TARONGA WILDLIFE HOSPITAL SYDNEY NUTRITION CENTRE

ACOUSTIC REPORT FOR STATE SIGNIFICANT DEVELOPMENT APPLICATION

Issued

9 December 2021

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Proj & Code	Taronga Wildlife Hospital Sydney Nutrition Centre	TAR-3399
Doc Title	Acoustic Report for State Significant Development Application	
Ref	20211209.TAR3399.0003.Rep-N.docx	
Date	9 December 2021	Revision: ISSUE
Author(s)	Sav Shimada	

Circulation	**Organisation**	**Location**	**Delivered Via**
Kristine Marshall	Taronga Zoo	Sydney	Aconex
Matthew Spooner	Taronga Zoo	Sydney	Aconex

Attachment(s)	Appendices as listed in the Table of Contents

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1 Introduction

Acoustic Studio has been commissioned to provide acoustic engineering services for the proposed construction and operation of the new Taronga Wildlife Hospital Sydney Nutrition Centre ("Nutrition Centre") at Taronga Zoo, Mosman.

The Nutrition Centre forms Stage 1 of a two-stage proposal which will include a new Wildlife Hospital under Stage 2. The Stage 2 Wildlife Hospital will be carried out as a separate development.

The Nutrition Centre Project has been categorised as a "State Significant Development". This acoustic assessment report has been prepared in support of the EIS for the proposed project.

An operational and construction acoustic assessment has been carried out for the proposal, and is detailed in this report along with the findings and recommendations. It has been prepared as part of the State Significant Development Application (SSDA) to be submitted to NSW Department of Planning and Environment for the proposed Nutrition Centre. The Stage 2 Wildlife Hospital will be assessed under a separate SSDA. The acoustic assessment report addresses the acoustic requirements in the Secretary's Environmental Assessment Requirements (SEARs) for application SSD-17655146.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the construction and operation of the proposed Nutrition Centre.
- Determine existing ambient and background noise levels at the nearest noise sensitive receivers that surround the site.
- Establish the appropriate noise assessment criteria in accordance with the relevant standards and guidelines.
- Carry out an assessment to determine whether the relevant criteria can be achieved based on proposed operations and likely construction methods. Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure compliance with the assessment criteria.

2 Project Description

2.1 Project overview

Taronga Conservation Society Australia (Taronga) is proposing to construct and operate a new Nutrition Centre in the grounds of Taronga Zoo. The Nutrition Centre forms Stage 1 of a two-stage development for a new Taronga Zoo Wildlife Hospital and Sydney Nutrition Centre. Stage 2 (the Wildlife Hospital) will be carried out as a separate development with its own development application.

The Nutrition Centre will cater for zoo animal specialists and will operate during normal zoo opening hours.

The new facility will replace the existing animal nutrition facilities. The relocated and expanded Nutrition Centre will provide modern facilities for wildlife care, nutrition and research.

Stage 1, the Taronga Wildlife Hospital, Sydney – Nutrition Centre is located back of house and will replace several standalone buildings currently providing animal food preparation and storage.

Stage 1 – Nutrition Centre incorporates the following:

- New animal food and meat preparation facilities to serve the Taronga site
- Open plan offices and meeting spaces to serve the Nutrition Centre and Stage 2 Hospital
- New tunnel under the back of house service road to link to the Stage 2 Hospital

It is proposed that deliveries to the Nutrition Centre development will be made via the existing secure entrance on Whiting Beach Road.

The proposal is shown in Figure 1 on the following page.

Figure 1: Plan view of the proposed Taronga Zoo Stage 1 Sydney Nutrition Centre and Stage 2 Wildlife Hospital

2.2 Key Acoustic Assessment Considerations

The SEARs require that the Environmental Impact Statement (EIS) must include a noise and vibration assessment in accordance with the relevant EPA guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and outline the proposed management and mitigation measures that would be implemented.

The key design considerations for the project are external noise emissions from operation of the following spaces and equipment associated with the Nutrition Centre works:

- Breakout noise from building services and plant servicing the Nutrition Centre.
- Road traffic noise from deliveries to the Nutrition Centre and staff arrivals and departures.

Noise emissions from each of these spaces / operations may need to be managed to limit environmental noise impacts on nearby residential receivers.

Construction activities may have a temporary noise impact on sensitive receivers inside and outside the zoo premises. This noise impact assessment considers these in detail.

2.3 Operating Hours

The Nutrition Centre will be open and in use during zoo opening hours, every day of the year including Christmas Day. Hours are seasonal, as follows (source: taronga.org.au, accessed 14/5/2021):

- 9:30am-4:30pm including Public Holidays

Maintenance of the facilities including care of the animals typically occurs outside of zoo opening hours, including weekends and public holidays. Internal cleaning occurs at night, and external cleaning commences at 6am. The zoo and plant associated with facilities including the proposed Nutrition Centre operate 24 hours and day, 7 days a week.

Zoo staff hours are typically from 6am to 5pm.

2.4 Site Details and Local Sensitive Receivers

The site is located within a suburban environment characterised by low to medium levels of activity throughout the day and decreasing noise levels in the evening and night.

Residential receivers dominate around the site. Existing neighbouring residential buildings that surround the site are over 60m distant from the proposal site, and are:

- Residential properties on Whiting Beach Road to the north-east to north-west.

Figure 2 shows the location of the zoo and the surrounding area. The red shaded area shows the approximate zone of the Nutrition Centre works. The residential receivers that will potentially be most affected by the operation of the proposal are highlighted in blue.

The existing residential receivers are located across the road from the Zoo premises boundary. There are no additional receiver developments planned or approved in the area. The existing residents represent the most affected receivers.

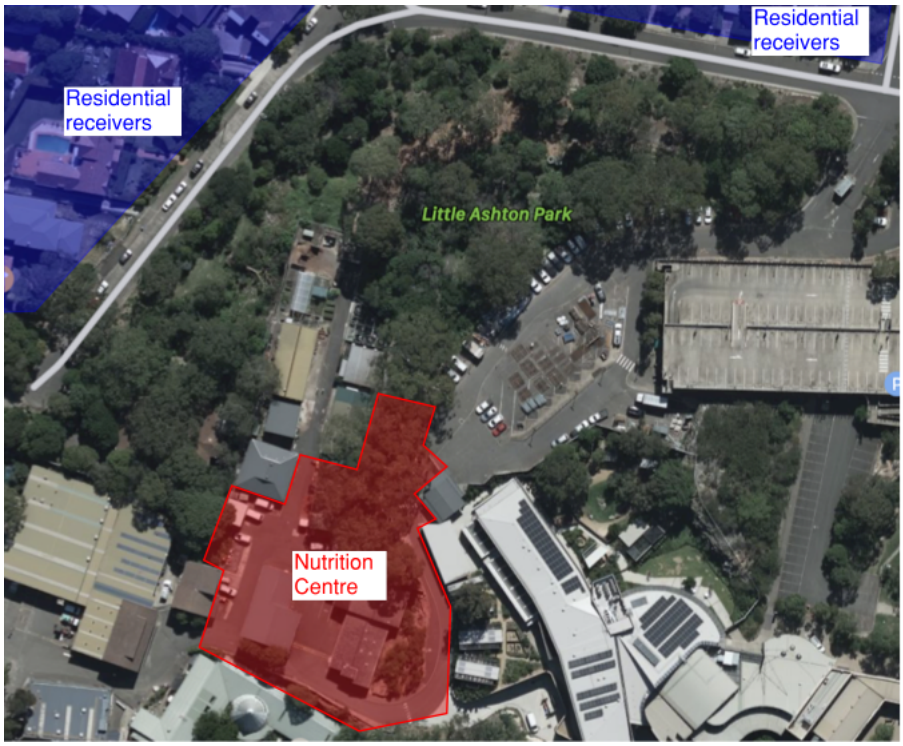


Figure 2: Plan view of the proposed Taronga Zoo Wildlife Hospital Sydney Nutrition Centre showing residential receivers along Whiting Breach Road to the north and north-west (top right and top left of the aerial photograph). Source: Apple maps downloaded 29 September 2021.

3 Existing Noise Environment

3.1 Noise survey approach

Environmental noise assessments for new developments in existing premises require an understanding of existing environmental noise in the absence of the development, to determine how audible and noticeable the development noise will be once the development is complete.

Noise surveys have been carried out by Acoustic Studio at the site and its surrounds in May 2021 to supplement data obtained previously in April and May 2017. The noise surveys were carried out to determine the ambient and background noise levels affecting the site and at the nearest noise sensitive receivers, and to measure the existing noise levels generated by the zoo.

Long-term (unattended) noise monitoring was carried out, in combination with attended observations.

3.2 Observations

Typically, road traffic around the site is governed by people driving to the zoo during the day, and by local residential traffic in the evening (6pm to 10pm) and night (10pm to 7am). Frog noise became audible after the afternoon measurements finished. Aircraft noise is relatively insignificant, and is generally restricted to a few commercial seaplanes, helicopters and passenger jets flying at a distance. Some ferry noise from the harbour may at times be indistinctly audible at quiet times during the night. There are no industrial noise sources in the near vicinity.

3.3 Noise Monitoring Locations

Noise surveys have been carried out by Acoustic Studio at the site and its surrounds in May 2021 to supplement data obtained previously in April and May 2017 to determine the ambient and background noise levels affecting the site and at the nearest noise sensitive receivers.

The 2021 measurement sites were in and around Whiting Beach Rd as shown in Figure 3.

Figure 3: Location of 2021 noise survey locations.

The 2021 noise monitoring location was selected to provide a secure noise logger location which best represents the nearest residential receivers on Whiting Beach Road, with minimal contribution of residential occupancy noise from cars exiting and entering driveways (etc). Attended measurements were also carried out at the boundary of residential receivers to confirm that the noise logger data was representative of receiver boundaries, in accordance with the NPfI.

The 2021 noise monitoring data was also compared with the 2017 noise logger data which was obtained for a previous project (Taronga Zoo African Savannah and Congo Exhibit). This was to ensure that the noise environment has not significantly changed.

The previous long term unattended noise logging was conducted from 27th April to 5th May 2017. A residential construction site at the south-western cul-de-sac at Whiting Beach Rd was active in 2017 and was the reason for locating the noise logger location to Rickard Avenue.

The noise monitoring periods were selected to obtain data from typical operations during school Term 2. The noise logging periods met the NSW Noise Policy for Industry requirement of obtaining seven days' worth of valid "school term" noise monitoring data.

A Brüel & Kjær Hand-held Analyser Type 2250, Serial Number – 3010373 was used to conduct attended noise monitoring. The last laboratory calibration date for the sound level meter was 20 November 2020. The calibration of the equipment was checked before and after the surveys with no variation in level observed.

Short-term attended measurements were carried out on three different occasions during May 2021 and also April and May 2015 to obtain octave band data of the existing background and ambient noise levels in environmental receiver locations. Noise levels at key locations within the zoo were measured by Acoustic Studio in March 2014 for a previous Taronga Zoo project, in March 2017 and again in May 2021.

Environmental noise measurement times included the most sensitive period that the proposed spaces would be occupied, including for external maintenance and cleaning (ie external cleaning between 6:00 am and 6:00 pm, and internal cleaning at night).

Two attended measurement areas were selected as follows (refer to Figures 2 and 3):

- Location P1 - At street level, at the closest boundary of the Whiting Beach Road residences and also Rickard Road. This represents the existing noise environment at these residential property boundaries. Measurements were conducted in May 2021.

Anthony Cano and Sav Shimada of Acoustic Studio Pty Ltd carried out the surveys.

3.4 Noise Monitoring Results

3.4.1 Long-term unattended noise monitoring

Unattended noise monitoring was carried out between 15th and 28th May 2021 and also in 27th April and 5th May 2017. The 2021 measurements were taken using a Ngara logger, Serial Number 878190. The 2017 measurements were taken using RTA02 logger #0038.

The 2021 noise logger location was on public land on Whiting Beach Road, opposite residential receivers. The reason the logger could not be installed directly at the receiver boundary was because there was no secure location which would not present a trip hazard to pedestrians, or which would not be affected by reflections from solid boundary fencing. Furthermore, the logger location on public land was not affected by residential occupancy noise including vehicles entering and exiting private driveways. Attended measurements were carried out near the noise logger site, but directly outside residential receiver boundaries. The attended measurements confirmed that the noise logger data was representative of the nearest residential receiver boundaries.

The 2017 noise logger location was at the end of the cul-de-sac at Rickard Avenue as the Whiting Beach Road location was affected by residential construction site noise. Observations during March, April and May 2017 indicated that the Rickard Avenue site was generally unaffected by residential construction noise, apart from infrequent audible construction events from the residence near the Whiting Beach Road.

Weather data was collected from the Bureau of Meteorology web site (www.bom.gov.au).

The measured noise levels were processed in accordance with the Noise Policy for Industry (NPfI, see Section 5.2.1) to determine the Rating Background Level (RBL) and

ambient noise conditions for Day, Evening and Night time periods. The NPfI method for determining RBLs was also applied for various construction scenarios, for standard construction hours and out of hours works.

These levels are provided in **Table 1** (Whiting Beach Road, 2021) and **Table 2** (Rickard Avenue, 2017).

Date	Descriptor	Measured sound level, dB(A)		
		Day (07:00-18:00)	Evening (18:00-22:00)	Night (22:00-07:00)
Friday 14/5/21	Ambient, L_{eq}	-	50	43
	ABL, L_{90}	-	41	35
Saturday 15/5/21	Ambient, L_{eq}	*[56] (weather affected)*	*[53] (weather affected)*	*[50] (weather affected)*
	ABL, L_{90}	*[41] (weather affected)*	*[45] (weather affected)*	*[43] (weather affected)*
Sunday 16/5/21	Ambient, L_{eq}	51	45	*[51] (weather affected)*
	ABL, L_{90}	39	39	*[39] (weather affected)*
Monday 17/5/21	Ambient, L_{eq}	*[54] (weather affected)*	40	44
	ABL, L_{90}	*[37] (weather affected)*	36	35
Tuesday 18/5/21	Ambient, L_{eq}	*[52] (weather affected)*	-	-
	ABL, L_{90}	*[37] (weather affected)*	-	-
Friday 21/5/21	Ambient, L_{eq}	50	40	43
	ABL, L_{90}	37	36	35
Saturday 22/5/21	Ambient, L_{eq}	51	38	44
	ABL, L_{90}	37	35	35
Sunday 23/5/21	Ambient, L_{eq}	52	-	-
	ABL, L_{90}	40	-	-
Wednesday 26/5/21	Ambient, L_{eq}	-	53	49
	ABL, L_{90}	-	43	41
Thursday 27/5/21	Ambient, L_{eq}	52	47	48
	ABL, L_{90}	41	42	40
Weekday construction period	RBL	41 (std hours)	41 (OOH)	37 (OOH)
Saturday construction period	RBL	38, 8am – 1pm (std hours) 36, 1 – 6pm (OOH)	38 (OOH)	35 (OOH)
Overall	**Ambient, L_{eq}**	**51**	**48**	**46**
	RBL, L_{90}	**39**	**38**	**35**

Table 1: Results of long-term unattended ambient & background noise monitoring – May 2021 – Whiting Beach Road.

