Multiplex

NEXTDC S4

Construction Noise and Vibration Management Plan

January 2026

For internal use

Question today
Imagine tomorrow
Create for the future

NEXTDC S4
Construction Noise and Vibration Management Plan

Multiplex

WSP
Level 11, 567 Collins St
Melbourne VIC 3000

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

Rev	Date	Details
1	09/12/25	Initial Draft
2	16/01/26	Issue
3	22/01/26	Issue revised

	Name	Date	Signature
Prepared by:	Liam Farrugia	22/01/26	
Reviewed by:	Camilo Chalela	22/01/26	
Approved by:	Ben Ison	22/01/26	

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.

Table of contents

Glossary

Assessment period	The period in a day over which assessments are made.
Background noise	The underlying level of noise present in ambient noise, generally excluding the noise source under investigation, when extraneous noise is removed. This is commonly described using the L_{AF90} descriptor.
Decibels (dB)	The level of noise is measured objectively using a sound level meter. The range of pressure variations associated with everyday living may span over a range of a million to one. Instead of expressing pressure in this enormous range of unit, it is convenient to condense this range to a logarithmic scale and give it the units of decibels.
dBA: A-weighted decibels	A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear. Most environmental noise is measured using the 'A' filter. The correction methodology is outlined in IEC61672-2:2013 Electroacoustics – Sound Level Meters – Part 2: Pattern evaluations tests.
dBC: C-weighted decibels	C-weighting is an adjustment made to sound-level measurement which is better suited for the assessment of low frequency noise. The correction methodology is outlined in IEC61672-2:2013 Electroacoustics – Sound Level Meters – Part 2: Pattern evaluations tests.
Frequency	The time rate for each wave peak (of a sound wave) to pass a given point. Subjectively frequency is the pitch of noise and is measured in hertz (Hz).
L_{90}	The level of noise exceeded for 90% of the time for which a given sound is measured. The L90 noise level expressed in units of dB and is commonly used to describe the level of background noise.
L_{eq}	Equivalent sound pressure level – the steady sound level that, over a specified period of time, will produce the same energy equivalence as the fluctuating sound level actually occurring.
L_{Max}	The maximum noise level during a specified period implementing a fast time constant.
Rating Background Level (RBL)	The median value of the ABLs during each assessment period (day/evening/night) over the whole duration of monitoring period. This level is considered for the calculation of criterion under Queensland legislation.

1 Introduction

Multiplex has engaged WSP Australia Pty Ltd (WSP) to provide a Construction Noise and Vibration Management Plan (CNVMP) for the proposed NEXTDC S4 data centre development located at 16 Johnston Crescent, Horlsey Park, NSW (the Project).

This report considers the potential noise and vibration impacts that may be associated with the construction of the Project, identifies any potential noise and vibration risk, and provides high level recommendations of mitigation and management options.

1.1 Project description

NEXTDC has commissioned Multiplex to construct the following:

- Four 4-storey data centre buildings (A, B, C and D) which will include 2 data halls, plant rooms and office areas
- Security Office centre (SOC) building
- Above ground diesel and water storage tanks.

The Project will also include the following components which will be constructed by Transgrid and as such these are outside the scope of this CNVMP:

- HV Switching building
- 330 kV substation

1.2 Purpose of this plan

This CNVMP aims to achieve the following:

- Identify the relevant legislative requirements
- Identify potential noise impacts and sensitive receivers associated with the project
- Identify potential vibration impacts associated with the project
- Outline systems and management measures to reduce or eliminate identified noise or vibration impacts
- Outline the responsibilities of those involved in the control of noise and vibration impacts
- Outline an effective monitoring, auditing and reporting framework to assess the effectiveness of the controls implemented.

1.3 Reference documentation

- Aurecon, NEXTDC S4, Noise and Vibration Assessment, Revision H, Ref: P521243, 1 May 2025 (SSDA Noise and Vibration Assessment)
- Multiplex, NEXTDC S4 Stage 1 Phase 1 Construction Management Plan, Revision 3, 19 November 2025 (CMP)
- Multiplex, NEXTDC S4 Stakeholder and Communications Management Plan, Draft version, November 2025 (SCMP)

1.4 Relevant Guidelines

The following guidelines apply to the management of noise and vibration impacts from construction works in NSW:

- Approved methods for the measurement and analysis of environmental noise in NSW (Environmental Protection Authority, 2022)
- Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) (ICNG)
- Road Noise Policy (Department of Climate Change and Water, 2011) (RNP)
- Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) (AVTG)
- Construction Noise and Vibration Guideline (for roads and maritime works) (Transport for NSW, 2022) (CNVG)
- Noise Policy for Industry (NSW Environmental Protection Authority, 2017) (NPfI)
- *Australian Standard – Guide to noise and vibration control on construction, demolition and maintenance sites (AS 2436, 2010)*
- *British Standard BS 5228-1: Code of practice for noise and vibration control on construction and open sites. Part 1: Noise (BS 5228-1, 2014)*
- *German Standard DIN 4150-3 Structural Vibration – Part 3: Effects of vibration on structures (DIN4150-3, 1999)*
- *ISO 9613:2024 Acoustics – Attenuation of sound during propagation outdoors (ISO 9613)*
- Sydney Water Specialist Engineering Assessment Procedure, Version 1, February 2021 (SEAP)
- Sydney Water Technical Guideline – Building over and adjacent to pipe assets, October 2025 (SWTG)
- NEXTDC S4 – Program WOAP, December 2025

1.5 Staff qualification

All WSP staff involved with the preparation of this report are considered ‘suitably qualified’ through:

- Membership of the Australian Acoustical Society (AAS), and/or
- Being based in locations that hold membership of the Association of Australasian Acoustical Consultants (AAAC).

These personnel have completed other Construction Noise and Vibration Management Plans (CNVMP) and undertaken associated activities that have been endorsed previously by the NSW Environment Protection Authority (EPA).

2 Existing environment

2.1 Study area

The noise study area is provided in Figure 2.1, which includes the location of NEXTDC site, background noise monitoring locations, and representative sensitive receivers. The extent of the study area is based on the limits of potential construction noise impacts.

The Project is located in a semi-industrial area adjacent to farmland, approximately 2.5 km to the northeast of the township of Horsley Park and located in the Fairfield Local Government Area (LGA). Existing noise conditions in the surrounding area are typically very quiet and characterised by operational and local traffic noise from nearby industrial sites, distant road traffic and natural environmental noise (such as wind and wildlife).

