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Picton Treatment and Reuse Project

Noise and Vibration Impact Assessment

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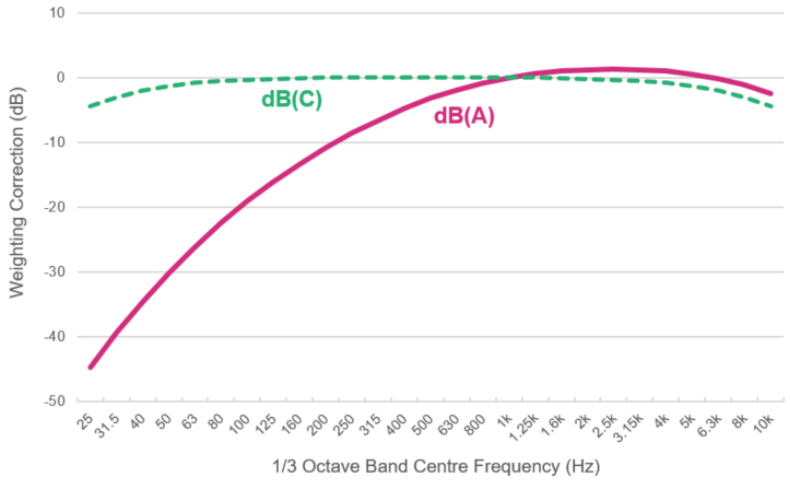
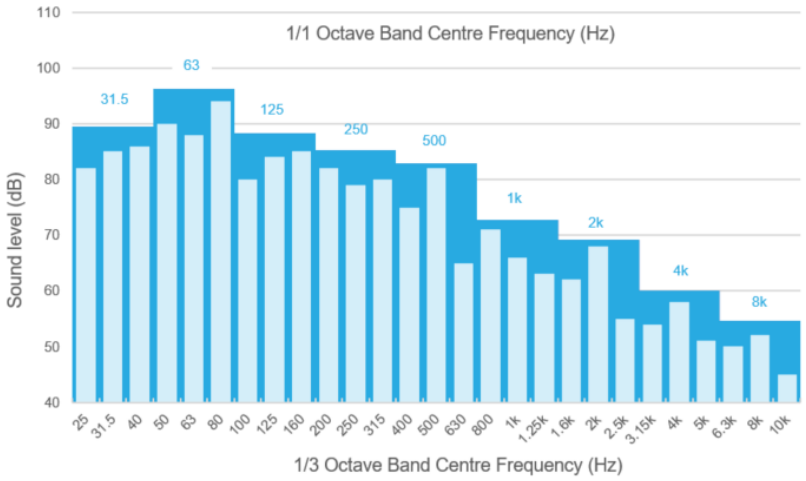
Glossary

Abbreviation / Term	Definition
Project-Specific Terms	
CEMP	Construction Environmental Management Plant
HDD drilling	Horizontal Directional Drilling consists of drilling an underground path under a waterway or other designated area to install a pipe.
Open trenching	Open trenching excavation consists of digging down a trench, installing a new pipe then backfilling the trench.
REF	Review of Environmental Factors
WRP	Water Recycling Plant
Noise and Vibration-Specific Terms	
Ambient noise level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a building is being investigated, the ambient noise level is the noise level from all other sources without the fan operating, such as traffic, birds, people talking and other noise from other buildings.
Background noise level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. **Assessment Background Level (ABL)** A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time. **Rating Background Level (RBL / min$L_{A90,1hour}$)** A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.
CNVS	Construction Noise and Vibration Strategy
Decibel (dB)	The logarithmic scale used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressures, which would be cumbersome if presented on a linear scale. Use of a logarithmic scale allows all sound levels to be expressed based on how loud they are relative to a reference sound (typically 20 µPa, which is the approximate human threshold of hearing). For sound in other media (e.g. underwater noise) a different reference level is used. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dB weighting curves	The frequency of a sound affects its perceived loudness and human hearing is less sensitive at low and very high frequencies. When seeking to represent the summation of sound pressure levels across the frequency range of human hearing into a single number, weighting is typically applied. Most commonly, A-weighting, denoted as dB(A), is used for environmental noise assessment. This is often supplemented by the linear or C-weighting curves, where there is the potential for excess low-frequency sound at higher sound pressure levels.

Abbreviation / Term	Definition
	
dB(A)	dB(A) denotes a single-number sound pressure level that includes a frequency weighting ('A-weighting') to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A). Some typical dB(A) levels are shown below. **Sound Pressure Level dB(A)** — **Example** 130 — Human threshold of pain 120 — Jet aircraft take-off at 100 m 110 — Chain saw at 1 m 100 — Inside nightclub 90 — Heavy trucks at 5 m 80 — Kerbside of busy street 70 — Loud stereo in living room 60 — Office or restaurant with people present 50 — Domestic fan heater at 1m 40 — Living room (without TV, stereo, etc) 30 — Background noise in a theatre 20 — Remote rural area on still night 10 — Acoustic laboratory test chamber 0 — Threshold of hearing
Equipment with special audible characteristics	Refer to a type of equipment/activities Refers to specific activities with characteristics that can cause annoyance and disturbance, containing noticeable factors such as tonality, low frequency noise, impulsive or intermittent noise as listed below and including similar activities: • Use of beeper style reversing or movement alarms, particularly at night-time • use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work • grinding metal, concrete or masonry

Abbreviation / Term	Definition
	• rock drilling • line drilling • vibratory rolling • bitumen milling or profiling • jackhammering, rock hammering or rock breaking • Impact piling • Sheet piling Those activities attract a 5 dB penalty to be added to the sound power level to account for the degree of annoyance.
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as 'pitch'. Human hearing ranges approximately from 20 Hz to 20 kHz. Sounds towards the lower end of the human hearing frequency range are perceived as 'bass' or 'low-pitched' and sounds with a higher frequency are perceived as 'treble' or 'high pitched'. Frequency analysis is often grouped into bands, or 'octave bands'. 1/1 octave or 1/3 octave bands are most commonly utilised and named based on the nominal centre frequency of the band (e.g. 31.5 Hz), are a summation of all frequencies between a defined lower and upper frequency. 
$L_{10(period)}$	The sound level exceeded for 10% of the measurement period, or alternatively, the sound levels would be lower for 90% of the time. The L_{10} is often defined as the 'average maximum' sound levels, as in AS1055-1984 with the advent of statistical sound level meters.
$L_{90(period)}$	The sound level exceeded for 90% of the measurement period. The L_{90} is often defined as the 'average minimum' or 'background' noise level for a period of measurement. For example, 45 $dBL_{A90,15min}$ indicates that the sound level is higher than 45 dB(A) for 90% of the 15-minute measurement period.
$L_{eq(period)}$	The equivalent ('eq') continuous sound level, used to describe the level of a time-varying sound or vibration measurement.

Abbreviation / Term	Definition
	The L_{eq} is often defined as the 'average' level, and mathematically, is the energy-average level over a measurement period – i.e. the level of a constant sound that contains the same sound energy as the measured sound.
L_{max}	The L_{max} is the 'absolute maximum' level of a sound or vibration recorded over the measurement period. As the L_{max} is often caused by an instantaneous event, it can vary significantly between measurements.
NML	Noise management level
OOH	Out-of-hours (i.e. outside of the standard construction hours stipulated in planning approval conditions)
OOHW	Out of Hours Work
Peak Particle Velocity (PPV)	The highest velocity of a particle (such as part of a building structure) as it vibrates. PPV is commonly used as a vibration criterion for the assessment of cosmetic and structural damage.
RNP	NSW EPA Road Noise Policy [1]
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of the environment and distance from a source. The sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Vibration	Waves in a solid material are called 'vibration', as opposed to similar waves in air, which are called 'sound' or 'noise'. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.
VDV	Vibration Dose Values

1 Introduction

Due to the increase in volume of wastewater entering the existing system at the Picton Water Recycling Plant (Picton WRP) and to continue effective management, the current system requires improvement and upgrade.

