Appendix C Noise and Vibration Assessment

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Noise and Vibration Impact Assessment
Transport for New South Wales
23 Oct 2019
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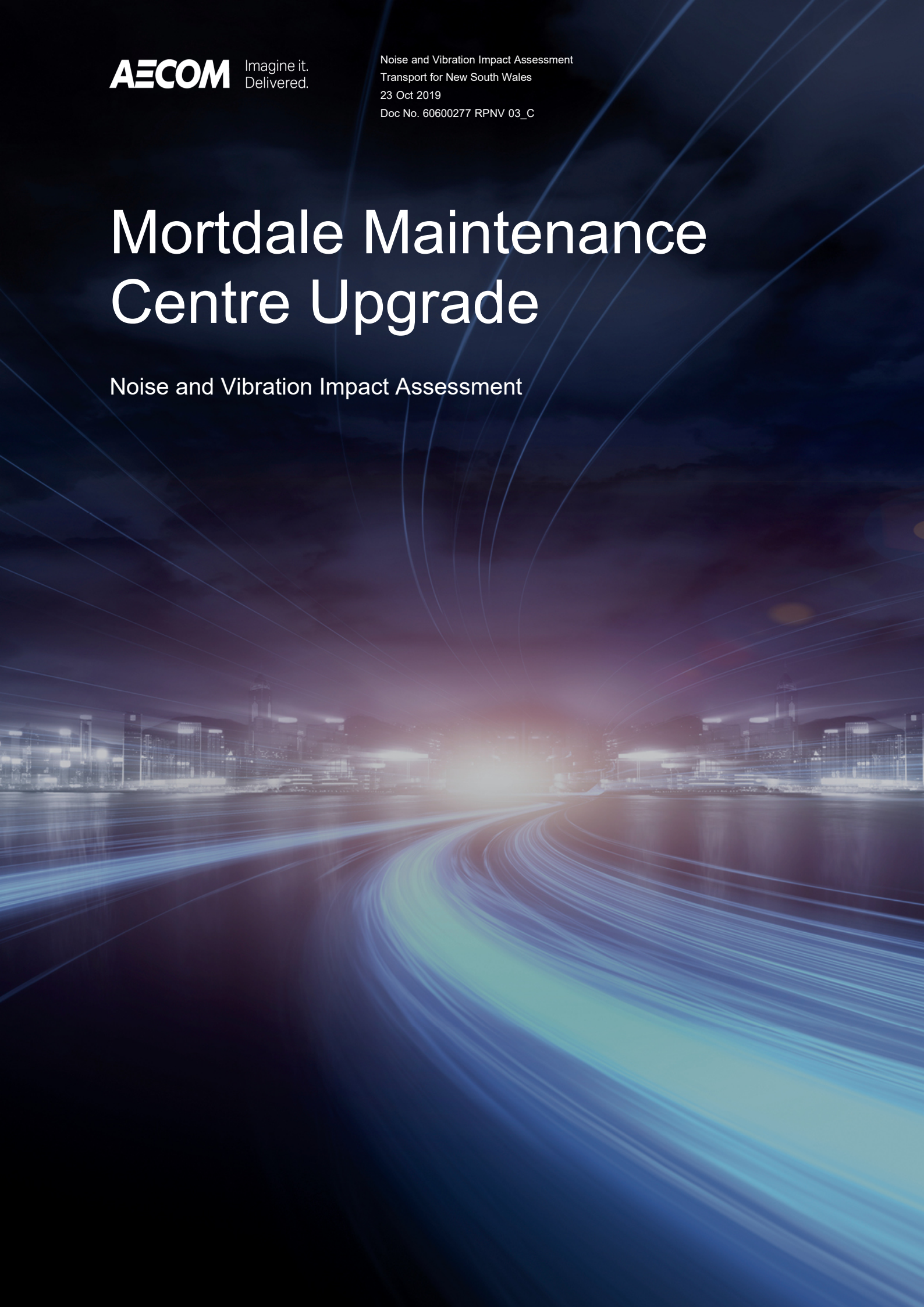
Mortdale Maintenance Centre Upgrade

Noise and Vibration Impact Assessment



Mortdale Maintenance Centre Upgrade

Noise and Vibration Impact Assessment

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Executive Summary

Transport for NSW (TfNSW) proposes to deliver service improvements on the T4 Illawarra Line, South Coast Line and T8 Airport Lines. The improvements would deliver greater capacity, reliability and connectivity for customers. To achieve this, TfNSW has developed the More Trains, More Services Program (the 'Program').

As part of the Program, TfNSW proposes to undertake an upgrade of the Mortdale Maintenance Centre (the Proposal). The upgrade is designed to support changes to the use of the Mortdale Maintenance Centre including a new bogie exchange workshop within the western side of the facility as well as associated utility adjustments.

This noise and vibration impact assessment forms part of the Review of Environmental Factors (REF) which assesses the potential impacts of the Proposal on the environment. Relevant guidelines and assessment procedures have been followed to ensure all applicable State requirements have been considered.

A survey has been undertaken of the existing conditions throughout the Proposal area. Buildings throughout the Proposal area have been visually inspected (from the outside) to identify their likely use and the number of storeys. Background noise levels have been monitored at a residential receiver location to identify the existing noise environment throughout the Proposal area. The existing noise environment allows this assessment to define appropriate noise criteria.

A construction noise impact assessment has been conducted in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) and *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2019). Reasonable worst-case construction scenarios have been assessed. Construction of the Proposal would occur both during standard construction hours and out-of-hours to minimise disruptions to the rail network. The out-of-hours work would be subject to the processes outlined in Section 3.1.

The assessment of noise associated with the construction of the Proposal indicates some exceedances of the ICNG noise management levels at the most affected sensitive receivers. Exceedances of the noise management levels occur during the day and night at the most affected sensitive receivers during certain activities. The magnitude of these impacts is consistent with similar construction projects and highlights the need for effective noise mitigation and management planning.

Measures have been recommended to mitigate the construction noise impacts at adjacent sensitive receivers. Specific noise management and mitigation measures would be detailed in the contractor's Construction Noise and Vibration Management Plan. The recommended management and mitigation measures which would be considered in the plan include:

- Effective communication with community and affected receivers about mitigation measures
- Training of construction site workers
- Use of noise barriers
- Noise monitoring
- Appropriate selection and maintenance of equipment
- Scheduling of work for less sensitive time periods
- Situating plant in less noise sensitive locations
- Construction traffic management
- Respite periods.

Minimum working distances for vibration intensive construction works have been presented. Equipment size would be selected by the contractor taking into account the minimum working distances and the distance between the construction works and the most affected sensitive receiver. If works need to be undertaken within minimum working distances, vibration monitoring would be undertaken.

An assessment of the likely construction traffic indicated that the noise increases along construction traffic routes are predicted to be well below the 2 dB increase screening criteria. Therefore, no further assessment is required in accordance with the Environment Protection Authority's *NSW Road Noise Policy* (RNP) (DECCW 2011).

The results of the assessment of fixed facilities associated with Maintenance Centre operations identified a number of exceedances of the project noise trigger levels for both the existing and future operations. In addition, a sleep disturbance assessment considering maximum noise levels associated with the operation of the Maintenance Centre identified a number of exceedances of the nominated sleep disturbance criteria for both existing and future assessed scenarios, with no change in maximum noise levels between existing and future operations.

Based upon these outcomes, it is recommended that the selection of a quieter warning siren would prevent any additional exceedances of the operational project noise trigger levels compared with the existing situation.

An assessment of operational road traffic produced as a result of the operations of the Maintenance Centre was conducted. It was found that the increased number of vehicles as a result of the operation of the Proposal would have an insignificant effect on the existing road traffic noise levels on surrounding roads.

1.0 Introduction

1.1 Overview

Transport for NSW (TfNSW) proposes to deliver service improvements in the T4 Illawarra Line, South Coast Line and T8 Airport Line, including capacity, reliability and connectivity improvements for customers. To achieve this, TfNSW has developed the More Trains More Services Program (the Program).

As part of the Program, the Mortdale Maintenance Centre Upgrade (the Proposal) would aim to support future operation of the T4 Illawarra and South Coast Lines.

AECOM Australia Pty Ltd (AECOM) has been commissioned by TfNSW to carry out a noise and vibration impact assessment for the construction and operation of the Proposal.

A glossary of acoustic terminology is provided in Appendix A.

1.2 Background

The Proposal would contribute to the transformation of the rail network to provide customers with more reliable, high capacity turn up and go services in the future. In response to growth in demand on these lines, the next stages of the program will deliver a 30 per cent uplift in the total number of peak services on the T4 Illawarra Line, reducing crowding and providing a more comfortable journey for customers in the Sutherland Shire, Illawarra and South Coast.

1.3 The Proposal

The key features of the Proposal at the Mortdale Maintenance Centre are summarised as follows:

- demolition of the existing sheds in the proposed workshop footprint, adjacent to the western boundary of the site
- construction of a bogie exchange workshop within the western side of the existing facility
- construction of two bogie transfer chambers between roads 1 and 2 (existing rail tracks within the Mortdale Maintenance Centre) and the new bogie exchange workshop adjacent to the western boundary
- installation of a bogie exchange system including its components such as a hydraulic jack and mechanically operated bogie drop table
- extension of the existing driveway on Hurstville Road and construction of a new driveway exit as part of the bogie delivery/collection area within the western side of the facility
- decommissioning of an existing electrical substation at the eastern boundary
- installation of three electrical padmount substations in the staff parking area adjacent to the eastern boundary
- reinstatement of staff parking spaces at the location of the decommissioned substation
- civil works to support the above works, including track modification at the loop siding, drainage and new retaining walls
- associated electrical works including combined services route and lighting
- provision for additional maintenance activities, including 24 hours a day, seven days a week operation of the bogie exchange workshop.

1.4 Relevant guidelines

The relevant policies and guidelines for noise and vibration assessments in NSW that have been considered during the preparation of this report include:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *Construction Noise and Vibration Strategy* (CNVS), Transport for New South Wales (TfNSW), 2019
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC)
- DIN 4150:Part 2-1999 *Structural vibration – Human exposure to vibration in buildings* (Deutsches Institut für Normung 1999)
- DIN 4150:Part 3-2015 *Structural vibration – Effects of vibration on structures* (Deutsches Institut für Normung 2015)
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *Noise Policy for Industry* (NPfI), Environment Protection Authority (EPA), 2017

2.0 Existing noise environment

2.1 Proposal area description

The Proposal is located within the existing Mortdale Maintenance Centre, 195-235 Hurstville Road (Lot 100/DP 1141151), about 20 kilometres south west of the Sydney CBD. The Proposal area is within Georges River Local Government Area (LGA).

Mortdale Maintenance Centre is bounded by Hurstville Road to the west and south, Georges River College and the Ausgrid Oatley Depot to the East, and the rail line to the north.

Mortdale is a predominantly residential suburb, with residential receivers surrounding the Mortdale Maintenance Centre, in addition to some educational, recreational and commercial use. The acoustic environment is characterised by typical suburban noise, in addition to road traffic noise from Hurstville Road/Boundary Road and some noise contribution from the existing site activities of the Mortdale Maintenance Centre.

An overview of the Proposal area showing the noise monitoring location and assessment receivers is shown in Figure 1 below.