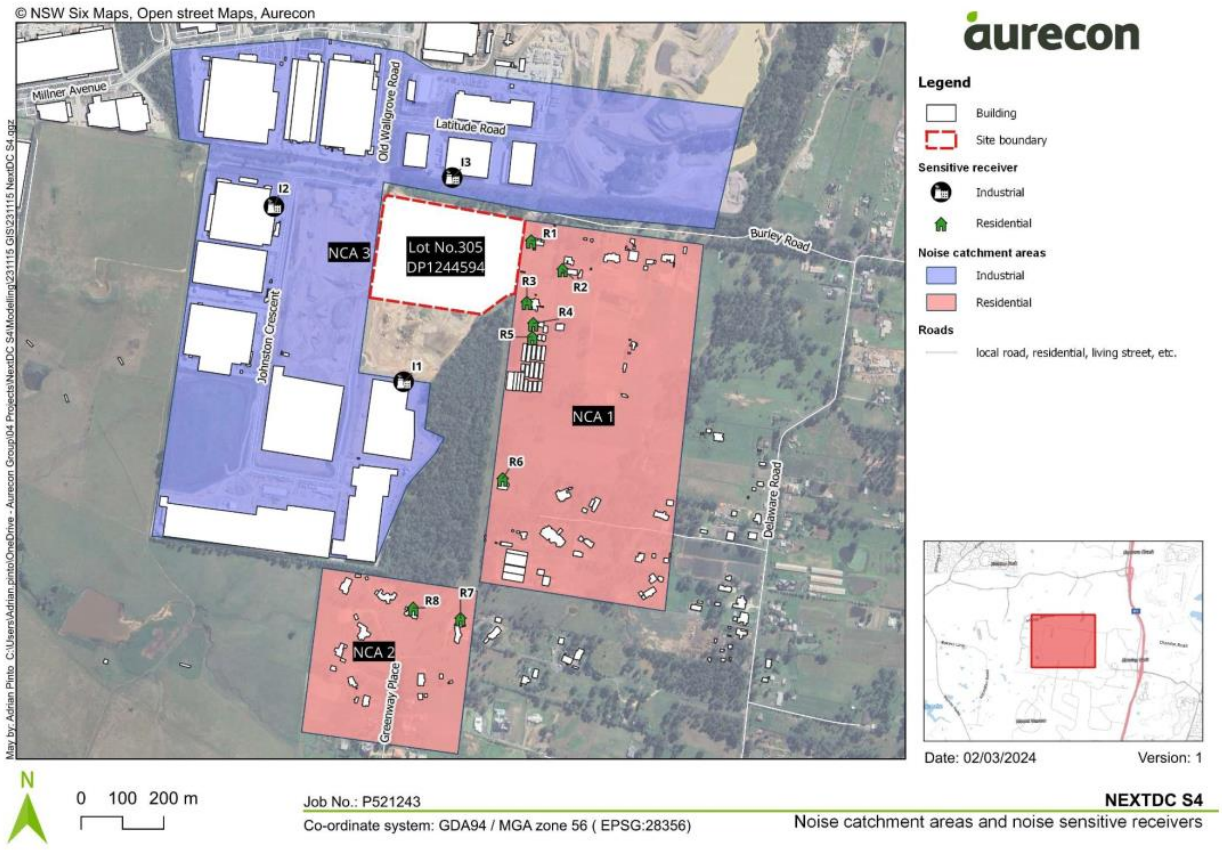

Figure 2.1 Noise catchment areas and nearest sensitive receivers (Source: Aurecon Report: S4-ACO-AUR-REP-0000-0000-NVA-SPC-H Figure 4-2)

2.2 Noise sensitive receivers

The SSDA Noise and Vibration Assessment identified 11 representative noise sensitive receivers surrounding the Project and separated these into Noise Catchment Areas (NCAs) based on similar land use and ambient noise environment.

These are listed in Table 2.1.

Table 2.1 Representative noise sensitive receivers

NCA	ID	Address	Receiver Category	Distance to receiver from closest edge of Project footprint (m)
NCA1	R1	321-325 Burley Rd, Horsley Park NSW 2175	Residential (Rural)	21
	R2	285 Burley Rd, Horsley Park NSW 2175	Residential (Rural)	102
	R3	315-319 Burley Rd, Horsley Park NSW 2175	Residential (Rural)	35
	R4	301-313 Burley Rd, Horsley Park NSW 2175	Residential (Rural)	95
	R5	301-313 Burley Rd, Horsley Park NSW 2175	Residential (Rural)	120
	R6	253-255 Delaware Rd, Horsley Park NSW 2175	Residential (Rural)	403
NCA2	R7	49-53 Greenway Pl, Horsley Park NSW 2175	Residential (Rural)	742
	R8	47-48 Greenway Pl, Horsley Park NSW 2175	Residential (Rural)	726
NCA3	I1	12 Johnston Cres, Horsley Park NSW 2175	Industrial	192
	I2	2 Johnston Cres, Horsley Park NSW 2175	Industrial	262
	I3	2 Latitude Dr, Horsley Park NSW 2175	Industrial	73

2.3 Vibration sensitive receivers

Vibration sensitive receivers include all regularly occupied buildings, utilities and sensitive structures within the study area. At sufficient levels, vibration can lead to cosmetic (and possibly structural) building damage as well as disturbance to occupants (human comfort). All identified noise sensitive receivers are also considered potentially vibration sensitive.

Vibration can also affect sensitive structures such as heritage listed buildings and underground utilities. Whilst it is understood that no heritage items have been identified in the area surrounding the project, there are buried Sydney Water assets located within close proximity to the northwest corner of the Project site. Impacts onto these will have to assessed.

2.4 Existing noise environment

A summary of noise measurements conducted within the study area on 5 till 12 December 2023 is used as the basis for deriving noise criteria, as documented in the SSDA Noise and Vibration Assessment, is presented below in Table 2.2.

Table 2.2 Summary of noise measurement results

Location	Rating background noise (RBL)[1,2] $L_{A90(period)}$dB			Average noise level[2] $L_{Aeq(period)}$dB		
	Day	Evening	Night	Day	Evening	Night
NCA 1	37	38	39	53	49	47
NCA 2	35	39	38	66	57	60

Note 1: RBL is the median of the measured L_{A90} noise level for each date during the day, evening, and night-time periods of the monitoring programme.

Note 2: For the rating background and ambient noise levels, the periods are defined as per the NPfI (EPA, 2017):

- *Day: the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays*
- *Evening: the period from 6.00 pm to 10.00 pm*
- *Night: the remaining periods.*
- *For the 15-hour and 9-hour ambient noise levels, as per the Development Near Rail Corridors and Busy Roads – Interim Guideline (NSW DoP, 2008), day refers to the 7am to 10pm while night refers to 10pm to 7am.*

3 Development consent conditions

Development consent conditions for the Project (SSD-63741210) have been issued by the Minister for Planning and Public Spaces.

Conditions relevant to construction noise and vibration are listed in Table 3.1 along with the relevant section of this document where they are addressed.

Table 3.1 Conditions compliance table

Aspect	No.	Condition	Report section
Hours of work	B1	The Applicant must comply with the hours detailed in Table 2 below, and as altered by conditions A7(b) and B2 of this consent Table 2 sets the following hours for construction activities: — 7am to 6pm Monday to Friday — 8am to 1pm Saturday	5.1.2
Out-of-hours Works	B2	Works outside of the hours identified in condition B1 may be undertaken in the following circumstances: (a) works that are inaudible at the nearest sensitive receivers; (b) works agreed to in writing by the Planning Secretary; (c) for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; or (d) where it is required in an emergency to avoid the loss of lives, property or to prevent environmental harm	N/A
	B3	Any out-of-hours works request seeking the agreement of the Planning Secretary (see condition B2(b)) must: (a) be prepared with regard to the relevant sections of the Interim Construction Noise Guideline (ICNG; (b) be accompanied by details of the nature and need for activities to be undertaken outside of the hours identified in condition B1; and (c) be accompanied by evidence confirming that: (i) the proposed activities are justified; (ii) appropriate consultation with potentially affected receivers has been and/or will be undertaken; (iii) the relevant local council has been and/or will be notified; (iv) any potential noise impacts associated with the out-of-hours works will not unreasonably impact on the acoustic amenity of sensitive receivers in the vicinity of the works.	N/A

Aspect	No.	Condition	Report section
Construction Noise Limits	B4	The development must be constructed to achieve, as far as is feasible and reasonable, the construction noise management levels detailed in the Interim Construction Noise Guide (ICNG). All feasible and reasonable noise mitigation measures must be implemented and any activities that could exceed the construction noise management levels must be identified and managed in accordance with the management and mitigation measures in Appendix 3 of this consent and the development's Construction Noise Management Plan (see condition B5).	4.1.1
Construction Noise Management Plan	B5	Prior to the commencement of construction, the Applicant must prepare a Construction Noise Management Plan (CNMP) for the development to the satisfaction of the Planning Secretary. The CNMP must form part of the development's CEMP in accordance with condition C2 and must:	-
	B5 (a)	be prepared by a suitably qualified and experienced noise expert(s)	1.5
	B5 (b)(i)	refine the construction methodology and work schedule to minimise construction noise impacts;	5.1 and 6
	B5 (b)(ii)	achieve, as far as is feasible and reasonable, the noise management levels in the ICNG;	5.2.4 and 5.2.5
	B5 (c)(i)	site-specific noise management and mitigation measures to be implemented during construction to reduce impacts on most affected sensitive receivers	6
	B5 (c)(ii)	a list of relevant management and mitigation measures, including any described in Appendix 3 of this consent;	6
	B5 (c)(iii)	a description of measures to be implemented to manage high noise generating works in close proximity top sensitive receivers;	6
	B5 (c)(iv)	strategies that have been developed in consultation with nearby sensitive receivers for managing noise impacts and high noise generating works, such as any alternative construction methods with lower source intensity levels and/or provision for respite periods;	(Section 7.2 lists the community consultation activities that will be undertaken to develop and implement additional mitigation/strategies as required)
	B5 (c)(v)	a description of the community consultation undertaken to develop the strategies in (c)(iii) and (c)(iv) above; and	
	B5 (c)(vi)	a complaints management system to be implemented for the duration of construction.	7.2

4 Assessment criteria

4.1 Construction noise

4.1.1 Interim Construction Noise Guideline

The following sections detail the applicable site-specific construction noise objectives based on the ICNG.

