

National Capital Authority

# Scrivener Dam Dissipator Strengthening Project

## Noise and Vibration Impact Assessment

January 2023

Confidential



# Question today *Imagine tomorrow* Create for the future

## Scrivener Dam Dissipator Strengthening Project Noise and Vibration Impact Assessment

National Capital Authority

WSP  
Level 3, 51-55 Bolton St  
Newcastle NSW 2300  
PO Box 1162  
Newcastle NSW 2300

Tel: +61 2 4929 8300  
Fax: +61 2 4929 8382  
wsp.com

Rev	Date	Details
Rev 0	21/12/2022	Draft Assessment for NCA review
Rev 1	10/01/2023	Final report for issue

	Name	date	signature
Prepared by:	M Tonner	21/12/2022	
Reviewed by:	B Ison	21/12/2022	
Approved by:	B Ison	10/01/2023	

WSP acknowledges that every project we work on takes place on First Peoples lands.  
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

This document may contain confidential and legally privileged information, neither of which are intended to be waived, and must be used only for its intended purpose. Any unauthorised copying, dissemination or use in any form or by any means other than by the addressee, is strictly prohibited. If you have received this document in error or by any means other than as authorised addressee, please notify us immediately and we will arrange for its return to us.



# Table of contents

<b>Glossary</b> .....	<b>1</b>
<b>1 Project background</b> .....	<b>2</b>
1.1 Introduction.....	2
1.2 Purpose of this report.....	2
<b>2 Existing noise environment</b> .....	<b>3</b>
2.1 Sensitive receivers .....	3
2.2 Attended noise monitoring.....	5
<b>3 Project noise and vibration goals</b> .....	<b>7</b>
3.1 The Consolidated National Capital Plan .....	7
3.2 ACT noise guidelines.....	7
3.2.1 ACT noise zone standards .....	7
3.2.2 Exemptions.....	8
3.2.3 Attention-drawing noise characteristics .....	8
3.3 NSW Interim Construction Noise Guidelines (ICNG).....	9
3.4 Potential noise impacts on fauna.....	9
3.5 Proposed project noise goals .....	10
3.6 Vibration criteria .....	11
<b>4 Noise and vibration measurements of rock drilling units</b> .....	<b>13</b>
4.1 Measurement arrangement.....	13
4.2 Measurement methodology.....	14
4.2.1 Noise measurements .....	14
4.2.2 Vibration measurements.....	14
4.3 Measurement setup .....	14
4.4 Noise emissions.....	14
4.4.1 Modifying factors.....	14
4.5 Vibration measurements .....	16
4.5.1 Measurement results.....	16
<b>5 Noise assessment</b> .....	<b>17</b>
5.1 Modelling inputs .....	17
5.2 Model validation.....	17



<b>5.3</b>	<b>Predicted operational noise levels.....</b>	<b>18</b>
<b>5.4</b>	<b>Discussion .....</b>	<b>20</b>
5.4.1	National Zoo.....	20
5.4.2	Government House (Yarralumla) .....	20
5.4.3	Recreational areas.....	21
5.4.4	Residential suburban areas .....	21
<b>6</b>	<b>Vibration assessment .....</b>	<b>22</b>
6.1.1	Vibration assessment.....	22
6.1.2	Discussion .....	22
<b>7</b>	<b>Simulated noise impact testing.....</b>	<b>23</b>
7.1	Introduction.....	23
7.2	Methodology .....	23
7.3	Observations.....	23
<b>8</b>	<b>Recommendations .....</b>	<b>26</b>
8.1	Background.....	26
8.2	Noise management and mitigation .....	26
<b>9</b>	<b>Limitations .....</b>	<b>28</b>
9.1	Permitted purpose .....	28
9.2	Qualifications and assumptions .....	28
9.3	Use and reliance .....	28
9.4	Disclaimer .....	29

# Glossary

Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Audible range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 hz to 20 khz, although it is possible for some people to detect frequencies outside these limits.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the a-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Continuous vibration	Vibration continues uninterrupted for a defined period.
dBA: A-weighted decibels	The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the 'A' filter. A sound level measured with this filter switched in is denoted as dB(A). Most environmental noise is measured using the 'A' filter.
dB(C): C-weighted decibels	'C' weighted adjustments are relatively flat across lower frequencies, and as such are better suited for the assessment of low frequency noise.
Diffraction	The distortion around solid obstacles of waves travelling past.
Frequency	The time rate for each wave peak (of a sound wave) to pass a given point. Frequency is measured in hertz (Hz).
L <sub>90</sub>	The level of noise exceeded for 90% of the time for which a given sound is measured. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L <sub>eq</sub>	Equivalent sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring. The sound weighting of the noise measurement is commonly added, for example L <sub>Aeq</sub> or L <sub>Ceq</sub> .
L <sub>Max</sub>	The maximum noise level during a specified period
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level (SPL)	The level of sound pressure at a specific location, expressed in decibels.
Sound Power Level (SWL)	A measure of the acoustic energy emitted from a source of noise, expressed in decibels.

# 1 Project background

---

## 1.1 Introduction

The National Capital Authority (NCA) has commissioned WSP to investigate potential noise impacts associated with the Scrivener Dam Dissipator Strengthening Project (the project). The project will primarily involve rock drilling and concreting works associated with the installation of upgraded anchors and the placement of a topping slab over the existing dissipator.

The work area is located adjacent to the National Zoo and Aquarium, the grounds of Government House and numerous public recreational areas. The Zoo also houses accommodation facilities which may be considered particularly sensitive to noise.

The proposed construction works are expected to be inherently noisy and may impact these surrounding noise sensitive receivers. This report has been prepared to consider potential noise and vibration impacts that may be associated with the rock drilling works, which is expected to be the loudest operation involved with this work.

---

## 1.2 Purpose of this report

This report has been prepared to provide information and assessment of potential noise and vibration impacts arising from the use of the rock drill during the proposed works. It is intended to provide NCA and other relevant stakeholders with information to incorporate into more detailed environmental planning as the project progresses. It contains the following sections:

- 1) Introduction to the project and this report (Section 1)
- 2) The identification of noise sensitive receivers located in the vicinity of the work and a description of existing noise levels in the vicinity of the project (Section 2)
- 3) A preliminary discussion of potential noise goals for the identified noise sensitive receivers (Section 3)
- 4) The results of a noise monitoring undertaken for similar equipment (Section 4)
- 5) Assessment of potential noise impacts (Section 5)
- 6) Assessment of potential vibration impacts (Section 6)
- 7) The results and observations made during simulated drilling works at the National Zoo (Section 7)
- 8) Recommendations for noise management and future studies (Section 8).

## 2 Existing noise environment

### 2.1 Sensitive receivers

The work area is located adjacent to the National Zoo and Aquarium, the grounds of Government House and numerous public recreational areas. The Zoo also houses accommodation facilities which may be considered particularly sensitive to noise. Potential noise concerns were discussed with stakeholders at the National Zoo and Government house and a summary of the matters raised is provided in Table 2.1.