Figure 1 Proposal overview

2.2 Receivers

Residential and non-residential receivers potentially affected by the construction and operation of the Proposal have been identified within the Proposal area (refer to Figure 1). Receivers predominantly comprise residential properties located within the suburbs of Mortdale and Oatley. These noise sensitive receivers were identified using aerial photography, and their occupational uses were determined through a ground-truthing site survey exercise. This exercise, in conjunction with cadastral information, was used to determine the classification of any residential, commercial, industrial, educational and recreational buildings, as well as other uses (such as unoccupied sheds). Sensitive receivers in this area are predominantly one and two storey residential properties. Assessment criteria have been determined for all receivers as outlined in Section 3.0.

2.3 Noise monitoring

Ambient noise monitoring was conducted at one location within the Proposal area during May 2019. This included both long term monitoring and short term attended measurements.

The unattended noise measurements define the long term noise environment throughout the Proposal area and are used to define the construction and operational noise criteria. Attended noise measurements are carried out to determine what noise sources contribute to the local noise environment.

2.3.1 Instrumentation

Details of the equipment used for unattended long term noise monitoring are presented in Table 1. The noise monitoring location is shown graphically in Figure 1 above.

Table 1 Noise monitoring details

Address	Model	Serial number
23 Waratah Street, Oatley	SVAN 977	45416

The sound level meter used to conduct attended measurements was a Bruel & Kjaer 2250 (Serial Number 3009329). All acoustic instrumentation used for the assessment comply with the requirements of AS IEC 61672.1-2004 Electroacoustics – Sound level meters – Specifications and were calibrated before and after monitoring sessions with a drift in calibration not exceeding ± 0.5 dB.

All instruments used were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

2.3.2 Unattended background noise monitoring results

Unattended noise monitoring was carried out from 9 May 2019 to 17 May 2019 at one location considered to be representative of the noise sensitive receivers within the Proposal area (refer to Figure 1).

A sound level meter measures the noise level over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period respectively. The L_{A1} is indicative of maximum noise levels due to individual noise events. The L_{A90} is considered to be the background noise level. The L_{Aeq} parameter is the energy averaged sound level over the measurement period. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

The assessment background level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration. The RBL is representative of the average minimum background sound level, or simply the background level.

A noise logger report including graphical representations of the logging results, a summary of the results and the measurement location is provided in Appendix B. A summary of the measured L_{A90} background noise levels and existing L_{Aeq} ambient noise levels is presented in Table 2.

Table 2 Existing background and ambient noise levels, dB(A)

Address	Rating background level, L_{A90}, dB(A)			Ambient noise levels, L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
23 Waratah Street, Oatley	39	37	30	52	51	50

Notes:

1. *In accordance with the NPfI, time of day is defined as follows :*
   Day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
   Evening – the period from 6 pm to 10 pm.
   Night – the remaining periods.

2.3.3 Attended noise monitoring

Attended noise monitoring was conducted at the unattended monitoring location on 9 May 2019. The measurement was conducted over a 15 minute period. Weather conditions were clear on the day of monitoring, with no wind. The monitoring results from the attended measurements are presented in Table 3.

Table 3 Attended noise monitoring details

Address	Date	Time	Description	$L_{Amax, 15min}$ dB(A)	$L_{A10, 15min}$ dB(A)	$L_{Aeq, 15min}$ dB(A)	$L_{A90, 15min}$ dB(A)
23 Waratah Street, Oatley	9/5/2019	10:14 am	Noise environment dominated by distant road traffic from Hurstville Road and bird noise 42 dB(A). Distant banging from local construction barely audible. Train horns from Mortdale Maintenance Centre in distance audible approx. 52 dB(A). Train air brake release whistling noise 50 dB(A) clearly audible from Mortdale Maintenance Centre. Distant conversation and door slam from nearby carpark audible. Aircraft flyover 53 dB(A)	82	52	51	40

3.0 Assessment criteria

3.1 Construction noise criteria

The ICNG is a NSW Government document that identifies ways to manage impacts of construction noise on residences and other noise sensitive land uses. It is the principal guideline for the assessment and management of construction noise in NSW and is used to establish construction noise management levels (NML). As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'reasonable' worst case construction scenarios, has been carried out for these works.

Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using noise modelling software and are compared to the levels provided in the ICNG. Where an exceedance of the noise management levels (NMLs) is predicted the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially affected residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details should they wish to make a complaint.

Where construction noise levels at the receiver reach 75 dB(A) residential receivers are considered to be 'highly noise affected' and the proponent should, in consultation with the community, consider restrictions to the hours of construction to provide respite periods.

The ICNG defines what is considered to be feasible and reasonable as follows:

- Feasible - a work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements
- Reasonable - selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Additionally, the ICNG notes that strong justification is required for work that is proposed outside of standard working hours.

Residential receiver NMLs for this Proposal have been derived using the information presented below in Table 4.

Table 4 Construction noise management levels – Residential receivers

Time of day	Construction noise management level $L_{Aeq,15min}$	How to apply
Recommended standard hours: • Monday to Friday 7am to 6pm • Saturday 8am to 1pm • No work on Sundays or public holidays	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,15\ min}$ 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 dB(A)	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 (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - 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 - If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB(A)	• 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 dB(A) above the noise affected level, the proponent should negotiate with the community • For guidance on negotiating agreements see section 7.2.2 of the Interim Construction Noise Guideline.

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.

3.1.1 Construction hours

The majority of work required for the Proposal would be carried out during standard construction hours as recommended in the ICNG as follows:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm Saturdays
- No work on Sundays or public holidays.

Certain works may need to occur outside standard hours. These out-of-hours works would be of short duration, and may be required in some distinct cases to minimise disruptions to customers, pedestrians, motorists and nearby sensitive receivers. The construction contractor would require approval from TfNSW for any out-of-hours work. The affected community would be notified as outlined in TfNSW's Construction Noise and Vibration Strategy (CNVS).

3.1.2 Construction noise management levels

Provided in Table 5 are the applicable NMLs for the Proposal, based on the RBLs in Table 2 and NMLs in Table 4.

Table 5 Construction noise management levels - residential receivers

Period	RBL L_{A90}, dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out of hours noise management levels, $L_{Aeq,15min}$, dB(A)
Day	39	49	44
Evening	37	-	42
Night	30	-	35

NMLs recommended by the ICNG for non-residential sensitive land uses, such as schools, hospitals or places of worship are provided in Table 6. NMLs for commercial and industrial premises are provided in Table 7.

Table 6 Construction noise management levels – non-residential sensitive land uses

Land use	Noise management level, $L_{Aeq(15\ min)}$
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended "maximum" internal levels in AS2107 for specific uses.

Table 7 Construction noise management levels – Commercial and industrial land uses

Land use	Noise management level, $L_{Aeq(15min)}$
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)

3.1.3 Sleep disturbance

The ICNG requires a sleep disturbance assessment to be undertaken where construction works are planned to extend over more than two consecutive nights. The ICNG makes reference to the EPA's NSW *Environment Criteria for Road Traffic Noise* (ECRTN), now superseded by the *NSW Road Noise Policy* (RNP), for the assessment of sleep disturbance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10pm to 7am), the $L_{A1(1\ min)}$ noise level outside a bedroom window should not exceed the $L_{A90(15\ min)}$ background noise level by more than 15 dB(A). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken that should include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, *"Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions"*. Therefore, given that an open window provides around 10 dB(A) in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Table 8 presents the sleep disturbance screening and sleep disturbance awakening reaction criteria.

Table 8 Construction noise sleep disturbance criteria

Night time rating background level, dB(A)	Sleep disturbance screening $L_{A1(1min)}$ criteria, dB(A)	Sleep disturbance awakening reaction $L_{A1(1min)}$ criteria, dB(A)
30	45	65

3.1.4 Construction road traffic noise

Noise from construction traffic on public roads is not covered by the ICNG. However, the ICNG does refer to the ECRTN, which is now superseded by the RNP, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic, an initial screening test has been undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

3.2 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 9.

Table 9 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – *Structural Vibration in Buildings – Effects on Structures* (DIN 4150)
Human comfort (tactile vibration)	*Assessing Vibration: A Technical Guideline* (AVATG)[1]

Notes:

1. *This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

3.2.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

The German standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 10. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 10 Structural damage safe limits for building vibration (Vibration peak particle velocity)

Group	Type of structure	At foundation Less than 10 Hz	At foundation 10 Hz to 50 Hz	At foundation 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

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

3.2.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline *Assessing Vibration: A Technical Guideline* is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 11. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 11 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime [1] Preferred	Daytime Max	Night time Preferred	Night time Max
Critical areas[2]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Notes:
1. *Day is defined as 7:00 am to 10:00 pm. Night is defined as 10:00 pm to 7:00 am*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.*

3.3 Operational noise criteria

The EPA's *Noise Policy for Industry* (NPfI) provides noise trigger levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The assessment procedure for industrial noise sources has two components that must be considered:

- controlling intrusive noise impacts in the short term for residences; and
- maintaining noise level amenity for residences and other land uses.

3.3.1 Intrusiveness noise levels

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the RBL measured by more than 5 dB(A). The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in Fact Sheet B of the NPfI. Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or impulsiveness.

The intrusiveness noise levels applicable to the Proposal are presented in Table 12.

Table 12 Intrusiveness noise levels

Period	RBL. L_{A90}, dB(A)	Intrusiveness noise level (RBL + 5), dB(A)
Day	39	44
Evening	37	42
Night	30	35

Notes:
1. *In accordance with the* NPfI*, time of day is defined as follows :*
   Day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
   Evening – the period from 6 pm to 10 pm.
   Night – the remaining periods.

3.3.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the acceptable levels specified in Table 2.2 of the NPfI. As per the definitions of receiver types in Table 2.3 of the NPfI, residential receivers likely to be affected by noise from the operation of the facility are classed as being suburban residential.

The recommended amenity noise levels represent the objective for total industrial noise at receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

The project amenity noise level is equal to the recommended amenity level minus 5 dB(A). In addition, the project amenity level is converted from a period to 15 minutes by adding 3 dB(A). Therefore, the relevant project noise amenity level for each applicable type of receiver is shown below in Table 13.

Table 13 Recommended L_{Aeq} noise levels from industrial noise sources

Type of receiver	Indicative noise amenity area	Period	Recommended amenity noise level, $L_{Aeq(period)}$	Project amenity noise level, $L_{Aeq,15min}$
Residential	Suburban	Day	55	53
		Evening	45	43
		Night	40	38
School classroom	All	Noisiest 1-hour period when in use	45[1]	43
Place of worship	All	When in use	50	48
School playground	All	When in use	55	53
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50	48
Commercial premises	All	When in use	65	63

Notes:
1. External noise levels are based on a 10 dB(A) reduction from outside to inside through an open window.

3.3.3 Project noise trigger levels

The project noise trigger level is the lower of the intrusiveness and the amenity noise levels. Provided in Table 14 are the established project noise trigger levels for the assessment locations within the Proposal area. Table 14 presents the project noise trigger levels for the day, evening and night-time periods.

Table 14 Operational noise criteria

Type of receiver	Assessment period	Intrusive noise levels, $L_{Aeq,15min}$	Amenity noise levels, $L_{Aeq,15min}$	Project noise trigger levels, $L_{Aeq,15min}$
Residential suburban	Day	44	53	44
	Evening	42	43	42
	Night	35	38	35
School classroom - internal	Noisiest 1-hour period when in use	-	43	43
School playground	When in use	-	53	53
Area specifically reserved for passive recreation (e.g. national park)	When in use	-	48	48
Place of worship - internal	When in use	-	48	48
Commercial premises	When in use	-	63	63

3.3.4 Maximum noise level assessment

The NPfI requires the potential for sleep disturbance to be assessed by considering maximum noise levels events during the night-time period.

Where the subject development/premises night-time noise levels at a residential location exceed the following screening levels a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 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.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 15.