4.1.1.1 Recommended standard construction hours

The ICNG provides guidance for the assessment of construction noise. It establishes noise management levels according to the hours in which construction may take place. The ICNG recommended standard hours for construction are:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- No work on Sundays or Public Holidays

4.1.1.2 Work outside standard construction hours

The ICNG acknowledges that it may be necessary to conduct some activities outside the recommended standard construction hours, and allows the following activities when all feasible and reasonable mitigation measures are implemented to minimise the impacts to any surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine requires special arrangements to transport along public roads
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours

Construction Noise Management Levels

The ICNG states that the potential for construction noise impacts can be assessed by comparing the predicted noise levels at the assessment locations with the NMLs provided by the ICNG. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the noise management levels.

The ICNG NMLs are listed in Table 4.1.

Table 4.1 ICNG NMLs

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

Time of day	Noise Management Level ($L_{eq\ 15min}$ dBA)[1]	How to apply?
When property is in use	75 dBA	The external noise levels should be assessed at the most-affected occupied point of the premises.

Notes:

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

4.1.1.3 Applicable NMLs

The applicable NMLs for the Project have been documented in the SSDA Noise and Vibration Assessment and are reproduced in Table 4.2.

Table 4.2 Applicable NMLs

Locations	Recommended standard hours NML $L_{eq\ 15min}$ dBA	Outside standard hours NML $L_{eq\ 15min}$ dBA			Highly affected NML $L_{eq\ 15min}$ dBA
		OOHW period 1 (day)	OOHW period 1 (evening)	OOHW period 2 (night)	
NCA 1 All affected surrounding residential receivers	47	42	42[2]	42[2]	75
NCA 2 All affected surrounding residential receivers	45	40	40[2]	40[2]	75
All affected surrounding industrial receivers	75				-

Notes:

1. Any construction work conducted outside the recommended standard hours is defined as follows
   - OOHW Period 1 (Day) – Saturdays 7 am to 8 am and 1 pm to 6 pm; Sundays and Public Holidays 8 am to 6 pm.
   - OOHW Period 2 (Evening) – Monday to Saturday 6 pm to 10 pm.
   - OOHW Period 3 – Monday to Saturday 10 pm to 7 am; Sundays and Public Holidays 6 pm to 8 am.
2. As per NPFl Section 2.3 night-time levels have been adjusted to be no greater than the noise level for day or evening due to noticed presence of insect noise during noise monitoring.

4.1.2 *Construction road traffic noise*

The project will require vehicle movements to facilitate the delivery and removal of earthworks spoil, equipment, and construction staff.

Potential impacts from construction traffic noise on public roads associated with the project is assessed using guidance from the Road Noise Policy (RNP). The application notes from the RNP detail the requirements for operation-generated traffic noise as follows:

> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies where the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion*

Therefore, if the road traffic noise levels increase by more than 2 dBA as a result of the proposed construction traffic, and the criteria outlined in Table 3.4 are exceeded, mitigation options should be investigated. A 60 per cent increase in traffic is required to increase traffic noise levels by more than 2 dB

Table 4.3 Road traffic noise criteria for receivers on existing roads affected by the additional traffic from land use developments

Road type	**External road traffic noise criteria**[1]	
	Day, 7 am – 10 pm	**Night, 10 pm – 7 am**
Freeway/arterial/sub-arterial roads	60 dBA $L_{eq\ 15hr}$ and increase > 2dB	55 dBA $L_{eq\ 9hr}$ and increase > 2dB
Local roads	55 dBA $L_{eq\ 1hr}$	50 dBA $L_{eq\ 1hr}$

1. Façade corrected noise levels

4.2 Construction vibration

Vibration generating construction activities may lead to the following impacts risks:

- Cosmetic and structural building damage
- Loss of amenity due to perceptible vibration, termed human comfort.
- Damage to underground utilities

The following sections present vibration criteria for assessment and management purposes based on WSP's experience.

4.2.1 *Risk of structural / cosmetic damage*

4.2.1.1 DIN 4150 -3

The German standard DIN 4150-3 provides a recommendation for maximum allowable peak particle velocity vibration levels (applied in any orthogonal direction vi, with i=x,y,z) to reduce the risk of damage to structures. The DIN 4150-3 vibration criteria for short-term or transient vibration on structures are presented in Table 4.4 and in graphical form in Figure 4.1. DIN 4150-3 is typically adopted for assessing risk of building damage in contemporary major infrastructure projects in Australia and will be the primary vibration criteria for this assessment.

Table 4.4 DIN 4150-3 Structural damage vibration criteria, Peak Component Particle Velocity

Group	Type of structure	Peak Component Particle Velocity (PPV), mm/s				
		Measured at building foundation at a fundamental frequency range, all directions (x, y, z)			Plane of floor at uppermost storey horizontal direction (x,y)	Floor slabs vertical direction (z)
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design *(Commercial/Industrial)*	20	20 - 40	40 - 50	40	20
2	Dwellings and buildings of similar design and/or use *(Residential)*	5	5 - 15	15 - 20	15	20
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in group 1 or 2. *(Heritage)*	3	3 - 8	8 - 10	8	20

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values

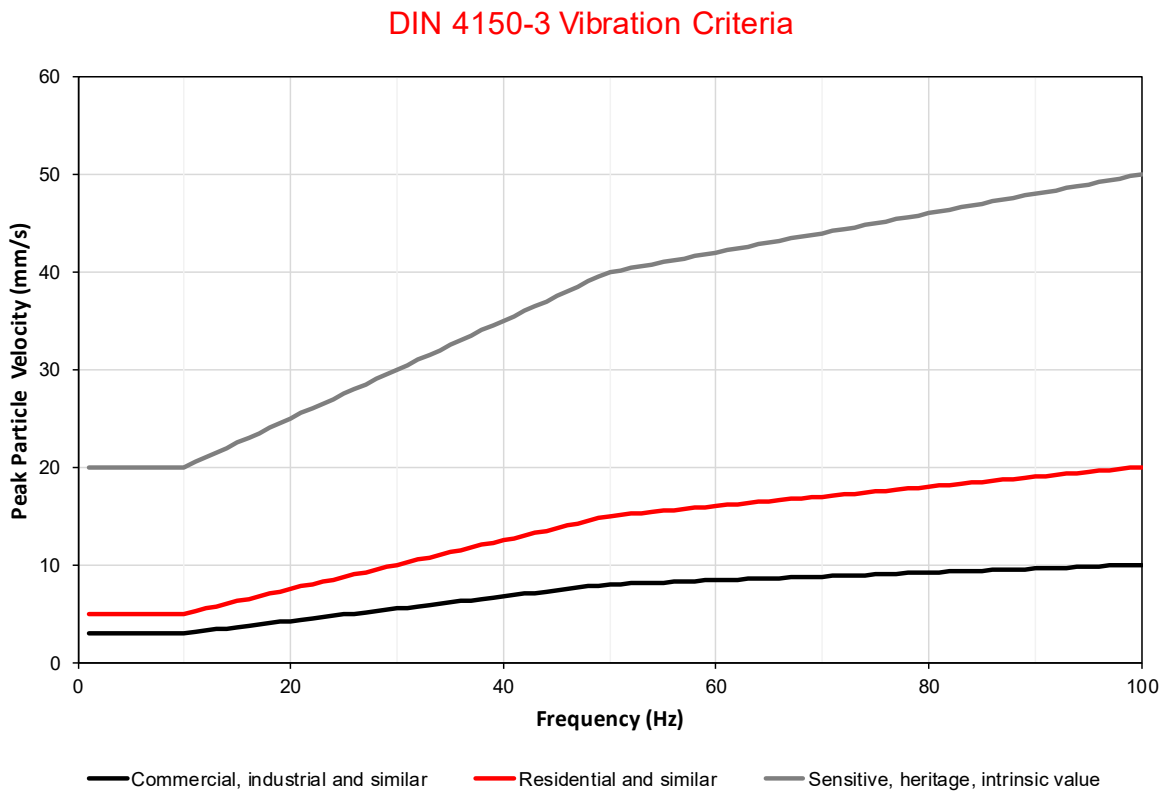

Figure 4.1 DIN 4150-3 Vibration Criteria

4.2.1.2 BS 7385-2

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. Damage of this nature is typically described as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls. If there is no determined significant risk of cosmetic damage, then structural damage is not considered a significant risk and is not further assessed.