Table 2.1 Summary of stakeholder noise discussions

Stakeholder	Issues raised
National Zoo	<ul style="list-style-type: none"> <li>— Accommodation facilities (generally single night stay, occupied sporadically between approximately 2pm to 10am)</li> <li>— Guest drinks are held on the Jamala verandas at 6pm each evening</li> <li>— Internal options existing for restaurant operations</li> <li>— Big cat enclosures closest fauna</li> <li>— Native marsupials can be skittish</li> <li>— Likely faunal reactions unknown, however major responses were noted during previous loud events (fighter jet flyovers, fireworks, etc)</li> <li>— Aquarium likely to be insensitive to noise</li> </ul>
Government House	<ul style="list-style-type: none"> <li>— Events held frequently, usually in the northern and eastern areas of site</li> <li>— Offices located in west and northern areas</li> <li>— Workshops located in western areas</li> <li>— Traffic noise currently dominant in western areas</li> </ul>
Residential areas	<ul style="list-style-type: none"> <li>— Potential noise impacts to suburban residential areas.</li> <li>— The most impacted receivers are located at Yarralumla and Curtin, approximately 2km to the east and south respectively.</li> </ul>

The location of the primary noise and vibration sensitive receivers are presented in Figure 2.1. A breakdown of these receivers is provided in Table 2.2.



Figure 2.1 Noise sensitive receivers





Table 2.2 Summary of noise sensitive receivers by receiver type

Receiver ID	Address	Suburb / Locality	Land use	Approximate distance from dam dissipater (m)
R1	Jamala Wildlife Lodge	Weston	Accommodation	50m
R2	National Zoo (Lion)	Weston	Animal enclosure	90m
R3	National Zoo (Snow Leopard enclosure)	Weston	Animal enclosure	100m
R4	National Zoo (Monkeys enclosures)	Weston	Animal enclosure	200m
R5	National Zoo (Other accommodation)	Weston	Accommodation	200m
R6	National Zoo (Giraffe enclosures)	Weston	Animal enclosure	275m
R7	National Zoo (Native animal enclosures)	Weston	Animal enclosure	300m
R8	National Zoo (Ostrich and Wapiti enclosures)	Weston	Animal enclosure	300m
R9	Open waterfront recreational spaces (north of dam)	Molonglo River (south west)	Active recreation	120m
R10	Scrivener Dam Offices	Scrivener Dam (east)	Office use	40m
R11	Governor General residence (Workshops)	Yarralumla	Workshops	200m
R12	Governor General residence (Offices)	Yarralumla	Office use	250m
R13	Governor General residence (Outdoor recreational areas)	Yarralumla	Passive recreation	350m
R14	Governor General residence (Government house)	Yarralumla	Accommodation	430m

## 2.2 Attended noise monitoring

Short term attended noise monitoring was carried out at some of these locations on 27 October 2022, to determine existing background noise levels and assist with the validation of the noise model to determine its accuracy (refer Section 5.2).

The monitoring of background noise levels was conducted during the daytime period and carried out at each location until a steady  $L_{Aeq}$  level was obtained. Within the zoo areas, noise levels ranged between approximately 55 – 65 dBA, with noise levels influenced by visitors, wild birds and on site water features. Road traffic noise from Tuggeranong Parkway was constantly audible in the background.

Details of all equipment used to conduct the noise survey are presented in Table 2.3. All equipment used in the survey were calibrated by a NATA-approved laboratory and have current calibration certificates as required in AS1055:2018.

The monitoring equipment was fitted with a windshield and was field calibrated before and after the monitoring. No significant drifts in calibration ( $\pm 0.5$  dB) were noted.

Table 2.3 Noise monitoring equipment

Monitoring	Equipment	Manufacturer	Model	Serial No.	Calibration due
Attended	Sound Level Meter	NTi	XL2	A2A-17705-E0	15/03/2024
Attended	Sound Level Meter	NTi	XL2	A2A-05718-E0	10/11/2023

The results of this monitoring are presented in Table 2.4.

Table 2.4 Summary of background noise monitoring results

Monitoring ID	Duration of measurement (Minutes)	Location	Monitored noise level dBA			Comment
			L <sub>Amax</sub>	L <sub>Aeq</sub>	L <sub>A90</sub>	
L1	3.7	Lion enclosure	86	67	59	Visitors, water feature, some wind
L2	3.6	Giraffe enclosure (1)	70	56	49	Wind, birds, visitors, dam water release, traffic on Tuggeranong Parkway
L3	4.1	Vicinity of ostrich, zebra, wolf enclosures	60	54	50	Visitors, some wind in tress, occasional birds, traffic on Tuggeranong Parkway
L4	1.8	Giraffe enclosure (2)	66	55	52	Staff working, traffic on Tuggeranong Parkway
L5	5.8	Vicinity of dingo, deer enclosures	66	59	56	Cars in parking lot, visitor noise, birds, traffic on Tuggeranong Parkway
L6	1.9	Tiger enclosure	70	62	56	Water feature (including pump), traffic on Tuggeranong Parkway
L9	1.2	Dam water release (Western foreshore)	73	72	71	Water noise dominant
L13	0.9	Dam water release (Eastern foreshore)	71	69	68	Water noise dominant
L14	1.4	Dam Water release (South dam offices)	69	67	66	Water noise dominant
L15	0.3	Dam water release (Public viewing platform)	69	67	66	Water noise dominant
M2	3.1	Molongo River (South of Dam 1)	68	65	64	Water noise dominant
M3	2.4	Molongo River (South of Dam 2)	65	62	62	Water noise dominant
M9	1.9	Jamala Lodge (Outside closest room)	66	65	65	Water noise dominant
M11	1.4	Jamala Lodge (Inside closest room)	50	41	40	A/C, exhaust fan and water noise (dam)

## 3 Project noise and vibration goals

---

### 3.1 The Consolidated National Capital Plan

These are areas of the ACT that have been identified as having special characteristics necessary for the National Capital. National functions include a range of uses and include the grounds surrounding Lake Burley Griffin, including Scrivener Dam and nearby potential affected areas. This is defined as the Lake Burley Griffin and Foreshores Precinct.

Within these Designated Areas the NCA has responsibility for determining detailed planning policy, and for providing approval for works. Governance of these areas is provided in The Consolidated National Capital Plan. This document states that NCA is required to assess any environmental impacts arising from the construction and maintenance activities, including any impacts concerning noise.

The stated nature of the environment of the Molonglo River area of the Lake Burley Griffin precinct is described to provide a quiet backwater for boating, fishing and birdwatching.

No other conditions relevant to noise appear to be contained within The Consolidated National Capital Plan.

---

### 3.2 ACT noise guidelines

Although not strictly applicable to this project, the ACT does provide provision for construction noise management in the following documents.

#### 3.2.1 ACT noise zone standards

The *Environment Protection Regulation (ACT) 2005 (EPR)* prescribes requirements designed to control or govern conduct regarding how the environment is impacted from activities and developments:

- Table 2.1 and Table 2.2 from Schedule 2 of the Regulation define noise zones and their associated noise standards. These noise standards apply to noise generated during **construction** and operation of a proposed development. Areas within Central National Area (Parliamentary Zone and Other Areas) are described as Zone C2.
- Once a noise zone has been identified according to the ACT Territory Plan and National Capital Plan, the Noise Standard for that zone is applicable as an upper limit.
- Zone C2 noise limits provide the following noise levels as their recommended upper limit:
  - Monday-Saturday 7 am–10 pm Sunday and public holiday 8 am–10 pm 55 dB L<sub>A10 T</sub>
  - Other times 45 dB L<sub>A10 T</sub>
- The following noise limits apply to residential areas (Zone G) :
  - Monday-Saturday 7 am–10 pm Sunday and public holiday 8 am–10 pm 45 dB L<sub>A10 T</sub>
  - Other times 35 dB L<sub>A10 T</sub>
- Section 8.2 of the *Noise Environment Protection Policy*, ACT states that these limits are to be measured as L<sub>A10 T</sub>, where ‘T’ is not less than 5 minutes or greater than 15 minutes.
- In assessing the noise impact at sensitive receivers, the EPR describes the compliance point as any point as near as practicable to the property boundary.