2017 data has been included in this acoustic assessment to supplement the 2021 data, because the noise logger failed during the two-week 2021 measurement period and because the COVID-19 pandemic in 2020 and 2021 has resulted in a decrease in typical road traffic and zoo visitor activity. A drop in day-time noise levels is likely to be related to COVID-19 reduced zoo visitor activity.

Given that the 2017 and 2021 data were so consistent, and given that the 2017 data is less than five years old and therefore still valid[1], both sets of data have been used to determine the rating background and ambient noise levels to use in the operational acoustic assessment.

For the construction noise assessment, the 2021 background noise levels have been used as this is considered relevant the COVID-19 reduced activity is likely to continue for construction phase which is planned for 2022.

Date	Descriptor	Measured sound level, dB(A)		
		Day (07:00-18:00)	Evening (18:00-22:00)	Night (22:00-07:00)
Thursday 27/4/17	Ambient, L_{eq}	56	48	50
	ABL, L_{90}	43	40	40
Friday 28/4/17	Ambient, L_{eq}	58	44	48
	ABL, L_{90}	41	37	38
Saturday 29/4/17	Ambient, L_{eq}	55	42	49
	ABL, L_{90}	40	38	37
Sunday 30/4/17	Ambient, L_{eq}	59	42	51
	ABL, L_{90}	40	37	37
Monday 1/5/17	Ambient, L_{eq}	54	48	48
	ABL, L_{90}	42	42	37
Tuesday 2/5/17	Ambient, L_{eq}	53	45	48
	ABL, L_{90}	41	40	38
Wednesday 3/5/17	Ambient, L_{eq}	54	44	51
	ABL, L_{90}	41	36	36
Thursday 4/5/17	Ambient, L_{eq}	55	43	49
	ABL, L_{90}	40	36	36
Weekday construction period	RBL	41 (std hours)	39 (OOH)	38 (OOH)
Saturday construction period	RBL	41, 8am – 1pm (std hours) 39, 1 – 6pm (OOH)	38 (OOH)	37 (OOH)
Overall	**Ambient, L_{eq}**	**56**	**45**	**49**
	RBL, L_{90}	**41**	**38**	**37**

Table 2: Results of long-term unattended ambient & background noise monitoring – April and May 2017 – Rickard Avenue.

[1] NSW TfNSW Infrastructure and Services Construction Noise and Vibration Strategy (April 2018) implies that noise survey data under five years old is considered to be valid, with this note on page 18: "If considered necessary (i.e. noise measurements are more than 5 years old), RBL measurements may be confirmed through the implementation of this [construction noise and vibration assessment] procedure."

Date	Descriptor	Measured sound level, dB(A)		
		Day (07:00-18:00)	Evening (18:00-22:00)	Night (22:00-07:00)
Weekday construction period	RBL	41 (std hours)	41 (OOH)	37 (OOH)
Saturday construction period	RBL	38, 8am – 1pm (std hours) 39, 1 – 6pm (OOH)	38 (OOH)	35 (OOH)
Operational noise	**RBL, L_{90}**	**40**	**38**	**37**

Table 3: Background noise levels used for construction noise and operational noise assessment. Construction phase RBLs based on 2021 survey (COVID-19 reduced activity). Operational phase RBLs based on 2017 and 2021 survey data combined (to represent likely post-COVID-19 activity).

3.4.2 Short-term Attended Measurements

Background and Ambient Noise Levels

Short-term noise monitoring was carried out in in May 2021, at Location P1 to obtain background and ambient noise levels. Measurements were taken between 10:30am and 11:30 on 28th May 2021, outside the boundaries of 13 Whiting Beach Road, 19 Whiting Beach Road, and 25 Rickard Avenue.

These measurements were taken to augment and confirm noise logger data.

Measured background noise levels were 45-48dBL_{A90}. Measured ambient noise levels were 52-56dBL_{Aeq}. These measurements confirmed that the noise logger data was valid and representative of the nearest affected receiver boundaries.

4 Relevant Standard and Guidelines

4.1 Guidelines used for the Operational Acoustic Assessment

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise criteria:

- Mosman Council Development Control Plan (DCP) 2012 – particularly the DCPs for Open Space and Infrastructure (2012), Business (2013) and Residential (amended 2013).
- Mosman Council Local Environment Plan (LEP) 2012.
- Sydney Regional Environmental Plan (SEPP SREP) (Sydney Harbour Catchment) 2005.
- Protection of the Environmental Operations (POEO) Act 1997.
- Environmental Planning and Assessment (EP&A) Act 1979.
- State Environmental Planning Policy (Exempt and Complying Development Codes) 2008.
- NSW Noise Policy for Industry (NPfI) 2017.
- AS2107:2016, *Acoustics—Recommended design sound levels and reverberation times for building interiors.*

The following documents have been referenced to derive numeric noise criteria where not explicitly provided in the local and state planning documents listed above.

- City of Sydney (CoS) Standard Conditions of Development Consent (SCDC) 2012.
- World Health Organisation (WHO) "Guidelines for Community Noise" 1999.

Applicable guidelines for road traffic noise impacts are:

- NSW EPA *Road Noise Policy* (2011)
- Australian Standard AS 3671-1989 *Acoustics – Road traffic noise intrusion – Building Siting and Construction* (for guidance only; applies to siting of the receiver buildings).

It is understood that regular zoo patron and staff numbers are unlikely to change due to this project.

4.2 Guidelines used for the Construction Acoustic Assessment

This acoustic report does not examine in detail the potential impacts from construction noise and vibration on residential receivers, since methodology and timing of works have not been developed. A detailed construction noise and vibration impact assessment and management plan would need to be prepared by the contractor once the likely construction methods are developed.

The primary references are:

- The EPA *Interim Construction Noise Guideline* (2009)
- The EPA *Assessing Vibration – a Technical Guideline* (2006)

It is necessary to examine potential impacts from construction vibration on both residential receivers and the structures within the zoo premises. Early works will include excavation (including tunnelling works), and potentially vibration-intensive construction activities such as piling.

Once the excavation, tunnelling and construction details for the early works are developed, the contractor would need to determine a construction methodology that will ensure no adverse effects on the any nearby sensitive structures inside the Zoo. Impacts on animals will be managed internally by Taronga Zoo and because it does not fall under POEO Act and EP&A Act assessment requirements, this aspect of construction noise and vibration assessment is not presented in this SSDA Acoustic Report.

Vibration effects on residential receivers are unlikely to be an issue given that they are over 200m from the construction site.

Historic buildings and structures have particular requirements for managing vibration effects on their cosmetic finishes and structure. The sensitive structures are to be assessed against Australian and international guidelines and standards, such as:

- Australian Standard AS 2187:2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives*
- British Standard BS 7385:2-1993 *Evaluation and measurement for vibration in buildings Part 2*
- German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects of Vibration on Structures.*

Vibration effects on buildings is a specialist acoustic field and will require careful collaboration between the acoustic specialist, the structural engineer, and the construction engineer.

5 Project Operational Noise Criteria

5.1 External Noise Emission Criteria - General

5.1.1 Local Development and Environment Plans

Mosman Council Development Control Plan (DCP) 2012 and Local Environment Plan (LEP) 2012 refer to environmental noise impacts in qualitative terms. The DCPs for Open Space, Business (2013), Residential (amended 2013). and Infrastructure (2012) have been referred to in preparing this acoustic report. In particular, the Infrastructure DCP 4.6 Objective 2: Acoustic privacy describes general noise considerations only.

Sydney Regional Environmental Plan (SEPP SREP) (Sydney Harbour Catchment) 2005 is relevant to developments in Taronga Zoo. Noise impacts are not explicitly mentioned in the SEPP SREP.

5.1.2 Environmental Planning and Assessment Act (EP&A) 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act) regulates the majority of planning approval and environmental impact assessment (EIA) requirements in NSW. Section 111 of the Act requires examination and consideration to the fullest extent possible of all matters affecting or likely to affect the environment by reason of its activities. Acoustic impacts are a common community concern to be addressed in an EIA.

5.1.3 Protection of the Environment Operation Act (POEO) 1997

The *Protection of the Environment Operations Act 1997* enables the Government to set out explicit policies and premise-based Environment Protection Licences (EPLs) which are regulated by the Environment Protection Authority NSW (EPA).

Taronga Zoo activities are conducted in accordance with Environment Protection Licence 1677, which contains no specific noise limits. Where an EPL contains no specific noise limits, accepted practice is to determine criteria in accordance with the POEO Act general provisions against the generation of "offensive noise", applying numerical criteria obtained from applicable environmental noise policies and guidelines.

Defining "offensive noise" for the purpose of an acoustic assessment is not a simple matter. The Protection of the Environment Operations (POEO) Act 1997 defines "Offensive Noise" as follows:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the

premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

The "regulations" referred to in (b) above are the POEO (Noise Control) Regulations (2008). Very few of these apply to Nutrition Centre activities. Whether noise from the Nutrition Centre activity is "offensive" therefore reduces, in most cases, to a question of whether it meets part (a) of the definition. There are no clear-cut criteria for this, but consideration can be given to:

- Whether the level of noise exceeds applicable goals and guidelines,
- Whether the nature, character or quality of the noise is "offensive" due to such characteristics as tonality, impulsiveness or verbal content,
- Whether the time at which it is made is problematic, such that it could interfere with sleep, or school examinations, etc.

The EPA Noise Guide for Local Government (DECCW, 2009) provides a checklist for offensive noise which can be applied to any noise-generating activities. In addition to the considerations listed above, the EPA checklist asks:

- Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
- Does the noise occur at times when people expect to enjoy peace and quiet?
- Is the noise atypical for the area?
- Does the noise occur often?
- Are a number of people affected by the noise?

The remaining consideration relates to "reasonable measures". It may be reasonable, for example, to manage a noise issue arising from animal enclosures which have been relocated, or re-introduced to the area. It may not be 'reasonable', on the other hand, to expect a significant reduction in noise from typical existing patron and animal noise during normal zoo operating hours.

5.1.4 Defining environmental noise criteria

The noise definitions and conditions provided by the Mosman Council DCP, LEP and POEO are generally focused around a subjective assessment.

Acoustic Studio recommends determining suitable objective criteria for assessing offensive noise, for noise emissions from mechanical plant, sound systems and patrons.

Compliance with the criteria described in sections 5.2 will ensure that the general noise conditions described in this section (5.1) will be met.

5.2 External Noise Emission Criteria - Mechanical Plant

5.2.1 New South Wales Noise Policy for Industry (NPfI)

The NPfI provides the framework and process for deriving noise goals for consents and licences that enable the EPA to regulate industrial premises that are scheduled under the *Protection of the Environment Operations Act 1997*. The EPA NPfI provides additional guidance on assessment of changes to existing premises (infrastructure and / or operations).

The NPfI applies to fixed facilities, commercial premises and individual industrial sources such as heating, ventilating and air conditioning (HVAC) equipment. It is also typically applied for general maintenance noise such as cleaning activities. It provides guidance on the methodology for determining limiting noise criteria designed for external noise emissions typically associated with mechanical plant.

The NSW NPfI defines environmental industrial noise goals in two ways. The goals apply at the most-affected point on or within the residential boundary and are location-dependent. They also depend on the occupancy: residential, commercial, educational, etc.

The INP considers the following when establishing the criteria:

- The *time of day* that the noise generating development will be in operation, defined by the following:
    - Day (7am to 6pm)
    - Evening (6pm to 10pm)
    - Night (10pm to 7am)
- The existing *Ambient* (L_{eq}) and *Background* noise levels (L_{90}) that surround the site.
- The *type of noise source* and its characteristics. The NPfI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

The residential ***intrusiveness*** criterion aims to control short duration noise impacts and is based on the existing background noise level, and is defined as:

$L_{Aeq,15\ minute}$ from new noise source ≤ Existing long-term $L_{A90,Day/Evening/Night}$ + 5.

The residential ***amenity*** criterion aims to maintain noise amenity for a particular land use. It defines recommended noise levels, called Acceptable Noise Levels (ANL), for different neighbourhood types. For example, the suburban residential ANLs are:

- Night time (7am to 6pm): 40 $dBL_{Aeq\ (11hrs)}$
- Evening (6pm to 10pm): 45 $dBL_{Aeq\ (4hrs)}$
- Night time (10pm to 7am): 40 $dBL_{Aeq\ (9hrs)}$

Modification factors apply to the amenity criterion when existing industrial noise exceeds the acceptable noise levels. No modification factors apply to the residential receivers surrounding Taronga Zoo.

The NSW NPfI applies "penalty" or "correction" factors to account for particular noise characteristics such as tonal, low frequency dominant, or intermittent noise. No penalty factors have been applied in this assessment of plant noise, based on the assumption that mechanical plant will be controlled at source to avoid intermittent, tonal, or low-frequency-dominant noise emissions.

Any non-operational period is excluded from an NPfI assessment. For the Nutrition Centre, it is assumed that some mechanical plant may be in operation 24 hours a day (fridges, freezers and server room air conditioning units), and that there will be limited facility maintenance activities (such as external cleaning activities between 6am and 7am, and internal cleaning at night).

5.2.2 Sleep disturbance

The potential for high noise level events at night and effects on sleep should be addressed in noise assessments.

The World Health Organisation (WHO) "Guidelines for Community Noise" 1999 suggest external noise levels of 55dBLAeq will result in negligible sleep disturbance effects. This ideal level does not account for intermittent noise events, or periods of higher noise.