Table 15 Night-time sleep disturbance screening levels

Type of receiver	Measured night time RBL, $L_{A90,15min}$, dB(A)	Sleep disturbance screening levels	
		$L_{Aeq,15min}$	L_{AFmax}
Residential	30	40	52

3.3.5 Operational road traffic noise

Noise from truck movements to and from the site as a result of the bogie exchange workshop upgrade was assessed using the RNP. Vehicle access for the bogie exchange workshop will be from Hurstville Road via Hillcrest Avenue. These roads are classified as sub-arterial roads.

Table 16 presents the EPA's road traffic noise assessment criteria for residential developments with potential to create additional traffic on existing roads. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor.

Table 16 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria dB(A)	
		Day (7 am 10 pm)	Night (10 pm 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60	$L_{Aeq, (9\ hour)}$ 55

To assess noise impacts from operational road traffic, an initial screening test has been undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

4.0 Construction noise assessment

4.1 Construction stages and scheduling

Construction activities to be carried out as part of the Proposal are outlined in Table 17. The work has been grouped into nine distinct construction stages based on proposed construction activities.

Certain work may need to occur outside standard construction hours. This has been discussed further in Section 3.1.1. In the absence of information regarding which activities are proposed to occur outside of standard construction hours, this assessment has considered all scenarios to be conducted both during standard construction hours and out-of-hours.

Table 17 Proposed construction activities

Construction stage	Activities
Site establishment and enabling works	• Establishment of site compound (i.e. erect fencing, tree protection zones (TPZs), site offices, amenities and plant/material storage areas) • Establishment of temporary facilities as required (e.g. hoarding, temporary toilets etc.).
Utility relocation	• Drop electricity wires and undertake overhead wiring adjustments • Relocation of electrical and communications services • Relocate existing drainage and drop pits • Install local routes and run cables for access gate • Install CCTV.
Infrastructure adjustments	• Relocate boom gate • Remove gate • Remove redundant footings • Relocate access road • Clip and lock existing track closest to Hurstville Road.
New bogie tracks, road and shed	• Demolish existing sheds – including part of the maintenance shed • Construct retaining wall adjacent to new bogie shed • Install footings and construction new bogie shed structure along western boundary (20 m x 50 m) • Construct bogie racks • Excavate pits for bogie drop table and bogie turntable • Install new track for bogie road • Replace overhead wire • Install gantry crane (if required) • Install new track between bogie road and No1 storage.
Driveway adjustments	• Redirect and/or provide temporary traffic management through the existing entry gate • Demolish parts of the existing driveway • Construct new retaining wall along extended driveway • Construct new exit gate, crossover and kerb layback • Construct new driveway surface and provide linemarking.
Demobilisation	• Reopen Mortdale car sidings shed door • Demobilise site establishment • Remove safety fence/barriers and hoarding • Unclip and unlock existing track closest to Hurstville Road.
Testing and commissioning	• Test electrical, communications and signalling components • Test and commission new bogie road, turntables.
Substation site establishment and enabling works	• Remove car parking spaces to allow for future padmount substations.

Construction stage	Activities
Substation infrastructure adjustments	• Install padmount substation and run cables through Mortdale Maintenance Centre.
Substation commissioning	• Commission new padmount substations.
Redundant substation demolition	• Demolish redundant existing substation • Resurface and create new staff car park spaces.

4.2 Plant and equipment levels

Presented in Table 18 are the typical sound power levels of the construction equipment to be used during each modelled construction scenario. The modelled scenarios include all equipment that could be reasonably assumed to be operating at the same time for an entire 15 minute period.

These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* and British Standard 5228: Part 1 2009 *Code of practice for noise and vibration control on construction and open sites*, 2009 as well as AECOM's noise database.

These sound power levels assume equipment is modern and in good working order. In AECOM's experience, L_{A1} sound power levels of construction activities are typically up to eight decibels above L_{Aeq} sound power levels.

For the noise assessment only the worst case construction scenarios have been considered (shaded blue in Table 18). These scenarios were chosen based not only on their overall sound power level, but also their location within the Mortdale Maintenance Centre boundary.

During the detailed design local site conditions and changes in work practices may cause some variation in the equipment used. While the equipment may vary, other major infrastructure projects have shown that due to the conservative approach to noise predictions, received noise levels are unlikely to be appreciably higher than those predicted in this assessment.

This approach is used at this point in the assessment to ensure that identified impacts are not under-predicted and adequate noise management and mitigation measures are considered early in the Proposal.

Table 18 Construction staging and typical sound power levels of construction equipment (modelled scenarios – blue)

Construction stage	Equipment	Sound power level, dB(A)
Site establishment and enabling works	Bobcat	104
	Trucks	98
	Lighting tower	95
	Generator	101
	Light vehicles	90
	Hand tools	98
	Total	**107**

Construction stage	Equipment	Sound power level, dB(A)
Utility relocation	8t Excavator	99
	Trucks	98
	Lighting tower	95
	Jackhammer	108
	Demolition saw	110
	Hand tools	98
	Total	**113**
Infrastructure adjustments	Demolition saw	110
	8t Excavator	99
	Hand tools	98
	Jackhammer	108
	Lighting tower	95
	Trucks	98
	Franna crane	93
	Total	**113**
New bogie tracks, road and shed	35t Rotary bored piling rig	103
	8t Excavator	99
	Franna crane	93
	Hand tools	98
	Generator	101
	Trucks	98
	Concrete pump	105
	Agitator	109
	Total	**112**
Driveway adjustments	35t Rotary bored piling rig	103
	Concrete pump	105
	Light vehicles	90
	8t Excavator	99
	Trucks	98
	Hand tools	98
	Total	**109**

Construction stage	Equipment	Sound power level, dB(A)
Demobilisation	Bobcat	104
	Generator	101
	Hand tools	98
	Light vehicles	90
	Lighting tower	95
	Trucks	98
	Total	**107**
Testing and commissioning	Hand tools	98
	Lighting tower	95
	Trucks	98
	Light vehicles	90
	Total	**102**
Substation site establishment and enabling works	Bobcat	104
	Generator	101
	Hand tools	98
	Lighting tower	95
	Light vehicles	90
	Trucks	98
	Total	**107**
Substation infrastructure adjustments	Demolition saw	110
	8t Excavator	99
	Hand tools	98
	Jackhammer	108
	Lighting tower	95
	Trucks	98
	Franna crane	93
	Total	**113**

Construction stage	Equipment	Sound power level, dB(A)
Substation commissioning	Hand tools	98
	Lighting tower	95
	Trucks	98
	Light vehicles	90
	Total	**102**
Redundant substation demolition	Trucks	98
	Hand tools	98
	8t Excavator	99
	Jackhammer	108
	Generator	101
	Total	**110**

4.3 Noise modelling methodology

Noise levels due to the construction activities shown in Table 18 were predicted at nearby noise sensitive receivers using SoundPLAN v8.0 noise modelling software. The noise model was created to represent 'reasonable' worst periods of construction work.

The following features were included in the noise model:

- Ground topography
- Ground absorption and reflection
- Receivers as shown in Figure 1
- Construction noise sources as outlined in Table 18.

Noise emissions from the construction sites have been modelled using an implementation of the ISO 9613-2:1996 propagation algorithm with neutral meteorological conditions.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment.

4.3.1 Construction modelling assumptions

The following assumptions were made in modelling the construction noise scenarios:

- All equipment would be operating simultaneously, which is unlikely hence a conservative assumption
- Equipment was assumed to be operating at the closest point in the Proposal area to each receiver, in order to present the worst-case scenario.
- Neutral atmospheric conditions i.e. relatively calm, no wind.

4.4 Predicted construction noise impacts

A summary of the number of receivers where construction noise levels are predicted to exceed NMLs during the loudest construction stages are presented for standard hours construction activities in Table 19 and for out-of-hours construction activities in Table 20. Out-of-hours work has been conservatively assessed against the more stringent night-time criteria. Appendix C presents the L_{Aeq} noise level contours.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity, while the construction equipment is at the nearest location to each sensitive receiver location. The assessed scenario does not represent the ongoing day to day noise impact at noise sensitive receivers for an extended period of time.

Particularly noisy activities, such as bored piling, are likely to persist for only a portion of the overall construction period. In addition, the predictions use the shortest separation distance to each sensitive receiver, however in reality the distance will vary between plant and sensitive receivers.

Table 19 Predicted construction noise impacts for residential receivers - Daytime

Construction scenario	NML	Number of receivers where noise levels >10 dB(A) above NML	Number of highly noise affected receivers where noise levels ≥75 dB(A)
New bogie tracks, road and shed	49	4	0
Driveway adjustments	49	1	0
Substation infrastructure adjustments	49	0	0

Table 20 Predicted construction noise impacts for residential receivers – Night-time

Construction scenario	NML	Number of receivers where noise levels may exceed the NML			
		NML exceedance <5 dB(A)	NML exceedance 5 14 dB(A)	NML exceedance 15 25 dB(A)	NML exceedance >25 dB(A)
New bogie tracks, road and shed	35	360	271	33	1
Driveway adjustments	35	311	135	26	0
Substation infrastructure adjustments	35	393	215	12	0

The results presented in Table 19 show that there is a very limited number of exceedances of the NMLs adopted in Section 3.1 during the daytime. During standard construction hours, there are up to four receivers where noise levels are anticipated to exceed the NMLs by more than 10 dB(A), and no receivers are expected to be considered highly noise affected (> 75 dB(A)).

The results presented in Table 20 show that during the night-time, noise levels at a large number of receivers are predicted to exceed the NMLs. Up to 665 receivers are predicted to exceed the NMLs in the worst-case scenario, which is also during the ‘New bogie tracks, road and shed’ scenario. This is predominantly due to the following reasons:

- High noise levels associated with proposed construction activities. It should be noted that this assessment is representative of the worst case 15 minute period of construction activity, where the construction equipment is at the nearest location to each sensitive receiver location. The assessed scenario does not represent the ongoing noise impact at noise sensitive receivers for an extended period of time. It should be noted that night-time construction activities are unlikely to occur at the same scale as day-time activities and as such, the predicted impacts may be less.
- Low background noise levels during the night-time period, resulting in low applicable NMLs.
- High concentration of residential receivers located throughout the Proposal area. Over 90% of receivers identified within the Proposal area have been classified as residential.

In order to reduce the potential noise impacts associated with night-time construction works, high-noise generating activities such as piling, excavating, jackhammering and concrete sawing should be avoided wherever feasible and reasonable during these hours. Further recommendations to mitigate construction noise impacts have been provided in Section 7.0.

4.5 Sleep disturbance assessment

Sleep disturbance is assessed using an $L_{A1(1\ min)}$ parameter, which is considered to be the maximum noise level excluding extraneous noise events. A sleep disturbance assessment has been undertaken for the proposed night works with the construction information available to date. The noise modelling results are provided in Table 21 below with predicted noise levels compared with the sleep awakening reaction criterion.

Table 21 Predicted $L_{A1(1min)}$ sleep disturbance impacts at residential receivers

Construction scenario	Sleep disturbance criteria, dB(A)	Maximum $L_{A1(1min)}$ noise level, dB(A)	Number of receivers where noise levels exceed	
			Sleep disturbance criteria	Awakening reaction criteria
New bogie tracks, road and shed	45	68	512	5
Driveway adjustments	45	60	231	0
Substation infrastructure adjustments	45	65	375	0

A large number of exceedances of the sleep disturbance screening criteria have been predicted due to the potential night-time construction works associated with the Proposal. These receivers are predominantly located along Waratah Street and Judd Street. Noise associated with construction works are not anticipated to exceed the awakening reaction criteria, with the exception of the 'New bogie tracks, road and shed' construction scenario, where it is predicted that noise at up to five receivers may exceed the awakening reaction criterion. These exceedances are attributed to the proximity of the construction site to residences located along Waratah Street.