### 3.2.2 Exemptions

The Regulation incorporates certain clauses that provide relaxation or exemption from the standards for noise emitted during certain construction activities. The relevant clause for this development is summarised in Table 3.1.

Table 3.1 Noise exemptions – extract from Table 2.3, EPR

Item	Noise	Conditions
21	Noise emitted in the course of development <sup>(1)</sup> .	<ul style="list-style-type: none"> <li>— The noise is emitted from a place other than a place in noise zone A or B; and</li> <li>— The development will not be finished within 2 weeks after the day it started; and</li> <li>— All relevant noise reduction measures mentioned in AS2436, as in force from time to time, are implemented; and</li> <li>— The noise is emitted between 7 am and 6 pm on Monday to Saturday, excluding public holidays.</li> </ul>

If the listed conditions are met when carrying out the relevant activities, the associated noise is exempt from meeting the noise standards determined by the EPR.

### 3.2.3 Attention-drawing noise characteristics

Certain noise characteristics have a higher potential to cause annoyance, generally requiring additional considerations. Tonality, low frequency emphasis and intermittency are generally considered to be attention-drawing and can cause greater disturbance. On the other hand, short-term single noise events are likely to be less disturbing and may warrant relaxation of the noise criteria. To address these scenarios, the ACT *Noise Measurement Manual* prescribes specific modifying factors for the assessment of relevant noise events, as summarised in Table 3.2.

The potential application of these penalties are discussed in Section 4.4.1.

Table 3.2 ACT Noise Measurement Manual – modifying factor corrections

Factor	Assessment / measurement	When to apply	Correction (Applied to the measured / predicted level) <sup>1</sup>
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: <ul style="list-style-type: none"> <li>— 5dB or more if the centre frequency of the band containing the tone is above 400Hz.</li> <li>— 8dB or more if the centre frequency of the band containing the tone is 160 to 400Hz inclusive.</li> <li>— 15dB or more if the centre frequency of the band containing the tone is below 160Hz.</li> </ul>	+5dB <sup>2</sup>
Low-frequency noise	Measurement of C-weighted and A-weighted level	Measure to assess C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15dB or more.	+5dB <sup>2</sup>
Impulsive noise	A-weighted fast and impulsive response	If a difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2dB.	Apply difference in measured levels as the correction, up to a maximum of +5dB.
Intermittent noise	Subjectively assessed	Level varies by more than 5dB.	+5dB

Factor	Assessment / measurement	When to apply	Correction (Applied to the measured / predicted level) <sup>1</sup>	
			Night (10pm to 7am)	Day (7am to 10pm)
Duration	Single-event noise duration	One event in any 24-hour period, with duration as below.		
		1 to 2.5 hours	0	-2
		15 min to 1 hour	0	-5
		6 min to 15 min	-2	-7
		1.5 min to 6 min	-5	-15
		Less than 1.5min	-10	-20

(1) Where two or more modifying factors are present, the maximum correction is limited to 10dB.

(2) Where a source emits noise which has both tonal and low-frequency components, only one 5dB correction should be applied.

### 3.3 NSW Interim Construction Noise Guidelines (ICNG)

Beyond the exemptions summarised in Table 3.1 there is no available ACT guidance or policy for assessment of construction noise, and noise assessments are not normally prepared for construction works. Guidance for this assessment has therefore reference NSW Interim Construction Noise Guidelines (ICNG).

A quantitative assessment requires the development of noise management levels (NMLs). For residential receivers, there are based on existing rating background noise levels (RBLs), however for non-residential receivers, additional guidance is provided.

Table 3.3 Noise management levels for non-residential sensitive receivers

Noise Management Levels	
Land use	Management Noise Level (external) (When in use)
	$L_{eq,15min}$ dBA
Passive recreation areas	60
Active recreation areas	65
Commercial and industrial premises	70

Feasible and reasonable safeguards and management measures should be implemented where NMLs are exceeded either during or outside of recommended standard hours for construction work.

The ICNG also states the following:

*The proponent should assess construction noise levels for the project and consult with occupants of commercial and industrial premises prior to lodging an application where required.*

*During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.*

### 3.4 Potential noise impacts on fauna

Substantial variation has been shown in scientific studies in the responses of wildlife to human-generated noise, ranging from serious to non-existent in different species and situations. The risk of hearing damage to wildlife is considered to be

unlikely from this project and any potential impacts are likely to be limited to behavioural effects. Research has shown potential behavioural impacts are probably greater from exposure to very loud noises at close proximity than from long-term exposure to lower noise levels and that many impacts associated with noise are more pronounced when associated with the nearby presence of human activity.

High noise levels have been shown, particularly in some species of birds and frogs, to interfere with communication essential for reproduction. Noise may affect also behaviour by causing animals to retreat from favourable feeding habitat near noise sources, however these impacts are likely to be less relevant to animals within a zoo environment. Decreased responsiveness of wildlife after repeated noise events is frequently observed and usually attributed to habituation.

In fish, studies have shown that behavioural responses depend not only on the noise characteristics, but also on the context of the noise event (e.g. type of noise, location, school size, etc). For example, no response has been noted in fish exposed to high levels of sonar noise, however a stress response is produced in those same fish when predatory sounds (such as a killer whale song) are played.

It is understood that the National Zoo also houses nocturnal animals such as Sugar Gliders and owls. Sugar Gliders are housed within a dark house and as such are active during daytime hours. However Tawny Frogmouth Owls are naturally nocturnal and may be impacted by excessive levels of daytime noise, although it is likely that these animals have been habituated to human induced noise during daytime hours.

It is likely that most animal species within the project area and surrounds are already well habituated to periodic noise disturbance from human activity. It is also likely that noise from the construction activities will be moderate and steady in nature, rather than impulsive and at high levels – as such impacts from the Project are expected to be manageable with the implementation of effective mitigation measures.