The report provides a noise and vibration assessment (NVIA) of the construction and operation for the upgrade of the system (The project) including an offsite reuse pipeline, Picton WRP upgrades and a proposed new discharge pipeline to the Nepean River to support a Review of Environmental Factors (REF) being prepared for the upgrade of the system.

2 Project Description

The proposal will require construction/installation of the following key structures:

- Additional upgrades at the Picton WRP
  - a new tertiary denitrification plant – above ground infrastructure would include denitrification filters, methanol storage and dosing facility, electrical switch room and new unloading bays, bunds, access roads and open trenched pipe
  - new open trenched wastewater transfer pipe from the equalisation basin to tertiary filters including upgrading existing transfer pumps
  - modify Eastern Dam pump or install new pumps including associated pipework and electrical controls
  - relocate Western Dam inlet pipe (open trench)
  - bank stabilisation works at the existing discharge channel to Stonequarry Creek including vegetation clearing, open trench excavation, installation of new headwall, reinstatement with existing stockpiled rock rip-rap
  - UV system upgrade and new chlorination system
- Additional off-site reuse
  - Stage 1 and Stage 2 recycled water pipeline to supply Koorana Farm (Farm 1) for irrigation up to 10 ha and Stilton Farm (Farm 2) for irrigation up to 50 ha. Open trenching to be used except under Remembrance Drive where HDD methods would be used.
- New Discharge pipeline
  - Open trenched new discharge pipeline from Eastern Dam, HDD under vegetation, extension of the pipe, down the rock face and into the Nepean River, near Maldon Weir.

Construction works are anticipated to be conducted during daytime hours.

3 Assessment requirements

The current Environmental Protection Licence (10555) dated 16 June 2020 for the project does not include any noise limits.

Therefore, the assessment has been carried out in accordance with current NSW noise policy, as follows.

3.1 Standard, policies and guidelines relevant to the assessment

The relevant guidelines, specifications and policy documents relevant to this NVIA are listed in Table 1 together with the area where those guidelines apply.

Table 1: Relevant Guidelines and areas where they apply

Assessment	Relevant Guidelines	Guideline used for:
Operation noise assessment	NSW Noise Policy for Industry (NPfI) (2017), Environment Protection Authority [2]	The NPfI provides guidelines for the assessment of noise impacts from the operation of an industrial development onto nearby receivers.
Operation road traffic noise assessment	NSW Road Noise Policy, Dept. of Environment, Climate Change and Water 2011 (RNP) [1]	The RNP is used for assessing noise of operation traffic when travelling on the road network from/to a development site.
Construction noise assessment	NSW Interim Construction Noise Guideline (ICNG), EPA 2009 [3]	The ICNG provides guidelines for the assessment and management of construction noise. The ICNG provides a range of work practices to minimise construction noise impacts
	Transport for NSW's Construction Noise and Vibration Strategy (2018) (CNVS) [4]	The CNVS provide practical guidance on how to mitigate the impacts on construction noise and vibration through the application of all feasible and reasonable mitigation measures. The CNVS addresses the assessment requirements of the ICNG. The CNVS was also used to source Sound power levels for construction equipment
	Australian Standard AS2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites [5]	Used to source Sound power levels for construction equipment
	BS 5228-1 -2009 Code of Practice for noise and vibration control on construction and open sites [6]	Used to source Sound power levels for construction equipment
Construction road traffic noise assessment	NSW Road Noise Policy, EPA 2011 (RNP) [1]	The RNP is used for assessing noise of construction traffic when travelling on the road network from/to a construction site.
Operation and Construction vibration assessment	NSW Assessing Vibration – a technical guideline (AVTG), EPA 2006 [7] (based on BS 6472 [8])	Used for assessing potential vibration disturbance to human occupants of buildings and building contents
	British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)' [8]	Used for assessing potential vibration disturbance to human occupants of buildings and building contents

Assessment	Relevant Guidelines	Guideline used for:
	British Standard 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings Part 2' [9]	Used for assessing potential structural or cosmetic damage to buildings/structures as a result of vibration
	DIN 4150-3 (2016) Vibrations in buildings - Part 3: Effects on structures [10]	Used to set guideline values for vibration effects on buildings/structures (including buried pipework)

4 Assessment methodology

The purpose of this report is to identify and assess the potential noise and vibration impacts of the construction and operation of the upgrade of the Picton WRP (and associated pipelines) onto nearby receivers.

4.1 Operational assessment

The methodology below is to assess the noise and vibration impacts of the operation of the project (Picton WRP and associated pipelines):

- Identify the nearest receivers (Refer to Section 5)
- Establish appropriate noise targets based on the Noise Policy for Industry (NPfI) [2] (Refer to Section 7.1)
- Examine the proposed plans and review existing information to identify acoustic aspects of the operation of the project in particular the proposed additional noise sources (Refer to Section 7.2).
- Carry out a quantitative acoustic assessment of potential noise and vibration impacts and compare against the relevant noise and vibration targets (Refer to Section 7.2).
- Identify where further design development is required and identify in-principle mitigation or management methods for the control of noise and vibration where required (Refer to Section 7.2).
- Outline the processes to be adopted for the continued design development of acoustic aspects for the project (Refer to Section 7.2).

4.2 Construction assessment

The methodology below is to assess the noise and vibration impacts of the construction of the project:

- Identify the nearest receivers likely to be impacted by the construction of the project noting that the assessment usually is undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to construction works. (Refer to Section 5).
- Establish the existing acoustic environment at relevant surrounding receiver locations to set project targets in accordance with relevant policy (Refer to Section 6)
- Identify anticipated construction activities (including plant and equipment used), hours of construction and duration of construction activities (Refer to Section 8.1)
- Conduct an assessment of construction noise and vibration impacts depending on anticipated duration of activities at anyone location (Refer to Section 8.3)
- Identify mitigation measures to be adopted during construction (Refer to Section 8.5)
- Outline the processes to be adopted for the continued design development of acoustic aspects for the project (Refer to Section 8.5).

5 Assessment locations

Receivers potentially impacted by the project are defined based on the type of occupancy and the activities performed in the land use. Noise and vibration receivers are categorised as follows:

- Residential
- Commercial
- Industrial
- Educational
- Place of worship
- Medical
- Recreation areas (passive or active)
- Childcare centres
- Hotels
- other structures

Noise and vibration sensitive receivers for this NVIA (including heritage structure and/or vibration sensitive structures) are shown in Figure 1 and described in Table 2.