There is currently no standards in Australia specifically addressing cosmetic damage to buildings from vibration. BS 7385 is proposed to be used for the assessment of cosmetic damage in buildings.

BS 7385 provides guidance on the 'evaluation and measurement of vibration in buildings' and defines guidance for categorising building damage in terms of 'cosmetic', 'minor' and 'major', providing limits for each.

These peak vibration limits are set so that the risk of 'cosmetic' damage in residential or commercial buildings is minimal. The limits have been set at the lowest level above which damage has been credibly demonstrated. The limits also assume that the equipment causing the vibration is only used intermittently, however if the equipment is used continuously (e.g. CFA piling), then the limits may need to be reduced by up to 50 per cent.

For 'minor' or 'major' vibrational damage to occur, BS 7385 states that vibration needs to be two times and four times (respectively for Group 1 and Group 2) the values shown in Table 4.5.

Guidance in BS 7385 also suggests that unless structurally unsound, heritage items should not be considered to be more sensitive than dwellings for the purposes of assessment.

Table 4.5 BS7385 Cosmetic damage vibration criteria, Peak Component Particle Velocity[1]

Group	Type of structure	Peak Component Particle Velocity (PPV), mm/s		
		4 Hz to 15 Hz	15 Hz to 40 Hz	≥ 40 Hz
1	Reinforced or framed structures Industrial or heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial buildings	15 – 20[2]	20 – 50	50

Notes:

1. All values referred to are at the base building, on the side of the building facing the source vibration (where feasible)
2. At frequencies blow 4 Hz a maximum displacement of 0.6 mm (zero to peak) will not be exceeded

4.2.2 *Human comfort*

Vibration criteria for human comfort have been based on the guidelines set out in the NSW Department of Environment and Conservation *Assessing Vibration: A technical guide,* 2006 (AVTG).

The AVTG vibration levels for continuous vibration human comfort have been reproduced in Table 4.6 in terms of Peak Velocity (mm/s) for continuous vibration, referencing Table C1.1 of Appendix C of the AVTG.

It should be noted that construction work is generally considered as an intermittent source of vibration. Therefore, continuous vibration targets are considered conservative.

Table 4.6 Preferred and maximum vibration levels for continuous vibration (criterion relevant to the project emboldened)

Location	Assessment period	Peak velocity, mm/s	
		Preferred value	Maximum value
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

4.2.3 Structural damage to buried services (DIN 4150-3)

As with cosmetic building damage, there is currently no standard in Australia for damage to underground services. Where possible, guidance should be sought from the asset owner regarding suitable construction vibration criteria for all underground utilities. In the absence of information from the asset owner, DIN 4150-3 has been referenced to provide indicative vibration criteria for buried utilities.

The vibration limits contained within DIN 4150-3 apply at the wall of the pipe and are outlined in Table 4.7.

The DIN 4150-3 standard defines short term and long-term vibration impacts as follows:

- Short term: Vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated.
- Long term: All types of vibration not covered by the definition of short-term vibration.

As a result, most construction activities would be considered long term as they have the potential to excite resonances within structures.

Table 4.7 DIN 4150 Part 3 – Damage to buried pipes vibration limits

Pipe material	**Peak wall vibration velocity, mm/s**	
	Short term works	**Long term works**
Steel	100	50
Clay, concrete, reinforced concrete, prestressed concrete, metal with or without flange (other than steel)	80	40
Masonry, plastic	50	25

Based on WSP's experience the following vibration levels are suggested for other underground utilities:

- Electrical cables and telecommunication cables (including fibre optic) – 50 mm/s.
- Gas pipelines - 20 mm/s (confirm with gas network supplier).

4.2.4 Damage to Sydney Water assets

The *Sydney Water Specialist Engineering Assessment Procedure*, Version 1, February 2021 (SEAP) nominates vibration limits for different asset types. These are presented in Table 4.8

Table 4.8 Sydney Water vibration limits

Asset type	**Threshold values for velocity (PPV) measured on the asset in mm/s**	
	Intermittent vibrations	**Continuous vibrations**
Brittle pipe assets – — Reinforced concrete (RC) — Vitrified Clay (VC — Earthenware (EW) — Cast Iron Cement Lined (CICL)	10	5

Asset type	Threshold values for velocity (PPV) measured on the asset in mm/s	
	Intermittent vibrations	**Continuous vibrations**
Ductile pipe assets — Steel Cement (mortar) Lined (SCL) — Ductile Iron Pipe (DI) — Polyvinyl Chloride (PVC) — Polyethylene (PE) — Polypropylene (PP) plastic pipe or tubing — Glass Reinforced Plastics (GRP)	20	10
Masonry	3	
Unreinforced concrete	3	

5 Assessment of noise and vibration impacts

5.1 Construction methodology

This section provides a description of the key construction works for the project which has been prepared in consideration of the Construction Management Plan (CMP) for the Project and additional information provided by Multiplex.

5.1.1 Activities and staging

Based on information provided by Multiplex construction works for the Project have generally been grouped into five (5) types of activities as follows:

- Site establishment
- Civil and earthworks
- Structure works
- Fit out works
- Plant installation and commissioning

Site establishment activities will occur throughout the whole site as required to construct each of the different components of the Project. The remainder activities will occur sequentially for each one of the four buildings (A, B ,C and D) but overlapping at different times .

Ten (10) construction stages have been determined as follows:

Table 5.1 Construction staging

Building	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
Building A	Site establishment	Civil and earthworks	Structure works	Structure works	Structure works	Structure works	Fit out works	Fit out works	Plant installation	Plant installation
Building B	Site establishment	Civil and earthworks	Civil and earthworks	-	-	Structure works	Structure works	Fit out works	Fit out works	Plant installation
Building C	Site establishment	Civil and earthworks	Civil and earthworks	Structure works	Structure works	Structure works	Fit out works	Fit out works	Plant installation	Plant installation
Building D	Site establishment	Civil and earthworks	Civil and earthworks	Civil and earthworks	-	Structure works	Structure works	Fit out works	Fit out works	Plant installation

5.1.2 Construction work hours

The hours of work will be as follows in line with the SSD consent conditions outlined in Section 0:

- 7am to 6pm Monday to Friday
- 8am to 1pm Saturday

If required Multiplex will seek agreement with the Planning Secretary for out-of-hours works in accordance with SSD consent conditions B1 and B2 outlined in Section 0.

5.2 Noise assessment

5.2.1 Noise modelling methodology

Prediction of construction noise impacts from the main external works has been completed using SoundPLAN version 9.1 noise modelling software, using the ISO 9613-2 calculation method. A three-dimensional model of the Project was developed, including elevation contours, locations of sensitive receivers, noise generating equipment and intervening buildings. The model considered noise sources, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings.

The parameters used and values adopted in the noise modelling are presented in Table 5.2.

Table 5.2 Modelling parameters

Parameter	Input
Buildings	Building footprints and number of floors taken from aerial photography. Building heights and number of floors were estimated from Google Street View as follows: per floor 3 metres, pitched roof 2.5 metres.
Topography	5 m contours were extracted from the Digital Elevation Model (DEM) available from Geoscience Australia via Elvis Elevation and Depth.
Façade calculation	Impacts calculated at the most affected facade of nearby receivers.
Façade correction	Standard façade correction +2.5 dB
Prediction algorithm	CONCAWE. The propagation model consider: — Locations of noise sources and receivers — Geometrical spread of noise (divergence) — Atmospheric absorption — Ground effects — Meteorological effects — Barriers and in-plant screening — Reflections from surfaces.
Meteorological conditions	Concawe Category 4 (representing neutral conditions)
Ground surface / absorption	Model assumed a ground absorption coefficient of 0.5.

Parameter	Input
Sources	Equipment has been modelled as area source per stage/location. All equipment per work stage has been modelled to operate simultaneously over a 15-minute period, representing worst case conditions. Number of equipment per work stage has been confirmed by Multiplex in Section 5.2.3.
Source noise levels	Sound power levels used are listed in Section 5.2.3.
Source locations	The locations of the sources are expected to change throughout the duration of the works. Therefore, sources have been modelled along the footprint of the buildings to represent worst case conditions.
Source heights	Construction plant and equipment heights are modelled 2 metres above ground.
Receiver heights	Receivers have been placed at an elevation of 1.5 m

5.2.2 Modelled scenarios

Construction noise scenarios have been modelled in accordance with the staging presented in Table 5.1.