### 3.5 Proposed project noise goals

In consideration of the guidance outlined above, and the existing noise levels within the zoo, the following preliminary noise goals are proposed for this work:

Table 3.4 Summary of noise sensitive receivers by receiver type

ID	Address	Suburb / Locality	Land use	Preliminary external noise goal dB L <sub>Aeq</sub> (15 minute)	Comments on derivation of goal
R1	National Zoo (Jamala Wildlife Lodge)	Weston	Accommodation	55	Zone C2 noise limits (due to its proximity to active recreational areas, taken as L <sub>Aeq</sub> instead of L <sub>A10</sub> )
R2	National Zoo (Lion)	Weston	Animal enclosure	65	ICNG (Active recreation) and in consideration of existing noise levels
R3	National Zoo (Leopard enclosure)	Weston	Animal enclosure	65	
R4	National Zoo (Monkeys enclosures)	Weston	Animal enclosure	65	
R5	National Zoo (Other accommodation)	Weston	Accommodation	55	Zone C2 noise limits (due to its proximity to active recreational areas, taken as L <sub>Aeq</sub> instead of L <sub>A10</sub> )



ID	Address	Suburb / Locality	Land use	Preliminary external noise goal dB L <sub>Aeq</sub> (15 minute)	Comments on derivation of goal
R6	National Zoo (Giraffe enclosures)	Weston	Animal enclosure	65	ICNG (Active recreation) and in consideration of existing noise levels
R7	National Zoo (Native animal enclosures)	Weston	Animal enclosure	65	
R8	National Zoo (Ostrich and wapiti enclosures)	Weston	Animal enclosure	65	
R9	Open waterfront recreational spaces	Molonglo River (south west)	Passive recreation	60	ICNG (Passive recreation in consideration of NCA Plan for Molonglo River)
R10	Scrivener Dam Offices	Scrivener Dam (east)	Office use	70	ICNG (Offices, commercial and industrial land use)
R11	Governor General residence (Workshops)	Yarralumla	Workshops	70	
R12	Governor General residence (Offices)	Yarralumla	Office use	70	
R13	Governor General residence (Outdoor recreational areas)	Yarralumla	Passive recreation	60	ICNG (Passive recreation in consideration of NCA Plan for Molonglo River)
R14	Governor General residence (Government house)	Yarralumla	Accommodation	50	Zone C2 noise limits (- 5dB due to its potentially sensitive landuse)
R15	Nearest residential areas of Curtin	Curtin	Residential	45	Zone G noise limits (standard hours)
R16	Nearest residential areas of Yarralumla	Deakin	Residential	45	

It should be noted that further consultation with National Zoo and Aquarium may refine these noise goals following the commencement of the project.

### 3.6 Vibration criteria

Criteria for the management of vibration from the rock drilling unit have been derived from guidelines set out in NSW Department of Environment and Conservation *Assessing Vibration: A technical guide, 2006* (AVTG). These guidelines establish the acceptable vibration values for human discomfort and have been reproduced in Table 3.5, which specifies ground vibration limits in terms of Peak Velocity measured in millimetres per second (mm/s). It should be noted that construction work is generally considered as an intermittent source of vibration, however continuous vibration presents a conservative assessment.

Table 3.5 Preferred and maximum vibration levels for continuous vibration

Location	Assessment period	Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.2	0.4
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Building damage vibration criteria are magnitudes larger than the human comfort guidelines and where these are met, there is no risk of building damage.

## 4 Noise and vibration measurements of rock drilling units

In order to investigate the potential noise and vibration impacts associated with the Project, the Client arranged for WSP to carry out noise and vibration measurements of drilling works that would be considered representative of the rock drilling units that will be used Scrivener Dam Dissipator Strengthening Project.

### 4.1 Measurement arrangement

A site visit to the Rutledge Drilling company site, was undertaken by WSP on the 15 November 2022 to measure the noise and vibration emissions from a rock drilling unit.

The rock drilling unit that was measured at the site was a compressed air driven mobile drilling rig, drilling 10 m deep holes into rock and soil conditions similar to Scrivener Dam, as illustrated in Figure 4.1.



Figure 4.1 Measured rock drilling unit

It should be noted that the drilling unit that was measured is not fully representative of the unit proposed for the Scrivener Dam Dissipator Strengthening Project. The proposed drilling rig for the Project is a hydraulic driven unit which is expected to produce noise emissions 5 to 10 dB lower than the compressed air driven drilling unit. Sound Power Level (SWL) emissions from the compressed air drilling unit will therefore present a conservative noise impact assessment for the Project.

## 4.2 Measurement methodology

### 4.2.1 Noise measurements

The total sound energy radiated by a noise source in all directions, is known as the sound power level (SWL), where the methodology to determine the SWL of a noise source from sound pressure level (SPL) measurements is specified in *International Standard ISO 3744:10 Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure— Engineering methods for an essentially free field over a reflecting plane (ISO 3744)*.

### 4.2.2 Vibration measurements

The Peak Velocity vibration at each measurement location was determined from the vibration levels measured in the vertical z-direction during the operation of the rock drilling unit.

## 4.3 Measurement setup

Noise and vibration measurements were undertaken at 10 m, 20 m and 30 m distances from the drill rig unit for a range of drilling depths from 0.25 m to 10 m.

The measurements were carried out at the Rutledge Drilling company site in Croftby, Queensland on Tuesday 15 November 2002 between 9:00 am and 02:30pm, where the meteorological conditions of the site included dry conditions, with minimal wind speeds.

All measurements during the generator noise and vibration tests were conducted with the equipment presented

Table 4.1 Noise and vibration measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration due
Sound Level Meter	Nti	XL2	A2A-05707-E0	30/04/2023
Sound and vibration analyser	SVAN	958A	36693	28/06/2024

All equipment used in the survey were calibrated by a NATA-approved laboratory and have current calibration certificates as required in AS1055:2018.

The monitoring equipment was fitted with a windshield and was field calibrated before and after the monitoring. No significant drifts in calibration ( $\pm 0.5$  dB) were noted.

## 4.4 Noise emissions

Details of the SWL noise emissions of the rock drilling unit, derived from the SPL measurements, is summarised in Table 4.2.

Table 4.2 Noise emission data of rock drilling unit

Measurement type	Noise emissions
Typical noise emissions of rock drilling unit	110 dBA SWL
Maximum noise emissions of rock drilling unit	115 dBA SWL

### 4.4.1 Modifying factors

Correction factors that may be applied to the measured noise levels to account for attention-drawing noise characteristics (refer Section 3.2.3) are discussed in the subsequent sections.

#### 4.4.1.1 Tonal noise

The SWL spectrum of the drilling unit, measured over the third-octave bands from 50 Hz to 5 kHz for typical noise emissions shown in Figure 4.2. The spectral noise of the drilling unit shows that the noise measurements do not contain a tonal characteristic. Therefore, the correction for tonality does not need to be applied to the measured drill unit noise levels.