The NPfI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq(15min)}$ and event L_{Amax} noise levels at the receiver:

> Event $L_{Aeq(15min)}$ > 40dB(A) or Night time RBL (background noise level) + 5 dB (whichever is greater). For this project, the night-time RBL is 37dB(A). Therefore the greater of the two Sleep Disturbance Screening levels is 37+5 = 42dB$L_{Aeq(15min)}$.
>
> Event L_{Amax} > 52dB(A) or Night time RBL (background noise level) + 15 dB (whichever is greater). For this project, the two methods both result in a Sleep Disturbance Screening levels is 37+15 = 52dB$L_{Aeq(15min)}$.

If the criterion is exceeded, then further assessment of sleep disturbance effects is warranted.

Because the proposed Nutrition Centre will not operate during night-time hours between 10pm and 7am, the risk of Sleep Disturbance does not require assessment. The only plant which may operate 24 hours a day produces a steady noise which will have to meet NPfI Intrusiveness and Amenity criteria at residential receivers, therefore the Intrusiveness and Amenity assessment is sufficient for the Sleep Disturbance risk assessment.

Based on experience with existing audio-visual displays and construction activities at the zoo, Taronga Zoo has advised that a Sleep Disturbance assessment is not specifically required for the zoo animals, and that a detailed animal disturbance assessment would be conducted based on observations during operation.

5.2.3 Mechanical plant noise audible in zoo premises

There is no particular guidance for managing plant noise impacting on patrons, staff and animals in the zoo.

Acoustic Studio recommends adopting a 55dBLAeq criterion for plant noise emissions to walkways, outdoor public and staff areas, and animal enclosures.

5.2.4 Summary of environmental noise targets for mechanical plant

Based on the measured noise levels detailed in Section 3.4, and in accordance with the methodology outlined in the NSW NPfI, **Table 4** details the corresponding limits of allowable noise emission from mechanical plant and general maintenance activities associated with the development at the nearest receiver boundaries, defined as a Project Specific Noise Trigger Level (PSNTL).

Since this is a particularly low noise area, the existing background and ambient noise levels are lower than the Acceptable Levels that define the Amenity Criterion. Therefore compliance with the more stringent Intrusiveness Criterion will also ensure compliance with the Amenity Criterion during Day and Evening hours. During Night time hours, the Amenity Level sets the PSNTL. The Night-time PSNTL is less than the Sleep Disturbance Level. Compliance with the PSNTL will result in negligible risk of Sleep Disturbance.

Period	Noise source / activities	NPfI Criteria, dBA			
		Amenity $L_{Aeq\ (period)}$	Intrusiveness $L_{Aeq\ (15\text{-}minute)}$	Project Specific Trigger Noise Level $L_{Aeq\ (15\text{-}minute)}$	Sleep disturbance $L_{Aeq\ (15\text{-}minute)}$, L_{Amax}
Day (7am-6pm)	Mechanical plant	50 (residences, zoo)	45	45	n/a
Evening (6pm-10pm)		40 (residences) 55 (zoo)	43	43	n/a
Night (10pm-7am)	Mechanical plant, Cleaning and maintenance	35 (residences) 55 (zoo)	42	38	43, 52

Table 4: NPfI project specific criteria for external noise emissions from cleaning and maintenance activities and mechanical plant

5.3 Traffic noise targets

This report assesses changes in character, location and potential increase in traffic noise associated with the project.

It is understood that regular zoo patrons, staff numbers and deliveries are unlikely to increase due to this project. Traffic noise due to construction activities should be assessed.

Any additional traffic generated by this proposal needs to be assessed in accordance with the following guidelines:

- NSW EPA *Road Noise Policy* (2011).
- Australian Standard AS 3671-1989 *Acoustics – Road traffic noise intrusion – Building Siting and Construction* (for guidance only; applies to siting of the receiver buildings).

The Road Noise Policy is applicable to traffic-generating developments including major road infrastructure developments. The emphasis is on achieving a reasonable balance between what is achievable on different road types and the sensitivity of different receiver types to road traffic noise. This is not directly relevant to the Nutrition Centre proposal as it does not include any new or upgraded road infrastructure.

The Australian Standard has a different emphasis, in that it aims to identify appropriate intrusive road traffic noise criteria in different building types. This is not applicable to the Nutrition Centre site as it is located in a quiet residential area with basic requirements for managing road traffic noise intrusion.

In the absence of directly applicable guidelines, policies or standards for assessing road traffic noise impacts from the Nutrition Centre, Acoustic Studio's approach is to examine the increase in traffic noise events and levels for most-affected sensitive receivers.

This acoustic report does not assess bus noise as the proposal will not change use of the existing bus operations serving the zoo.

5.4 Internal Acoustic Criteria

5.4.1 Greenstar / ESD

Greenstar / ESD initiatives for the development will consider acoustic design compliance with the background noise levels and reverberation times listed in AS2107:2016. For areas which are not explicitly listed in AS2107, an acoustic consultant will be responsible for defining appropriate design background noise levels and reverberation times in accordance with the principles of AS2107.

6 Operational Noise Assessment and Recommendations

The proposal has been assessed based on information provided by Taronga Zoo Conservation Society.

6.1 Operational noise assessment methodology

The acoustic assessment has considered the following:

- The Nutrition Centre will generally be open and in use during zoo opening hours, and will close by 5pm. Some cleaning and maintenance activities may take place between 5pm and 10pm (evening).
- Plant will operate 24-hours a day, 7 days a week.
- Noise predictions at the nearest residential receiver boundaries consider the total noise contribution from all noise sources.
- Distance attenuation, with conservative estimates for attenuation due to shielding from buildings, intervening topography and ground absorption.

6.2 Mechanical plant noise compliance

Plant associated with the operation of the Nutrition Centre should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of nearby receivers, including receivers within the zoo such as staff offices, public walkways and open spaces, and animal enclosures.

At this stage, final plant selections and locations have not been made; therefore a detailed assessment has not been carried out.

Most plant will operate during visitor hours. The wash bay is a potential noise source which should be operated during standard day-time hours. Fridges, freezers and server room air conditioning units will operate 24 hours a day.

In the absence of preliminary plant noise data or locations, Acoustic Studio makes the following general comments:

- The most restrictive criterion for the plant is 55dB(A) on open walkways and outdoor spaces nearest any mechanical inlet, outlet or outdoor unit. The nearest

residential receiver is over 50m distant, with screening from topography or existing buildings. Achieving the 55dB(A) target within the zoo premises will easily ensure compliance with the relevant criteria at all other receivers.

- Attenuation and / or internally-lined ductwork may be required for fans in order to meet the both internal and environmental noise criteria.
- Noise emissions from the external plant may be controlled via a combination of:
    - locating the units as far from transient or occupied areas as possible;
    - with natural screening provided by existing zoo buildings, structure and topography; and
    - additional localised acoustic screening as required.

During the detailed design stage, the acoustic consultant should provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Noise emissions from general maintenance and cleaning activities may need management controls such as time restrictions particularly for external area maintenance activities.

6.3 Traffic noise compliance

It is understood that regular zoo patron, staff and delivery numbers are unlikely to change due to this project.

Truck deliveries would be scheduled to occur outside the busiest traffic periods.

6.4 Cumulative noise impacts

In recognition of several recently completed and recently approved planned developments at Taronga Zoo's premises in Mosman, cumulative impacts need to be considered. The majority or Zoo developments, such as the proposed Reptile and Amphibian Conservation Centre, are distant enough from the Nutrition Centre to have no cumulative noise impact at residential receivers.

The Stage 2 Hospital will be adjacent to the Nutrition Centre, and both of these developments will be 50m to 100m from the nearest residential receivers. The design of these two developments will need to incorporate noise controls to ensure that there is no risk of increased cumulative noise impacts due to this project. For example, plant should be located on the eastern side of the new buildings, to take advantage of the noise screening provided by the buildings themselves, and deliveries should use the main entrance as currently so that there is no increase in delivery noise.

6.5 Summary of predicted operational noise compliance

Table 5 summarises the zoo activities associated with the current proposal, and demonstrates compliance with the applicable noise criteria for general operational noise.

		Project-Specific Noise Trigger Level, $L_{eq\ (15minute)}$, dBA	Sleep disturbance $L_{Aeq\ (15\text{-}minute)}$, L_{Amax}
Day (7am-6pm)	Criterion	45	n/a
	Complies?	**Yes**	n/a
Evening (6pm-10pm)	Criterion	43	n/a
	Complies?	n/a	
Night (10pm-7am)	Criterion	38	52 / 43
	Complies?	**Yes**	**Yes**

Table 5: Summary of compliance with project noise criteria at nearest residential receivers

7 Construction noise and vibration criteria

This acoustic report presents a high level review of the potential impacts from construction noise and vibration on residential receivers, as work methods and plans are not yet developed. A full construction noise and vibration impact assessment and management plan may be prepared by the contractor once the structure and construction methods are developed further.

7.1 Airborne noise management levels

7.1.1 Airborne noise management levels for residential receivers

The EPA *Interim Construction Noise Guideline* (ICNG, 2009) defines standard construction hours during which the construction Noise Management Level (NML, $L_{Aeq,15min}$) is 10dB above the applicable period background noise level. A strong justification is required for conducting works outside standard construction hours, and the NML during these periods is significantly lower.

The ICNG clarifies that NMLs are not considered to be "criteria" or "limits". This is in recognition of the fact that construction noise is often difficult to effectively reduce due to the nature of large plant and equipment and noise-generating activities. The NML is to be considered a target to work towards, by applying feasible and reasonable mitigation.

The background noise level used for the construction phase noise assessment is taken from the COVID-19 activity 2021 noise survey data, which is lower than pre-COVID-19 levels.

The ICNG also defines "Highly Affected" levels for daytime works, above which point there may be a strong community reaction against the noise. Evening and Night time works are not proposed.

Table 6 summarises the applicable residential construction noise criteria for different day-time periods during the week.

Period	Monday to Friday	Saturday	Sunday / Public Holiday	Highly Affected Level
Day: Standard construction hours	51 (7am – 6pm)	43 (8am – 1pm)	-	75
Day: Out of hours	-	44 (1pm-6pm)	44 (7am-6pm)	75

Table 6: Construction noise criteria (overall levels, $L_{Aeq,15min}$) at nearest residential receivers

7.1.2 Airborne noise management levels for non-residential receivers

Construction noise impacts on zoo staff and patrons need to be assessed.

For pedestrian walkways and exhibits, Acoustic Studio recommends applying a construction noise management level of 60-65dB$L_{Aeq(15minutes)}$.

This is 5-10dB higher than recommended levels in outdoor recreation areas in various environmental noise guidelines including the NSW EPA rail and road noise guidelines. It is also 8-11dB above measured background noise levels, and 2-8dB above ambient levels with groups of children, measured inside Taronga Zoo in March 2017. Due to the temporary nature of the construction and the transient use of the walkways, this is considered an appropriate target.

7.2 Ground borne noise management levels

The ICNG recommends ground-borne noise management levels at residences affected by nearby construction activities. Ground-borne or structure-borne noise is noise generated by vibration transmitted through the ground or structure and is re-radiated as audible airborne noise.

The ground-borne noise levels presented in **Table 7**below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of occupants during the more sensitive time periods.

Time of Day	Management level $L_{eq\ (15\ min)}$
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Table 7: Residential construction noise criteria for ground-borne noise

There is no risk of structure-borne noise at the nearest residential receivers due to the distance attenuation through ground between works and receiver buildings. Therefore structure borne noise has not been predicted and assessed in detail in this report.

7.3 Vibration effects on structures

Once the structural details for the works are developed, a construction methodology will be determined that will ensure no adverse effects on any sensitive structures and sites.

Typically the applicable vibration criteria for cosmetic damage to historic or heritage structures are taken from German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects of Vibration on Structures.* A short-term vibration velocity limit of 3mm/s

(<10Hz) and 3-8mm/s (10-50Hz) is typically applied to historic or heritage buildings. The duration of the works must be considered when determining the most relevant criteria.

Acoustic Studio recommends adopting German Standard DIN4150 criteria for heritage or historic structures. This should be the limiting criterion on site, and meeting this criterion will ensure that commercial vibration criteria are also met.

Figure 4 below summarises vibration targets to protect buildings from cosmetic building damage. If vibration measurements are conducted in third octave bands (Hz), then the on-site limit curve shall apply. If vibration measuring equipment is only capable of measuring overall peak levels, then a peak particle velocity limit of 3mm/s (rms) shall apply on site.

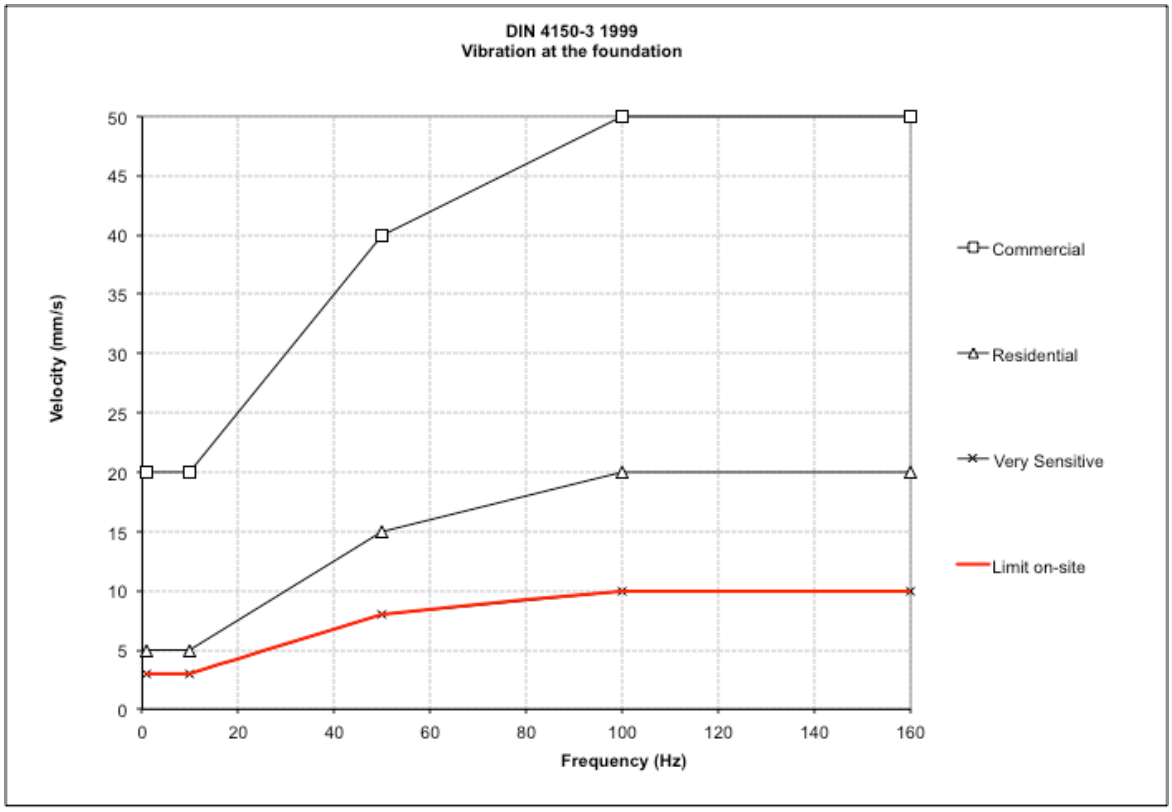


Figure 4: Vibration targets for protecting heritage and historic structures ("very sensitive"), and typical residential and commercial receivers.