5.2.3 Equipment quantities and sound power levels

Plant and equipment sound power levels have been extracted from the SSDA Noise and Vibration Assessment.

These sound power levels and equipment quantities for each modelled scenario, corrected for approximate usage factor, are presented in Table 5.3. Where appropriate a penalty of 5 dB has also been considered for noise sources which may be particularly annoying to nearby residences in accordance with the ICNG.

Table 5.3 Equipment sound power levels per modelled scenario

Plant item	SWL (dBA)	Usage Factor (%)	Annoyance Factor	Site Establishment	Civil and earthworks	Structure works	Fitout works	Plant and comissioning
Tower Crane (Diesel)	113	100				2		
Backhoe loader	110	40			5	1		
Compactor	106	20			4			
Concrete pump	109	100				2		
Concrete mixer truck	108	100				2		
Mobile crane	103	20		1	4	1	1	1
Excavator (30t) + bucket attachment	110	40			4			
Excavator (30t) + hydraulic hammer	122	20	5		4			
Generator (Diesel)	103	100		1	3	1	1	
Loader (Front-end)	112	40			4	1		
Forklift (diesel)	106	50		1	1	1	1	1
EWP	106	20			1	2	1	1
Concrete saw	118	20	5			1	1	
Grinder	113	50	5		1	1	1	
Handheld power tools	108	50				1	1	1

Plant item	SWL (dBA)	Usage Factor (%)	Annoyance Factor	Site Establishment	Civil and earthworks	Structure works	Fitout works	Plant and comissioning
Flood lighting	90	100		1	1	1	1	1
Concrete trowels	106	100			4	2		
Grader	113	100			4			
Jack hammer	126	20	5		4	1		
Roller (Vibrator)	109	20	5		4			
Roller (Smooth-drum)	107	20		1	4			
Pavement laying machine	114	50			3			
CFA & Bored Piling Rig.	110	20			5			
Scraper	114	40			3			
Truck (>20 tonne)	108	40		2	4	1	1	1
Truck (water cart)	108	40		2	4	1		
Vehicle (light commercial e.g. 4WD)	103	10		2	3	2	2	1
Total sound power level (dBA)				**112**	**133**	**134**	**125**	**116**

5.2.4 *Predicted construction noise impacts*

A summary of the predicted construction noise levels is presented in

Table 5.4, compared against the NML applicable for standard hours works. Several exceedances of the NMLs are predicted which are discussed further below.

Actual construction noise levels are expected to vary based on the location, number, and duration of operation of construction machinery, and therefore construction noise predictions have been presented as a worst-case, conservative scenario to represent the potential construction noise impact.

Table 5.4 Predicted noise levels for all assessed receivers for all construction stages

Receiver ID	NML (Standard hours/OOOHW)	Predicted Noise Levels, $L_{eq\ (15min)}$ dBA									
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
I1	75/75	63	**80**	**78**	73	73	75	75	74	74	63
I2	75/75	60	**79**	**78**	75	73	74	71	59	53	50
I3	75/75	68	**86**	**85**	**82**	**81**	**81**	**80**	**80**	67	67
R1	47/42	**62**	**75**	**74**	**71**	**72**	**70**	**75**	**77**	**73**	**65**
R2	47/42	**58**	**70**	**69**	**67**	**68**	**67**	**72**	**74**	**71**	**63**
R3	47/42	**62**	**75**	**74**	**71**	**70**	**71**	**75**	**78**	**75**	**66**
R4	47/42	**59**	**71**	**70**	**68**	**67**	**68**	**73**	**77**	**75**	**65**
R5	47/42	**58**	**70**	**70**	**67**	**66**	**68**	**72**	**76**	**74**	**64**
R6	47/42	**48**	**61**	**61**	**58**	**58**	**59**	**64**	**67**	**66**	**55**
R7	45/40	**45**	**61**	**60**	**56**	**55**	**57**	**60**	**63**	**62**	**51**
R8	45/40	**47**	**60**	**59**	**57**	**56**	**57**	**60**	**63**	**62**	**51**

1 The cells with **red bold text** show exceedances of highly affected the Highly Affected Level criteria

2 The cells with **orange bold text** show exceedances of both standard hours and OOH NMLs

3 The cells with **green bold text** show exceedances standard hours NMLs

5.2.5 Discussion

It should be noted that the noise predictions are worst-case as they assume that all equipment will be in use simultaneously and continuously during the assessment period. In addition, these predictions are made with the construction activity at the closest location to the receiver. Noise levels may therefore be reduced when activity is further away and less equipment is in use as per the construction schedule

The outcomes of the assessment show that the highest noise impacts are predicted to occur under Stages 2 and 3 for the industrial receivers, when the noisiest activities such as the use of jackhammers, excavators, scrapers, pavement laying machines, graders and piling will take place. Predicted noise levels for Industrial receivers generally remain within the 75 dB NML for most activities. Noise levels for Civil and earthworks and Structure Works are predicted to exceed the 75 dB NML at receiver I3.

Exceedances have been predicted for all stages at all residential receivers with exceedances of highly noise affected NMLs (>75dB) predicted at receivers R1, 3, 5 and 5 for Stage 8.

The noise levels predicted for Stage 8 are generally higher than those for the other stages. This is primarily due to the conservative assumptions used when modelling the fit-out works. To ensure the predictions were as conservative as reasonably practicable, the noise sources were represented as plane sources positioned on the most exposed elevations of the buildings. In reality, however, fit-out activities could occur at various locations within the buildings, often in shielded or internal areas, which would result in lower, mitigated noise levels.

Mitigation and management measures are required to be implemented as presented in Section 6.

5.3 Vibration assessment

Certain construction activities will require the use of vibration intensive equipment that may affect the nearest sensitive receivers. The most vibration intensive activities/equipment proposed to take place during construction include:

- Vibratory roller
- Excavator with large hydraulic hammer
- Pile boring
- Jackhammer

5.3.1 Cosmetic damage and human comfort

The CNVG includes indicative safe working distances to achieve the cosmetic damage and human comfort vibration criteria. These are presented in Table 5.5.

It should be noted that the distances are indicative only and results may vary depending on the activity, equipment, local ground, and receiver conditions.

Table 5.5 Indicative vibration safe working distances for building damage

Plant item	Rating	Indicative safe working distance, cosmetic damage	Indicative safe working distance, human comfort
Vibratory roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m

Plant item	Rating	Indicative safe working distance, cosmetic damage	Indicative safe working distance, human comfort
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Large hydraulic hammer	1600 kg - 18 to 34t excavator	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	2 m
Bored or CFA piling	≤ 800 mm	2 (nominal)	4

Receiver R1 is potentially within the indicative safe working distance for cosmetic damage due to the use of vibratory rollers and large hydraulic hammer. All other receivers are outside the indicative safe working distances for cosmetic damage.

Receivers R1, R3 and I3 are potentially within the indicative safe working distance for human comfort for vibratory rolling and large hydraulic hammers.

Receiver R4 is potentially within the indicative safe working distance for human comfort for vibratory rolling and large hydraulic hammers.

Mitigation and management measures are required to be implemented as presented in Section 6.

5.3.2 Damage to Sydney Water assets

There is a Sydney Water sewer pipe located in the northwest corner of the Project site along with two maintenance structures (manholes).

The section of pipe connecting the two manholes is located approximately 4.9 m below the ground surface level. Another section is located approximately 9 m below the ground surface level, connecting to the sewer network surrounding the site.

Works will take place directly above the assets as required to construct an internal road for the Project as shown in Figure 5.1, with the likely most affect assets highlighted in yellow.