Table 2: Receiver and monitoring locations

Receiver	ID	Address	Approximate Distance to Picton WRP site boundary (m)	Approximate Distance to near pipeline location/discharge
Residential	R1	2300 Remembrance Driveway, Picton	340 m	275 m
	R2	2245 Remembrance Driveway, Picton	440 m	245 m
	R3	2240 Remembrance Driveway, Picton	800 m	65 m
	R4	75 Stilton Lane, Picton	760 m	30 m
	R5	10 Stilton Lane, Picton	980 m	270 m
	R6	2260 Remembrance Driveway, Picton	485 m	45 m
	R7	2290 Remembrance Driveway, Picton	345 m	120 m
	R8	2247 Remembrance Driveway, Picton	550 m	155 m
	R9	464 Wilton park road, Wilton	1,340 m	258 m
Noise monitor	L1	2300 Remembrance Driveway Noise Monitoring location from the noise compliance report [11]	330 m	-
Heritage areas / structures	-	Koorana Farm (R3) - 2240 Remembrance Driveway (Also listed as Heritage)	-	65 m from nearest pipeline location
	-	Maldon Weir	-	40 m from the discharge location
	-	Nepean River sensitive heritage site	-	100 m south of the discharge location

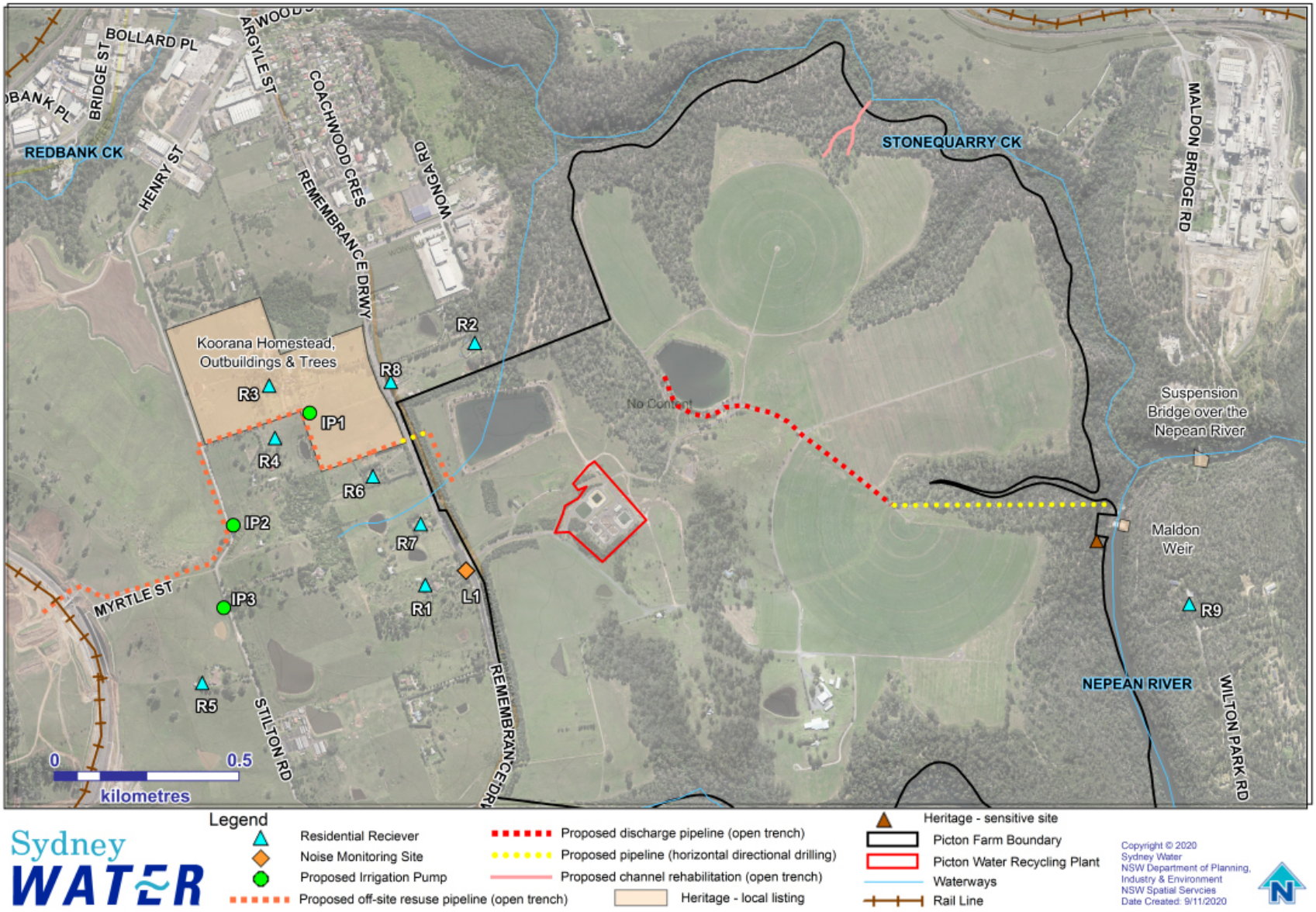


Figure 1: Pipeline, site and receiver locations

6 Receiver acoustic environment

Criteria for the assessment of operational and construction noise for residential receivers are usually derived from the existing noise environment of an area, excluding noise from the subject development. All other receivers have a fixed criteria dependant on land use type.

Unattended and attended noise monitoring carried out for noise compliance purposes has been referred to. A review of the Ensure noise compliance report memorandum for the Picton WRP, dated 28 April 2020 [11] (Henceforth referred to as the 'noise compliance report') contained the following:

- Unattended monitoring was conducted for a period of 14 days starting Wednesday 1 April 2020 at 2300 Remembrance Drive. The location of the noise monitoring is shown in Section 5).
  Outcome of the monitoring is reproduced below in Table 3.

Table 3: Unattended noise monitoring results summary

Location	Rating Background Level (RBL) dBA			Ambient noise levels $L_{Aeq(15minutes)}$, dB		
	Day	Evening	Night	Day	Evening	Night
2300 Remembrance Drive (L1 on Figure 1)	39	35	29	68	65	61

- Attended monitoring conducted at 2300 Remembrance Driveway was also conducted on Wednesday 1 April to supplement the unattended monitoring period. The attended monitoring indicated that the primary ambient noise source was road traffic travelling along Remembrance Driveway, and that noise contributing to the background levels were from insects and birds and that at the time of the noise monitoring no operational equipment at the WRP was audible at the monitoring location.

As the monitoring results did not indicate any contribution from the existing operations, they have been adopted as base line measurements suitable for informing project noise criteria.

7 Operational noise and vibration assessment

7.1 Operational criteria

7.1.1 Fixed operational facility

Fixed operational facilities refer to:

- plant and equipment that operates within a site boundary, or
- plant located outside a site boundary operating at a permanent location

Trigger noise levels have been derived from the NPfI based on Section 6 and are reproduced in below in Table 4. Criteria applicable to the operation of the project correspond to the Project Specific Noise Trigger Level (PSNTL).

Table 4: Operational criteria (for residential receivers)

Receiver type	Time period	Intrusive	Amenity		Project-specific noise trigger level (PSNTL)	Sleep Disturbance
		Intrusive Noise Trigger Levels $dBL_{Aeq, 15min}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(period)}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(15min)}$	**$dBL_{Aeq, 15min}$[6]**	
Residential	Day	44[1]	45[3]	58[4]	**44**	**N/A**
	Evening	40[1]	40[3]	45[5]	**40**	**N/A**
	Night	35[12]	35[3]	40[5]	**35**	**52**

Notes:

1. Based on results in Table 3
2. As per NPfI minimum background
3. Receivers located near the site are classified as rural as per the NPfI
4. Includes a conversion factor of 3 dB to account for peak activities to convert the $L_{Aeq(period)}$ to an $L_{Aeq(15minutes)}$
5. While a 3 dB conversion factor of 3 dB would applied to convert the $L_{Aeq(period)}$ to an $L_{Aeq(15minutes)}$ as per NPfI, the 3 dB has not been applied here as noise sources from the site are anticipated to be continuous.
6. Project Specific is the lower of the intrusive noise trigger levels and the PANL $L_{Aeq(15min)}$

Note that sleep disturbance considered to be both awakenings and disturbance to sleep stages should be considered. The NPfI [2] outlines the following noise trigger levels for assessment of night-time noise levels at residential locations:

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

Where these trigger levels are exceeded, a detailed maximum noise level (L_{Amax}) event assessment should be undertaken.