4.6 Construction traffic assessment

Construction activities were based on indicative construction movements and have been used in lieu of rigorously defined vehicle movements which would be determined during detailed design. Construction traffic movements in this assessment were used to conservatively assess the following number of vehicles:

- 50 light vehicle movements during the daytime and night-time periods.
- 50 heavy vehicle movements during the daytime and night-time periods.

Traffic counts for the existing AM peak (8am – 9am) and PM peak (5pm – 6pm) traffic flows have been sourced from a survey in a previous assessment completed for TfNSW titled '*Oatley Station Accessibility Upgrade – Preliminary Design – Traffic, Transport and Access Impact Assessment'* dated April 2014. These values have been converted to a daytime (15 hour) and night-time (9 hour) traffic volume. This conversion assumed the peak hour traffic flow is 11% of the daily 24 hour traffic volume, and 88% of the daily 24 hour traffic volume occurs during the 15 hour day (7am to 10pm) period whilst the remaining 12% of vehicles travel during the 9 hour night-time (10pm to 7am) period. These volumes are presented in Table 22 below. It has also been assumed that current traffic consists of 10% heavy vehicles during the daytime and 20% in the night-time.

Table 22 Existing traffic flows and additional traffic flows due to construction traffic

Road	Period	Existing traffic flow		Additional traffic flow		Relative noise increase, dB(A)
		Light	Heavy	Light	Heavy	
Hurstville Road (East of Oatley Parade)	Daytime	8,388	932	50	50	0.1
	Night-time	1,088	272	50	50	0.5

The results indicate that the predicted noise increases are significantly lower than the 2 dB(A) screening criteria presented in the RNP. As a result, no further consideration of construction traffic is required at this stage.

5.0 Construction vibration assessment

Vibration intensive work has the potential to occur as part of the construction work. Work may include the use of pile driving and jackhammering activities.

Typical minimum distances for the construction equipment that may be part of this Proposal are provided in Table 23. Minimum working distances have been developed to meet the recommended levels of vibration in British Standard 6472-1992 and DIN 4150, and are based upon the safe working distances presented in TfNSW's CNVS and AECOM's library of vibration data.

Minimum working distances should be adhered to when operating vibration intensive equipment near buildings in order to minimise the risk of discomfort to occupants and structural damage.

Table 23 Recommended minimum working distances for vibration intensive equipment

Equipment	Rating/description	Minimum working distance (metres)	
		Cosmetic damage[1]	Human response
Piling rig – bored	≤ 800 mm	2 (nominal)	N/A
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

Notes:

1. *More stringent conditions may apply to heritage or other sensitive structures*

The minimum working distances presented in Table 23 assume individual items of plant would be operating independently. Concurrent operation of vibration intensive equipment should be avoided, however if it is necessary to operate multiple items of equipment concurrently close to the safe working distance then vibration monitoring is recommended.

The minimum working distances for cosmetic damage are general considered to be conservative and working within them would not necessarily result in damage. However, factors such as work practices and intervening ground conditions can affect vibration levels so vibration monitoring is recommended within these distances and should be carried out at the beginning of the work in order to refine the safe working distances for site specific conditions.

It is unlikely that vibration intensive equipment would be used within 60 m of sensitive receivers. A discussion of vibration mitigation is provided in Section 7.0.

6.0 Operational noise assessment

6.1 Assessment overview

Noise emissions associated with the operation of the Mortdale Maintenance Centre were assessed in accordance with the NPfI. Noise levels were predicted at nearby receiver locations based on typical operational noise from similar maintenance facilities, in addition to measurements of typical operations conducted on-site on 19 and 22 August 2019. The typical scenarios were modelled to assess the potential for noise emissions to impact nearby sensitive receiver locations and achieve the required project noise trigger levels presented in Section 3.3.3. The predicted noise levels are presented in Section 6.4 for 'reasonable' worst case daytime and night-time operations.

It is understood that the major operational change expected at the Mortdale Maintenance Centre is the inclusion of the bogie exchange workshop, located near the western perimeter of the Mortdale Maintenance Centre. This bogie exchange workshop is designed to facilitate the removal and installation of rail bogie assemblies on existing rolling stock for maintenance purposes. Noise measurements of a similar bogie exchange system at Hornsby Maintenance Depot were undertaken on 22 August 2019. Major noise sources contributing to the operation of this system included a motorised floor and gantry, in addition to a warning siren that is switched on when the gantry system is in use.

6.2 Noise modelling methodology

The operational noise levels were predicted using an implementation of CONCAWE[1] algorithms in the SoundPLAN v8.0 noise propagation software.

6.2.1 Meteorological conditions

Both standard and noise enhancing meteorological conditions were considered in accordance with the NPfI, with the following parameters:

Daytime/evening

- Standard meteorological conditions – Pasquill stability class D with wind speed up to 0.5 m/s at 10 metres
- Noise enhancing meteorological conditions – Pasquill stability class D with wind speed up to 3 m/s at 10 metres.

Night-time

- Standard meteorological conditions – Pasquill stability class D with wind speed up to 0.5 m/s at 10 metres
- Noise enhancing meteorological conditions – Pasquill stability class D with wind speed up to 3 m/s at 10 metres, and/or stability category F with winds up to 2 m/s at 10 metres.

The modelling includes:

- Ground topography
- Buildings and structures
- All identified noise producing items within the project site modelled as point or line sources where appropriate
- All sources are modelled to assume a 'reasonable' worst case 15-minute period scenario
- Ground absorption.

[1] CONCAWE – The oil companies' international study group for conservation of clean air and water – Europe (established in 1963) Report 4/81 "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the equipment and other noise sources.

All predicted noise levels are free field and 1.5 m above ground level at the most-affected point within a residential property boundary within 30 m of the nearest facade.

6.3 Scenarios and noise sources modelled

This section discusses the assumed sources of noise emission from the Mortdale Maintenance Centre and proposed bogie exchange workshop. The activities are generally categorised into the following groups:

- Steady-state or quasi steady-state noise sources which typically produce continuous and consistent noise levels
- Discrete noise, which occurs infrequently and for short durations of time. This type of noise includes train horns, car door slams, etc.

To undertake the operational noise assessment in accordance with the NPfI, the existing and future operations were considered for both the daytime and the night-time periods. These scenarios have been assumed to represent ‘reasonable’ worst case operational conditions. The noise sources and assumptions that have been considered in each scenario are detailed below:

Scenario 1 – Daytime - Existing operations

- One 8-car T-set train would move in the parking bay in the Mortdale Maintenance Centre, sounding its horn prior to moving
- One train would move through the wash bay
- Car door slam in carpark
- All roller doors on the existing Mortdale Maintenance Centre and the wash bay would be open during operations as a conservative assumption.

Scenario 2 – Daytime - Future operations

- One 8-car T-set train would move in the parking bay in the Mortdale Maintenance Centre, sounding its horn prior to moving
- One train would move through the wash bay
- Bogie drop would occur within the proposed bogie exchange workshop
- One truck movement within the site boundary, using the proposed driveway layout would occur
- One forklift movement would occur outside the proposed bogie exchange workshop on the western site boundary
- Reversing beeper from forklift
- Car door slam in carpark
- All roller doors on the existing Mortdale Maintenance Centre, the proposed bogie exchange workshop and the wash bay would be open during operations as a conservative assumption

Scenario 3 – Night-time - Existing operations

- One 8-car T-set train would move in the parking bay in the Mortdale Maintenance Centre, sounding its horn prior to moving
- Car door slam in carpark
- All roller doors on the existing Mortdale Maintenance Centre and the wash bay would be open during operations as a conservative assumption.

Scenario 4 – Night-time - Future operations

- One 8-car T-set train would move in the parking bay in the Mortdale Maintenance Centre, sounding its horn prior to moving
- Bogie drop would occur within the proposed bogie exchange workshop
- All roller doors on the existing Mortdale Maintenance Centre and the proposed bogie exchange workshop would be open during operations as a conservative assumption
- Car door slam in carpark.

Table 24 provides the typical noise levels for operational plant used in the assessment.

Table 24 Maintenance Centre reference noise levels

Source	Sound power level (SWL), dB(A)	Notes
T-set pulling into parking bar, release compressed air	84 L_{Aeq}[1]	-
Train wash	102 L_{Aeq}[1]	Opening at each end of wash facility
Bogie exchange workshop gantry	81 L_{Aeq}	Within bogie exchange workshop
Bogie exchange workshop warning siren	94 L_{Aeq}	Within bogie exchange workshop
Forklift	92 L_{Aeq}[1]	Moving on proposed bogie exchange workshop entry road
Forklift reversing beeper	98 L_{Amax}	-
Car door slam	97 L_{Amax}	In carpark on southern boundary
Truck	102 L_{Aeq}[1]	Moving on proposed bogie exchange workshop entry road
Train horn	110 $L_{A10,1min}$[2]	Train moving in maintenance facility – one 1-second burst

Notes:

1 In the noise impact assessment this sound power level was adjusted for a 15-minute assessment period

2 In the noise impact assessment this sound power level was adjusted for a 15-minute assessment period, assuming a 1-second burst.

6.4 Noise modelling results

6.4.1 L_{Aeq} noise levels

A summary of the predicted operational noise impacts associated with the existing operations of the Mortdale Maintenance Centre, and of the proposed Mortdale Maintenance Centre with bogie exchange workshop is presented for the daytime in Table 25 and for the night-time in Table 26. A graphical presentation of results is shown in Appendix D.

6.4.1.1 Daytime operations

Table 25 Summary of predicted noise levels for daytime operations of Mortdale Maintenance Centre

Operations	Meteorological condition	Project noise trigger level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers exceeding project noise trigger levels
Existing	Standard meteorological conditions	44	42	0
	Noise-enhancing meteorological conditions	44	45	1
Future	Standard meteorological conditions	44	45	1
	Noise-enhancing meteorological conditions	44	45	4

6.4.1.2 Night-time operations

Table 26 Summary of predicted noise levels for night-time operations of Mortdale Maintenance Centre

Operations	Meteorological condition	Project noise trigger level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers exceeding project noise trigger levels
Existing	Standard meteorological conditions	35	26	0
	Noise-enhancing meteorological conditions	35	27	0
Future	Standard meteorological conditions	35	38	3
	Noise-enhancing meteorological conditions	35	38	4

6.4.2 Maximum noise level assessment

Table 27 presents a summary of the sleep disturbance noise levels associated with forklift reversing beepers, car door slams, and train horns for the existing and future operations. These noise levels were predicted at nearby residential receivers within the Proposal area. A graphical representation of results is shown in Appendix D.