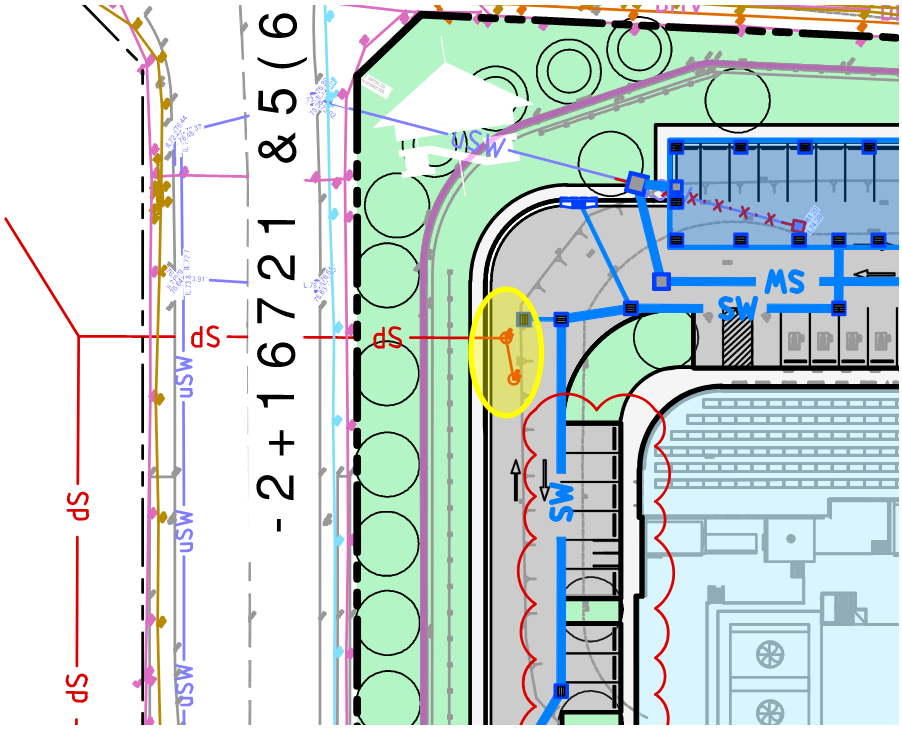

Figure 5.1 Sydney Water assets directly beneath new internal road

Multiplex have indicated that the pipes are ≤ 300 mm diameter PVC pipes. At this stage it is not clear what the material of the manholes is, but it is assumed that these are reinforced concrete.

An assessment of construction vibration impacts onto the sewer pipe and the manholes is presented in the following sections.

5.3.2.1 Assessment methodology

Section 4.6 of the AVTG refers to the US Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment Manual* (1995). The FTA uses the following formula to predict the PPV at a receiver, based on a point source of vibration under normal propagation conditions.

$$PPV_{receiver} = PPV_{ref}.\left(\frac{d_{ref}}{d}\right)^{1.5}$$

Where:

- $PPV_{receiver}$ = peak particle velocity at the receiver (the water main) (mm/s)
- PPV_{ref} = peak particle velocity of the source, measured at the reference distance (mm/s)
- d_{ref} = reference distance for the vibration source (m)
- d = distance from the source to the receiver (the water main) (m)

Section 4.6 of the AVTG guideline also refers to the Transport Research Laboratory's (TRL) *Groundborne vibration caused by mechanised construction works* (2000). The TRL uses the following formula to predict the PPV at a receiver, based on expected and indicative plant specifications.

$$v_{res} = k_s\sqrt{n}.\left(\frac{A}{x+w}\right)^{1.5}$$

Where:

v_{res} = peak particle velocity at the receiver (the water main) (mm/s)

k_s = scaling factor, for probability of predicted value being exceeded, where;

- k_s = 75, with a 50% probability of the vibration level being exceeded
- k_s = 143, with a 33% probability of the vibration level being exceeded
- k_s = 276, with a 5% probability of the vibration level being exceeded

n = number of sources (vibratory drums)

A = nominal amplitude of the vibrating roller (mm)

x = distance along the ground surface from the roller (m)

w = width of the vibrating drum (m)

Note: Valid for distances 2 – 110 m

The two methodologies have been used depending on the type of equipment expected to be used for the works.

5.3.2.2 Inputs

Inputs adopted for the vibration assessment are listed in Table 5.6 and Table 5.7, for calculations following the FTA and TRL methodologies respectively.

Table 5.6 Vibration assessment inputs – FTA method

Equipment	**Peak particle velocity of the source, PPV_{ref}**	**Reference distance, d_{ref}**	**Distance from source, d**	
			To sewer pipe	**To manhole**
5T excavator with auger	1.15 mm/s	1.0 m	4.9 m	0.2 m (*It is unclear what the minimum distance will be to the manholes. The distance noted is assumed and indicative for assessment purposes)
14T excavator	1.00 mm/s	3.0 m		
Plate compactor	3.80 mm/s	1.0 m		
12T Roller (static)	2.30 mm/s	4.0 m		
Asphalt profiler	4 mm/s	5.0 m		
Asphalt paver	1 mm/s	5.0 m		
Loaded trucks	1.93 mm/s	7.6 m		

Table 5.7 Vibration assessment inputs – TRL method

Equipment	**Type**	**Scaling factor, k_s**	**Number of vibratory drums, *n***	**Nominal amplitude, *A* (mm)**	**Drum width, *w* (m)**
Vibratory roller	Continuous	276 (95% confidence)	2	0.64	1.5

5.3.2.3 Assumptions

— Estimated vibration levels have been based on previously published and measured data for similar equipment types. They are not based on the actual plant items proposed to be used by the contractor nor necessarily based on comparable site conditions and geology. As such there is inherent risk in relying on these estimated vibration levels

and associated offset distances with reasonable level of confidence, particularly where estimated vibration levels are outside of the reference data range.

- The distance from the works to the manholes has been assumed as minimal. It is not clear exactly what this will be but 0.2 m has been assumed for assessment purposes
- The following assumptions have been made regarding construction plant:
  - A plate compactor has been assumed for compaction works
  - A static 12T roller and an 8T CAT CB7 vibratory roller have been used to determine safe working distances, offering a range based on equipment choice.
  - It is understood that rock breaking is not included in the construction method and therefore has not been assessed.

Ground vibration is attenuated by a variety of factors as it propagates away from the source. For the purpose of this desktop assessment only geometric spreading has been considered.

5.3.2.4 Estimated vibration levels

Results are summarised in Table 5.8 as the estimated Peak Particle Velocity at the Sydney Water asset from the nearest proposed works. Cell text that is **highlighted red** indicates a non-compliance for a particular plant at the corresponding Sydney Water asset

Table 5.8 Estimated vibration results at minimum proposed working distances

Sydney Water asset	Type	Threshold values for velocity (PPV) (mm/s)[1]	Approx. minimum proposed distance, m	Estimated vibration velocity level, (PPV) (mm/s)							
				5T excavator with auger	14T excavator	Plate compactor	12T Roller (static)	Asphalt profiler	Asphalt paver	Loaded trucks	Roller (Vibrator) CAT CB7 (8T) (High)
Sewer pipe	225 PVC	10	4.9	0.1	0.5	0.4	1.7	4.1[2]	1.0[2]	3.7[2]	**12.3**
Manhole	1500 RC	5	0.2	**12.9**	**58.1[2]**	**42.5**	**205.7[2]**	**500[2]**	**125[2]**	**454[2]**	**90.2[2]**

Notes:

1. Results are presented against continuous vibration thresholds as worst case
2. Outside reference measurement range

5.3.2.5 Estimated minimum safe working distances

Estimated minimum safe working distances are summarised in Table 5.9 and Table 5.10 showing the minimum distance between the vibration source and the Sydney Water asset to meet the vibration threshold for Peak Particle Velocity. Cell text that is **highlighted red** indicates a non-compliance for a particular plant at the corresponding Sydney Water asset.

Table 5.9 Estimated minimum safe working distances – continuous vibration

Sydney Water asset	Type	Threshold values for velocity (PPV) (mm/s)	Estimated minimum safe working distance from source to asset, m[1]							
			5T excavator with auger	14T excavator	Plate compactor	12T Roller (static)	Asphalt profiler	Asphalt paver	Loaded trucks	Roller (Vibrator) CAT CB7 (8T) (High)
Sewer pipe	225 PVC	10	0.2	0.6	0.5	1.5	2.7	1.1	2.5	**6.4**
Manhole	1500 RC	5	**0.4**	**1.0**	**0.8**	**2.4**	**4.3**	**1.7**	**4.0**	**10.7**

Sydney Water asset	Type	Threshold values for velocity (PPV) (mm/s)	Estimated minimum safe working distance from source to asset, m[1]							
			5T excavator with auger	14T excavator	Plate compactor	12T Roller (static)	Asphalt profiler	Asphalt paver	Loaded trucks	Roller (Vibrator) CAT CB7 (8T) (High)
Notes: 1. Minimum distance from works to receiver										

Table 5.10 Estimated minimum safe working distances – intermittent vibration

Sydney Water asset	Type	Threshold values for velocity (PPV) (mm/s)	Estimated minimum safe working distance from source to asset, m[1]							
			5T excavator with auger	14T excavator	Plate compactor	12T Roller (static)	Asphalt profiler	Asphalt paver	Loaded trucks	Roller (Vibrator) CAT CB7 (8T) (High)
Sewer pipe	225 PVC	20	0.1	0.4	0.3	0.9	1.7	0.7	1.6	3.7
Manhole	1500 RC	10	0.2	**0.6**	**0.5**	**1.5**	**2.7**	**1.1**	**2.5**	**6.4**
Notes: 1. Minimum distance from works to receiver										

5.3.2.6 Discussion

The desktop screening assessment indicates that vibration levels from all of the proposed construction activities are likely to exceed Sydney Water's limits at the manholes based on the assumed minimum separation distance.