7.4 Vibration effects on humans

The DEC guideline "*"Assessing Vibration: a technical guideline, 2006"* provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990.

The guideline provides vibration levels for which there is a low probability of comment or disturbance to building occupants. The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in **Table 8** below.

Continuous	Impulsive	Intermittent
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.	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.

Table 8: Examples of vibration source types

There are no direct references for allowable vibration levels for Zoo exhibits and back of house areas. However, a useful reference is the criteria for human exposure to continuous and impulsive vibration are detailed in **Table 9** that follows – particularly for gorillas situated adjacent to the site. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Offices, schools, educational institutions	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					
Offices, schools, educational institutions	Day or night time	0.64	0.46	1.28	0.92
Workshops	Day or night time	0.64	0.46	1.28	0.92

Table 9: Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Note: Daytime is 7am-10pm and night time is 10pm to 7am.

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. **Table 10** sets out the acceptable VDV values for intermittent vibration in similar uses of building to back of house and exhibit areas at Taronga Zoo.

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 10: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

7.5 Construction-related road traffic

This report assesses changes in character, location and potential increase in traffic noise associated with the project during construction phase.

Any additional traffic generated by this proposal during construction phase needs to be assessed in accordance with the following guidelines:

- NSW EPA *Road Noise Policy* (2011).
- Australian Standard AS 3671-1989 *Acoustics – Road traffic noise intrusion – Building Siting and Construction* (for guidance only; applies to siting of the receiver buildings).

The Road Noise Policy is applicable to traffic-generating developments including major road infrastructure developments. The emphasis is on achieving a reasonable balance between what is achievable on different road types and the sensitivity of different receiver types to road traffic noise. This is not directly relevant to the Nutrition Centre proposal as it does not include any new or upgraded road infrastructure.

The Australian Standard has a different emphasis, in that it aims to identify appropriate intrusive road traffic noise criteria in different building types. This is not relevant to the Nutrition Centre development.

In the absence of directly applicable guidelines, policies or standards for assessing road traffic noise impacts from the Nutrition Centre project, Acoustic Studio's approach is to examine the increase in traffic noise events and levels for most-affected sensitive receivers.

If construction-related traffic occurs during night-time hours (10pm to 7am), then the potential for sleep disturbance must be assessed.

The sleep disturbance criterion L_{AMax} not exceeding the $L_{A90,\,(15\ minute)}$ by more than 15 dB(A) is a screening criterion, not an absolute goal for the purpose of assessing impact from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance screening criterion is exceeded, the detailed analysis should cover the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW *Road Noise Policy* (2011).

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur
- Time of day (normally between 10pm and 7am)
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. The NSW *Road Noise Policy* (RNP, 2011) Section 5.3 "Response to a Change in Noise Level" states:

> *While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. […] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB in maximum noise levels.*

The RNP Section 5.4 "Sleep Disturbance" states that:

> *From the research on sleep disturbance to date it can be concluded that:*
>
> - *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
> - *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

The internal noise levels provided in the RNP are related to potential sleep awakenings.

Typically noise impact assessments consider the worst case scenario, when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB attenuation from outside to inside, through the open window. This situation is considered likely during warmer seasons.

When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB.

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

8 Construction noise assessment and recommendations

8.1 Construction sequence

The proposal is to be carried out in four phases over a duration of approximately 18 months, as described in detail in the Construction Management Plan:

- Phase 1 – Pre-construction
- Phase 2 – demolition, excavation and rockbreaking (including tunnelling), tipping fill, piling
- Phase 3 – New Nutrition Centre Building
- Phase 4 – Post construction activities.

The main phases of work have been described in terms of the following "noise scenarios". A scenario is a work phase, characterised by the type of plant and equipment used, concurrent activities, location of works, and timing of works. The duration of each scenario is not yet known.

The works phases shown below are indicative only. The Contractor is responsible for preparing a Works Plan and Schedule, including updated noise and vibration impact assessments for proposed methods and timing of each stage of work.

Noise Scenario / Activity Description	List of plant	Notes about subjective impact
Phase A. Pre-Construction	Generators Trucks Hammers Hand tools	High vibration: N Tones or impulses: Y - reversing alarms
Phase B. Demolition, excavation, piling	Excavating and Rockbreaking Concrete saws Piling Tipping fill Jackhammers Removal of building waste	High vibration: Y Tones or impulses: Y
Phase C. New Nutrition Centre Building	Truck and Crane Hand tools Removal of building waste	High vibration: Y - piling Tones or impulses: Y - reversing alarms
Phase D. Post Construction Activities	Truck and Crane Diggers, excavators Hand tools	High vibration: Y – digger / excavator Tones or impulses: Y - reversing alarms

Table 11: Indicative work phases and subjective impact considerations

8.2 Hours of work

The hours of work affect community noise impacts. This is due to the fluctuations of ambient noise through the day, and the type of activities typically conducted by the community during Day, Evening and Night.

Standard construction hours defined in the *Interim Construction Noise Guidelines* (7am – 6pm, Monday to Friday, and 8am – 1pm, Saturday) are considered the least sensitive times of day.

The proposed works hours for this project are:

- Weekdays 7am to 6pm (Standard construction hours)
- Saturdays 8am to 1pm (Standard construction hours)
- Saturdays 7am to 8am works (out of hours works) if inaudible at most affected residential receivers

Construction vehicles may enter the zoo during the following hours:

- Weekdays 7am to 5pm
- Saturdays 8am to 1pm.

It is noted that for the purposes of road traffic noise assessments, the hours before 7am are considered to be "night time" and are typically considered to be times when residential receivers are more sensitive to road traffic noise. For the purposes of construction noise assessments, the hours before 8am on Saturday are considered to be more noise-sensitive.

The Contractor's Construction Noise and Vibration Management Plan must state the hours of work, and any deviations to the schedule must be assessed and approved prior to commencing the altered works schedule.

9 Construction noise assessment considerations

9.1 Noise and Vibration Sources

Potential noise sources during the construction stage are identified in **Table 11**. These noise sources are based on the proposed works described in the Construction Management Plan[2]. The total duration of the works to complete both the Stage 1 Nutrition Centre and the Stage 2 Wildlife Hospital is expected to be approximately 11 months. There may be some overlap and the Nutrition Centre works can be assumed to be up to 6 months.

Typical airborne noise levels associated with each noise source have been extracted from AS 2436-2010. For this assessment a conservative approach has been taken, which has applied the levels provided in the standard as $L_{eq,T}$ noise sound power levels.

The ICNG imposes a 5dB penalty for sources with a tonal noise content, or associated with high vibration levels. A 5dB penalty is also applied to vehicles with tonal reversing alarms. Non-tonal or broadband reversing alarms do not attract this 5dB penalty. The 5dB penalty is added to the predicted construction noise level at the receiver boundary. These activities have been identified in **Table 12**.

Table 12 also identifies potential sources of perceptible vibration. Vibration levels associated with plant typically depend on the material being worked on. For example jackhammers and excavator hammers used on age-hardened concrete or hard rock will generate higher levels of vibration than the same equipment used on soft limestone or brick.

[2] State Significant Development Application – Taronga Zoo Wildlife Hospital Sydney Nutrition Centre – Construction Management Plan, RPS Group, September 2021

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
Dump Truck (tipping material)	117	89 (+5dB penalty – tonal reversing alarm)
Truck, Forklift *(vibration source)*	107	79 (+5dB penalty – tonal reversing alarm)
Front end / Wheeled loader *(vibration source)*	111	83 (+5dB penalty – tonal reversing alarm)
Piler (bored)	111	83
Piler (impact sheet) *(vibration source)*	137	109 (+5dB penalty)
Piler (vibratory) *(vibration source)*	125	97 (+5dB penalty)
Rock breaker *(vibration source)*	118	90 (+5dB penalty)
Excavator *(vibration source)*	107	79
Vibratory roller *(vibration source)*	108	80
Asphalt Paver *(vibration source)*	108	80
Asphalt Rotomill (scabbler)	111	83
Skidsteer loader (½ tonne) *(vibration source)*	104	76
Generator, 4 stroke portable petrol	103	75
Generator, diesel	113	85
Compactor *(vibration source)*	113	85
Concrete Saw, handheld *(vibration source)*	117	89 (+5dB penalty)
Jack Hammer *(vibration source)*	121	93 (+5dB penalty)
Hammer / percussive drill *(vibration source)*	112	84 (+5dB penalty)
Electric drill *(vibration source)*	91	63
Electric hand tools	102	74
Welder	105	77
Mobile crane	106	78

Table 12: Typical mid-point sound power and pressure levels of plant typical to proposed construction. These sound level values do not include the 5dB penalty noted for some types of work. The 5dB penalty is added to the predicted sound level at the receiver.

9.2 Methodology

The assessment considers the noise impact from each category of major works as follows:

- Noise predictions at receiver boundaries have been carried out for each piece of equipment that may be used during major works.
- Each piece of equipment is modelled as a point noise source.
- To provide a worst case $L_{eq\,(15min)}$ prediction, it is assumed that equipment is used continuously over the assessment period. However, for dump trucks, it is assumed that the noise from this particular piece of equipment is not used continuously and

has been assessed to generate noise for 3 minutes out of a 15-minute assessment period.

- Predictions only consider the distance attenuation between source and receiver, which is conservative because the natural topography is likely to result in both shielding and ground absorption.
- It is assumed that works activities in various parts of the site may be carried out simultaneously.
- In accordance with the proposed work hours, noise predictions are to be compared with weekday Day-time, Saturday 6-7am, and Saturday 7am to 1pm noise management levels.
- Vibration levels are difficult to predict without detailed material and structural information which affects the vibration at source (related to the material being worked on), and the vibration transmission through the receiving structure. Therefore vibration risks have been assessed at a high level, based on measurements taken at other construction sites.
- It will be necessary to confirm vibration through monitoring early in the any works phase that involves high-vibration activities such as excavating, to re-assess whether levels are expected to exceed applicable criteria at heritage or historically significant structures.

10 Predicted Construction Noise Levels

Table 13 details the predicted construction noise levels from the Nutrition Centre redevelopment, at the nearest residential receivers.

Noise and vibration risks are discussed in the accompanying text.

The tables provide noise level predictions for individual pieces of equipment and the combined contribution for activities that may occur simultaneously. Noise levels have been based on the typical mid point noise levels detailed in Section 9.1.

All works will be conducted over 50m distant from the nearest residential receivers.

Table 13 below shows conservatively predicted noise levels at residential and zoo receivers, without any noise mitigation measures applied. Since predicted noise levels exceed applicable targets, **Table 14** presents levels predicted when basic mitigation measures are applied, which are the use of hoarding, petrol generators, and bored piling.

As explained in Section 7.1.1, NMLs are not considered to be hard “limits”. Exceeding the NMLs is not considered a “non-compliance”, but rather leads to the requirement to consider reasonable and feasible mitigation. The three key mitigation measures described in **Table 14** suggest that the resulting noise levels may be up to 10dB above the NML at the nearest residential receiver. This is considered to be a marginal to moderate impact.

Moderate impacts can be further managed by applying the mitigation measures described in the sections that follow.

Noise Scenario / Activity Description	List of plant (dBL_{Aeq} at 10m)	Highest Predicted Level at Residential Receivers – without noise mitigation	Comments
Phase A. Pre-Construction	Generators (75 petrol / 85 diesel) Trucks (79) Hammers (70) Hand tools (74) Tree removal and mulching (88)	56 / 66 60 51 55 69	Exceeds NML. Similar to existing daytime ambient noise levels (56dB(A)), therefore impact from hand tools, hammers and petrol generators is considered negligible or minor. Hoarding will reduce noise by approximately 10dB. Plan truck access routes and times to minimise impacts. Use petrol generator rather than diesel.
Phase B. Demolition, excavation, piling	Rock breaker (90) Excavator (79) Concrete saws (89) Piling (bored 83 / vibratory 97 / impact 109) Truck (tipping fill) (89) Jackhammers (90) Hammer / Percussive drill (84) Removal of building waste (84) Compactor (85)	71 60 70 64 / 78 / 90 70 71 65 65 66	Exceeds NML. Hoarding will reduce noise by approximately 10dB. Consider quieter methods for piling, cutting / breaking rock or masonry, tipping fill, and for collecting and removing waste. Tunnelling impacts depend on method: cut and cover will result in higher airborne noise impacts than boring method.
Phase C. New Nutrition Centre Building	Truck (79) Crane (78) Hand tools (74) Removal of building waste (84)	60 59 55 65	Exceeds NML. Hoarding and / or noise curtains will reduce noise by approximately 10dB.
Phase D. Post Construction Activities	Truck (79) Truck (tipping fill) (89) Compactor (85) Crane (78) Diggers, excavators (79) Hand tools (74) Asphalt paver (80)	60 70 66 59 60 55 61	Exceeds NML. Hoarding and / or noise curtains will reduce noise by approximately 10dB. Consider quieter methods for compacting and tipping fill.

Table 13: Predicted construction noise levels at representative residential receivers, for indicative works phases and activities. These predicted levels assume no noise mitigation measures have been adopted.