The noise from the operation of the project is expected to be relatively continuous during night-time, without the movement of trucks or other variable noise sources, therefore the night-time $L_{Aeq(15minutes)}$ in Table 4 is sufficient for assessing sleep disturbance.

Modifying factors

Table C1 of the NPfI [2] sets modifying factor corrections for annoying noise characteristics such as tonality, dominant low frequency, intermittency or irregularity.

7.1.2 Road traffic noise

Increased traffic generated on the public road network is assessed in accordance with the NSW *Road Noise Policy* (RNP) [1].

When assessing noise impact using the existing road network, an initial screening test is first undertaken by evaluating whether noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the proposed development.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) further assessment is required to be conducted in accordance with the RNP. Table 3 of the RNP sets out the assessment criteria for particular types of project, road category and land use.

No additional trucks or cars movement are proposed as a result of the operation of the project and therefore no road traffic noise assessment is required.

7.1.3 Vibration

Vibration impacts are generally assessed in accordance with NSW Assessing Vibration: a technical guideline [12], AS 2187:Part 2 [13], BS 7385 Part 2 [9] and DIN 4150 [14].

No vibration generating equipment has been identified as proposed to be installed as part of the project and therefore no vibration assessment is required.

7.2 Project operational assessment

7.2.1 Site layout

The proposed site layout is shown in Figure 2. Identified noise sources as part of the project are shown in Figure 2 and are described in Table 5.

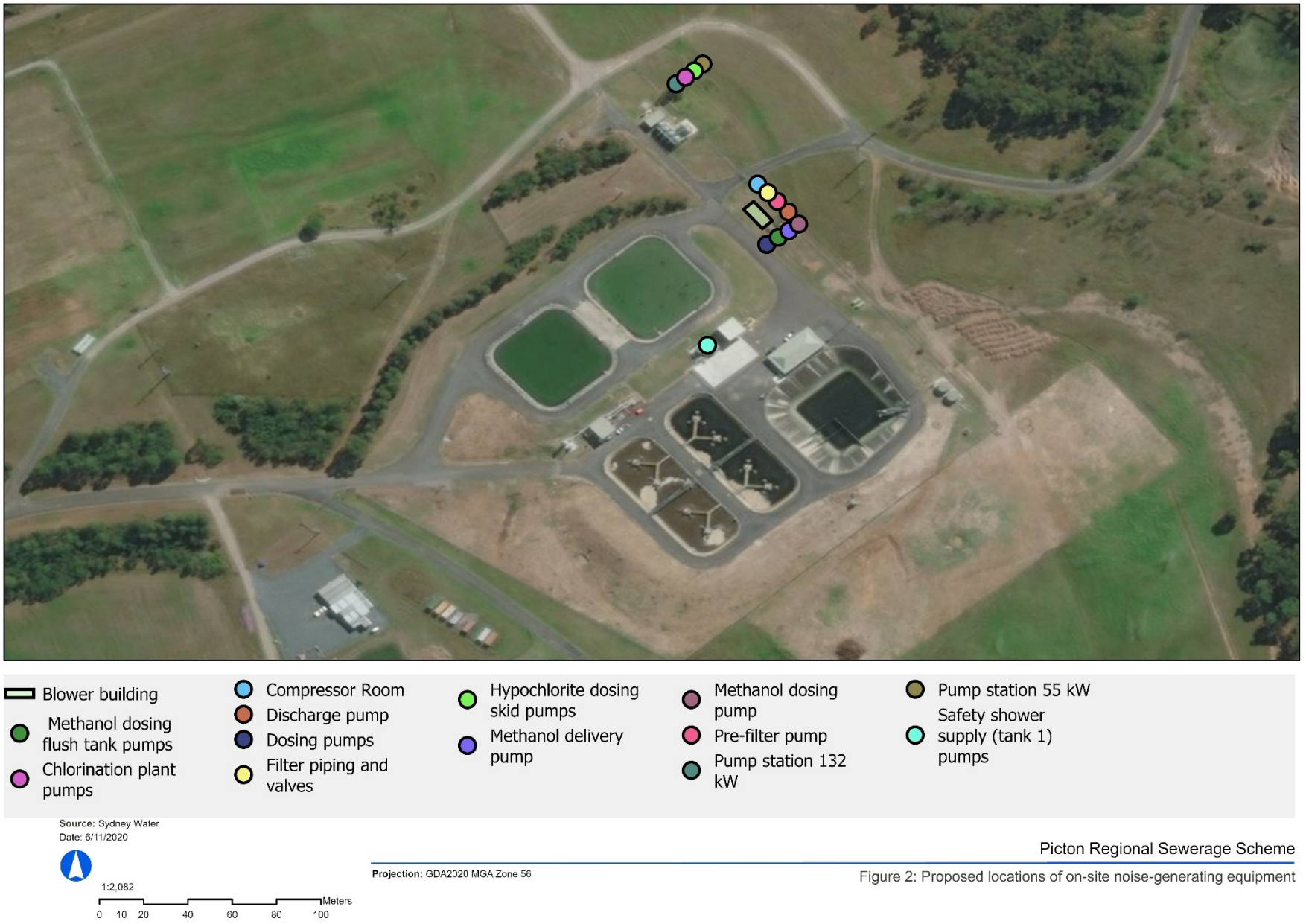


Figure 2: Site layout (locations of pumps are approximate locations)

Table 5: Proposed noise sources for the project

Item	Quantity	Location	Horsepower (kW)	RPM	Broadband $dBL_{Aeq(15minute)}$	Octave Band Centre Frequency Hz (dB)							
						63	125	250	500	1 k	2 k	4 k	8 k
Dosing pump	2	Outloading Bay, external	5	1500	83	73	74	76	76	79	76	72	66
Methanol dosing flush tank pump	2	North-east of site, external	5	1500	83	73	74	76	76	79	76	72	66
Safety shower supply (tank 1) pump	2	Centre of site, external	5	1500	83	73	74	76	76	79	76	72	66
Pre-filter	1	Denitrification plant, external	1	1500	76	66	67	69	69	72	69	65	59
Air compressor	1	New compressor room, internal	6	-	97	83	88	87	85	88	93	90	83
Discharge pump	1	Denitrification plant, external	37	1500	91	82	83	85	85	88	85	81	75
Filter piping and valves	1	Denitrification plant, external	37	1500	91	82	83	85	85	88	85	81	75
Methanol dosing	1	Methanol dosing plant, external	5	1500	83	73	74	76	76	79	76	72	66
Methanol delivery pump	1	Methanol dosing plant, external	5	1500	83	73	74	76	76	79	76	72	66
Pump station	1 (duty/assist/standby)	Chlorination plant, external	5	1445	83	73	74	76	76	79	76	72	66
Hypochlorite dosing skid pump	1 (duty/standby)	Chlorination plant, external	0.2	3600	71	61	62	64	64	67	64	60	54
Pump station	1 (duty/standby)	Re-use pipe, external	55	1500	93	83	84	86	86	89	86	82	76
Pump station	1 (duty/standby)	Re-use pipe, external	132	1500	96	86	87	89	89	92	89	85	79
Irrigation pump IP1[1]	1	Along pipeline (near Koorana Farm), external	3.5	2900	83	73	74	76	76	79	76	72	66
Irrigation pump IP2[1]	1	Along pipeline (near Stilton Lane Farm North), external	8	2900	87	77	78	80	80	83	80	76	70
Irrigation pump IP3[1]	1	Along pipeline (near Stilton Lane Farm South & West), external	25	2900	92	82	83	85	85	88	85	81	75

Notes:

1. Location shown on Figure 1

Note that the sources listed in Table 5 are anticipated to be operational continuously during daytime, evening and night-time.