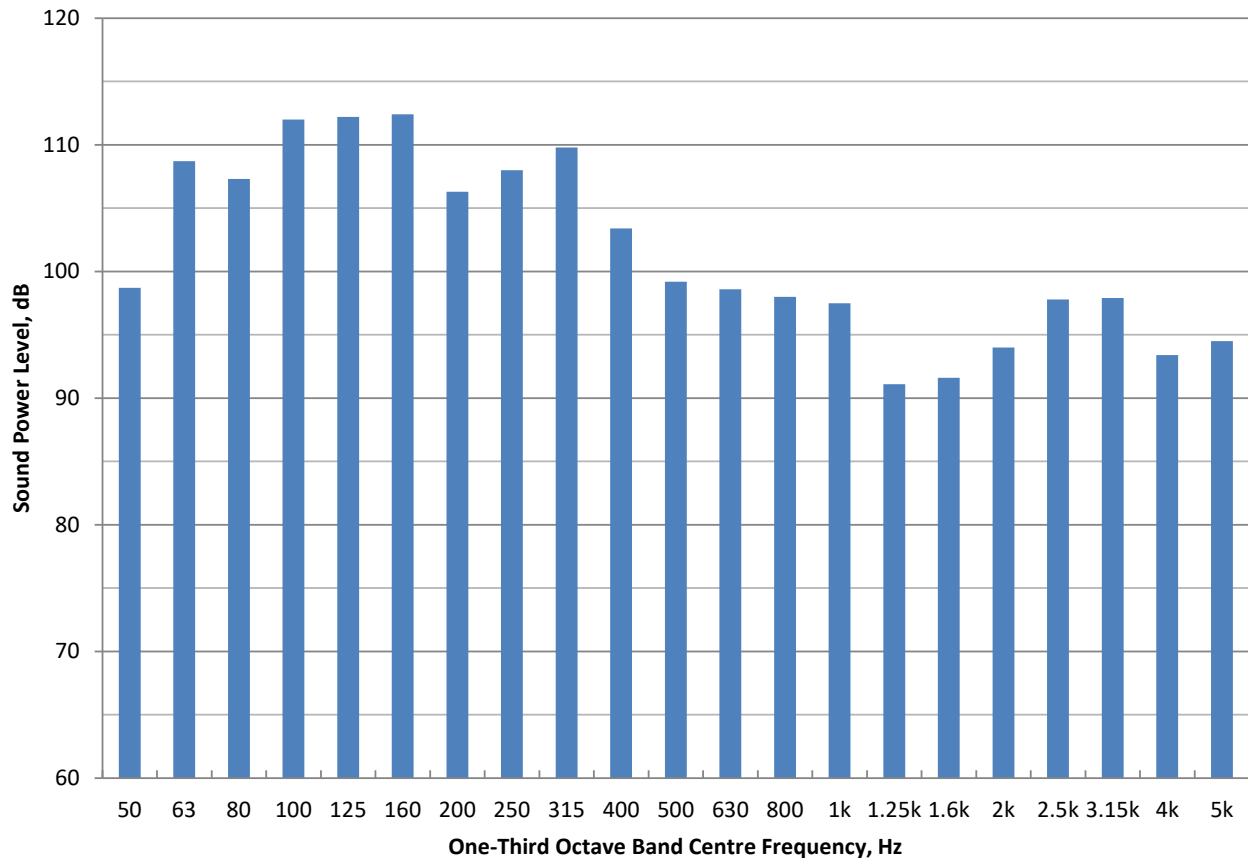


Figure 4.2 1/3 octave band sound power levels of rock drilling unit

#### 4.4.1.2 Low-frequency noise

Table 4.3 presents the measured C and A-weighted rock drilling unit noise levels, which shows that difference between the weighted noise levels is less than 15 dB. Therefore, no low-frequency noise correction is required to be applied to the drill unit noise levels.

Table 4.3 C and A-weighted measured drilling unit noise levels

Noise emissions	Measured $L_{Ceq,1min}$	Measured $L_{Aeq,1min}$	Difference
Typical	91 dB	82 dB	9 dB
Maximum	88 dB	87 dB	1 dB

#### 4.4.1.3 Impulsive noise

Table 4.4 presents the measured A-weighted maximum noise levels of the rock drilling unit, which shows that the difference between the fast response and impulse response is 2.5dB during normal operations. However this remains below the assessed ‘maximum’ SWL used in this assessment and as such no impulsive noise correction has been applied to the results of this assessment.

Table 4.4 A-weighted maximum noise levels

Noise emissions	Measured $L_{AF,max}$ (fast response)	Measured $L_{AI,max}$ (impulse response)	Difference	Corrected level $L_{Aeq,SWL}$
Typical	88 dB	90 dB	+ 2.5 dB	112.5 dB
Maximum	90 dB	92 dB	+ 1.3 dB	115 dB

## 4.5 Vibration measurements

### 4.5.1 Measurement results

The highest vibration levels determined from the operation of the rock drilling unit, measured in the vertical z-direction are shown in Table 4.5, which presents the maximum Peak Velocity vibration levels measured at the monitored distances from the drill rig unit.

Table 4.5 Z-axis Peak Velocity vibration levels from operation of the rock drilling unit

Measurement location	Measured maximum Peak Velocity level
~5 m from the drill rig unit	3.8 mm/s
~10 m from the drill rig unit	0.71 mm/s
~20 m from the drill rig unit	0.16 mm/s
~30 m from the drill rig unit	0.07 mm/s



## 5 Noise assessment

### 5.1 Modelling inputs

Noise modelling was conducted to determine the predicted level of operational noise at the identified noise sensitive receivers surrounding the proposal. Modelling was undertaken within SoundPLAN modelling software and utilised the following inputs.

Table 5.1 Noise modelling assumptions

Modelling element	Input/assumption/source reference
Noise Model	SoundPLAN (Version 8.2)
Ground elevation geometry	ACTmapi (September 2022, <a href="https://www.actmapi.act.gov.au/imagery.html">https://www.actmapi.act.gov.au/imagery.html</a> )
Ground absorption	40% soft ground for grass, wooded areas, and park land 0% for areas of water
Assessment standard	ISO9613-2:1996 noise prediction algorithm
Weather Conditions	Neutral meteorological conditions
Building footprints and heights	Derived from satellite and aerial imagery (ACTmapi, October 2022)
Receiver locations	Determined from aerial photography and on ground truthing
Drill Sound Power Level	115dBA

### 5.2 Model validation

The noise model used for the assessment was subjected to a validation process to ensure the accuracy of its noise predictions. The model validation process allows for the identification of any errors in the modelling setup and to demonstrate that the noise model accurately represents the existing, real-world conditions.

The validation process involved setting up a noise model using the determined sound power levels of water releases from the dam sluice pipes that were underway at the time of attended noise monitoring (outlined in Section 2.2). This monitoring provided a monitored noise level of 72 dBA at a distance of 46m, which corresponds to a Sound Power Level of approximately 109 dBA.

Noise predictions for the water release were modelled for monitoring sites locations where an accurate indication of the water release noise level could be determined. If the results from the model are within approximately 2dB then it is assumed that the model is accurate to real world operation of the site and can be used for predicting noise levels from future scenarios.

Table 5.2 Results of noise model validation

ID	Location	L <sub>Aeq</sub> (period) dBA		
		Predicted noise level	Measured noise level	Difference
L9	Dam water release (western foreshore)	64.0	65.0	-1.0
L13	Dam water release (eastern foreshore)	70.1	72.0	-1.9
L14	Dam Water release (South Dam Offices)	70.4	69.0	1.4

ID	Location	L <sub>Aeq</sub> (period) dBA		
		Predicted noise level	Measured noise level	Difference
L15	Dam water release (public viewing platform)	65.9	67.0	-1.1
M2	Molongo River (South of Dam 1)	65.6	67.0	-1.4
M3	Molongo River (South of Dam 2)	63.9	64.7	-0.8
M9	Jamala Lodge (Outside closest room)	63.3	62.3	1.0
Median difference				-1.1
Standard deviation				1.2

The validation results show that the modelled noise levels are within +/- 2dB at each location assessed and as such the model is considered validated. The noise model is considered representative of actual operational noise levels.