Noise Scenario / Activity Description	List of plant (dBL_{Aeq} at 10m)	Highest Predicted Level at Residential Receivers – without noise mitigation	Comments
Phase A. Pre-Construction	Generators (75 petrol) Trucks (79) Hammers (70) Hand tools (74) Tree removal and mulching (88)	46 50 41 45 69	Meets NML apart from mulching. Consider off-site mulching in a less noise-sensitive location.
Phase B. Demolition, excavation, piling	Rock breaker (90) Excavator (79) Concrete saws (89) Piling (bored 83) Truck (tipping fill) (89) Jackhammers (90) Hammer / Percussive drill (84) Removal of building waste (84) Compactor (85)	61 50 60 54 60 61 55 55 56	Most activities exceed NML, although within 5dB of existing ambient noise levels (56dB(A)). Consider quieter methods for cutting / breaking rock or masonry, tipping fill, and for collecting and removing waste. Silencers should be used where possible on noisy items such as jackhammers. Tunnelling impacts depend on method: cut and cover will result in higher airborne noise impacts than boring method. Enclosures for cut-and-cover will reduce impacts.
Phase C. New Nutrition Centre Building	Truck (79) Crane (78) Hand tools (74) Removal of building waste (84)	50 49 45 55	Exceeds NML, but similar to existing ambient noise levels (56dB(A)), therefore negligible to minor noise impacts are expected.
Phase D. Post Construction Activities	Truck (79) Truck (tipping fill) (89) Compactor (85) Crane (78) Diggers, excavators (79) Hand tools (74) Asphalt paver (80)	50 60 56 49 50 45 51	Some activities exceed NML, although within 5dB of existing ambient noise levels (56dB(A)). Therefore negligible to minor noise impacts are expected. Consider quieter methods for compacting and tipping fill.

Table 14: Predicted construction noise levels at representative receivers, for indicative works phases and activities with basic noise mitigation implemented. These predicted levels assume noise curtains or hoarding, petrol generator, and bored piling are used. Noise mitigation measures to control residual impacts are recommended.

General comments are as follows.

Local hoarding around the worksite is recommended for all external works. When works are moving around the site, including mobile cranes, jackhammers, and concrete saws, local "noise curtains" such as EchoBarrier or Flexshield will assist with reducing noise near the source. To break the line-of-sight between source and receiver, a partial enclosure with a roof may be required for some activities due to the local topography. This

recommendation for a partial cover is relevant to tunnelling works – particularly if the method is cut-and-cover.

If generators are required for the site set-up, petrol generators or biodiesel / solar hybrid generators should be used instead of conventional diesel.

Mulchers are known to generate high noise levels. This can be managed by carrying out the mulching at a less noise-sensitive site, for example in a different location within the Zoo so that the distance attenuation to the residences provides a noise benefit.

Electric tools are to be selected instead of petrol or pneumatic tools where possible.

Piling has the potential to cause significant noise impacts. The method of piling also needs to consider vibration effects on the structures nearby. The piling method needs to be selected to minimise both noise and vibration impacts and therefore bored or screw type piling methods should be implemented.

Truck access should be limited to designated time periods and site access gates should be as far as possible from sensitive enclosures and well-used walkways. Vehicle pathways around the site should be arranged to minimise the need for reversing. Where reversing is necessary, non-tonal reversing alarms should be implemented where safe and practical.

Further noise and vibration controls are discussed in detail in the following sections.

11 Noise Management and Mitigation Measures

11.1 General noise control elements

The noise and vibration objectives, management and mitigation measures in environmental assessment documentation are based on an initial design and construction methodology. It is expected that the works methodology and staging may be altered. Consequently it may be necessary to update the assessment and associated noise management plan at several stages throughout the project.

As a general rule for best practices, prevention and elimination of noise would be applied as universal work practice during construction, especially when construction works are to be undertaken outside recommended standard hours.

Where elimination and prevention are not feasible options, the reduction of the noise at the source and the control of transmission path between the construction site and the receiver are the preferred options for noise minimisation through engineering and or administration controls. Providing treatments at the affected residences or other sensitive land uses would only be implemented as a last resort.

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

- Plant and equipment
  - Use quieter work methods.
  - Use quieter equipment.
  - Use low noise and vibration piling methods such as bored or screw piling.
  - Use mobile noise curtains for external works with noisy hand-held tools
  - For noisy works, consider carrying out in continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block
  - Operate plant in a quiet and effective manner.
  - Plant used intermittently to be throttled down or shut down.
  - Use mains power supply where possible, rather than use generators.
  - Use one larger generator to power multiple plant items (ensuring safe cabling). Use petrol generators instead of diesel generators.
  - Switch off generators when not in use, particularly during out-of-hours work periods.

- Maintain equipment regularly.
- Where appropriate, obtain acoustic test certificates for equipment

- On site noise management
  - Strategically locate equipment and plant. Locate generators away from sensitive receivers.
  - Avoid the use of reversing alarms through site layout to minimise reversing, or provide for alternative systems such as non-tonal reversing alarms.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Enclose the work site as far as possible from receivers, and use hoarding. Noise reductions of at least 10dB are expected due to effective hoarding.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Consider signage at walkways affected by construction noise.
  - Manage waste removal from the site to minimise noise impacts.
  - Reduce noise from metal chutes and bins by placing damping material in the bin.
  - Locate waste deposit bins as far as possible from sensitive receivers.
  - Where possible, carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.
  - Delivery vehicles to should be fitted with straps rather than chains for unloading, wherever possible.
  - Keep windows closed during all internal works.
- Consultation, notification and complaints handling
  - Provide information to affected neighbours and zoo patrons before and during construction as required.
  - Maintain good communication between the community and project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
  - Schedule activities to minimise noise impacts.
  - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
  - Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. Ensure noisy plant schedules are clear in Works Plan.

- Keep truck drivers informed of designated routes, parking locations and delivery hours.
- Schedule deliveries to planned construction hours only.

- Mandatory site rules of conduct
  - Avoid the overuse of public address systems, radios or stereos outdoors.
  - No swearing or unnecessary shouting.
  - No unnecessary dropping of materials from height, throwing of metal items, and slamming of doors.
  - No extended periods of engine idling.

11.2Construction-related Road Traffic

Construction-related road traffic is a temporary noise source but one which requires assessment and management, particularly for heavy vehicles accessing the site.

Construction vehicles likely to be generated by the proposed construction activities include:

- Articulated trucks for the delivery of machinery (including mobile cranes and diggers);
- Trucks to collect demolition and excavated materials;
- General vehicles such as concrete trucks, medium rigid trucks, tradespeople's utilities and courier vans.

The temporary additional traffic increase due to construction would not result in an increase of 2 dB, which is considered to be noticeable.

However, it is also important to recognise that heavy vehicles associated with construction can generate maximum noise levels which are higher than general car traffic, and can lead to greater disturbance than cars.

Taronga Zoo's vehicle policy includes a limit on heavy vehicle movements to be used for removing spoil of other materials to between 7:30am and 4:30pm Monday to Friday, and between 7:30am to 1:00pm on Saturday, or as required by Mosman Council.

Access routes will be limited to the main Whiting Beach Road entry. It is noted that this is in a residential area, and therefore driver behaviour will need to be managed to minimise impacts.

Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided. These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.

Truck arrivals to and departures from site should be scheduled to occur outside the busiest traffic periods, but where possible should also avoid noise-sensitive night time periods.

Over-sized vehicles and deliveries may be required out of standard work hour to meet road safety requirements (for example, under a Road Occupancy Licence). In such cases, residents may need to be informed in advance if there is a potential for Sleep Disturbance due to night-time construction vehicle passby events.

11.3 Communication and complaints

The following procedures are an example of the procedures that would be specifically adopted for complaints relating to noise.

Upon receipt of a complaint The Contractor would:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position;
- Establish from the monitoring equipment if the allowable noise levels have been complied with;
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted;
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity would be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity would then cease.

Any activity which is directed to cease due to excessive noise would not recommence until the Project Manager is satisfied that the requirements of the relevant criteria can be met and has given permission to recommence the activity.

The Site Supervisor would ensure that a report of any incident is provided to the Project Manager.

The Project Manager would provide a report on the incident to the relevant stakeholders.

The Contractor would provide a 24 hour telephone contact number and this number would be prominently displayed on the site.

11.4 Timing of works

The assessment of proposed construction activities has indicated construction noise levels are likely to meet or be within 5dB of the standard daytime construction NML at the nearest residential receivers, provided that the following noise control measures together with best practices detailed in the previous sections are considered in order to minimise the noise impacts.

- Construction activities would typically occur during the prescribed standard hours (at the least sensitive times of the day).
- Where work must be carried out during noise sensitive periods, residents would be informed and management principles would be in place to ensure a minimal amount of impact. This may include:
    - Do not use noise sensitive equipment likely to exceed the relevant criteria i.e impact or vibratory piling rigs, and diesel generators, rock-breakers, concrete cutters and jackhammers without effective noise curtains.
    - Where possible limit construction works to those internal to buildings so as to contain the noise and minimise noise emissions externally.
    - Outside standard hours, only carry out activities at locations where compliance with the criteria (RBL+5) can be achieved.

11.5 Equipment and plant selection

This assessment has been based on typical noise sources defined in AS 2436-2010. The contractor would aim to choose the quietest pieces of equipment where feasible and reasonable. If the final equipment selection varies significantly from items specified in **Table 11**, it is recommended that an additional assessment be carried out for noise sources other than those included in this report and revisions made to the noise management plan where necessary.

Based on the results of the assessment, key pieces of equipment have been noted to dominate the overall noise contribution at the receiver position including piling rigs, concrete saws, jackhammers and dump trucks.

Where possible alternative methods or selection of quieter equipment would be considered. Lessening the time in use and ensuring equipment is not used simultaneously will further reduce the noise impact at residents.

Where possible, reduce the number of noise sources/activities running simultaneously at the same location.

Limit the number of site vehicles such as dump trucks at any one time.

A screen or enclosure would be used when carrying out external building works that are predicted to exceed the noise management level at environmental receivers. Typically screens and enclosures constructed with plywood would be sufficient. Reference shall also be made to specific screening and enclosures detailed in Appendix F of AS 2436:2010.

11.6 Vibration Management Measures

It is the contractor's responsibility to identify potential vibration generating sources in the proposed work methods.

The contractor shall refer to the demolition and landscaping plans to determine where rock cutting, excavation, piling, or other vibration-generating activities are to occur. The contractor shall refer to the Structural Engineer's report and plans to identify structurally sensitive or historic or sensitive structures requiring protection from vibration.

The Contractor would carry out a review of vibration generated by construction activities. The levels of vibration generated will be site specific and will depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties. The Contractor would carry out a preliminary vibration survey, which will determine whether a means of vibration mitigation will be necessary on the site.

11.6.1 Works requiring a vibration assessment

A preliminary vibration assessment is to be carried out for each key vibration generating activity, ie:

- Piling
- Rock breaking including for tunnelling
- Concrete saw cutting including for tunnelling
- Jackhammering
- Percussive / Hammer drilling
- Concrete and brick drilling
- Any other activities proposed by the contractor which is likely to generate perceptible vibration.

These activities should also be monitored for the risk of cosmetic damage.

When considering the measured vibration impact associated with construction works, the following would be taken into account.

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

11.6.2 Dilapidation survey

Vibration-intensive activities such as heavy demolition, excavation, tunnelling and piling often warrant condition surveys and monitoring.

The Heritage Impact Assessment[3] identifies potential items of historic or heritage significance in or near the site. They include built features and trees. These items are to be protected from vibration and other construction-related effects.

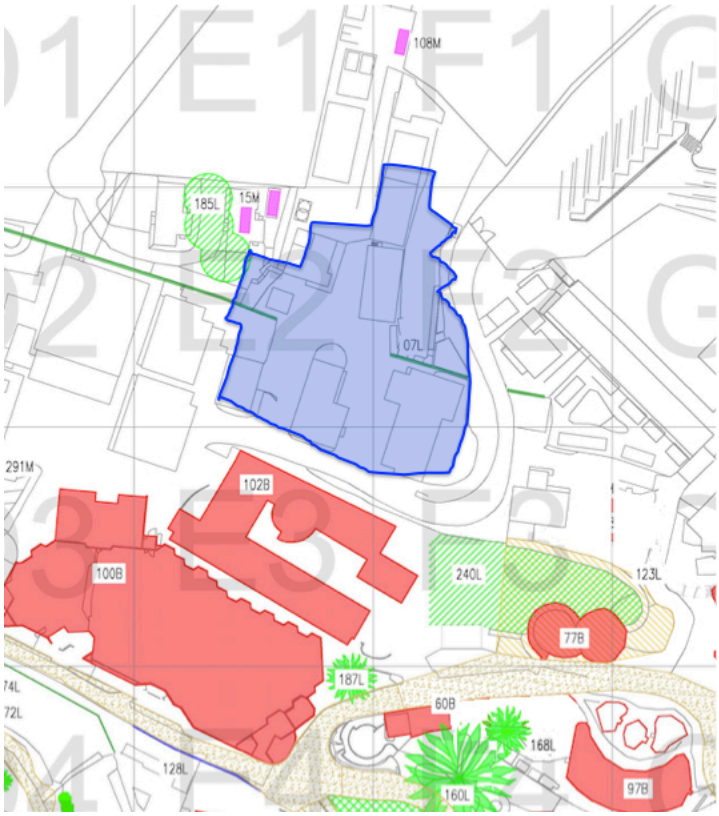


Figure 5: Architectural plan showing items of historic or heritage significant within and surrounding the site (source: Heritage Impact Assessment[3]).

The Construction Management Plan also describes heritage items which will themselves be subject to demolition and potentially reconstruction works, including a retaining wall within the site. Any works affecting the heritage items, requires close consultation with a heritage specialist for planning and carrying out the works.

The Contractor would be required to conduct a dilapidation survey up to 50m from the work site prior to high vibration works.

[3] *Proposed Wildlife Hospital and Animal Nutrition Centre Heritage Impact Assessment*, Geoffrey Britton Environmental Design & Heritage Consultant, November 2021

11.6.3 Vibration monitoring inside the Zoo

Preliminary vibration monitoring is to be carried out for each key vibration generating activity, ie:

- Concrete saw cutting
- Jackhammering
- Percussive / Hammer drilling
- Concrete and brick drilling
- Percussive piling
- Any other activities proposed by the contractor which is likely to generate perceptible vibration.

The purpose of the vibration monitoring is to assess the risk of potential structural damage to historic or heritage structures within the premises.

Monitoring is also required in situations where there are changes in equipment and activities or work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so as to provide results that are readily comparable to the preliminary survey and relevant criteria provided in Section 7.3 and 7.4.

If vibration monitoring is required at any item or structure with heritage or historic significance, the method of affixing the vibration sensor will need to be reviewed and approved by a heritage consultant to ensure that there is no damage to the item or structure.