Table 27 Summary of predicted L_{Aeq} and L_{Amax} noise levels for maximum noise level assessment

Operations	Meteorological conditions	Sleep disturbance L_{Aeq}		Sleep disturbance L_{Amax}	
		Screening level, dB(A)	Number of receivers exceeding L_{Aeq} noise levels	Screening level, dB(A)	Number of receivers exceeding L_{Amax} noise levels
Existing	Standard meteorological conditions	40	0	52	11
	Noise-enhancing meteorological conditions	40	0	52	18
Future	Standard meteorological conditions	40	0	52	11
	Noise-enhancing meteorological conditions	40	0	52	18

6.4.3 Discussion

The operational noise assessment presented in this section identified a number of exceedances of the project noise trigger levels and maximum noise levels as a result of the existing operations of the Mortdale Maintenance Centre, as well as the future operations of the Mortdale Maintenance Centre with the new bogie exchange workshop. With consideration to the daytime operations of the facility, the existing daytime operational scenario predicts one exceedance of the project noise trigger level as a result of the operation of the train wash. Noise levels at this receiver are predicted to exceed the project noise trigger level by 1 dB(A). This receiver is located at 31 Judd Street, the closest residential receiver to the wash facility. By comparison, the assessment of the future daytime operations of the Mortdale Maintenance Centre indicated that up to four receivers are predicted to exceed the project noise management levels during the worst-case meteorological condition. Exceedances of up to 1 dB(A) are predicted. These exceedances are located at 31 Judd Street, 3B Wonoona Parade, 25C Waratah Street and 27 Waratah Street. These exceedances are predominantly due to the use of the bogie exchange system and associated warning siren with both roller doors of the building open, with the exception of the exceedance at 31 Judd Street, which is due to the operation of the wash facility.

With consideration to night-time operations, the existing night-time operational scenario predicts that there are no exceedances of the project noise trigger levels. However, in the future night-time scenario, up to four receivers are predicted to exceed the project noise trigger levels by up to 3 dB(A).

The results of the maximum noise level assessment indicate that a number of exceedances of the L_{Amax} sleep disturbance criteria are predicted for both the existing and future operations of the Mortdale Maintenance Centre, with noise levels at up to 18 receivers predicted to exceed the sleep disturbance criteria. These exceedances are due to the use of train horns whilst stabling operations are underway. However, it is noted that the future operations of the Mortdale Maintenance Centre are not predicted to result in a greater number of train movements within the facility, and as a result the number of maximum noise events is not expected to increase from what is currently predicted.

A discussion of potential mitigation measures to ameliorate noise impacts associated with the stabling facility is included in Section 7.0.

6.5 Operational traffic assessment

The Proposal would generate three additional truck movements per day as a result of the operation of the proposed bogie exchange workshop. This increase in the number of vehicles would have an insignificant effect on the existing road traffic noise levels on surrounding roads. This is based on the

existing traffic flows in the area and the fact that traffic flows would have to double to produce an increase of 3 dB(A). As a result, no further assessment of operational road traffic noise is required.

7.0 Mitigation measures

7.1 Construction noise and vibration mitigation

This section of the report presents construction noise and vibration mitigation measures to be considered for implementation to minimise and manage construction noise impacts.

The construction noise assessment presented in Section 4.0 of this report detailed a number of exceedances of the NMLs within the Proposal area. These were predicted as a result of various different construction activities. The following generic and receiver specific mitigation measures have been identified.

7.1.1 Construction Noise and Vibration Management Plan

A Construction Noise and Vibration Management Plan (CNVMP) should be developed for the Proposal and implemented prior to commencement of construction activities. The CNVMP should include all feasible and reasonable safeguards to manage the noise emissions from the site and any complaints which may occur due to construction noise. The CNVMP should include, as a minimum, the following:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work
- description and identification of all construction activities, including work areas, equipment and duration
- description of what work practices (generic and specific) would be applied to minimise noise and vibration
- a complaints handling process
- noise and vibration monitoring procedures, including for heritage structures
- overview of community consultation required for identified high impact works.

Construction works should be planned and carried out during standard construction hours wherever possible. Table 28 presents the standard mitigation measures contained within the *Construction Noise and Vibration Strategy* which should be considered as mitigation measures as part of the CNVMP.

Table 28 Transport for NSW's Construction Noise and Vibration Strategy standard mitigation measures

Action required	Safeguard details
Management measures	
Implement any project specific mitigation measures required	In addition to the measures set out in this table, any project specific mitigation measures identified in this report.
Implement stakeholder consultation measures	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities will be delivered to sensitive receivers at least seven days prior to commencement of relevant works.
Site inductions	All employees, contractors and subcontractors will receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items or slamming of doors.

Action required	Safeguard details
Noise monitoring	A noise monitoring program will be implemented to assist in confirming and controlling the site specific potential for disturbance at particularly sensitive localities at the commencement of activities and periodically during the construction program as the works progress. The program will be developed in accordance with the CNVMP and any approval/licence conditions. The results will be reviewed to determine if additional mitigation measures are required. All measurements will be undertaken in accordance with Australian Standard *1055.2018 – Acoustics – Description and measurement of environmental noise.*
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction will be carried out during the standard daytime working hours. Should out-of-hours works be required an out-of-hours works application form will be submitted to TfNSW for approval on a case-by-case basis. Work generating high noise and/or vibration levels will be scheduled during less sensitive time periods as far as practicable. This will potentially include the use of breakers and jackhammers.
Construction respite period	Noise with special audible characteristics and vibration generating activities (including jack hammering) will only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work will be undertaken in the same area over any seven day period, unless otherwise approved by the relevant authority.
Equipment selection	Quieter and less vibration emitting construction methods will be used where feasible and reasonable (e.g. rubber wheeled instead of steel tracked plant). Equipment will be regularly inspected and maintained to ensure it is in good working order.
Maximum noise levels	The noise levels of plant and equipment will have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions will be considered as part of the selection process.
Use and siting of plant	Simultaneous operation of noisy plant within discernible range of a sensitive receiver will be avoided. The offset distance between noisy plant and adjacent sensitive receivers will be maximised. Plant used intermittently will be throttled down or shut down. Plant and vehicles will be turned off when not in use. Noise-emitting plant will be directed away from sensitive receivers where reasonable and feasible.

Action required	Safeguard details
Plan work site and activities to minimise noise and vibration	Traffic flow, parking and loading/unloading areas will be planned to minimise reversing movements within the site. Truck drivers will be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (i.e. minimising the use of engine brakes, and no extended periods of engine idling).
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) will be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries will occur as far as possible from sensitive receivers. Site access points and roads will be selected as far as possible away from sensitive receivers. Dedicated loading/unloading areas will be shielded if close to sensitive receivers. Delivery vehicles will be fitted with straps rather than chains for unloading, wherever possible.
Silencers on mobile plant	Where possible noise from mobile plant will be reduced through additional fittings including: • residential grade mufflers • silenced air parking brake engagement.
Construction related traffic	Vehicle movements will be routed away from sensitive receivers and scheduled during less sensitive times. The speed of vehicles will be limited and the use of engine compression brakes will be minimised. On-site storage capacity will be maximised to reduce the need for truck movements during sensitive times.
Vibration minimum working distances	If vibration intensive equipment is to be used within the minimum working distances for cosmetic damage, as presented in Table 10, then it is recommended that attended vibration measurements are undertaken when work commences, to determine “site specific minimum working distances”. The minimum working distances for cosmetic damage from Table 10 are generally considered to be conservative and working within them would not necessarily result in damage however as factors such as work practices and intervening structures can affect vibration levels. In addition, vibration intensive work should not proceed within the site specific minimum working distances unless a permanent vibration monitoring system is installed approximately one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective. It is also advisable to carry out building condition surveys of sensitive historical structures before construction work begins.

Action required	Safeguard details
Path controls	
Shield stationary noise sources such as pumps, compressors, fans, etc.	Stationary noise sources will be enclosed or shielded to the greatest extent possible whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Structures to shield residential receivers from noise will be used such as site shed placement, earth bunds, fencing, and erection of operational stage noise barriers (where practicable).

7.1.2 Community Consultation and Complaints Handling

All residents and sensitive receivers impacted by noise levels from the Proposal which are expected to exceed the NML should be consulted prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the receivers would include:

- programmed times and locations of construction work
- the hours of proposed works
- construction noise and vibration impact predictions
- construction noise and vibration mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration would be detailed in a Community Liaison Management Plan for the construction of the Proposal and would include a 24 hour hotline and complaints management process.

7.1.3 TfNSW's *Construction Noise and Vibration Strategy* - Additional Mitigation Measures

TfNSW's *Construction Noise and Vibration Strategy* provides practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from airborne noise, ground-borne noise and vibration generated during the construction of TfNSW projects. This is managed through the application of all feasible and reasonable mitigation measures. Where exceedances are still expected to occur after standard mitigation measures have been applied, the *Construction Noise and Vibration Strategy* recommends the implementation of additional mitigation measures. These mitigation measures are specified within the *Construction Noise and Vibration Strategy* and presented in Table 29.

The provision of additional mitigation is based on the predicted exceedances above RBLs and when the exceedances occur. The RBLs can be found in Table 5.

Table 29 How to implement additional airborne noise management levels

Construction hours	Receiver perception	dB(A) above RBL	dB(A) above NML	Additional management measures
Standard hours Monday-Friday (7am-6pm) Saturday (8am-1pm)	Noticeable	5 to 10	0	-
	Clearly audible	> 10 to 20	< 10	-
	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 20	PN, V
	75 dB(A) or greater	N/A	N/A	PN, V, SN
OOHW Period 1 Monday-Friday (6pm-10pm) Saturday (7am-8am, 1pm-10pm) Sunday/PH (8am-6pm)	Noticeable	5 to 10	< 5	-
	Clearly audible	> 10 to 20	5 to 15	PN
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP[#], DR[#]
OOHW Period 2 Monday-Saturday (12am-7am, 10pm-12am) Sunday/PH (12am-8am, 6pm-12am)	Noticeable	5 to 10	< 5	PN
	Clearly audible	> 10 to 20	5 to 15	PN, V
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RP, DR
	Highly intrusive	> 30	> 25	PN, V, SN, AA, RP, DR

Notes: *PN = Project notification* *SN = Specific notification, individual briefings, or phone call*
V = Verification monitoring *DR = Duration respite*
RP = Respite period *RO = Project specific respite order*
AA = Alternative accommodation

** SWLs used for the purpose of estimating noise impact shall be increased by 5 dB(A) where works will include: power saws for the cutting of timber, masonry & steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling & profiling; jack hammering, rock hammering & rock breaking; or impact piling as a correction factor for noise with special audible characteristics.*

[#] Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays / Public Holidays 8am-6am)

Table 30 outlines the additional mitigation measures, as outlined in the *Construction Noise and Vibration Strategy*.

Table 30 Description of additional mitigation measures

Measure	Description	Abbreviation
Periodic Notification	For each project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au). Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the Community Engagement Team in cases where AMMM are not triggered as shown in Tables 9 to 11, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the Community Engagement Team will determine the community engagement strategy on a case-by-case basis.	PN
Verification Monitoring	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise). The purpose of monitoring is to confirm that: ● construction noise and vibration from the project are consistent with the predictions in the noise assessment ● mitigation and management of construction noise and vibration is appropriate for receivers affected by the works Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the Construction Noise and Vibration Impact Statement (CNVIS) amended. Refer to Section 8.4 for more details.	V

Measure	Description	Abbreviation
Specific Notification	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. • Letters may be letterbox dropped or hand distributed • Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs • Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.	SN
Respite Offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre-purchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all projects.	RO
Alternative Accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative construction methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the Vibration Management Levels (VMLs) for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC

Measure	Description	Abbreviation
Respite Period	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of consecutive evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol (Section 6). Note; this management measure does not apply to OOHW Period 1 – Days (See Table 1).	RP
Duration Reduction	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with Community Engagement Representatives.	DR

7.2 Operational noise mitigation

The results of the assessment of the existing and future operations of the Mortdale Maintenance Centre identified a number of exceedances of the project noise trigger levels during the daytime and night-time. During the daytime operational scenarios, noise levels at one receiver are currently predicted to exceed the project noise trigger levels, whilst noise levels at up to four receivers are predicted to exceed the project noise trigger levels for the future scenario, with exceedances of up to 1 dB(A) predicted.