### 5.3 Predicted operational noise levels

This section presents the predicted noise levels and potential noise impacts during the operation of the drill rig, which is expected to be the loudest equipment proposed for use on the site. The unit was modelled at the eastern and western ends of the dissipator to provide an indication of the likely range of maximum noise levels at each receiver.

Potential operational noise impacts were determined against the preliminary noise goals outlined in Section 3.5.

The results of this assessment are presented below in Table 5.3 and graphically in Appendix A.

Table 5.3 Predicted drilling noise levels

Receiver ID	Receiver	Suburb / locality	Project noise goal L <sub>Aeq,15 min</sub> dBA	Predicted maximum operational noise levels dBA L <sub>Aeq,15 min</sub> <sup>1</sup>		Potential Risk of noise impacts
				Eastern drill site	Western drill site	
R1	National Zoo (Jamala Wildlife Lodge)	Weston	55	63	62	Moderate
R2	National Zoo (Lion)	Weston	65	59	58	Nil <sup>2</sup>
R3	National Zoo (Leopard enclosure)	Weston	65	62	61	Nil <sup>2</sup>
R4	National Zoo (Monkeys enclosures)	Weston	65	51	46	Nil <sup>2</sup>
R5	National Zoo (Other accommodation)	Weston	55	57	55	Low
R6	National Zoo (Giraffe enclosures)	Weston	65	57	56	Nil <sup>2</sup>
R7	National Zoo (Native animal enclosures)	Weston	65	50	50	Nil
R8	National Zoo (Ostrich and wapiti enclosures)	Weston	65	52	52	Nil
R9	Open waterfront recreational spaces	Molonglo River (south west)	41	45	38	Low
R10	Scrivener Dam Offices	Scrivener Dam (east)	70	67	62	Nil
R11	Governor General residence (Workshops)	Yarralumla	70	41	45	Nil
R12	Governor General residence (Offices)	Yarralumla	70	38	37	Nil
R13	Governor General residence (Outdoor recreational areas)	Yarralumla	60	31	31	Nil
R14	Governor General residence (Government house)	Yarralumla	50	26	25	Nil
R15	Nearest residential areas of Curtin	Curtin	45	< 35	< 35	Nil
R16	Nearest residential areas of Yarralumla	Yarralumla	45	< 35	< 35	Nil

- (1) Based on the maximum noise emissions of rock drilling unit
- (2) Ongoing consultation with National Zoo and Aquarium is recommended.

## 5.4 Discussion

This assessment presents a conservative consideration of potential drilling noise during the proposed works. The actual drill unit is likely to be 5-10 dB quieter than the assessed unit (refer Section 4.1). In addition, the maximum monitored noise levels have been modelled, typical drilling noise was 5dB below these levels. As such, it would be reasonable to assume to actual drilling noise may be in the order of 10dB below these predicted levels.

The results of this maximum noise modelling shows that noise impacts may occur during these works. However it is important to note that as described in Section 3.2.2, where the noise is generated under the following conditions, no noise criteria apply to the work:

*Noise emitted in the course of maintaining or repairing something; and*

**a** *the noise is emitted:*

**i** *between 7 am and 8 pm on Monday to Saturday; or*

**ii** *between 8 am and 8 pm on Sunday or a public holiday; and*

**b** *any noise exceeding a zone noise standard is emitted for periods totalling not more than 40 hours in any 8-week period; and*

**c** *the equipment used is maintained and operated in accordance with the*

The following observations are made in reference to the results outlined in Table 5.3.

### 5.4.1 National Zoo

The primary noise risks during the work have been identified as likely to occur at accommodation locations within the Zoo. This area is the closest receiver to the dam and several rooms directly overlook the dam itself. Construction of the rooms is generally sound and a reduction of approximately 15 to 20dB is predicted to occur from inside to outside. This may lead to internal noise levels from the dam works of approximately 40 to 50dB.

*AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors* is commonly used to consider the suitability of interior noise levels for a range of building uses. The document does not contain recommended levels for hotel rooms during daytime hours, however outlines a design sound level range for living areas of residential buildings that are located near major roads, to be between 35 – 45dB  $L_{Aeq}$ . The predicted noise levels may be marginally higher than this, however as construction noise is a temporary impact, these levels are expected to be manageable with moderate noise mitigation measures. However impacts may be noted at the start and end of work shifts, during which times accommodation guests are likely to be residing in their rooms.

The impact of noise on animals within the Zoo is largely unknown at this stage. Predicted noise levels are likely to be within the normal range of noise levels currently experienced by the animals. However existing noise sources are highly variable, and the consistent nature of the drilling noise may impact animals in different ways.

The highest noise levels for animal enclosures have been predicted for enclosures in the northern areas of the Zoo, in particular around the Lions and Snow Leopards. It is recommended that the behaviour of these animals is carefully observed during preliminary testing and early phases of the work to identify any behavioural changes.

### 5.4.2 Government House (Yarralumla)

Construction will be audible at Government House but notable noise impacts are expected unlikely based on the nominated project goals. However some events at the Government House may require low levels of background noise (for example to allow speeches during formal functions, etc) and management recommendations have been provided in Section 6.

Noise impacts at other working areas of Government House are considered unlikely.

#### *5.4.3 Recreational areas*

Noise impacts are not expected to occur at waterfront recreational areas north of the Scrivener Dam, where predicted noise levels are well below the proposed project noise goals.

However noise levels at recreational waterfront areas south of the dam are expected to extend approximately 200m south of the dam wall along the Molonglo River.

#### *5.4.4 Residential suburban areas*

The suburbs of Curtin and Yarralumla are the most affected residential areas. Noise impacts in these suburbs are expected to remain below existing background noise levels and are likely to be inaudible at most times.

No exceedances of noise goals have been predicted to occur at any other locations.

## 6 Vibration assessment

### 6.1.1 Vibration assessment

The vibration levels recorded during the operation of the rock drilling unit and presented in Section 4.5 have been assessed against the recommended vibration criteria for residential areas during daytime hours (refer Section 3.6), which is considered the most onerous vibration target for the Project.

Table 6.1 Z-axis Peak Velocity vibration levels from operation of the rock drilling unit

Measurement location	Measured maximum Peak Velocity level	Peak Velocity target	Vibration target met?
~5 m from the drill rig unit	3.8 mm/s	0.28 mm/s	No
~10 m from the drill rig unit	0.71 mm/s	0.28 mm/s	No
~20 m from the drill rig unit	0.16 mm/s	0.28 mm/s	Yes
~30 m from the drill rig unit	0.07 mm/s	0.28 mm/s	Yes

### 6.1.2 Discussion

The results of the vibration measurements show that the target for the maximum permissible Peak Velocity vibration level for residential areas are greater than these targets within 10 m from the drill rig unit. The measurements show that the emitted vibration levels from the unit diminish rapidly as the distance from the unit increases.

As the closest sensitive receiver is approximately 40 m from the dam dissipater (Scrivener Dam Offices), the risk of vibration generated from rock drilling unit to cause a disturbance to adjacent sensitive receivers is considered low. There is considered to be no risk of building damage.



# 7 Simulated noise impact testing

---

## 7.1 Introduction

Due to the highly variable nature of faunal responses to noise and the lack of robust information available on the potential impact of construction noise on captive wildlife, NCA commissioned WSP to undertake simulated testing of the proposed works at areas of the National Zoo.