As the air compressor is located within the compressor room, noise contribution from the air compressors has been modelled as break-out noise through the compressor room roof and façade. It is assumed that the roof and façade are metal cladding. The assumed sound transmission loss for the metal cladding is given in Table 6.

Table 6: Transmission Loss of building envelope materials

Material	R_w	Octave Band Centre Frequency - Transmission Loss, dB							
		63	125	250	500	1 k	2 k	4 k	8 k
Metal cladding	18	-9	-12	-15	-15	-16	-20	-23	-23

The predicted breakout noise from the compressor room is given in Table 7.

Table 7: External building surfaces – Sound power per unit area – L_w/m^2

Building	Façade	Surface	Surface area (m^2)	Broadband $dBL_{Aeq(15minute)}$[1]	Octave Band Centre Frequency Hz (dB)[1]							
					63	125	250	500	1 k	2 k	4 k	8 k
Compressor Room	All façades & roof	Metal Cladding	372	73	71	73	68	66	68	69	61	53

Notes:

1. Noise levels take into account transmission loss of elements (Refer to Table 6)

7.2.2 Existing sources

The April 2020 noise compliance report [11] indicated that noise from the existing Picton WRP could not be directly measured at the receiver locations. To establish likely noise contribution of the Picton WRP at the nearest receivers, the compliance report included near field measurements and predictions. From the near field measurements, the most significant operational equipment were identified as the Aerators for IDAL 1 and 2, the flow distribution structure and the Odour Control Unit. Based on the measurements, noise emissions from the Picton WRP were predicted, and indicated compliance with the Picton WRP 35 $dBL_{Aeq(15minute)}$ night-time criteria (per current conditions of approval) for the receiver located the closest to the site (R1).

The report did not state whether the predictions were conducted for standard meteorological conditions or enhanced meteorological conditions. However, as the unattended monitoring in the compliance report indicated that the background noise level at the nearest receivers, which would be representative of existing steady state sources was 29 dBA, it is reasonable to assume that existing site contributions are 29 dBA under standard weather conditions and 35 dBA under enhanced meteorological conditions.

7.2.3 Project operational noise predictions

For this assessment, a noise assessment was conducted in line with NPfI [2] recommendations.

Table 8 includes both standard meteorological (Pasquill-Gifford Stability Category D, no wind) and noise enhancing conditions (Pasquill-Gifford Stability Category F, source-to-receiver 2 m/s wind vectors).

Based on the type of noise sources (continuous sources) proposed to be added for the project, only the more stringent night-time scenario has been assessed. Compliance with the night-time scenario would imply compliance with the daytime scenario.

Existing site noise contributions are based on the previous compliance report, with R3, R4 and R5 being predicted based on respective distance propagation with reference to R1 as documented in the report.

Table 8: Predicted night-time operational noise levels, dBA

Receiver ID	Predicted Levels, $L_{Aeq,15min}$			Night-time Criteria, $L_{Aeq,15min}$	Compliance
	Assumed existing site contribution[1] - Existing	Project contribution - Proposed	Cumulative - Existing + Proposed		
Standard meteorological conditions					
R1	29	30	32	35	YES
R2	29	31	33	35	YES
R3	23	36	36	35	NO (+1)
R4	23	33	33	35	YES
R5	21	33	33	35	YES
Enhanced meteorological conditions					
R1	35	35	38	35	NO (+3)
R2	35	36	39	35	NO (+4)
R3	28	36	37	35	NO (+2)
R4	28	36	37	35	NO (+2)
R5	26	37	37	35	NO (+2)

Note:

1. **As per Section** 7.2.2 **and** 7.2.3

The noise levels presented in Table 8 indicate that exceedances are predicted, which are minor under standard meteorological conditions, however increase to 4 dB above the noise goals at the worst-case receivers under noise-enhancing meteorological conditions. The assessment identified no characteristic requiring penalties in accordance with the NPfI, such as excessive low frequency content or tonality.

Under the NPfI, the cumulative contribution of the site (Existing and proposed, including off-site pumps) is to be assessed. As the existing site equipment is predicted to just comply with the night-time criteria under enhanced meteorological conditions, new equipment needs to be significantly less than the criteria (more than 10 dB on a cumulative basis). This results in a particularly onerous criteria for new equipment. It is recommended to confirm the noise contribution of existing plant, and where necessary, investigate noise reduction of existing operations. Should this not be feasible, a marginal increase in total site noise may be reasonable, particularly if limited to enhanced meteorological conditions.

Notwithstanding, individual noise contributions are presented in Table 9 to inform which sources requires mitigation.

Table 9: Noise contribution of sources predicted to require mitigation or reselection (Enhanced met conditions)

Noise sources	L_{Aeq} contribution				
	R1	R2	R3	R4	R5
Existing plant					
Total existing plant	35	35	28	28	26
Additional Plant and equipment as part of the Project (Future Plant)					
Dosing pump	20	20	13	13	9
Methanol dosing flush tank pump	20	20	13	13	9
Safety shower supply (tank 1) pump	21	18	13	13	9
Pre-filter	10	11	3	3	0
Air compressors	5	5	0	0	0
Discharge Pump	26	26	18	18	14
Filter piping and valves	26	26	18	18	14
Methanol dosing	17	18	10	10	6
Methanol delivery pump	17	18	10	10	6
Pump station pump (chlorination plant)	20	22	13	13	9
Hypochlorite dosing skid pumps	5	7	0	0	0
Pump station pump (reuse pipe, 55 kW)	27	30	21	21	16
Pump station pump (reuse pipe, 132 kW)	30	33	24	23	19
Irrigation pump IR1	16	19	35	33	13
Irrigation pump IR2	19	15	30	30	24
Irrigation pump IR3	21	16	22	25	36
Total (future plant)	**35**	**36**	**37**	**36**	**37**
Future plant target (assuming no reduction of existing plant)	**25**	**25**	**34**	**34**	**34**

A review of the plant and equipment will be conducted during detail design to address predicted non-compliances.

Reduction of the noise levels at the receivers can be achieved by selecting pumps with lower noise level and/or installing barriers and/or enclosures around the noisiest pumps (for the future plant) and/or reassessing mitigation measures to the existing plant.

8 Construction noise and vibration assessment

8.1 Construction works description

8.1.1 Methodology

While a detailed construction methodology is not yet known, the works have been broadly broken down into phases based on anticipated construction activities. The overall construction timeframe is expected to be approximately 18 months. Table 10 summarises the anticipated construction activities and anticipated associated equipment.

Location of open trenching and HDD drilling was shown in Section 5.

Table 10: Construction activities for the project

Phase (Duration)	Typical Construction Activities Methodology	Anticipated significant noise and vibration emitting equipment
Picton WRP		
Phase 1: Excavation works	Excavation works for the foundation of the structures	Concrete saw, Excavators, tipper trucks, cranes
Phase 2: Civil works	Concrete works for concrete slabs, bunds, loading bays	Concrete trucks, concrete pumps
Phase 3: Structure construction	Building works for the new electrical switch room and compressor room	Cranes, hand tools
Phase 4: Mechanical and electrical installation	Mechanical and electrical works to install the equipment, structure and pipework	Hand tools
Pipelines – Open trenching		
Phase 1: Excavation works	Trenching works for installation of pipelines and electrical conduits.	Excavators, tipper trucks
Phase 2: Pipe laying	Pipe laying and welding	Cranes, welding equipment
Phase 3: Landscaping	Restauration	Excavators, rollers
Pipeline – HDD drilling		
Phase 1: Excavation works	Site entry excavation	Chainsaw, Excavators, tipper trucks
Phase 2: drilling	Drilling	HDD drilling rigs, pumps, compressors
Phase 3: Pipe installation	Pipe installation	Cranes, welding equipment
Phase 4: Landscaping	Restauration	Excavators, rollers
Discharge point		
Phase 1: Excavation works	Excavation works for the foundation of the structures Shallow trenching into rock	Chainsaw, Excavators, tipper trucks Jackhammer

8.1.2 Hours of work

Construction of the project is anticipated to be carried out during standard construction hours (as per Section 8.2.1).