11.7 Noise monitoring and reporting

11.7.1 Airborne noise monitoring

Due to the low predicted construction noise impact risk, provided that the recommended noise control measures can be applied, noise monitoring at residential receiver locations is unlikely to be required.

Noise monitoring is recommended if noise-intensive piling such as impact sheet piling cannot be avoided, or other activities that result in residential noise level predictions exceeding the NML by more than 10dB. For example, noise monitoring may be considered during heavy demolition, excavation, tunnelling piling works.

Additional positions (for example, in the Zoo premises) may also be selected for noise monitoring.

It is recommended that noise monitoring be carried out for a minimum of 1 week during the period where the greatest impacts are expected, or for the duration of the noisy works (whichever is less). Monitoring results can be reviewed at the end of the week, however could be reviewed on more regular intervals depending on the type of work and level of

noise expected. The requirement for further monitoring would be reviewed after this time or sooner if deemed necessary by the Acoustic Consultant and Project Manager.

11.8 Construction noise and vibration compliance

This report establishes applicable noise criteria for the proposed works. Potential vibration effects have been identified.

Works that will require careful noise and vibration management include pneumatic breakers during rock-breaking, percussive piling, concrete pumps, and dumping spoil into trucks. This list is not exhaustive.

The contractor may be requested by Taronga Zoo to prepare a detailed Construction Noise and Vibration Noise Management Plan for the works once the demolition and construction method is more progressed. This Plan would focus on managing impacts within the Zoo premises, and will need to outline the proposed stages of work, plant and equipment to be used, and times of day during each week that construction is expected to occur. The Plan will need to demonstrate that all feasible and reasonable measures will be applied to meet the relevant Noise Management Levels.

All feasible and reasonable measures to meet the applicable Noise Management Levels will need to be identified and applied.

Acoustic Studio strongly recommends that works are conducted during standard construction hours where possible. However, where the works are expected to be inaudible at the most affected residential receivers, some out of hours works may be necessary. Such flexibility would ensure that public safety within zoo premises is not compromised by construction activity, while still maintaining acoustic amenity for local residents. An example is building fit-out works carried out entirely within the new buildings, provided that windows and doors are kept closed.

Particular consideration of construction-related road traffic noise impacts is required. Construction vehicles are only to use the Bradleys Head Road (south) access gates outside zoo opening hours. Zoo traffic management policy restricts heavy vehicles moving spoil or waste to between 7:30am to 4:30pm Mondays to Fridays, and 7:30am to 1pm on Saturdays. For this project, construction related traffic will be restricted to 7am to 5pm Monday to Friday, and 8am to 1pm Saturday.

Dilapidation surveys are recommended for nearby historic and heritage structures.

12 Summary and Conclusions

A noise assessment has been carried out for the proposed Taronga Wildlife Hospital Sydney Nutrition Centre (Nutrition Centre) redevelopment at Taronga Zoo, Mosman.

External noise emissions associated with the operation of the Nutrition Centre have been assessed. The assessment has adopted methodology from relevant guidelines to assess particular noise sources and expected worst-case impacts as follows:

- External mechanical plant and maintenance noise emissions – NSW Noise Policy for Industry (NPfI) overall A-weighted noise criteria.

Short-term and week-long ambient noise monitoring has been carried out to establish the existing background noise levels of the neighbourhood.

The noise impacts have been predicted at the most sensitive boundary positions, taking into account distance attenuation, building and ground reflections, directivity and, where applicable, shielding by the zoo buildings / structures.

A general operational environmental noise assessment has been carried out for mechanical plant and cleaning and maintenance activities. These noise sources are likely to be effectively controlled through:

- Appropriate design and location of the mechanical plant system during the detailed design stage: responsibility of the architect, builder and mechanical and acoustic consultants;
- Operating the wash facility during standard daytime business hours, unless the location and noise levels can comply with evening and night time project specific noise management levels; and
- Management controls for the timing of cleaning and maintenance activities, and for closing doors if required for cleaning the inside of the enclosures.

A high level construction environmental noise assessment has been carried out, based on assumptions about the type of equipment that would be used on site. These noise sources are likely to be effectively controlled through:

- Hoarding around the work site, and local enclosures of noisy plant or activities;
- Selection of quieter plant, including a commitment to use quieter petrol or biodiesel / solar generators rather than diesel generators if generators are required
- Use of electric rather than pneumatic or petrol hand tools where possible;
- Selection of quieter methods where possible and appropriate, particularly for piling, excavation and jackhammering;
- Selection of low vibration work methods where possible and appropriate;
- Vibration monitoring and management controls for historic and heritage structures.

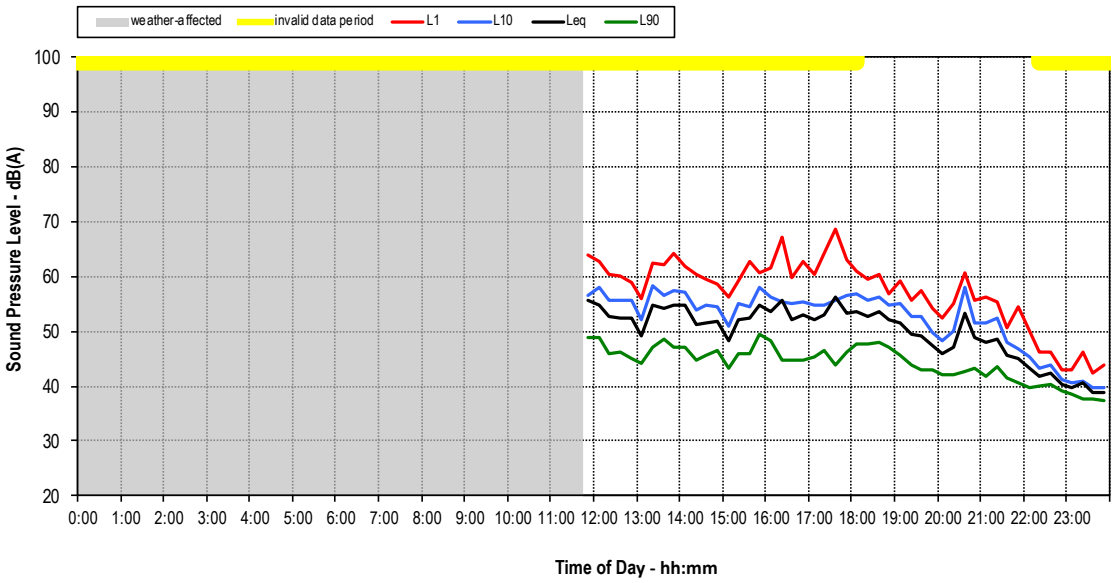
Provided the recommendations detailed in this report are correctly implemented, it is anticipated that the Nutrition Centre construction and operations will have no adverse noise impact at the nearest residential receivers.

APPENDIX

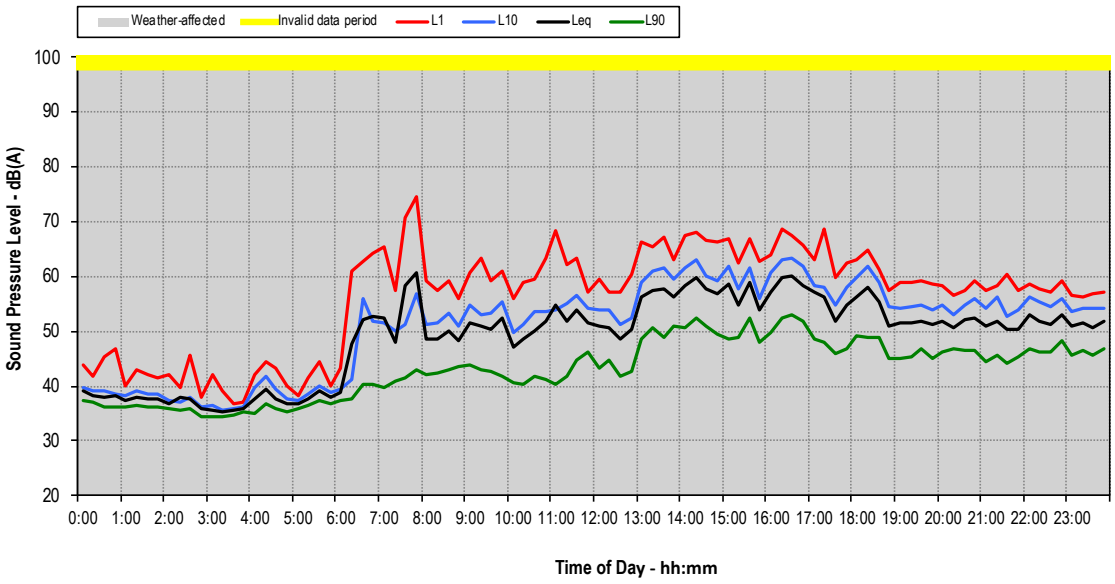
Noise logger graphs

2021 data – Affected by COVID-19 reduced activity. Also weather-affected and missing data due to intermittent logger failure.

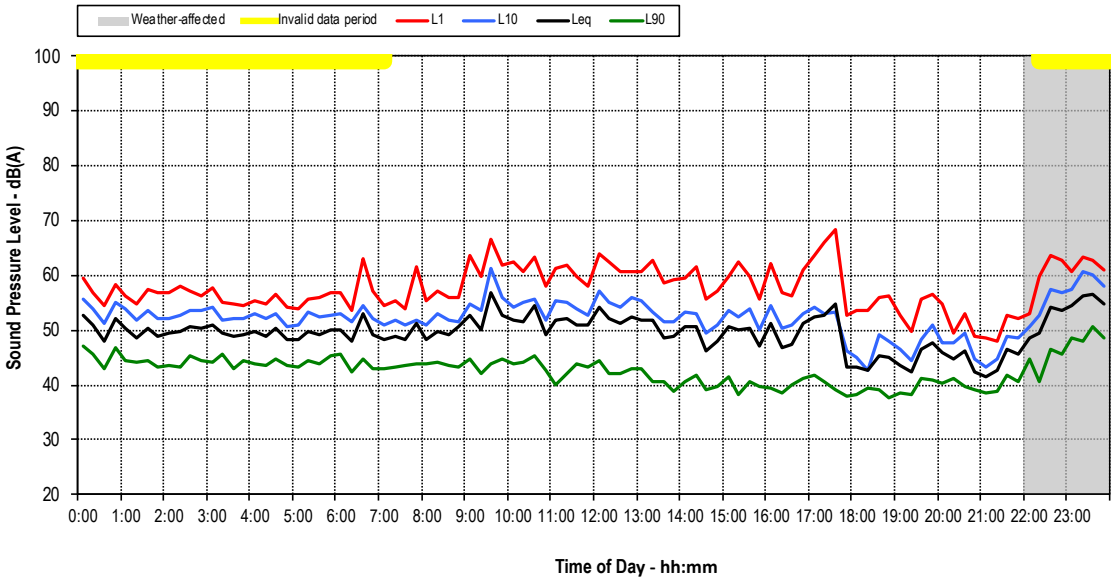
Whiting Beach Road (Taronga Zoo) - Friday 14 May 2021



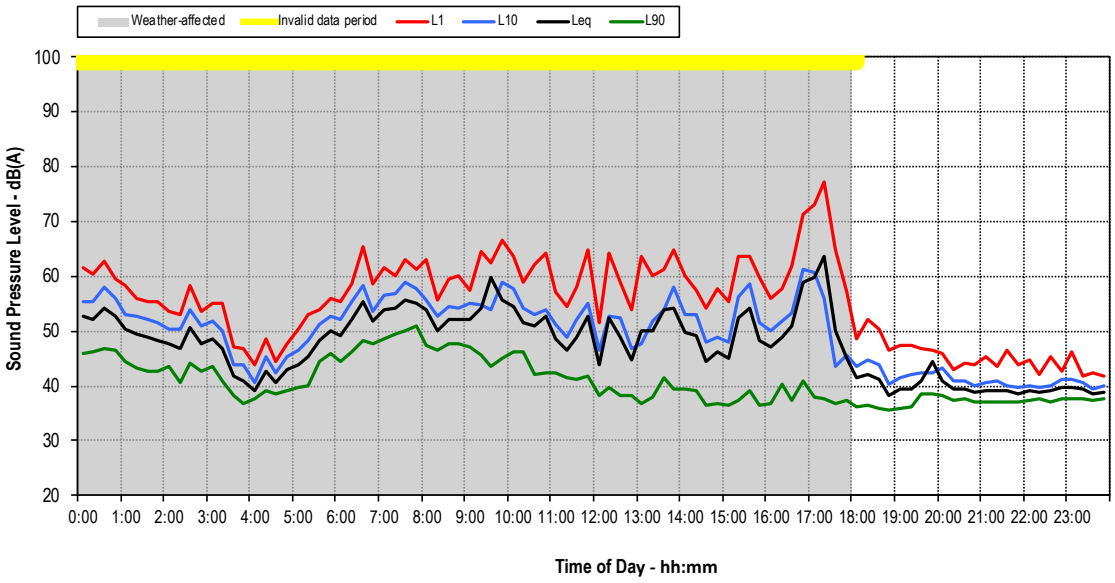
Whiting Beach Road (Taronga Zoo) - Saturday 15 May 2021



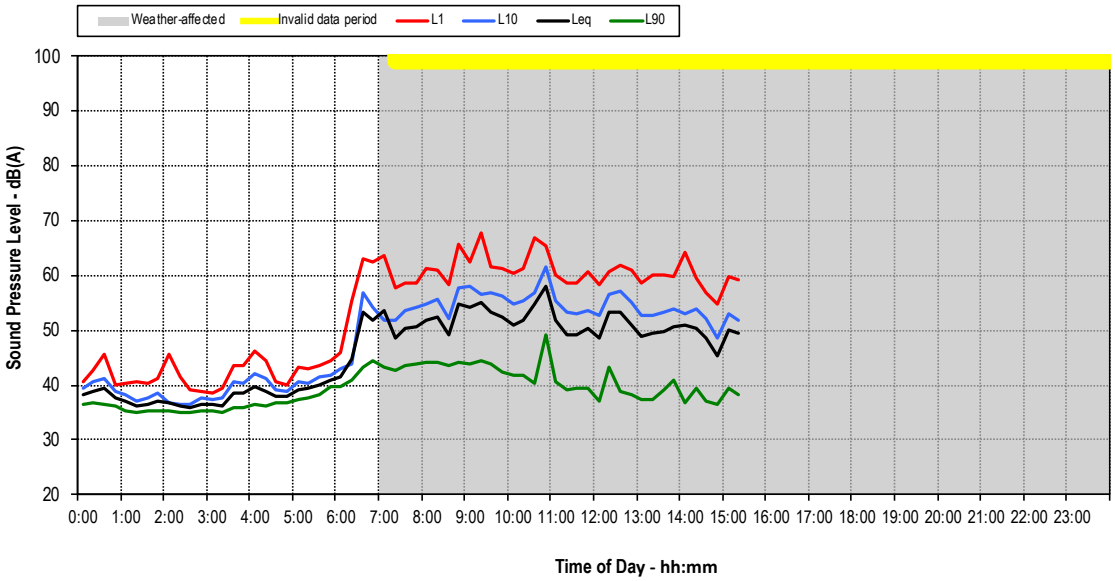
Whiting Beach Road (Taronga Zoo) - Sunday 16 May 2021



