Regional Rail Dubbo Maintenance Facility REF

Transport for NSW

Noise and Vibration Assessment

Final

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Executive Summary

As part of the Regional Rail Project (RRP), Transport for NSW (TfNSW) plans to develop a rail maintenance facility at Dubbo, NSW to maintain a new diesel train fleet that would replace XPT, XPLORER and Endeavour services (the 'Proposal'). Jacobs was engaged by TfNSW to prepare a Review of Environmental Factors (REF) for the construction and operation of the Proposal. Impacts to the local noise environment have been identified as a potential risk during the project, and are assessed in this noise and vibration assessment which supports the REF.

The Proposal would comprise six tracks each capable of stabling 200 metre trains, with three of these roads being partly covered by the maintenance building. Access to Proposal site would be possible from both the east and west from the Main Western Line.

The nearest residential receivers to the Proposal site are located directly to the south, along residential streets near Wingewarra Street. Other noise sensitive receivers are located to the north and west of the Proposal, in addition to Dubbo TAFE located directly to the north.

In order to establish construction and operational noise criteria, existing levels of noise were monitored at five receiver locations. These monitoring locations were selected to be representative of background noise levels at the nearest residential receivers to the proposed facility.

Construction and operational noise impacts associated with the Proposal were modelled, using SoundPLAN (version 8.0) noise modelling software. SoundPLAN is recognised and accepted by both TfNSW and the EPA.

Predicted construction noise impacts

Exceedances of construction Noise Management Levels (NMLs) are predicted to occur during all construction stages. The highest noise impacts are forecast to occur during earthworks and land clearing activities.

Construction generated road traffic is unlikely to result in any exceedances of relevant criteria, however an increase in road noise during shift changes is likely to be occur in the vicinity of the main gates (White Street). As most traffic will turn west onto White Street, this impact would reduce as vehicles move away from residential receivers.

Where earthworks are carried out in the vicinity of the Boradze depot buildings, potential exceedances of heritage ground vibration criteria may occur.

Construction Mitigation measures

Standard techniques for controlling noise impacts during construction are presented in the ICNG and the TfNSW CNS. A Construction noise and vibration management plan (CNVMP) would be prepared during construction which considers these measures.

Site specific noise mitigation measures have been considered, and the most effective of these is to limit work to standard working hours wherever possible. The transmission of noise would be considered during the design of site layout, in particular the screen of unloading areas or other noisy activities behind site sheds or other buildings and the design of onsite roads to remove the need for frequent reversing.

Trucks would not be allowed to queue along White Street or other residential roads prior to the opening of gates.

Building inspections of the Boradze depot buildings would be carried out prior to the commencement of construction activities. Low vibration work methods would be considered within the vicinity of these structures.

Operational noise impacts (Operational rail noise)

Noise modelling was undertaken using SoundPLAN (version 8.0) noise modelling software and the adoption of the Nord2000 noise prediction method.

Noise modelling indicated that an increase of rail noise levels of up to 3dB may occur at the most affected residences to the north of the site, however predicted noise levels would be well below the trigger levels outlined in the Rail Infrastructure Noise Guideline and as such noise mitigation measures are not required.

A decrease in train noise of up to 8dB(A) is predicted for residential properties to the south of the project area.

Operational noise impacts (Maintenance facility)

Potential operational noise impacts from the maintenance facility at surrounding receptors have been modelled using the CONCAWE algorithm within SoundPLAN v8.0.

Noise impacts associated with activities at the maintenance facility are primarily predicted to occur where noisy works are underway within the maintenance shed. Noise is likely to spread west, impacting receivers located to the south west of the building, along Grevillea Close and Hakea Place. However, some exceedances have also been predicted to occur at Dubbo TAFE.

External noise sources are generally screened by on site buildings and are not expected to result in exceedances of the site criteria.

Maximum noise levels associated with horn testing and the triggering of substation circuit breakers are likely to result in sleep disturbance impacts for sensitive receivers around the Proposal including Dubbo TAFE

Operational noise management measures

Noise management measures have been recommended to reduce identified impacts associated with the proposed facility. These measures would be considered in detail during preparation of the Noise Management Plan for the site and where reasonable and feasible, may include:

- Modifying operating procedures to reduce noise intensive activities during the evening and night at locations exposed to receivers
- The installation of sound insulation within the walls of the maintenance shed
- Construction of a noise barrier to reduce noise for receivers to the southern and south eastern site boundaries, where the most impacted receivers are located. The highest noise levels have been predicted to occur along the rear of properties on Hakea Place and Grevillea Close and a noise mound interrupting a direct line of sight between the door of the maintenance shed and these properties would be effective in reducing noise impacts
- Close the door of the maintenance shed when in use
- Alternatives to testing or use of the country horn at the site would be considered, particularly during night time hours
- Development of an operational noise and vibration management This plan would further develop reasonable and feasible mitigation strategies reducing identified noise impacts.

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to assess potential noise and vibration impacts associated with the proposed Regional Rail Dubbo maintenance facility in accordance with the scope of services set out in the contract between Jacobs and Transport for NSW. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Transport for NSW and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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1. Introduction

As part of the Regional Rail Project (RRP), Transport for NSW (TfNSW) plans to develop a rail maintenance facility at Dubbo, NSW to maintain a new diesel train fleet that would replace XPT, XPLORER and Endeavour services (the 'Proposal'). Jacobs was engaged by TfNSW to prepare a Review of Environmental Factors (REF) for the construction and operation of Proposal. Impacts to the local noise environment have been identified as a potential risk during the project, and are assessed in this noise and vibration assessment which supports the REF.