During the night-time operational scenarios, the existing night-time operational scenario predicts that there are no exceedances of the project noise trigger levels. However, in the future night-time scenario, noise levels at up to four receivers are predicted to exceed the project noise trigger levels by up to 3 dB(A).

In addition, a sleep disturbance assessment considering maximum noise levels associated with the operation of the Mortdale Maintenance Centre also identified up to 18 exceedances of the nominated sleep disturbance criteria for both the existing and future night-time scenarios.

The largest contribution to these exceedances is noise associated with the use of the bogie exchange workshop in the case of the project noise trigger level exceedances, and the use of train horns for the maximum noise level assessment.

A conservative approach was taken in developing the operational assumptions used to complete this assessment. This was done in order to ensure that operational noise impacts at sensitive receivers are not under-predicted, and adequate noise management and mitigation measures are considered early in the Proposal. The actual activities of the Proposal once fully operational may be less than what has been considered here and as such, the operational noise impacts would be lower.

It is noted that the NPfI noise trigger levels do not represent mandatory noise limits. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and

so would ‘trigger’ a management response. In this case, the assessment should identify reasonable and feasible mitigation. For new developments and redevelopments, mitigation strategies should be considered in a hierarchical approach:

- Controlling noise at the source
- Once the controls at the source are exhausted, controlling the transmission of noise
- Once source and transmission controls are exhausted, considering mitigation measures at the noise-sensitive receivers.

Site measurements conducted on 22 August 2019 of an existing bogie exchange system at the Hornsby Maintenance Centre indicated that a warning siren is used when the system is in use. This warning siren was used as the basis of this noise assessment. It is also understood that a similar warning siren would also be implemented for the operation of the proposed bogie exchange workshop at the Mortdale Maintenance Centre. It is proposed that the selection of a warning siren with a lower sound power level than which has been assessed in Section 6.3 (i.e. lower than the equivalent siren at Hornsby Maintenance Centre) would help achieve the project noise trigger levels. This would be investigated further during the detailed design phase.

8.0 Conclusion

A Noise and Vibration Impact Assessment has been completed for the Mortdale Maintenance Centre Upgrade (the Proposal). Nearby noise and vibration sensitive receivers were identified. Attended and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish operational noise criteria and construction NMLs.

8.1 Construction noise

Construction work packages have been developed in consultation with TfNSW and the proposed equipment has been detailed within this report. Three distinct representative construction stages were used in a computer-based noise model to determine the predicted noise levels generated from the Proposal.

The predicted construction noise levels exceed the construction NMLs at some receivers. The magnitude and number of exceedances are detailed in Section 4.4.

Measures have been recommended to mitigate construction noise impacts upon nearby sensitive receivers.

The final number, degree and nature of these measures would be selected by the contractor and be largely dependent on the construction strategy and work carried out. Specific noise management and mitigation measures would be detailed in the contractor's CNVMP. The recommended management and mitigation measures which would be considered in the plan include:

- Effective communication with community and affected receivers about mitigation measures
- Training of construction site workers
- Use of temporary noise barriers
- Monitoring
- Appropriate selection and maintenance of equipment
- Scheduling of work for less sensitive time periods
- Situating plant in less noise sensitive locations
- Construction traffic management
- Respite periods.

8.1.1 Construction traffic

An assessment of the likely construction traffic indicated that increases in road traffic noise levels would be considerably lower than the 2 dB(A) threshold outlined in the RNP. Therefore, no further assessment of construction traffic is required in accordance with the RNP.

8.2 Construction vibration

Minimum working distances to nearby structures have been recommended for nominated plant. If the minimum working distances are maintained, then no adverse impact from the vibration intensive works are likely in terms of human response or cosmetic damage. It is unlikely that work would be undertaken within the minimum working distances for heritage, commercial and residential receivers during the proposed vibration intensive works. Should works be required within the minimum working distances, the recommended additional mitigation measures would be implemented.

8.3 Operational noise

The results of the assessment of fixed facilities associated with Maintenance Centre operations identified a number of exceedances of the project noise trigger levels for both the daytime and night-time operations. In addition, a sleep disturbance assessment considering maximum noise levels associated with the operation of the stabling facility identified a number of exceedances of the nominated sleep disturbance criteria for both the existing and future scenarios.

Potential mitigation options have been provided and should be considered by the Proponent when determining feasible and reasonable mitigation measures.

Based upon these outcomes, it is recommended that the selection of a quieter warning siren would prevent any further exceedances of the operational project noise trigger levels, compared with the existing scenario. This has been discussed further in Section 7.2.

Appendix A

Acoustic terminology

Appendix A Acoustic terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel, dB	The measurement unit of sound.
A Weighted decibels, dB(A)	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency, Hz	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level, L_{eq}	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level, ABL	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level, RBL	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Noise Policy for Industry and Road Noise Policy.

Appendix B

Logging results

Noise Logger Report

23 Waratah Avenue, Oatley

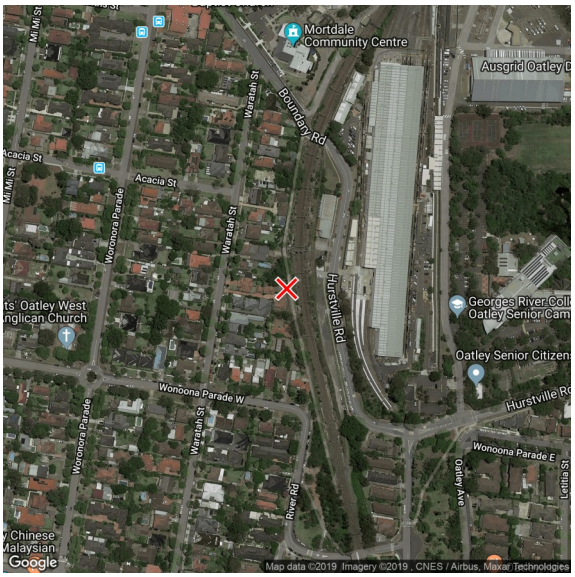
Item	Information
Logger Type	SVAN 977
Serial number	45416
Address	23 Waratah Avenue, Oatley
Location	Backyard
Facade / Free Field	Free Field
Environment	Noise environment dominated by distant road traffic from Hurstville Road and bird noise 42 dB(A). Distant banging from local construction barely audible. Train horns from facility in distance audible approx 52 dB(A). Train air brake release whistling noise 50 dB(A) clearly audible from facility. Distant conversation and door slam from nearby carpark audible. Aircraft flyover 53 dB(A)

Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Thu May 9 2019	56	51	53	-	39	-	55	53
Fri May 10 2019	51	50	51	-	-	-	51	51
Sat May 11 2019	49	52	47	-	-	30	51	47
Sun May 12 2019	50	51	49	38	37	29	50	49
Mon May 13 2019	51	51	51	39	37	30	51	51
Tue May 14 2019	52	52	50	-	35	30	52	50
Wed May 15 2019	51	50	51	39	38	28	51	51
Thu May 16 2019	52	51	50	39	39	30	52	50
Fri May 17 2019	52	-	50	-	-	-	52	50
Summary	**52**	**51**	**50**	**39**	**37**	**30**	**52**	**50**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

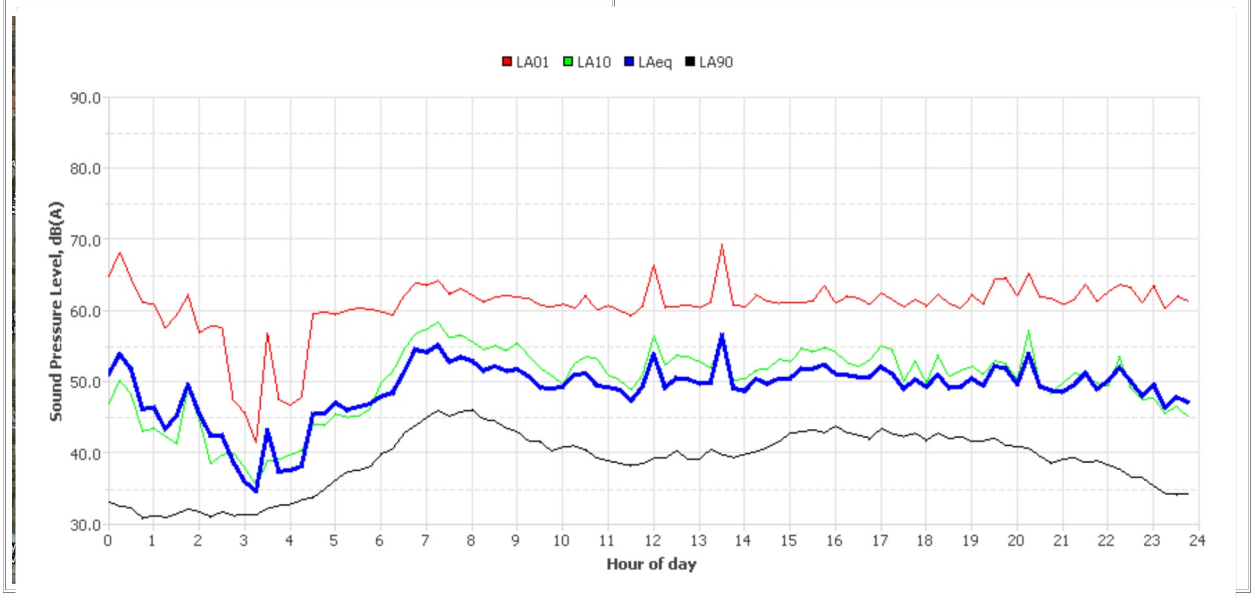
Logger Location



23 Waratah Avenue, Oatley

Logger Deployment Photo

Typical Day



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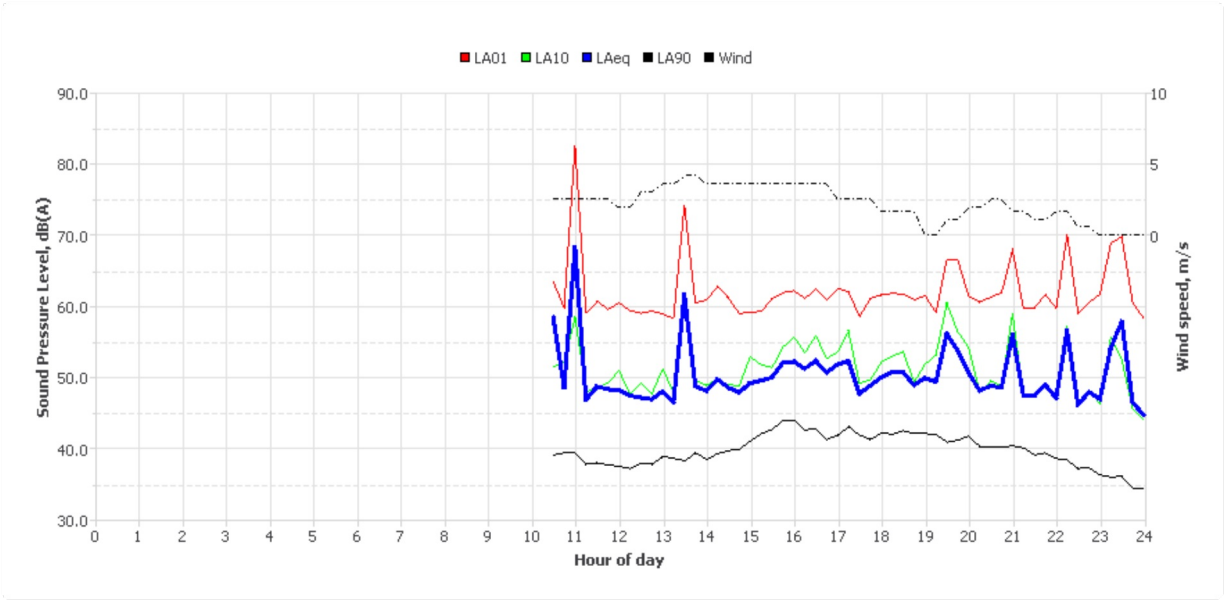