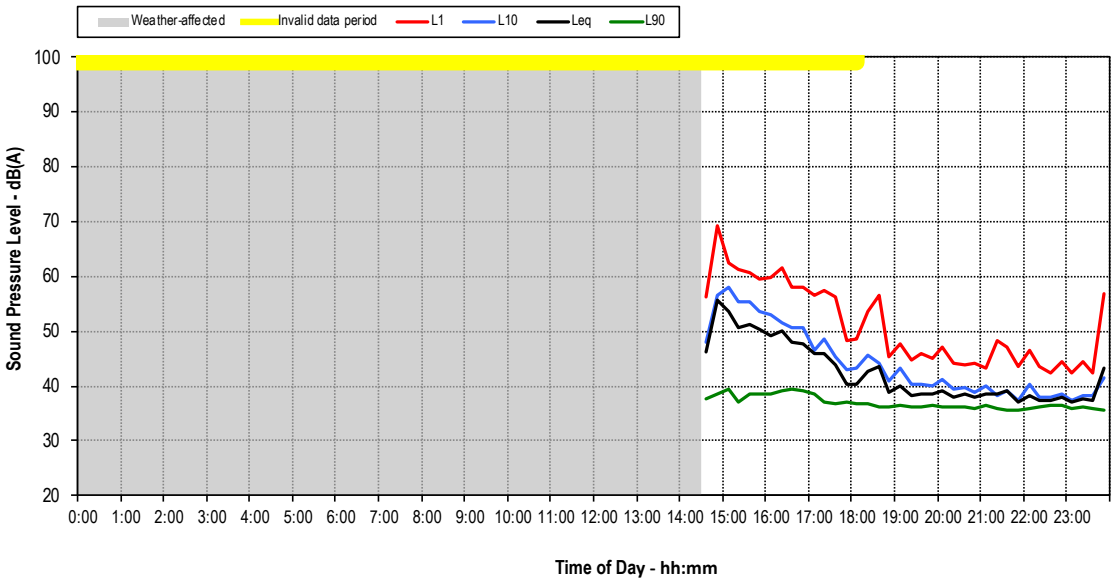
Whiting Beach Road (Taronga Zoo) - Monday 17 May 2021



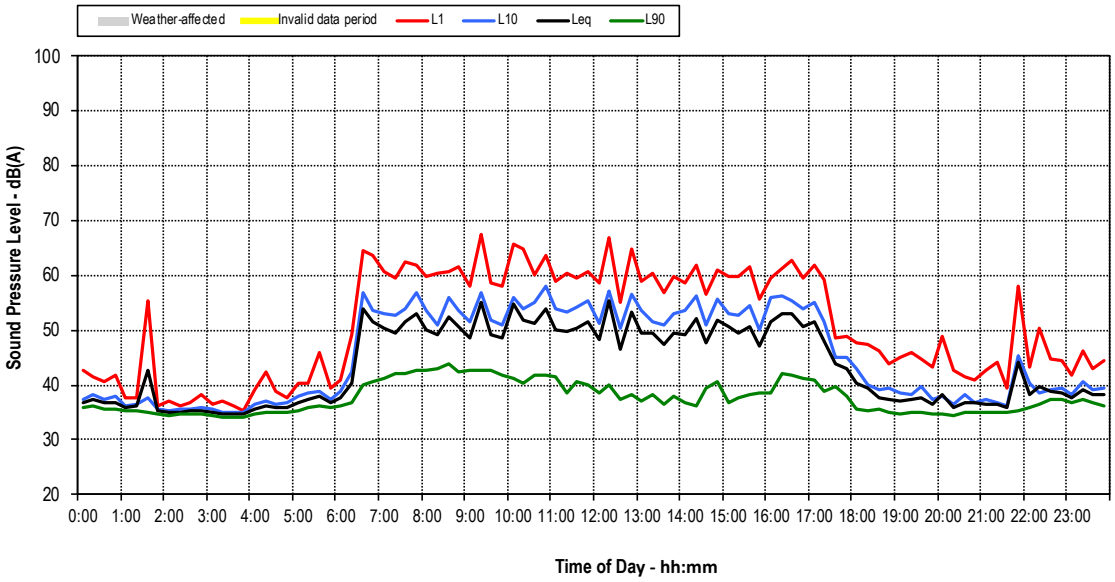
Whiting Beach Road (Taronga Zoo) - Tuesday 18 May 2021



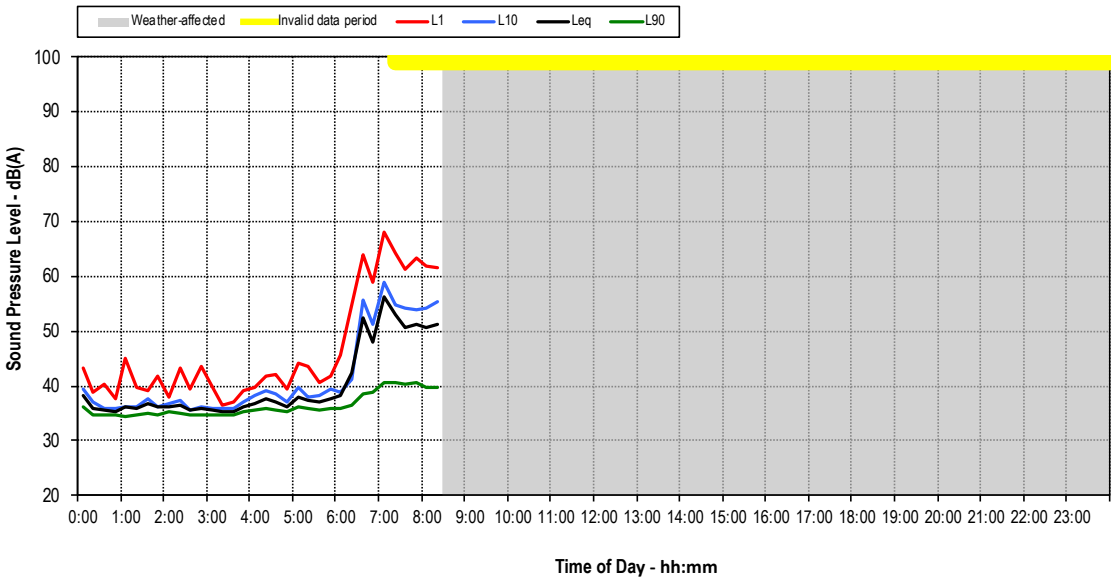
Whiting Beach Road (Taronga Zoo) - Friday 21 May 2021



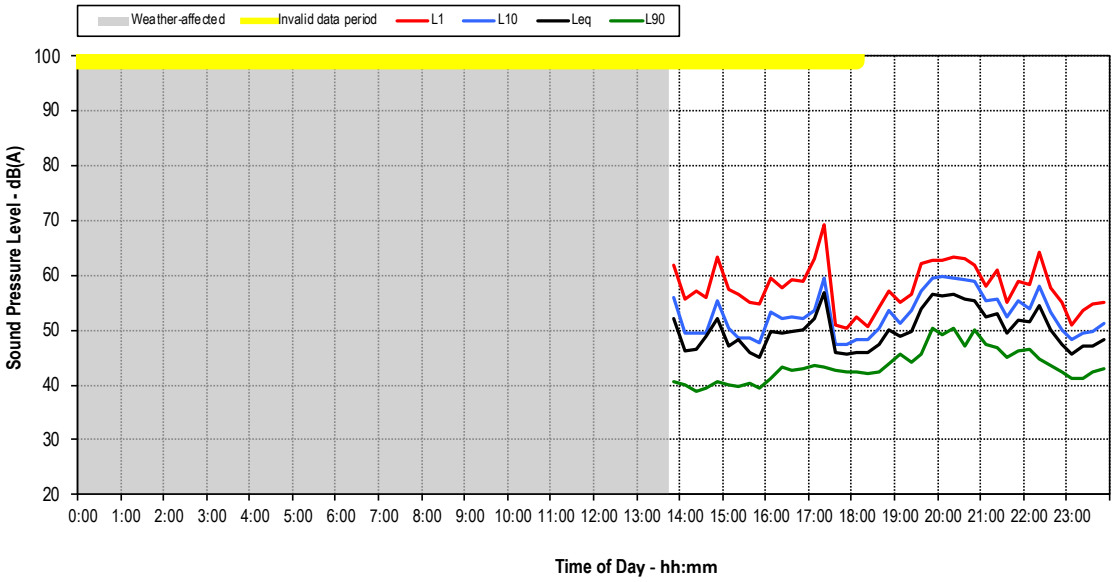
Whiting Beach Road (Taronga Zoo) - Saturday 22 May 2021



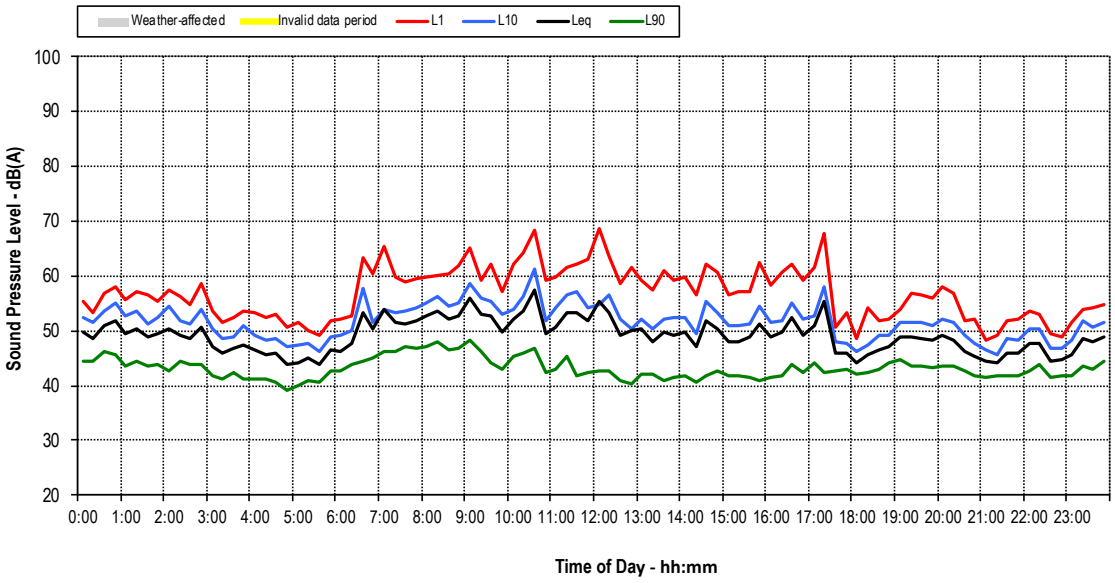
Whiting Beach Road (Taronga Zoo) - Sunday 23 May 2021



Whiting Beach Road (Taronga Zoo) - Wednesday 26 May 2021

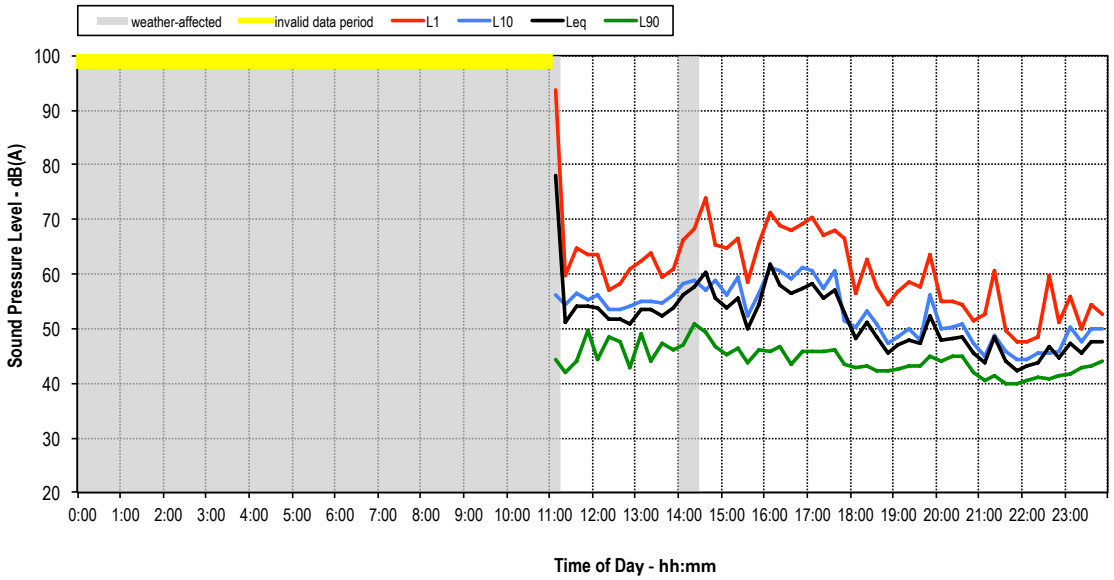


Whiting Beach Road (Taronga Zoo) - Thursday 27 May 2021



2017 data – Not affected by COVID-19 reduced activity (pre-COVID-19), and still valid as less than five years old.