The vibratory roller specifically is also expected to result in vibration levels above the Sydney Water's limits at the sewer pipe.

It should be noted that the estimated vibration levels fall outside the range of available reference data in some instances, particularly in relation to the predictions for the vibration levels at the manholes, and therefore may not be reliable. Accordingly, it is strongly recommended that alternative low-vibration construction methods for those activities predicting exceedances be considered and supported by trial vibration measurements.

Where assets are at a greater distance from vibration intensive works than the estimated safe working distances (as outlined in Section 5.3.2.5), vibration levels are expected to remain within acceptable limits.

It is strongly recommended that real-time vibration monitoring be carried out at the commencement of, and during identified vibration intensive works to manage vibration risk. Refer to Section 7.3 for monitoring requirements.

6 Noise and vibration management and mitigation measures

6.1 Management measures

In consideration of the predicted exceedances of Project NMLs outlined in Section 5, the mitigation and management measures outlined in Table 6.1 shall be implemented to reduce the disturbance to the nearby receivers during the construction

Table 6.1 Management controls

Action required	Applies	Details
Implement community consultation measures (refer to Section 7.2)	Noise Vibration	Letter box drop to potentially affected receivers. Participate in meetings with community members
Site inductions.	Noise Vibration	All employees, contractors and subcontractors are to receive a noise specific induction as part of their site induction. The induction must at least include: — All relevant project specific and standard noise and vibration mitigation measures. — Relevant licence and approval conditions. — Permissible hours of work (i.e. tools down at 6pm Monday to Friday and 3pm Saturday, assuming works will be permitted after 1pm) — Any limitations on high noise generating activities. — Location of nearest sensitive receivers. — Construction employee parking areas. — Designated loading/unloading areas and procedures. — Site opening/closing times (including deliveries). — Environmental incident procedures.
Behavioural practices.	Noise	— Machinery will be operated in a manner which reduces maximum noise level events such as shaking excavator buckets, dropping materials into trucks from height or steel on steel contact. — No swearing or unnecessary shouting or loud stereos/radios on site. — No dropping of materials from height, throwing of metal items and slamming of doors.
Monitoring.	Noise Vibration	A monitoring program as specified in Section 7.3 is to be carried out.

Action required	Applies	Details
Plan worksites and activities to minimise noise and vibration	Noise Vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Forward-in / forward-out movements are preferred. Prohibit queueing of idling vehicles prior to commencement of work
Complaint handling.	Noise Vibration	A complaint handling procedure as specified in Section 7.2 is to be carried out.
Construction hours and scheduling	Noise	Where feasible and reasonable, construction and deliveries shall be carried out during normal working hours. Work generating high noise levels shall be scheduled during less sensitive time periods. Noisy works closest to the sensitive receivers should be undertaken during the less sensitive periods and move away as the evening progresses to increase the offset distance between the works and the receivers. Works must not occur between 10pm and 7am.
Approvals	Noise Vibration	Proposed works outside normal working hours must be communicated to the relevant authority for approval.
Sequencing operations	Vibration	Sequencing operations so that vibration-causing activities do not occur simultaneously if possible.
Maintenance of plant	Noise Vibration	All plant and tools are to be regularly maintained and checked to ensure that they are running correctly and not producing excessive noise emissions. Periodic inspection of equipment shall be conducted to ensure that they have been maintained correctly and are not generating excessive noise.

6.2 Source controls

The source mitigation measures outlined in Table 6.2 shall be implemented to reduce the potential disturbance to the nearby receivers during the construction.

Table 6.2 Source controls

Action Required	Applies	Details
Equipment selection	Noise Vibration	Alternative, quieter and less vibration emitting construction methods shall be used where feasible and reasonable. For example: - Use of electric cranes - Hydraulic bursters - Road saws Number of plant operational out of hours kept to the minimum for that task.

Action Required	Applies	Details
Rock breaker mitigation		Quieter construction methods will be used for rock breaking where feasible and reasonable. This may include bulldozer mounted rippers or other methods such as rotary grinders (where suitable). Where alternative methods are not feasible and reasonable rockbreaker operations will be noise attenuated in the form of a rockbreaker acoustic shroud (example https://www.hushtecsolutions.com/rock-breaker-shroud/)
Maximum noise levels	Noise	The noise levels of plant and equipment must have operated SWLs equal to or below that specified in Section 5.2.3
Rental plant and equipment	Noise	The noise levels of plant and equipment items are to be considered in rental decisions.
Use and siting of plant	Noise Vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided if possible. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down when not in use. Noise-emitting plant to be directed away from sensitive receivers if possible. All engine and enclosures panels to be kept closed. Use non-impactful techniques to remove debris from piling rigs (e.g., removal of debris by hand tools, use of excavator attachment)
Noisy fabrication work	Noise	Carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.
Generators	Noise	Use mains power supply rather than use generators. Switch off generators when not in use, particularly during out of hours work / peak customer use for station works. Locate generators away from residences and behind structure that could provide acoustic shielding. Use one larger generator to power multiple plant items (ensuring safe cabling). Use mobile noise curtains around generators. Mark location of Mains power and generators on Site Plan.
Plan worksites and activities to minimise noise and vibration	Noise Vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Forward-in / forward-out movements are preferred. Prohibit queueing of idling vehicles prior to commencement of work

Action Required	Applies	Details
Non-tonal reversing alarms	Noise	Non-tonal reversing beepers (or an equivalent mechanism) shall be fitted and used on all construction vehicles and mobile plant regularly used for any out of hours' work.
Compression Brakes	Noise	Truck drivers must limit compression braking as far as practicable.
Hand tools	Noise	As much as practical the use of hand tools such as grinders, impact wrenches, hammers etc. shall be used in specifically designated areas as far as possible from sensitive receivers and preferably separated by a barrier if possible. Metal on metal contact shall be avoided where possible.
Deliveries and truck movements	Noise	Where feasible and reasonable, deliveries will be carried out during the standard daytime working hours Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Forward-in / forward-out movements are preferred to reduce the use of reversing beepers. Truck drivers will limit compression braking as far as practicable. Steel chain type tie downs will not be use. Vehicles to be fitted with straps instead. Reduce the number of vehicle trips to and from the site – organise amalgamated loads rather than using a number of vehicles with smaller loads. Show material transport plans in Works Schedule. Loading and unloading of materials is to occur as far as possible from sensitive receivers. Loading/unloading areas to be shielded if close to sensitive receivers. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site, such as by including drive-through for parking and deliveries. Show traffic flow, loading/unloading areas on Site Plan. Select site access points and roads as far as possible away from sensitive receivers Nominate an off-site truck parking area away from residences, for trucks arriving prior to gates opening. These measures will be communicated to all truck drivers accessing the site.

6.1 Path controls

The mitigation path controls outlined in Table 6.3 shall be implemented to reduce the disturbance to the nearby receivers during the construction.

Table 6.3 Path controls

Action Required	Applies	Details
Shield stationary noise sources such as pumps, compressors, fans etc.	Noise	Stationary noise sources shall be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Noise	Use structures to shield residential receivers from noise such as site shed placement;
Shield sensitive receivers from noisy activities	Noise	Use of fencing; erection of temporary noise barriers/site hoardings. Primarily during louder work stages

7 Compliance management

7.1 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to environmental issues, including noise and vibration management. The induction training will address the following elements related to noise and vibration management:

- The existence and requirements of this sub-plan
- Work hours and the requirement for strict compliance
- Delivery hours, access routes and loading / unloading locations
- Noise mitigation measures
- Project environmental responsibilities
- Location of sensitive noise receivers
- The importance of regular plant maintenance.

Records would be kept of all personnel undertaking the site induction and training, including the contents of the training, date and name of trainer/s.