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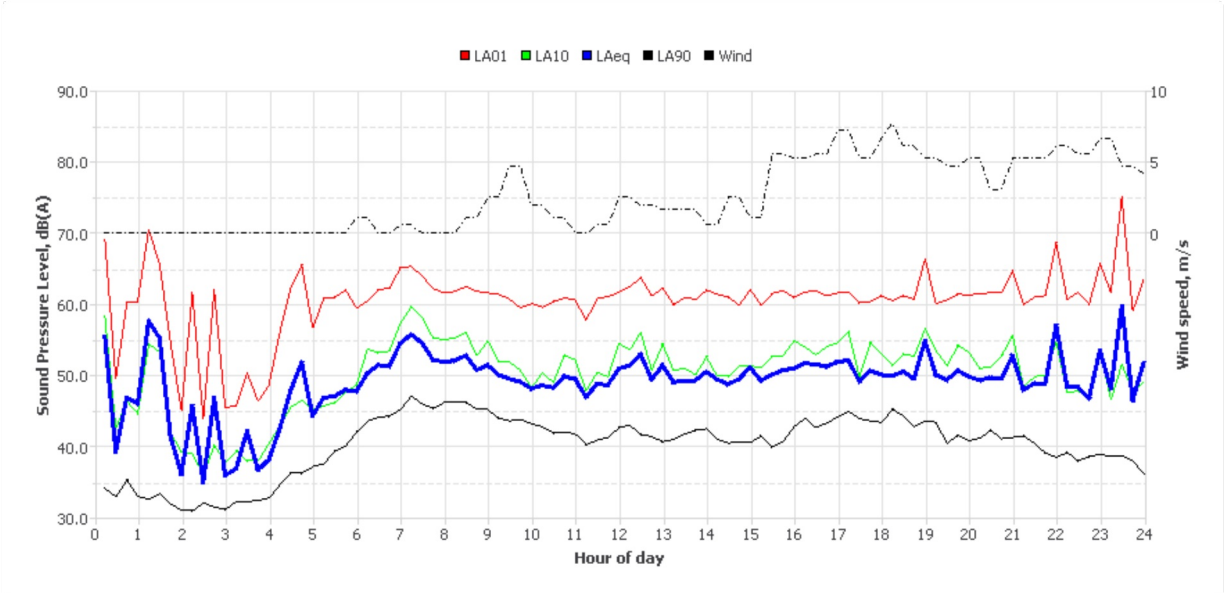
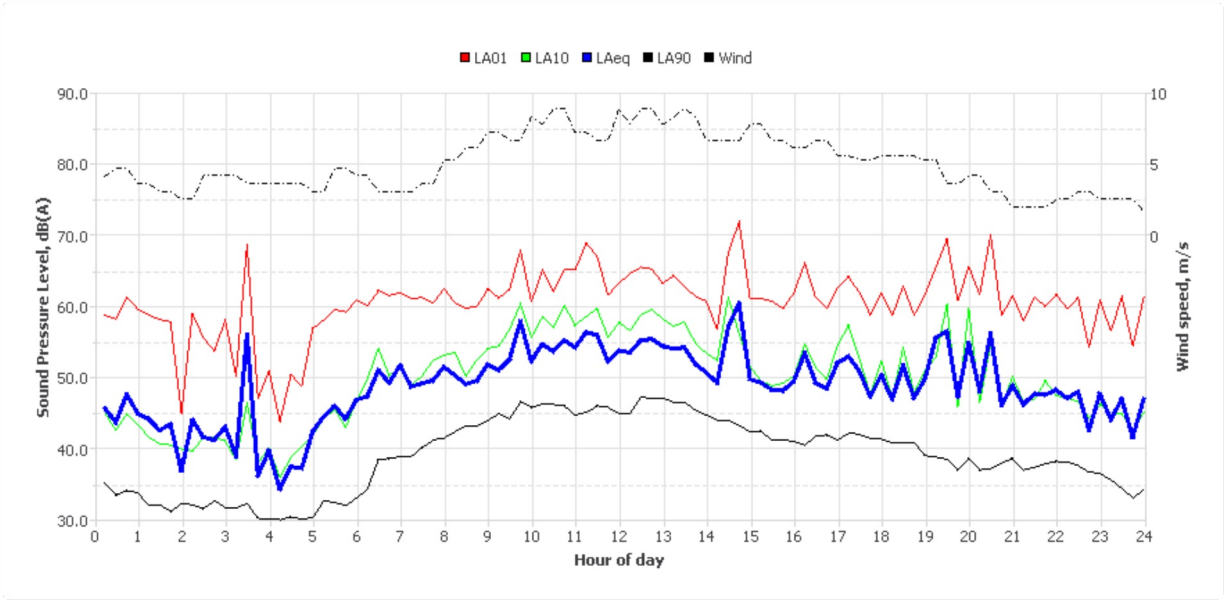
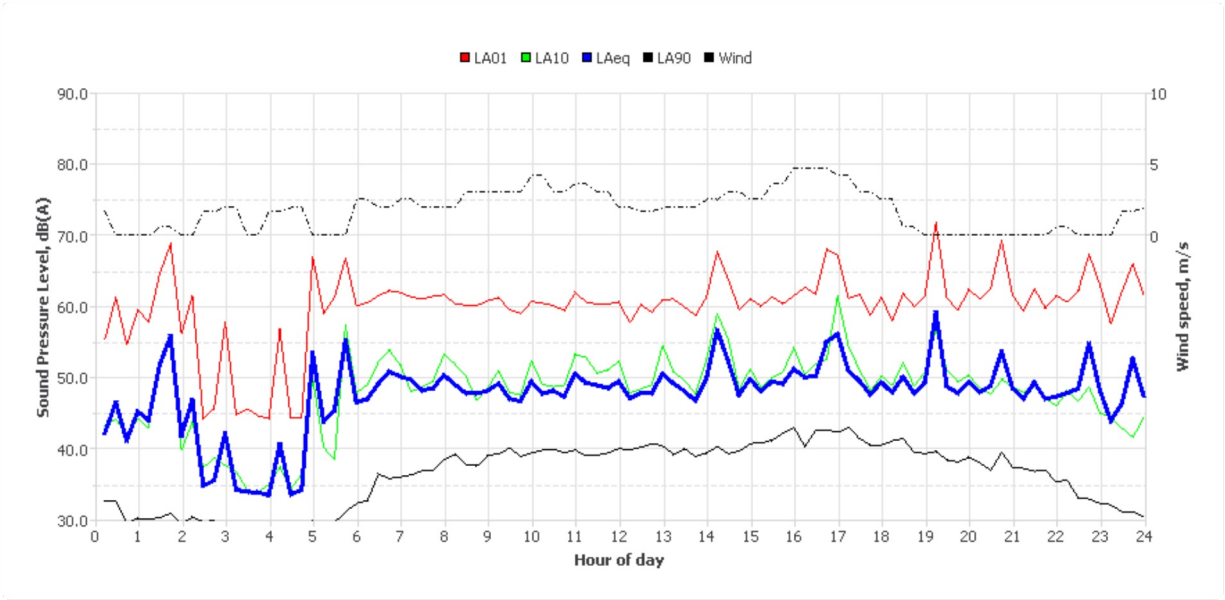