Taronga Zoo - Rickard Rd - Thursday 27 April 2017



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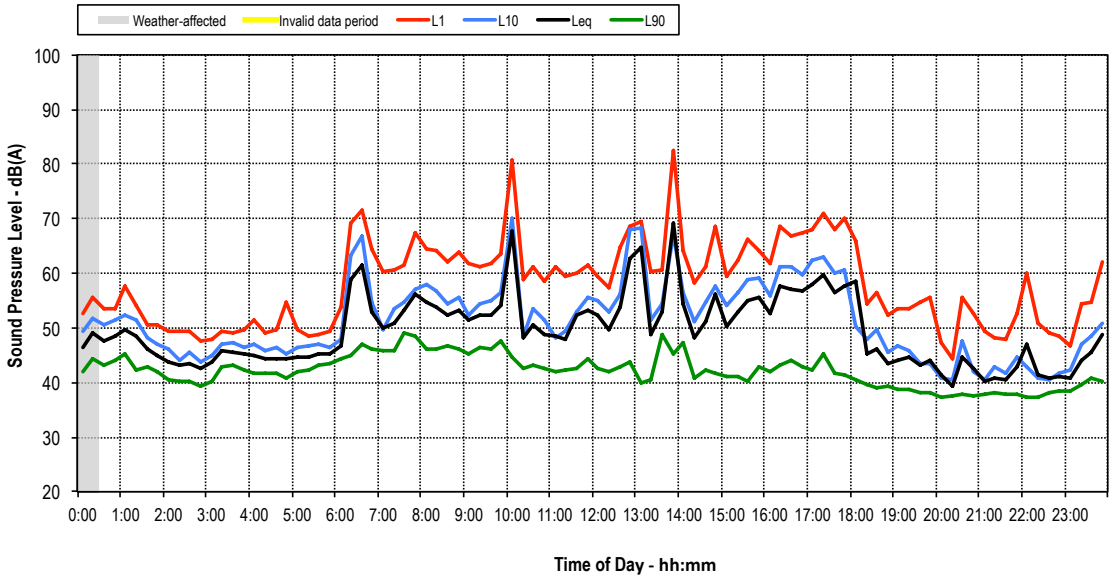
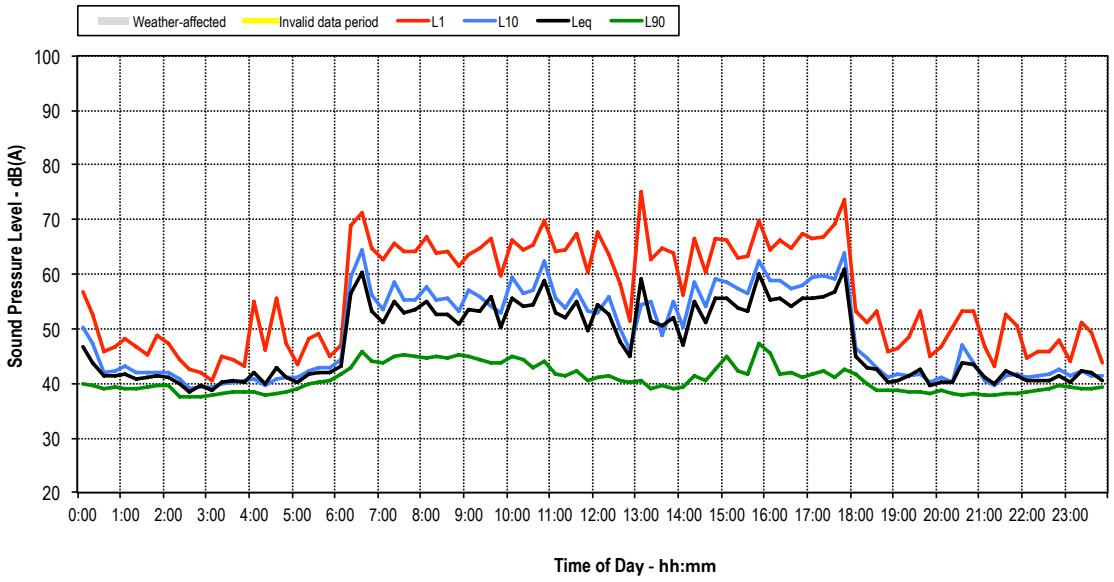
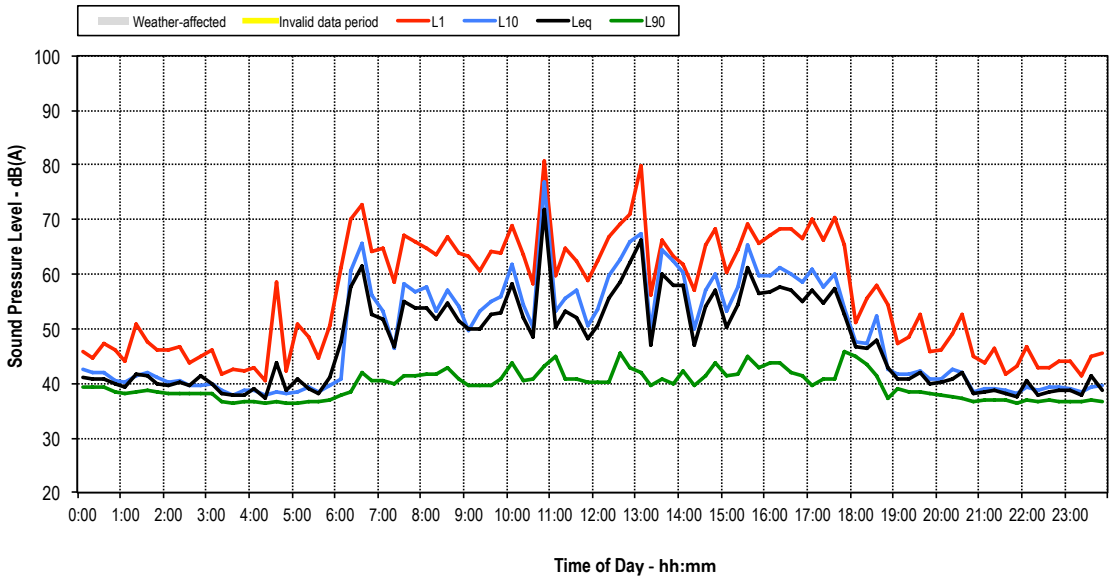


Taronga Zoo - Rickard Rd - Saturday 29 April 2017



Taronga Zoo - Rickard Rd - Sunday 30 April 2017



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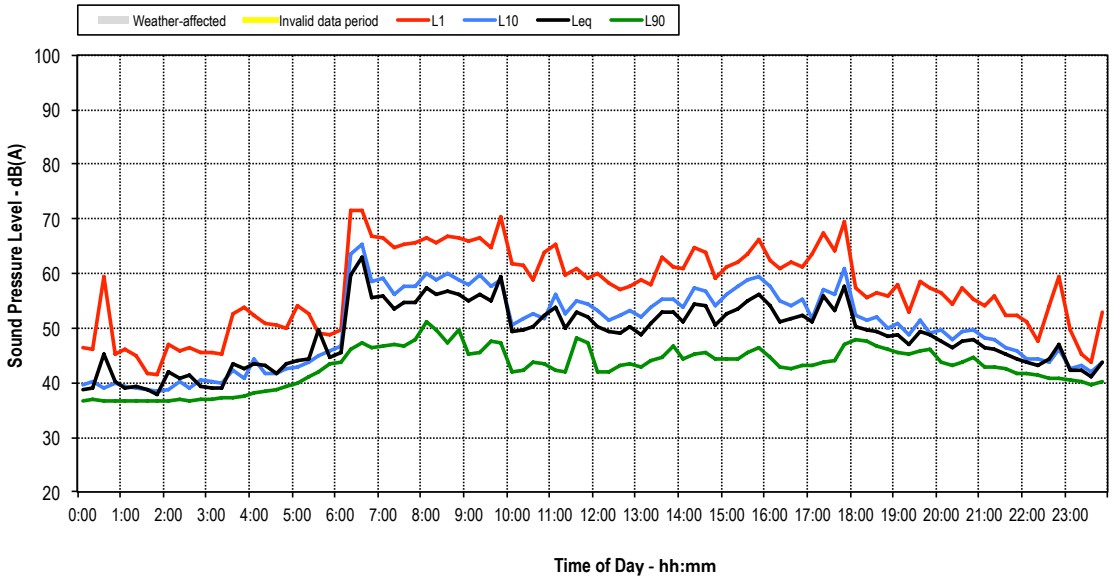

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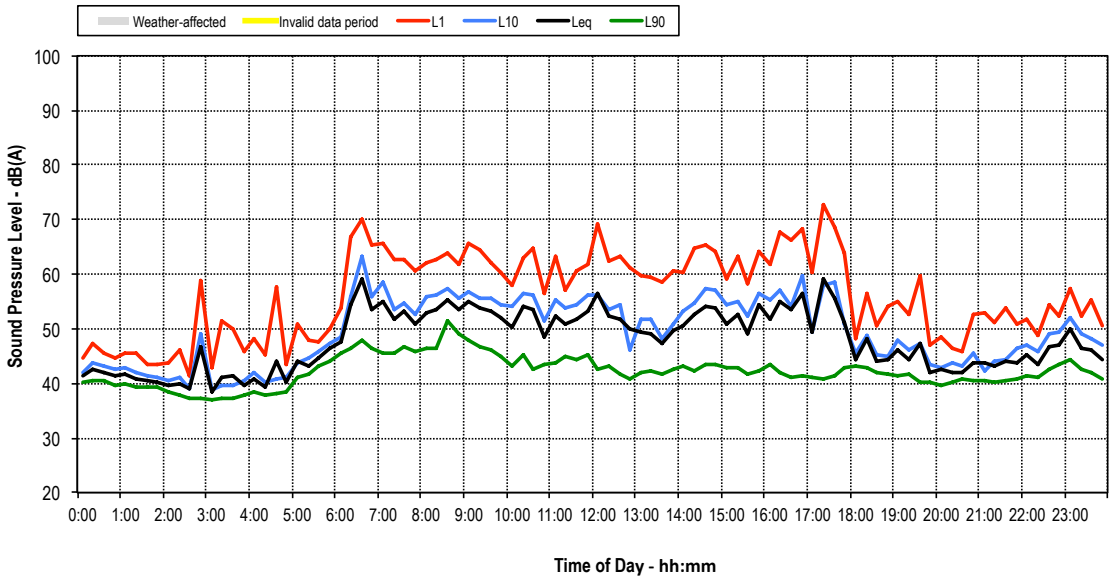

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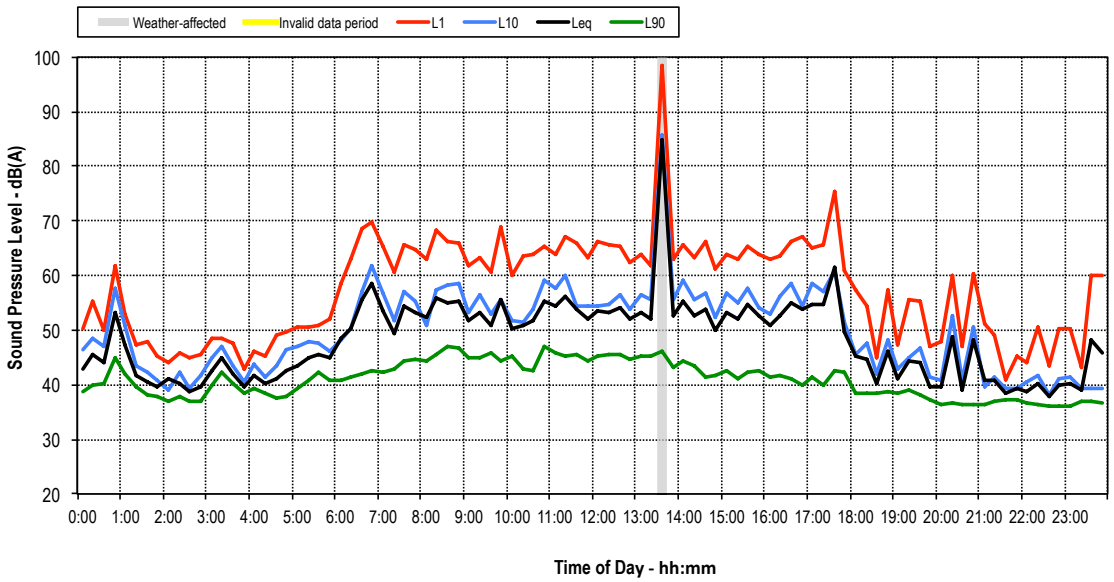

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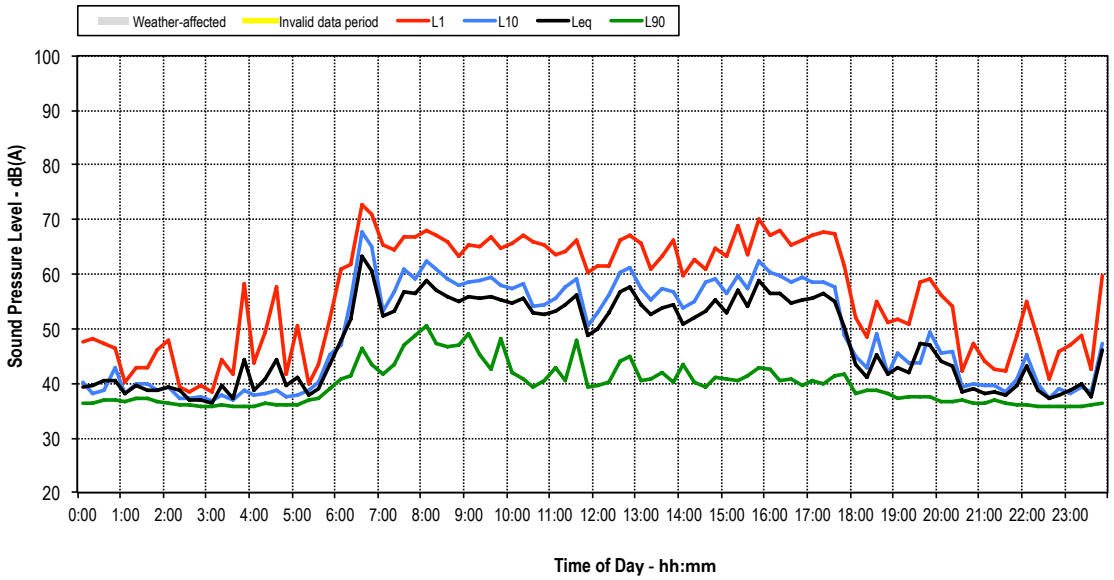

Taronga Zoo - Rickard Rd - Friday 05 May 2017