Key staff will undertake more comprehensive training relevant to their position and/or responsibility. This training may be provided as “toolbox” training or at a more advanced level by the Environmental or Safety Manager or delegated representatives.

7.2 Community consultation and complaints handling

Multiplex has developed a Stakeholder and Communications Plan (SCMP) to establish the approach to stakeholder communication and consultation activities that Multiplex will undertake to ensure positive outcomes are achieved for the community.

Community consultation will include the following activities:

- Engaging with the community to keep them informed, for example community meetings with community and workers.
- Advising the community of work to be undertaken. Notifications will occur at least 24 hours prior to commencement of any out-of-hours works and work where any exceedance of the Project NMLs has been predicted..
- Installing and maintaining a site information board at the front of the site with contact details, hours of operations, after-hours emergency contact details, and regular information updates. The board shall be located to be visible from the outside boundary.
- Recording and managing any complaints.

The SCMP for the Project establishes the following protocol for handling complaints:

- All complaints received by Multiplex will be managed by the Community and Stakeholder Manager in consultation with the Project Manager.
- All complaints will be recorded and resolved where appropriate by the Community and Stakeholder Manager.
- A register will be maintained outlining the source and nature of the complaint and corrective action will be reported and documented.

- The complaint will be investigated promptly to determine the cause and corrective action that will be required to be planned and implemented.
- Complainants will be acknowledged by telephone within one (1) working day.
- Complainants will be informed of the corrective action that has been taken to mitigate or otherwise resolve the adverse effects.

The approach to resolving complaints will include:

- Confirming the nature of the complaint and the requested action.
- If the response requires alternative resolution, the Community and Stakeholder Manager will contact appropriate project staff for input and discussion of options for resolution. If a major issue, the matter will be escalated within Multiplex and the client will be informed and involved as appropriate.
- The resolution approach is to be mutually acceptable where possible to the complainant, Multiplex and the client as required. Resolution would be actively sought to ensure the project continues to move forward.

A complaints register will be developed, maintained and reported as part of the project reporting requirements.

7.3 Noise and vibration monitoring

The monitoring of noise and vibration is an essential part of assessing impacts and determining compliance with approval conditions and community concerns. Noise and vibration monitoring are scheduled to document impact, assist in the administration of any community enquiries and to support construction activities.

7.3.1 Methodology and locations

7.3.1.1 External receivers

Based on the predicted construction noise levels in Section 5.2.4, the following noise monitoring plan is recommended

It is recommended to install three (3) unattended noise and vibration monitors at the following locations:

- West boundary of R1
- West boundary of R3
- South boundary of I3

Monitoring should be continuous for at least until the completion of Stage 3. Additional monitoring must be completed in the event of a community complaint.

In addition, it is recommended to conduct attended noise and vibration measurements during specific activities that have the potential to cause high noise impacts (e.g. jackhammering) to better characterise the noise impacts and inform potential mitigation controls.

7.3.1.2 Sydney Water assets

Vibration monitoring shall be conducted at Sydney Water assets where works take place within the estimated impact distances in Table 5.9. A detailed Vibration Monitoring Plan (VMP) should be developed, covering monitoring locations, methods, trigger levels, response actions, roles/responsibilities and reporting for approval by Sydney Water.

It is recommended that pre-construction vibration monitoring is conducted to measure ambient/background vibration at the proposed monitoring points to establish baseline PPV and frequency content.

Additionally, it is recommended to undertake short, controlled trials at the commencement of vibration intensive work to validate site-specific minimum working distances, vibration transfer rates and instrument placement prior to construction works. The results of these trials will be used to update the monitoring plan as required.

Where feasible, use borehole-mounted vibration sensors in close proximity to the vibration sensitive asset (or ideally firmly fixed to the structure).

7.3.2 Instrumentation

Noise monitors shall:

- Log noise continuously in 15-minute intervals.
- Log the following noise indices as a minimum: L_{Aeq}, $L_{A01,}$ $L_{A10,}$ L_{A90}, L_{Amax}.
- Meet the instrumentation specification requirements of Australian Standard IEC 61672.1-2004 *Electroacoustics – Sound level meters* (AS IEC 61672), Australian Standard AS1055.1 *Acoustics – Description and measurement of environmental noise* and carry current calibration certificates from a NATA approved calibration facility.
- Be capable to send alerts based on trigger levels in line with the NMLs in Section 4.1.1.3.
- Be fitted with wind shields, and calibrated prior to measurements to measure drift.
- Comply with the requirements of AS 1259.2-1990. “Acoustics- Sound Level Meters, Part 2- Integrating and Averaging” and carry appropriate NATA certification.

Vibration monitors shall:

- Log vibration continuously as PPV mm/s.
- Cover the dominant activity band (typically ~4–250 Hz) at suitable sample rates to capture transients.
- Be capable of sending alerts based on trigger levels in line with the vibration criteria in Section 4.2.
- Be calibrated prior to measurements to measure drift.

In the event of trigger levels being exceeded, work would cease immediately and suitable mitigation and / or management measures would be considered.

7.3.3 Monitoring reports

The results of any monitoring undertaken will be documented in monthly reports. These should include:

- Date, time and location of monitoring.
- Name of person conducting the monitoring.
- Statistical descriptors to be recorded for 15 minute intervals include L_{Aeq}, L_{AMax} and L_{A90} levels and the primary noise sources contributing to each statistic.
- PPV mm/s vibration levels
- Details of site activity, environmental noise characteristics and weather to be noted.

Where noise and vibration monitoring indicates exceedances of the project construction noise and vibration criteria outlined in Section 4, the non-conformance procedures outlined in Section 7.4 shall be followed.

7.4 Non-compliances

All results of monitoring will be reviewed and maintained by the Multiplex Site Manager. Issues of concern or non-compliance will be documented and discussed with NEXTDC with the view of resolving the issue or determining a way

forward. NEXTDC will be informed of all non-compliances within 24 hours of identification and will include sufficient detail to describe the nature of the issue, immediate actions taken, and any potential environmental impacts.

Where identified exceedances may impact the safety of people or property, work at the concerned site shall cease immediately. Typical emergency situations that may result in substantial noise and/or vibration impacts may include substantial noise events during out of hours works or vibration causing significant structural damage to nearby buildings and/or Sydney Water assets.

These events are considered highly unlikely, however in the event of such an event occurring:

1. Work would cease immediately
2. Any occupants would be evacuated with due consideration to safety
3. The area would be secured to prevent unauthorised access
4. If relevant, a structural assessment would be undertaken and the results compared with any previous dilapidation survey
5. Where any damage is associated with construction, rectification work would be implemented or compensation agreed.

An Environmental Incident Report form would be completed by the Multiplex Site Manager for any incident causing a noise and / or vibration impact on local residences. This form will include investigation outcomes and proposed corrective and preventative actions. Multiplex will implement agreed actions and monitor their effectiveness to prevent recurrence.

7.5 Reporting

Records relating to noise and vibration on the project shall be maintained for a period of four years in the Site Environmental register or equivalent. These records shall include details related to noise and vibration management, including:

- Training / inductions records
- Equipment inspections
- Noise or vibration monitoring reports
- Audit or reviews
- Communication regarding noise management
- Details of complaints.

7.6 Plan review

Continual improvement of this plan will be achieved by the continual evaluation of environmental management performance against proposed control measures, environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continual improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management which leads to improved environmental performance.
- Determine the root cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address non-conformances and deficiencies.

- Verify the effectiveness of the corrective and preventative action.
- Document any changes in procedures resulting from process improvement.
- Make comparisons with objectives and targets.

Changes to this plan will be approved by Multiplex representatives and stakeholders (if required) and documented in the document control section for each revision. A copy of the updated plan and changes will be distributed to all relevant stakeholders.

8 Limitations

This Report is provided by WSP Australia Pty Limited (WSP) for Multiplex (Client) in response to specific instructions from the Client and in accordance with WSP's proposal and agreement with the Client (Agreement).

8.1 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).

8.2 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.

8.3 Use and reliance

This Report should be read in its entirety and must not be copied, distributed or referred to in part only. The Report must not be reproduced without the written approval of WSP. WSP will not be responsible for interpretations or conclusions drawn by the reader. This Report (or sections of the Report) should not be used as part of a specification for a project or for incorporation into any other document without the prior agreement of WSP.

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.

8.4 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 depredation costs, business interruption or economic loss) of any kind whatsoever, suffered on incurred by a third party.