The aims of this monitoring were to observe animal behavior to the predicted noise levels under controlled conditions and to provide zoo staff with an understanding of actual predicted noise levels and how they may be perceived within the site.

---

## 7.2 Methodology

The simulated work was undertaken at relevant noise sensitive areas of the National Zoo and in the presence of qualified Zoo staff. The following methodology was employed for the testing.

- 1 Potentially noise sensitive monitoring locations were identified by zoo representatives
- 2 A recording of the drill unit was played at each noise sensitive location through speakers at the operational noise level predicted in Table 5.3. The predicted level of animal exposure was correlated with a calculated speaker volume and confirmed using a NTi XL2 Sound Level Meter (S/N A2A-05718-EO), independently calibrated by a NATA accredited laboratory on 10 November 2021 and next due for calibration before 10 November 2023
- 3 Observations of animal behaviour were noted and agreed by both project and zoo representatives
- 4 Monitoring was conducted until the zoo representative was satisfied that impacts were unlikely to increase.

An example of the monitoring configuration is provided in Figure 7.1.



Figure 7.1 Simulated noise exposure configuration

---

## 7.3 Observations

Testing parameters and observation notes have been presented below in Table 7.1.

Table 7.1 Simulated drilling observations

Receiver ID	Receiver	Simulated noise level dBA <sup>1</sup>	Notes / observations	Potential Risk of noise impacts
R1	Jamala Wildlife Lodge Pool / front apartment	63	Simulated noise during this test was not substantially louder than existing background noise from the dam release water. Although drilling noise would be clearly audible at external spaces, it was agreed that there was a low likelihood of substantial impacts.	Low
R1	Jamala Wildlife Lodge Dining room / adjacent external spaces	63	External spaces: Simulated noise during this test was not substantially louder than existing background noise from the dam release water. Although drilling noise would be clearly audible at external spaces, it was agreed that there was a low likelihood of substantial impacts.  Internal spaces: A reduction of approximately 16dB was monitored at internal spaces. Although the drilling noise was audible in the lack of other noise sources, it was well below the existing levels of background noise and it was agreed that there was a low likelihood of substantial impacts.	Unlikely
R2	Lion enclosure (eastern)	59	At the commencement of testing, the 2 lions in this enclosure were generally sleeping or relaxing in a reclined position. When the simulation began, both lions stood up and appeared curious, watching the testing group intently. During this time, they were relatively immobile and alert. Within 2 minutes, both lions appeared relaxed and had resumed their previous behaviour.  It was agreed that there was a low likelihood of substantial impacts.	Unlikely
R2	Lion enclosure (southern)	59	At the commencement of testing, the 4 lions in this enclosure were generally sleeping or relaxing in a reclined position. When the simulation began, both lions stood up and appeared curious, watching the testing group intently. During this time, they were relatively immobile and alert. Within 2 minutes, both lions appeared relaxed and had resumed their previous behaviour.  It was agreed that there was a low likelihood of substantial impacts.	Unlikely

Receiver ID	Receiver	Simulated noise level dBA <sup>1</sup>	Notes / observations	Potential Risk of noise impacts
R5	Alternative accommodation	57	Simulated noise during this test was not substantially louder than existing background noise from the dam release water. Drilling noise may be audible at external spaces during periods of low background noise, however, it was agreed that there was a low likelihood of substantial impacts.	Nil
R6	Giraffe enclosure	57	At the commencement of testing, one of the 2 giraffes (and 2 zebras) in this enclosure appeared curious, approaching the noise source cautiously and watching the testing group intently. During this time, one giraffe was relatively immobile and alert. No response was observed in the other giraffe or either zebra. Within approximately 3 minutes, the giraffe appeared to be resuming normal behaviour.  It was agreed that there was a low likelihood of substantial impacts.	Unlikely
R8	Zebra enclosure	52	At this location, the simulated noise was not substantially louder than existing background noise levels. Although the zebras in this enclosure did notice the noise and look up as it reached maximum volume, no other reaction was observed and they resumed their normal behaviour almost immediately.	Nil

1 Refer Table 5.3

# 8 Recommendations

---

## 8.1 Background

Preliminary noise predictions outlined in Section 5 indicate that noise impacts may occur at accommodation areas throughout the Zoo and at animal enclosures located in the northern areas of the Zoo. Although no notable impacts have been identified as likely to occur at Government House based on the ICNG noise goals, given the particularly sensitive nature of some activities, management measures should be considered.

Simulated noise testing of drilling activities showed that the predicted noise levels are unlikely to generate significant behavioural impacts for fauna at the zoo, however ongoing observations should be maintained to confirm long term impacts do not arise.

This assessment has considered potential noise and vibration impacts associated with the rock drill, which is expected to be the loudest equipment on site, however additional plant will be involved with works and should be considered.

---

## 8.2 Noise management and mitigation

Noise management measures are likely to be required and these will be finalised in future stages of the study, prior to the commencement of construction activities. However effective measures to be considered may include the following:

- Work during 7 am and 6 pm on Monday to Saturday, excluding public holidays (per time restrictions to qualify for the exemption).
- Stakeholder consultation:
  - To determine upcoming events at the Zoo and Government House and their potential sensitivity to noise
  - To track any animal behavioural changes and determine additional and acceptable mitigation measures
- Consideration of respite periods or shutdowns during particularly sensitive time periods
- Discussion of noise management measures with hotel guests. This may include closing of doors and windows and not remaining in rooms for extended periods during works.
- Localised noise screens around noisy plant (where acoustic effectiveness can be demonstrated prior)
- Site inductions for construction staff to include information about noise impacts and management measures
- Noise monitoring of construction works and at receiver locations at the commencement of operations and in response to noise complaints.

Prior to the finalisation of this assessment, the following actions are recommended to assist with accurate determination of potential noise impacts and the identification of reasonable and feasible noise management measures and controls.

- The preparation of a Construction Noise and Vibration Management Plan to consider likely noise and vibration impacts and required management measures following the development of detailed construction methodology
- The consideration of a later start time for construction works to reduce impacts at Zoo accommodation areas
- Consider if quieter construction methods are viable, particularly alternatives to hammer drilling. Likewise use the smallest suitable equipment on site.
- Sound Power Level testing of the proposed drilling equipment should be undertaken to ensure modelling inputs are accurate
- Precise work areas and a full equipment list should be developed to determine potential total noise impacts

- Noise monitoring and simultaneous animal observations should be undertaken within the Zoo in response to any reasonable concerns raised by authorised Zoo representatives
- Potential noise impacts should be considered when planning worksite layout (in particular noisy areas such as compounds, stockpiles, laydowns, etc)
- Alternatives to reversing / warning beepers (broadband alarms, cameras, etc) should be installed on all on site equipment.

## 9 Limitations

This Report is provided by WSP Australia Pty Limited (WSP) for the NCA (Client) in response to specific instructions from the Client and in accordance with WSP's proposal dated 31 August 2022 and agreement with the Client dated 8 September 2022 (Agreement).

---

### 9.1 Permitted purpose

This Report is provided by WSP for the purpose described in the Agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (Permitted Purpose).

