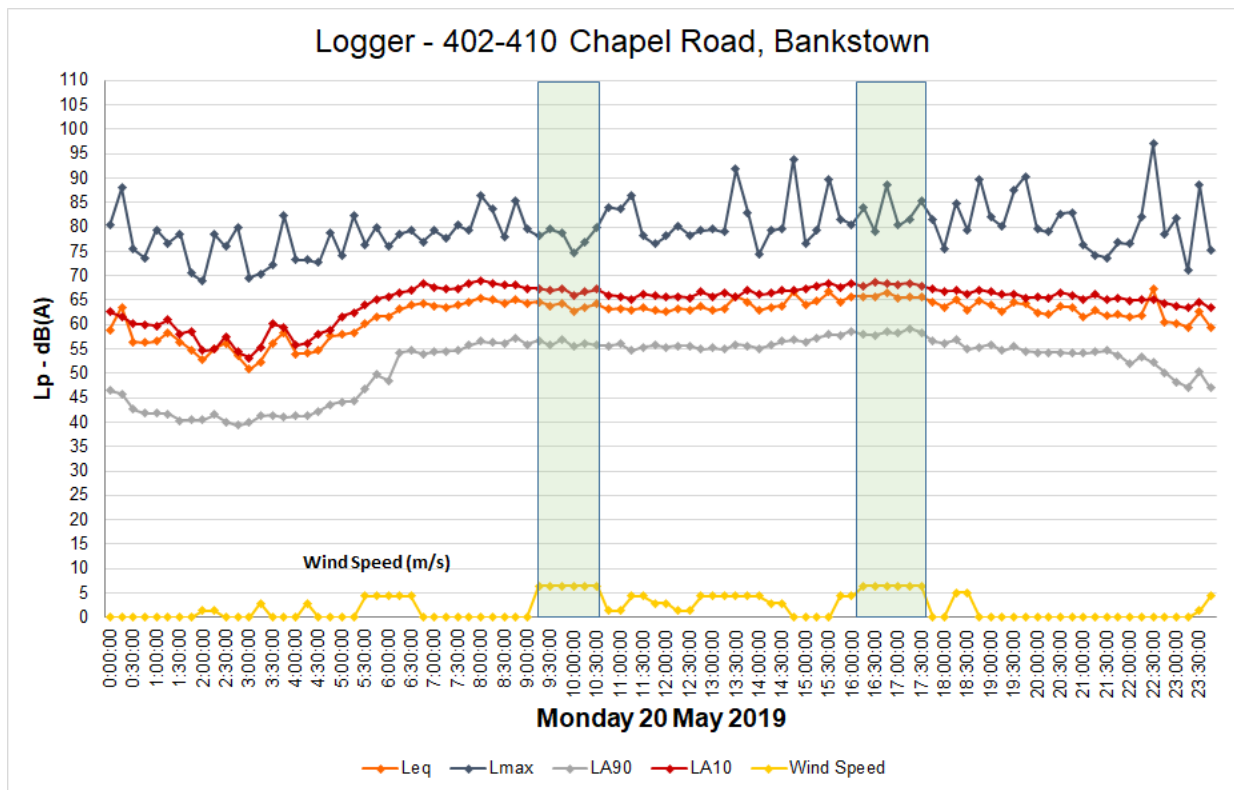


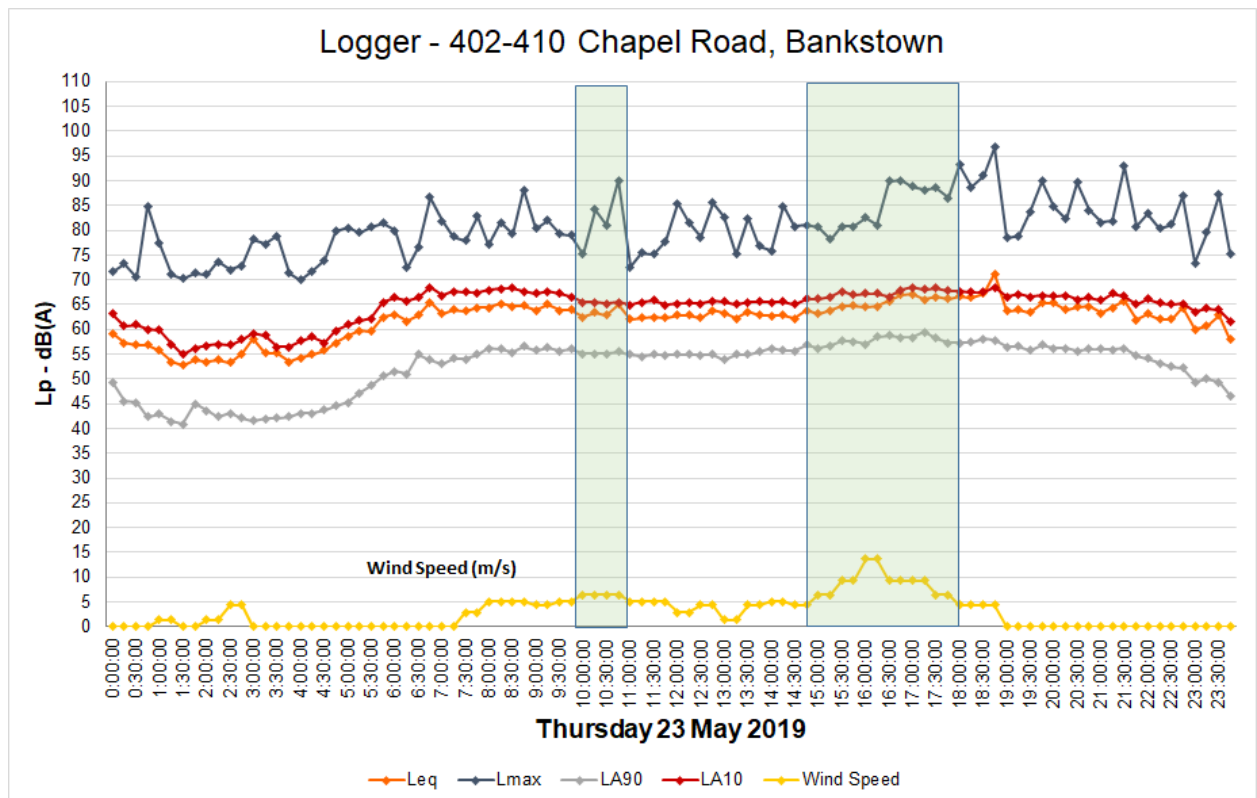
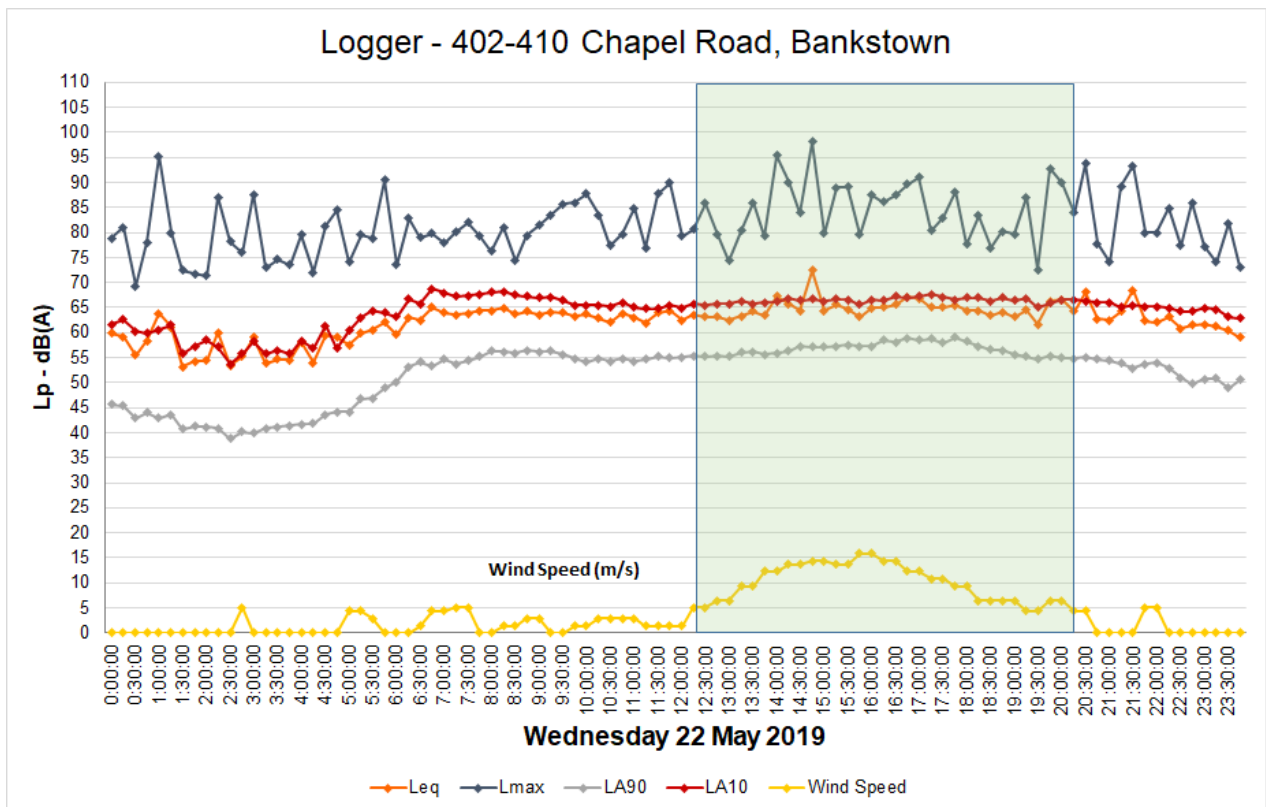


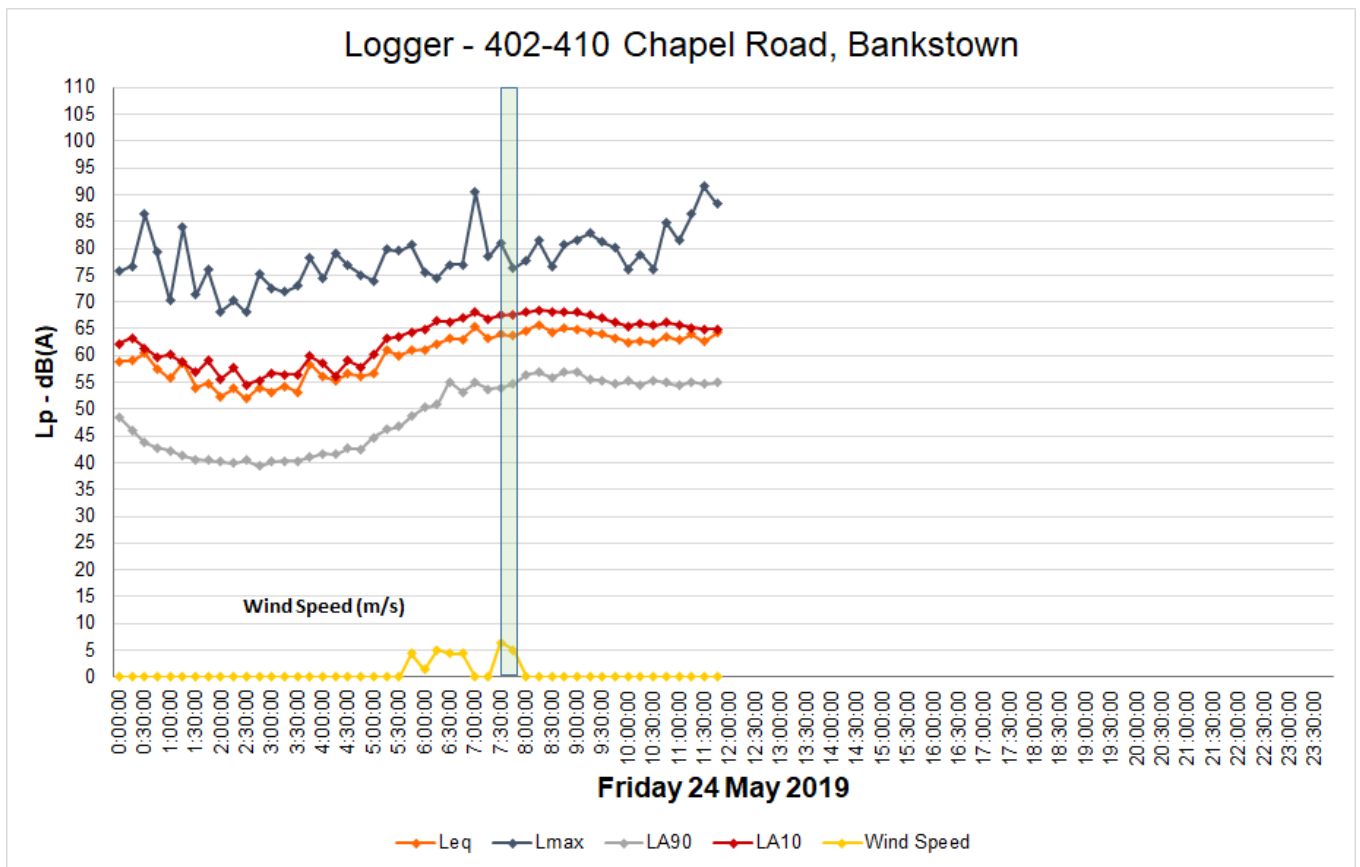
402-410 Chapel Road Bankstown NSW - unattended measured noise levels, Wednesday 16 May to Thursday 24 May 2019. NB: There was no rain during the monitoring period and the bands indicate wind speeds in excess of 5 m/s:













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