8.1.3 Construction traffic

The construction of the project will generate an increase in vehicle movements on the surrounding road network. Additional vehicle movements will be generated by:

- The arrival and departure of construction plant, equipment and vehicles;
- The haulage and delivery of road work materials, and removal of waste to and from the construction zones
- The arrival and departure of construction workers at the start and end of each work day.

8.2 Construction noise and vibration criteria

The primary objectives concerning the management of construction noise and vibration are:

- Works and activities to be undertaken in a manner that will minimise noise and vibration impacts on sensitive receivers.
- Minimise unreasonable noise and vibration impacts on residents and businesses.
- Avoid cosmetic and structural damage to buildings, structures and/or heritage items.
- Avoid damage to sensitive equipment or additional time spent reconducting measurements
- Undertake active community consultation.
- Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners

Regarding quantitative criteria, there is no single NSW DPIE or EPA policy document that summarises all relevant noise and vibration criteria and objectives for construction activities. TfNSWs CNVS, however provides a useful summary in its Appendix A [4], which is generally consistent with the RMSs CNVG [2]. Relevant standards and policies have been summarised in Section 3.

8.2.1 Construction assessment time periods

Table 11 summarises the recommended construction hours derived from the ICNG and CNVS. Note that the ICNG [15] outlines recommended ‘standard hours’ for construction, while the CNVS [4] provides additional guidance in the defining of periods out of the standard hours (out of hours work – OOHW) that account for times when people are more sensitive to noise and vibration.

The ICNG acknowledges that the following activities have justification to be undertaken outside the standard recommended construction hours assuming all feasible and reasonable mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses.

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads;
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.

Note that the construction of the project is anticipated to be conducted only during Standard hours.

Table 11: Construction assessment time periods

Period	Days and hours	
Standard hours	Day	Monday to Friday – 7 am to 6 pm Saturdays – 8 am to 1 pm
OOHW Period 1	Day	Sundays and public holidays – 8 am to 6 pm Saturday 7 am to 8 am and 1 pm to 6 pm
	Evening	Monday to Saturday – 6 pm to 10 pm
OOHW Period 2	Evening	Sunday and public holidays – 6 pm to 10 pm
	Night	Monday to Saturday – 12 am to 7 am and 10 pm to 12 am Sundays and public holidays – 12 am to 8 am and 10 pm to 12 am

8.2.2 Construction noise objectives

8.2.2.1 Airborne noise management levels (NMLs)

Construction airborne noise objectives are based on the ICNG [15] and Section 6. Construction noise management levels are presented in Table 12.

Table 12: Construction NMLs – external noise levels

Receiver Description	Standard hours LAeq(15 min)[1]	
	Noise affected	Highly noise affected[2]
Residential receivers	49	75

8.2.2.2 Ground-borne noise management levels (GNMLs)

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne construction noise is usually present on tunnelling projects when equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. The ground-borne noise inside buildings initially propagates as ground-borne vibration, before entering the building, which causes floors, walls and ceilings to gently vibrate and hence radiate noise. Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher ambient levels which mask the audibility of ground-borne noise emissions. During night-time periods however, when ambient noise levels are often much lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

As the construction of the project is anticipated to be conducted during daytime standard hours, no further assessment has been conducted.

8.2.2.3 Traffic noise criteria

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as additional road traffic rather than as part of the construction site.

Increased traffic generated on the public road network is assessed in accordance with the NSW *Road Noise Policy* (RNP) [1].

When assessing noise impact using the existing road network, an initial screening test is first undertaken by evaluating whether noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the proposed development.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) further assessment is required to be conducted in accordance with the RNP. Table 3 of the RNP sets out the assessment criteria for particular types of project, road category and land use.

Table 13: Road traffic noise criteria for residential land uses

Road category	Type of project/land use	Assessment criteria – dBA	
		Day 7 am-10 pm	Night 10 pm-7 am
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arteria/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)
Notes: These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.			

8.2.3 Vibration criteria

The effect of vibration in buildings can be divided into three main categories:

1. **Human perception of vibration**: when the occupants or users of the building are inconvenienced or possibly disturbed by vibration**.** Guidance in relation to acceptable vibration levels for human comfort are provided in NSW *Assessing Vibration: a technical guideline* [7]. This document is based on the guidelines contained in BS 6472:1992 [8].
2. **Effects on building contents**: when the building contents may be affected. People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect their operation. Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives [16, 17, 18, 19].
3. **Effects of vibration on structures:** those in which the integrity of the building or the structure itself may be affected, ranging from cosmetic to major structural damage. The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive. Guidance may be found in AS 2187:Part 2 [13], BS 7385 Part 2 [9] and DIN 4150 [10] which also has criteria of particular reference for heritage structures and buried pipework.

8.2.3.1 Disturbance to buildings occupants

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC *'Assessing Vibration; a technical guideline'* [7]. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 [8]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 14.

Table 14: Types of vibration – Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 15 reproduces the 'Preferred' and 'Maximum' values for continuous and impulsive vibration and Table 16 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration (Table 2.2 and Table 2.4 of the Guideline respectively [7]).

Table 15: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshop	Day- or night-time	0.040	0.029	0.080	0.058
Impulsive vibration (weighted[2] RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshop	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am
2. Wg for z axis and Wd for x and y axes

Table 16: Acceptable vibration dose values (VDV) for intermittent vibration (m/s$^{1.75}$)

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

Notes:
1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am
2. Note that the VDV is dependent upon the level and duration of the vibration event and the number of vibration events occurring during the assessment period; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

8.2.3.2 Impact on building contents

8.2.3.2.1 Sensitive equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. No sensitive equipment has been identified near the construction areas.

8.2.3.3 Impact on structures and services

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [20] and/or German Standard DIN4150-3 [10]. Additional information is also provided in the CNVS.

8.2.3.3.1 Standard structures

British Standard 7385 Part 1:1990 [21], defines different levels of structural damage as:

- *Cosmetic – The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor – The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major – Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

BS7385-2 (Table 1 and Section 7.4.2) sets limits for the protection against the different levels of structural damage and those levels are reproduced in Table 17. The criteria relate predominantly to transient vibration that does not give rise to resonant responses in structures, and to low rise buildings.

Table 17: BS 7385-2 Structural damage criteria

Line	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:

1. Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.
2. Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2
3. All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, the values in Table 17 may need to be reduced by up to 50%. Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities. On the basis that the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range) for activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

8.2.3.3.2 Sensitive structures

German Standard *DIN 4150 – Part 3 'Structural vibration in buildings – Effects on Structure'* [22] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures however should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed. If a heritage building or structure is found to be structurally unsound (following inspection) DIN 4150-3, line 3 of Table 1, provides a conservative cosmetic damage objective that should be adopted unless alternative limits are justified by a dilapidation or structural survey. The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.

Table 18: DIN 4150-3 structural damage criteria

Line	Type of structure	Guideline values for velocity, mm/s				
		Vibration at the foundation at a frequency of			At horizontal plane of highest floor	In the vertical direction, at floor slabs
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz1	All frequencies	All frequencies
3	Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (eg listed buildings under a preservation order)[3]	3	3 to 8	8 to 10	8	20[2]

Notes

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.
2. Guideline value might have to be lowered to prevent minor damage
3. Line 1 refer to buildings used for commercial purposes, industrial buildings and buildings of similar design, while Line 2 refers to residential buildings and buildings of similar design and/or occupancy

8.2.3.3.3 Buried services

DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework (see Table 19).