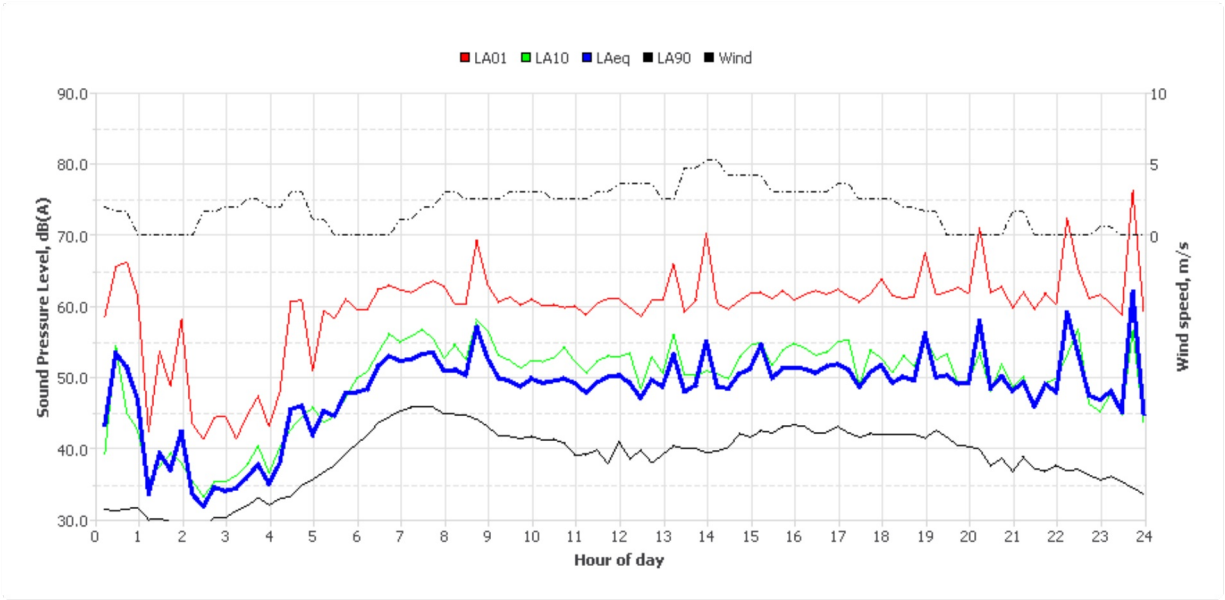
Saturday, 11 May 2019



Sunday, 12 May 2019



Monday, 13 May 2019



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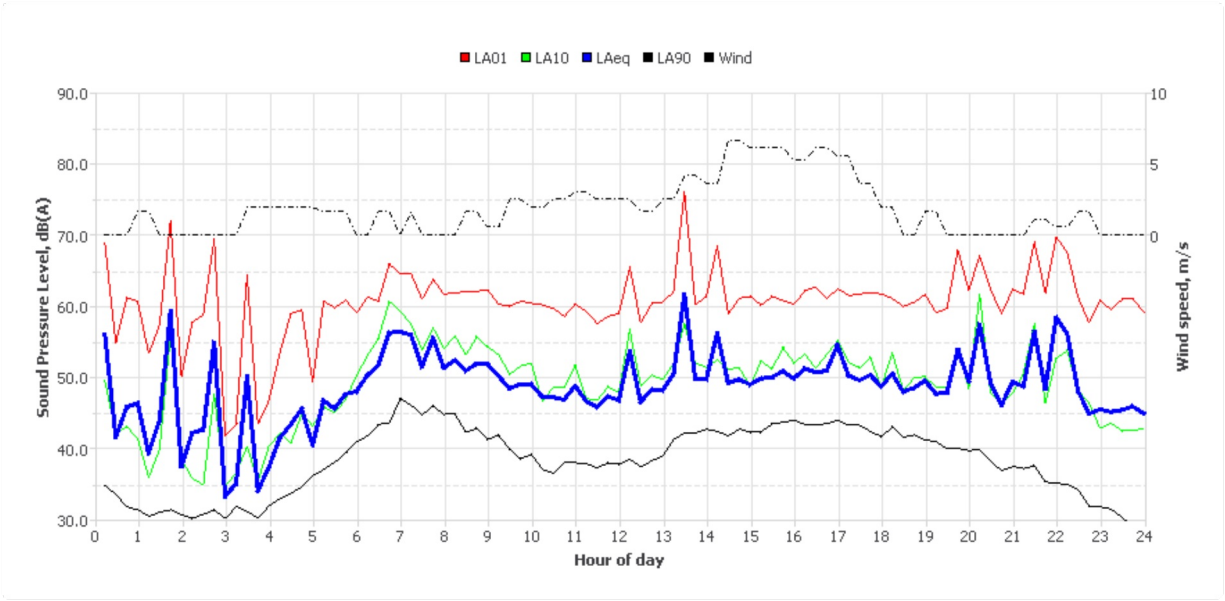
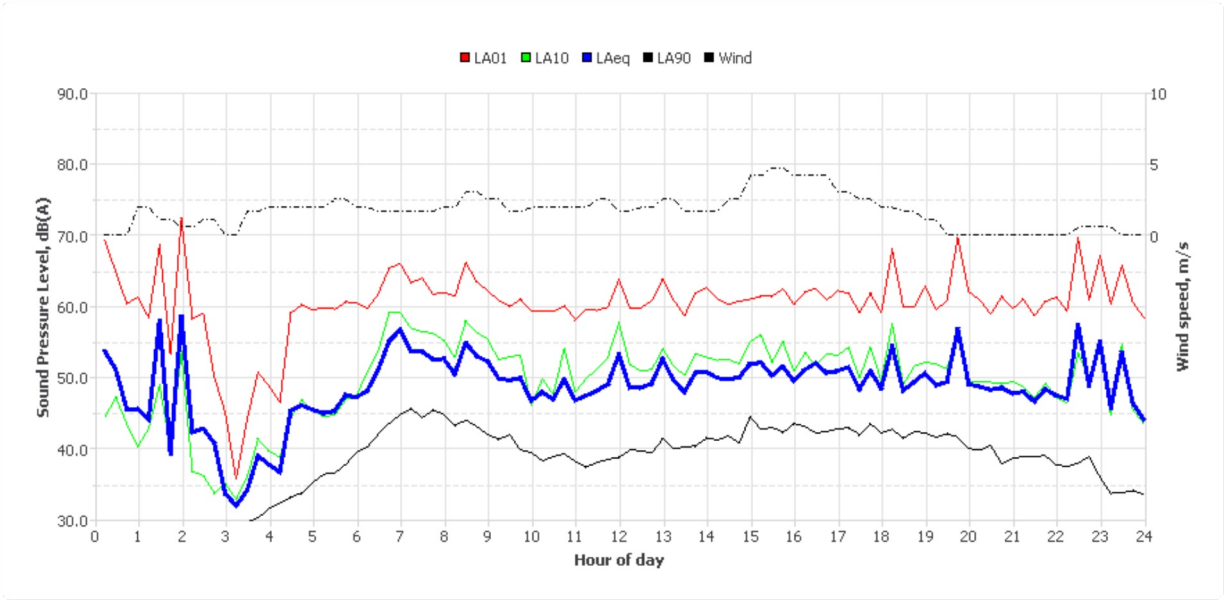


Wednesday, 15 May 2019



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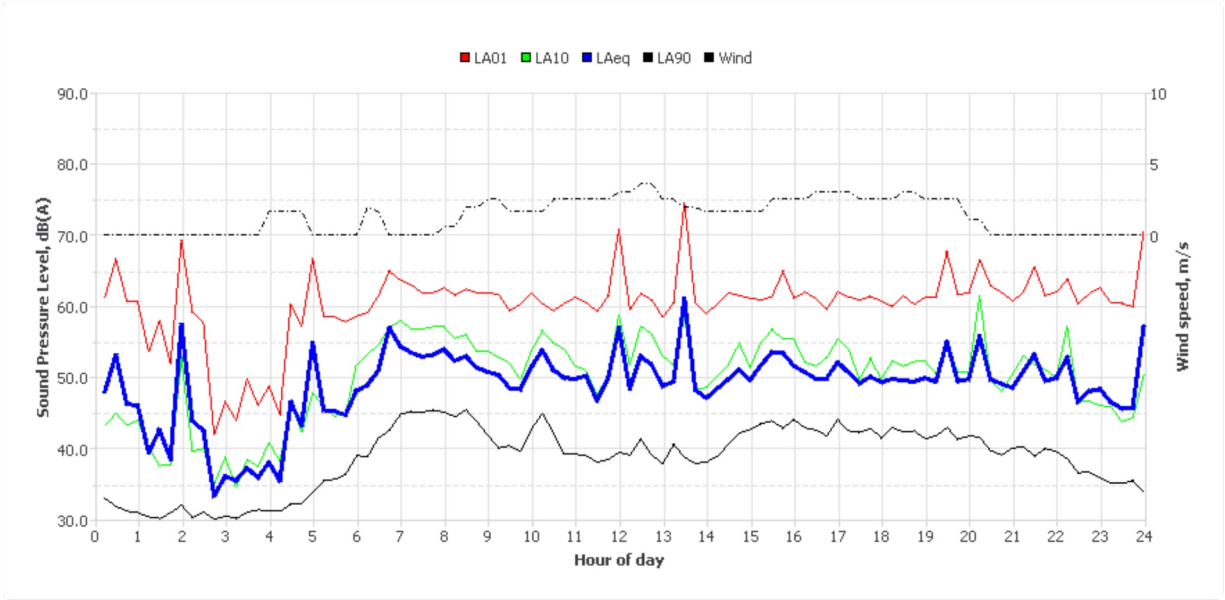
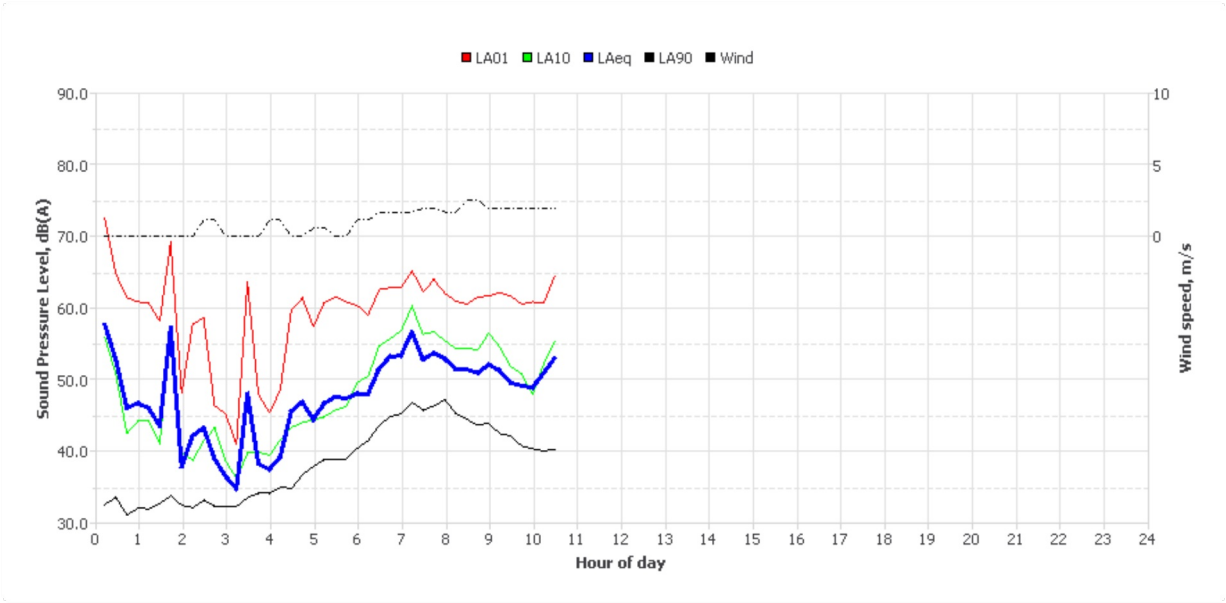


Friday, 17 May 2019



Appendix C

Construction noise contours

AECOM

Highly Noise Affected Level ≥ 75 dB(A)
Standard Hours NML ≥ 49 dB(A)
Out-of-Hours Daytime NML ≥ 44 dB(A)
Out-of-Hours Evening NML ≥ 42 dB(A)
Out-of-Hours Night-time NML ≥ 35 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial

Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Construction Noise Contours - New bogie tracks, road and shed

0 50 100 200 300 m

N

SEP 2019

60600277

C-1

AECOM

Highly Noise Affected Level ≥ 75 dB(A)
Standard Hours NML ≥ 49 dB(A)
Out-of-Hours Daytime NML ≥ 44 dB(A)
Out-of-Hours Evening NML ≥ 42 dB(A)
Out-of-Hours Night-time NML ≥ 35 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial

Mixed Use
Residential
Commercial
School
Not Assessed

0 50 100 200 300 m

N

Mortdale Maintenance Centre Upgrade
Construction Noise Contours - Driveway adjustments

SEP 2019
60600277

C-2

AECOM

Highly Noise Affected Level ≥ 75 dB(A)
Standard Hours NML ≥ 49 dB(A)
Out-of-Hours Daytime NML ≥ 44 dB(A)
Out-of-Hours Evening NML ≥ 42 dB(A)
Out-of-Hours Night-time NML ≥ 35 dB(A)
Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial
Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Construction Noise Contours - Substation infrastructure adjustments

0 50 100 200 300 m

N

SEP 2019

60600277

C-3

Appendix D

Operational noise contours

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Daytime - Existing Operations - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-1

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Daytime - Existing Operations - Noise-enhancing Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-2

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Daytime - Future Operations - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-3

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Daytime - Future Operations - Noise-enhancing Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-4

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Night-time - Existing Operations - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-5

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Night-time - Existing Operations - Noise-enhancing Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-6

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Night-time - Future Operations - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-7

AECOM

Daytime Project Noise Trigger Level ≥ 44 dB(A)

Evening Project Noise Trigger Level ≥ 42 dB(A)

Night-time Project Noise Trigger Level ≥ 35 dB(A)

Mortdale Maintenance Centre

Community Centre

Passive Recreation

Place of Worship

Industrial

Mixed Use

Residential

Commercial

School

Not Assessed

Mortdale Maintenance Centre Upgrade

Night-time - Future Operations - Noise-enhancing Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-8

AECOM

Sleep Disturbance Screening Level ≥ 52 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial
Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Existing Operations - L_{AMax} Assessment - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019
60600277

D-9

AECOM

Sleep Disturbance Screening Level ≥ 52 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial
Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Existing Operations - L_{AMax} Assessment - Noise-enhancing Meteorological Conditions

SEP 2019
60600277

D-10

0 50 100 200 300 m

N

AECOM

Sleep Disturbance Screening Level ≥ 52 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial
Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Future Operations - L_{AMax} Assessment - Standard Meteorological Conditions

0 50 100 200 300 m

N

SEP 2019

60600277

D-11

AECOM

Sleep Disturbance Screening Level ≥ 52 dB(A)

Mortdale Maintenance Centre
Community Centre
Passive Recreation
Place of Worship
Industrial
Mixed Use
Residential
Commercial
School
Not Assessed

Mortdale Maintenance Centre Upgrade

Future Operations - L_{AMax} Assessment - Noise-enhancing Meteorological Conditions

SEP 2019
60600277

D-12

0 50 100 200 300 m

N