---

### 9.2 Qualifications and assumptions

The services undertaken by WSP in preparing this Report were limited to those specifically detailed in the Report and are subject to the scope, qualifications, assumptions and limitations set out in the Report or otherwise communicated to the Client.

Except as otherwise stated in the Report and to the extent that statements, opinions, facts, conclusion and / or recommendations in the Report (Conclusions) are based in whole or in part on information provided by the Client and other parties identified in the report (Information), those Conclusions are based on assumptions by WSP of the reliability, adequacy, accuracy and completeness of the Information and have not been verified. WSP accepts no responsibility for the Information.

WSP has prepared the Report without regard to any special interest of any person other than the Client when undertaking the services described in the Agreement or in preparing the Report.

---

### 9.3 Use and reliance

This Report should be read in its entirety and must not be copied, distributed or referred to in part only. WSP will not be responsible for interpretations or conclusions drawn by the reader.

WSP is not (and will not be) obliged to provide an update of this Report to include any event, circumstance, revised Information or any matter coming to WSP's attention after the date of this Report. Data reported and conclusions drawn are based solely on information made available to WSP at the time of preparing the Report. The passage of time; unexpected variations in ground conditions; manifestations of latent conditions; or the impact of future events (including (without limitation) changes in policy, legislation, guidelines, scientific knowledge; and changes in interpretation of policy by statutory authorities); may require further investigation or subsequent re-evaluation of the Conclusions.

This Report can only be relied upon for the Permitted Purpose and may not be relied upon for any other purpose. The Report does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise. It is the responsibility of the Client to accept (if the Client so chooses) any Conclusions contained within the Report and implement them in an appropriate, suitable and timely manner.

In the absence of express written consent of WSP, no responsibility is accepted by WSP for the use of the Report in whole or in part by any party other than the Client for any purpose whatsoever. Without the express written consent of WSP, any use which a third party makes of this Report or any reliance on (or decisions to be made) based on this Report is at the sole risk of those third parties without recourse to WSP. Third parties should make their own enquiries and obtain independent advice in relation to any matter dealt with or Conclusions expressed in the Report.



## 9.4 Disclaimer

No warranty, undertaking or guarantee whether expressed or implied, is made with respect to the data reported or the Conclusions drawn. To the fullest extent permitted at law, WSP, its related bodies corporate and its officers, employees and agents assumes no responsibility and will not be liable to any third party for, or in relation to any losses, damages or expenses (including any indirect, consequential or punitive losses or damages or any amounts for loss of profit, loss of revenue, loss of opportunity to earn profit, loss of production, loss of contract, increased operational costs, loss of business opportunity, site deprecation costs, business interruption or economic loss) of any kind whatsoever, suffered on incurred by a third party.

# Appendix A

## Rock drilling noise contour maps







R9 Open waterfront recreational spaces

R1 Jamala Wildlife lodge (National Zoo)

R3 National Zoo (Leopard enclosure)

R2 National Zoo (Lion enclosure)

R10 Scrivener Dam Offices

R12 Governor General residence (Offices)

R13 Governor General residence (Outdoor recreational areas)

R14 Governor General residence (Government house)

R5 National Zoo (Other accommodation)


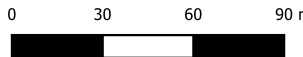













R4 National Zoo (Monkeys enclosures)

R11 Governor General residence (Workshops)

R6 National Zoo (Giraffe enclosures)

R8 National Zoo (Ostrich and wapiti enclosures)

R7 National Zoo (Native animal enclosures)

Map: Western drill site	Author: MT		 1:2,500 at A3	<b>Predicted operational noise level dBA Leq, 15 min</b>			<b>Legend</b>  Noise Sensitive Receivers  Receiver most at risk of noise impacts  Building	<b>Scrivener Dam Dissipator Strengthening Project</b> Western drill side 
Date: 21/12/2022	Approved by:			 >80  75-80  70-75	 65-70  60-65  55-60	 50-55  45-50  40-45		

To be read in conjunction with WSP document: PS133986-BI-NC ACO-REP-3  
Map Source: NSW SIX Maps  
© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it is supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCS Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.





R9 Open waterfront recreational spaces

R1 Jamala Wildlife lodge (National Zoo)

R3 National Zoo (Leopard enclosure)

R2 National Zoo (Lion enclosure)

R10 Scrivener Dam Offices

R12 Governor General residence (Offices)

R13 Governor General residence (Outdoor recreational areas)

R14 Governor General residence (Government house)

R5 National Zoo (Other accommodation)

R4 National Zoo (Monkeys enclosures)

R11 Governor General residence (Workshops)

R6 National Zoo (Giraffe enclosures)


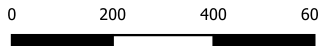




























R8 National Zoo (Ostrich and wapiti enclosures)

R7 National Zoo (Native animal enclosures)

Map: Eastern drill site	Author: MT		0 30 60 90 m	<b>Predicted operational noise level dBA Leq, 15 min</b> >80 65-70 50-55 75-80 60-65 45-50 70-75 55-60 40-45			<b>Legend</b> ● Noise Sensitive Receivers ● Receiver most at risk of noise impacts ■ Building		<b>Scrivener Dam Dissipator Strengthening Project</b> Eastern drill side 
Date: 21/12/2022	Approved by:						1:2,500 at A3		
To be read in conjunction with WSP document: PS133986-BI-NC ACO-REP-3 <small>Map Source: NSW SIX Maps</small> <small>© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it is supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCS Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.</small>									


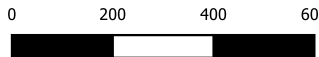




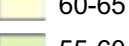
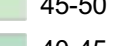







Map: Impact on suburbs Western drill	Author: MT			<p><b>Predicted operational noise level dBA Leq, 15 min</b></p> <table border="0"> <tr> <td> &gt;80</td> <td> 65-70</td> <td> 50-55</td> </tr> <tr> <td> 75-80</td> <td> 60-65</td> <td> 45-50</td> </tr> <tr> <td> 70-75</td> <td> 55-60</td> <td> 40-45</td> </tr> </table>	 >80	 65-70	 50-55	 75-80	 60-65	 45-50	 70-75	 55-60	 40-45	<p><b>Scrivener Dam Dissipator Strengthening Project</b> Impact on suburbs Western drill side</p> 
 >80	 65-70		 50-55											
 75-80	 60-65	 45-50												
 70-75	 55-60	 40-45												
Date: 21/12/2022	Approved by:	1:15,000 at A3	<p><a href="http://www.wsp.com">www.wsp.com</a></p>											
<p>To be read in conjunction with WSP document: PS133986-BI-NC ACO-REP-3 Map Source: NSW SIX Maps</p> <p><small>© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it is supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCS Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.</small></p>														





Map: Impact on suburbs Eastern drill	Author: MT			<b>Predicted operational noise level dBA Leq, 15 min</b>			<b>Scrivener Dam Dissipator Strengthening Project</b> Impact on suburbs Eastern drill side
Date: 21/12/2022	Approved by:		1:15,000 at A3	 >80	 65-70	 50-55	
To be read in conjunction with WSP document: PS133986-BI-NC ACO-REP-3 <small>Map Source: NSW SIX Maps</small>			 75-80	 60-65	 45-50	www.wsp.com	
<small>© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it is supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCS Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.</small>			 70-75	 55-60	 40-45		