Table 19: Guideline values for short-term vibration impacts on buried pipework

Line	Pipe material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50
Note: For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 **[22]** should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered. For Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.		

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's specification [23], which states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/s the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

8.3 Construction assessment

8.3.1 Airborne noise

Predicted construction noise levels are provided in Table 20 which identify the predicted noise levels at varying distances from relevant plant and equipment as provided in Section 8.1 and Appendix A . Plant is conservatively assumed to operate continuously for the 15-minute period. Note that the cumulative operation of the plant listed in Table 10 is not anticipated to increase significantly predicted noise levels as listed in Table 20 below, given the conservative assumption of continuously operating plant.

Table 20: Affected distance for individual plant items

Distance (m)	Sound pressure levels													
	Pump and dewatering equipment 96	Trenching machine/ excavator (20t) 105	Concrete pump 106	Truck 107	Crane 108	Roller (non vibratory) 109	Welding equipment 110	Micro-tunnelling/ directional drilling 112	Concrete pump truck 113	Vibratory roller 114[1]	Dozer D9 116	Chainsaw 119[1]	Concrete saw / excavator breaker (10t) 123[1]	Jackhammer 126[1]
30	58	67	68	69	70	71	72	74	75	76[2]	78[2]	NA[3]	NA	NA[3]
50	54	63	64	65	66	67	68	70	71	72	74	NA	81[4]	NA[3]
75	51	60	61	62	63	64	65	67	68	69	71	NA[3]	78[4]	NA[3]
100	48	57	58	59	60	61	62	64	65	66	68	NA[3]	75	NA[3]
150	44	53	54	55	56	57	58	60	61	62	64	NA[3]	71	NA[3]
200	42	51	52	53	54	55	56	58	59	60	62	NA[3]	69	NA[3]
300	38	47	48	49	50	51	52	54	55	56	58	61	65	68
500	34	43	44	45	46	47	48	50	51	52	54	57	61	64
700	31	40	41	42	43	44	45	47	48	49	51	54	58	61
1000	28	37	38	39	40	41	42	44	45	46	48	51	55	58
2000	22	31	32	33	34	35	36	38	39	40	42	45	49	52
3000	18	27	28	29	30	31	31	34	35	36	38	41	45	48

Notes:

Red – Highly noise affected receivers (> 75 dBA)

Green – Noise affected receivers (>NML of 49 dBA)

1. Sound power levels include a 5 dB penalty because these plant and equipment are identified as containing special audible characteristics (refer to Appendix A).
2. Only one receiver is potentially affected – R4
3. The closest receiver to potential chainsaw and jackhammer activities is ~260 m away (R9)
4. Only one receiver is potentially affected – R6 within distance of 75 m of potential rock breaking activities for HDD pit construction

A review of Table 2, Table 10 and predicted noise levels in Table 20 indicate that noise levels from the construction of the Picton WRP are likely to meet or be below the NMLs at all the receivers except when the concrete saw or the excavator breaker is used. In the event of the concrete saw or the excavator breaker is used, noise levels at the closest receivers are predicted to be above the NMLs but below the 75 dBA highly noise affected levels.

A review of Table 2, Table 10 and predicted noise levels in Table 20 indicate that noise levels from the construction of the pipeline are predicted to be above the NMLs at the receivers located the closer to the works but below the 75 dBA highly noise affected levels except at R4 and R6. Predicted levels at R4 and R6 are above the highly noise affected level of 75 dBA during the construction of the pipelines when works are conducted the closest to the receivers. It is noted that works will be moving along the pipeline alignment and that worse case noise levels will not be experienced at the receivers during the entire duration of the construction of the pipelines.

Mitigation and management measures to reduce noise and vibration impacts at nearby sensitive receivers are to be applied for the construction of the project. (Refer to Section 8.5 for the mitigation and management measures).

8.3.2 Vibration

As a guide, the recommended minimum working distances for vibration intensive plant in Table 21 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers.

Table 21: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance (m)			
		Cosmetic damage			Human response (OH&E Vibration Guideline) – Disturbance to building occupants
		BS 7385 **Table 17 Line 1 (Screening criterion of 25 mm/s as per Section 8.2.3.3)**	**BS 7385** **Table 17 Line 2 (Screening criterion of 7.5 mm/s as per Section 8.2.3.3)**	**DIN 4150** **Table 18 Line 3 (Screening criterion of 3 mm/s as per Section 8.2.3.3)**	
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	2 m	5 m	11 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	2 m	6 m	13 m	20 m
	< 200 kN (Typically 4-6 tonnes)	5 m	12 m	26 m	40 m
	< 300 kN (Typically 7-13 tonnes)	6 m	15 m	31 m	100 m
	> 300 kN (Typically 13-18 tonnes)	8 m	20 m	40 m	100 m
	> 300 kN (> 18 tonnes)	10 m	25 m	50 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	1 m	2 m	5 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	3 m	7 m	15 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	9 m	22 m	44 m	73 m
Pile Driver – Vibratory	Sheet piles	9 m	22 m	44 m	73 m
Piling Rig – Bored	≤ 800 mm	1 m (nominal)	2 m (nominal)	5 m	10 m (nominal)
Piling Rig – Hammer	12t down force	6 m	15 m	30 m	50 m
Jackhammer	Hand-held	1 m (nominal)	1 m (nominal)	3 m	5 m
Mechanised bored tunnelling works (Tunnel Boring Machine, Horizontal Directional Drilling, Micro-tunnelling)[1]	-	1 m to 5 m	2 m to 12 m	4 m to 24 m	6 m to 35 m

Note1: Plant has been added – calculation based on TRL document **[24]** using Godio et al formula, equation 24

The minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions.

Based on information provided, at the time of this assessment, including anticipated equipment to be used for the construction of the pipes in Section 8.1 and location of sensitive receivers to the work in Section 5, receivers are unlikely to be at risk of cosmetic damage due to vibration generated by the construction works, therefore vibration monitoring and property condition surveys are not deemed to be required.

Notwithstanding, measures to minimise vibration should be adopted as per Section 8.5.

Should the pipeline alignment change or type of construction equipment revised, vibration monitoring and property condition surveys shall be conducted as per Section 8.5.4 and Section 8.5.5.

8.4 Construction traffic assessment

Depending on the type of roads used to access work areas, additional traffic generated by the construction of the project may impact on the amenity of the nearby receivers. Where construction traffic is directed to busy roads, any increase in traffic noise is likely to be negligible. On local roads, there is greater potential for impact.

Construction traffic should be planned to minimise impact on sensitive receivers on lower order roads wherever practicable.

8.5 Mitigation and management measures

Noise mitigation measures for each major construction activity are discussed in the following sections. These mitigation measures are considered to represent all ‘feasible and reasonable’ mitigation measures suitable for implementation during construction of the project. As noted previously, this is a preliminary study, therefore selection of equipment will be revised and noise and vibration mitigation and management measures will be implemented by the successful contractor once further information is available.

8.5.1 Construction noise and vibration management plan

For all construction works, the contractor would be expected to prepare detailed noise and vibration mitigation and management measures to be incorporated in the Construction Environmental Management Plant (CEMP). This plan should include, but not be limited to the following:

- Roles and responsibilities
- Noise sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

8.5.2 General mitigation measures

In general, practices to reduce construction noise impacts will be required, and may include;

- Adherence to the standard approved working hours as outlined in Section 8.2.1.
- Manage noise from construction work that might be undertaken outside the recommended standard hours.
- Locate stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers.
- Use site sheds and other temporary structures or screens to limit noise exposure where possible.
- Select of low-noise construction equipment and/or methods
- Reselect appropriate construction equipment or modify the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.
- Carry out consultation with the community and surrounding building owners/occupants during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures.

8.5.3 Universal work practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.
- Avoid the overuse of public address systems.
- Avoid shouting and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.

8.5.4 Vibration – minimum working distances

As a guide, the recommended minimum working distances for vibration intensive plant in Table 21 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, vibration measurements are required at the start of vibration generating activities that are within the minimum working distances in Table 21.

If vibration intensive works are required within the minimum working distances in Table 21 and attended vibration monitoring has established risk of exceedance, extended monitoring should be carried out.

8.5.5 Property condition surveys

Property surveys (or dilapidation surveys) should be conducted before start of construction works where it has been established that the property, structure or utility is at risk of damage during the construction work. The survey findings could require amendment to proposed vibration criteria or management measures and therefore should be undertaken in suitable advance of when the works start.

9 Conclusion

An acoustic assessment has been carried out for the project. The report included an assessment of the noise emissions from the proposed additional noise sources to be added as part of the project as well as an assessment of the noise and vibration impacts from the construction of the project (including the construction of the Picton WRP site and construction of the pipelines and discharge).

The operational assessment indicated some exceedance of criteria, and while minor under standard meteorological conditions, the exceedance was up to 4 dB under noise enhancing meteorological conditions. The exceedance was contributed to by the existing site contribution, as under the NPfI, a cumulative assessment is required. Accordingly, mitigation measures are required to be implemented, which could include existing equipment, along with future plant. The extent of mitigation measures may be reduced if it can be demonstrated that the existing plant contribution is lower than predicted (Refer to the noise compliance report [11]). Selection of plant and equipment and adequate mitigation measures should be confirmed during detailed design prior to construction.

The construction assessment showed that while specific activities and work schedules are not yet known, noise management levels might be exceeded, and that mitigation and management measures are expected to be developed further in a formal CEMP, to be prepared prior to commencement of works. The construction assessment identifies based on current available information, receivers are unlikely to be at risk of cosmetic damage due to vibration generated by the construction works hence vibration monitoring and property condition surveys are not deemed to be required. Should the pipeline alignment change or type of construction equipment revised, vibration monitoring and property condition surveys shall be conducted as per Section 8.5.4 and Section 8.5.5..

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Appendix A

Equipment sound power levels

All plant and equipment used for the construction of the project should have operating sound power or sound pressure levels below or equal to the allowable noise levels presented in Table 22. Those noise levels have been compiled from a selection of field measurements conducted between 2004 and 2008 of plant and equipment operating on construction projects throughout NSW and are therefore considered to be representative of plant and equipment sound power levels which are readily achieved by current plant and equipment normally used on construction sites.

Plant and equipment with higher Sound power levels than those presented in Table 22 would be deemed to be emitting an excessive level of noise and should not be permitted to operate on construction sites.

Table 22: Recommended Equipment Sound Power Levels - L_w

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Asphalt Paver	112		AS2436
Angle Grinder	108		BS5228
Asphalt Rotomill	111		AS2436
Backhoe	108		AS2436
Backhoe (with Auger)	111		AS2436
Bulldozer	114		AS2436
Bulldozer (CAT D9)	116		CNVS
Bulldozer (CAT D10)	121		CNVS
Circular Saw (Hand-held)	115		BS5228
Chainsaw - petrol	114		CNVS
Compactor	115	5	AS2436
Compressor	110		AS2436
Concrete Agitator Truck	111		AS2436
Concrete Pencil Vibrator	105	5	BS5228
Concrete Pump	106		AS2436
Concrete Pump Truck	113		AS2436
Concrete Saw	122		AS2436
Concrete Vibratory Screed	115		AS2436
Crane (Franna)	98		CNVS
Crane (Mobile)	113		AS2436
Crane (Tower)	105		AS2436
Crane (Truck Mounted)	108		CNVS
Elevated Work Platform (Cherry Picker)	105		AS2436
Excavator	117		AS2436
Excavator (Idling) (25t)	95		BS5228

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Excavator (3t)	90		CNVS
Excavator (6t)	95		CNVS
Excavator (6t) + hydraulic hammer	115	5	CNVS
Excavator (10t)	100		CNVS
Excavator (10t) + hydraulic hammer	118	5	CNVS
Excavator (15t)	100		BS5228
Excavator (25t)	95		BS5228
Excavator (30t)	102		BS5228
Excavator (30t) + hydraulic hammer	122	5	CNVS
Excavator (40t)	106		BS5228
Filtration Unit	109		AS2436
Forklift	106		AS2436
Fuel Tanker Pump	100		BS5228
Generator (Diesel)	113		AS2436
Grader	115		AS2436
GritBlaster (Grit & Nozzle Air Noise)	129		AS2436
Hand Tools (Electric)	110		AS2436
Hand Tools (Pneumatic)	117		AS2436
Hydraulic Power Pack	106		BS5228
Jack Hammer	121	5	AS2436
Lighting Tower	80		CNVS
Lighting - Daymakers	98		CNVS
Light Vehicle - 4WD	103		CNVS
Line Marking Truck	108		CNVS
Loader (Front-end) (23t)	112		CNVS
Loader - Skidsteer (Bob-cat) (1/2t)	107		CNVS
Loaders - Skisteer (Bob-cat) (1t)	110		CNVS
Loader - Tracked (0 - 50kW)	115		CNVS
Loaders - Tracked (200 -300kW)	121		CNVS
Lorry with Lifting Boom	105		BS5228
Machine Mounted Hydraulic Drill	115	5	AS2436
Machine Mounted Percussive Drill	116	5	AS2436
Machine Mounted Pneumatic Drill	121	5	AS2436
Micro tunnelling/directional drilling	112		Based on Lw for a piling rig - bored
Mulcher (Chipper)	116		CNVS
Pavement Laying Machine	114		CNVS

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Pavement Profiler	117		CNVS
Piling (Bored)	112		CNVS
Piling (Impact Sheet)	147	5	BS5228
Piling (Vibratory)	133		AS2436
Piling rig (Impact)	129	5	CNVS
Pneumatic Spade	115		BS5228
Pulveriser (mounted on Excavator)	108		AS2436
Rattle Gun (hand-held)	104		CNVS
Road Lorry (Empty)	111		BS5228
Road Lorry (Full)	108		BS5228
Rigid Road Lorry	110		BS5228
Road Sweeper	104		BS5228
Rock Breaker	118		AS2436
Roller (Smooth-drum)	107		CNVS
Roller (Large Pad Foot)	109		CNVS
Roller (Vibrator)	109	5	CNVS
Scraper	116		AS2436
Sideboom/Pipe layers	108		Based on Lw for a crane
Slurry management equipment	96		Based on Lw for a water pump (Electric)
Spreader	95		AS2436
Trenching Machine (25kW)	105		BS5228
Truck	107		AS2436
Truck (Dump)	117		AS2436
Truck (Road Truck/Truck & Dog)	108		CNVS
Truck (Vacuum)	109		CNVS
Truck (Water Cart)	108		AS2436
Vehicle (Light Commercial e.g. 4WD)	111		AS2436
Water Pump	93		BS5228
Water Pump (Diesel)	106		BS5228
Water Pump (Electric)	96		BS5228
Water Jet Pump	91		BS5228
Wrench (Impact)	111	5	CNVS
Welder	110		AS2436

Note that the penalty is to be applied to the sound power level Lw as the equipment is characterised as containing special audible characteristics.