The objectives of this assessment were to:

- Provide a brief overview of the Proposal, including any aspects particularly relevant to noise and vibration (Section 2)
- Identify key construction and operational noise and vibration risks (Section 2.2)
- Characterise key features of the environment surrounding the Proposal including nearby sensitive receivers, land uses, terrain features, prevailing climate and meteorological conditions and existing noise levels (Section 3)
- Determine criteria for assessing potential impacts associated with the Proposal based on guidance presented in the relevant statues and guidelines (Section 4)
- Assess potential noise and vibration impacts associated with the construction of the Proposal (Section 5)
- Assess potential noise and vibration impacts associated with the operation of the Proposal (Sections 6 and 7)
- Develop suitable mitigation and monitoring measures as identified to be necessary, including an evaluation of how they would achieve any required levels of reduction (Section 8).

2. Proposal overview

2.1 Key features

The Proposal would comprise six tracks each capable of stabling 200 metre trains, with three of these roads being partly covered by the maintenance building. Access to the Proposal site would be possible from both the east and west from the Main Western Line. The site would cover an area of approximately 220,000 square metres and would be bounded by a perimeter fence.

The key features of the Proposal are shown in Figure 2.1 and would comprise the following:

- Maintenance facility elements:
  - Fleet maintenance building would include three tracks to undertake maintenance activities partly housed within a single covered enclosure. The size of the building would be approximately 220 metres by 30 metres
  - Wheel lathe – a separate enclosed building allowing for train wheels to be periodically machined using an underfloor wheel lathe
  - Train wash – an enclosed structure comprising automated wash equipment for train sets with nearby waste water treatment plant
- Administration building – a building comprising office facilities, kitchen, dining area and amenities
- Security building
- Storage area, loading dock and fuel delivery area – used for the delivery and storage of plant, equipment and diesel fuel
- Rail infrastructure works:
  - Realignment of the Main Western Line through the site
  - Six maintenance rail tracks (three tracks within the maintenance facility building and three external)
  - A connection to the Main Western Line on the western side of the site
  - Decanting and provisioning infrastructure
- Road vehicle infrastructure:
  - Access roads throughout the site
  - Staff car park
- Power supply including a substation, and utility adjustments
- Relocated detention basins
- Earthworks.

Subject to planning approval, construction is expected to commence in 2019 and take around 30 months to complete.

Figure 2.1: Site layout, surrounding receivers and noise monitoring locations

2.2 Primary noise and vibration risks

The elements of the Proposal that would be most likely to give rise to noise or vibration impacts (if any) include:

- Potential construction impacts:
  - Rock breaking and earthworks
  - Night works (referred to as Out of Hours Works (OOHW))
  - Delivery of construction materials
  - Vibration impacts on buildings or heritage structures associated with earthworks
- In relation to the operation of the Proposal:
  - Train maintenance activities
  - Horn testing
  - Operation of the wheel lathe and train wash facilities
  - Train movements (including bunching and stretching)
  - Airborne and ground-borne noise associated with heavy rail from the realigned rail line.

Section 8 outlines measures for avoiding, managing and mitigating any such impacts.

3. Existing environment

This section of the report describes the existing environment around the Proposal as relevant to noise and vibration, including surrounding receivers, land use, terrain, prevailing climate and meteorology and existing background noise levels.

3.1 Surrounding sensitive receivers

The nearest residential receiver areas in relation to the Proposal include:

- Receivers north of the site along Darby Close, White Street and Welchman Street
- Receivers to the north east off Hopkins Parade and Bonner Crescent
- Receivers to the south along Wingewarra Street, Hakea Place, Grevillea Close, Aspen Road and Boronia Place
- Receivers to the south west along Aspen Road, Mulga Court, Cedar Court, Maple Court and Kurrajong Court
- Receivers to the west along Fitzroy Street.

The nearest non-residential sensitive receiver locations in relation to the Proposal:

- Dubbo North Public School to the north west
- TAFE Western – Dubbo Myall Street Campus to the north
- Orana Heights Public School to the south east
- Dubbo Showground to the west
- Dubbo Salvation Army – Gipps Street to the west.

These sensitive receiver locations listed above are shown in relation to the Proposal in Figure 2.1.

3.2 Terrain

Terrain around the Proposal was observed during a site visit and validated using elevation data obtained from NASA SRTM3. This identified that terrain around the Proposal is generally flat although generally sloping towards the south and west, with typical ground elevations ranging from sea level up to heights of approximately 50 metres within the extent of the study area.

3.3 Climate and meteorology

The nearest weather station with long-term historical climate records is at Dubbo Airport (station number 065070). This station is located approximately five and a half kilometres to the north west of the Proposal. This data indicates that the locality around the Proposal experiences warm summers with mean daily maximum temperatures of around 32 degrees Celsius. Months through autumn and winter are the coldest and driest periods of the year with average monthly rainfall from March to August of around 44 millimetres (mm) per month.

3.3.1 Temperature inversions

To evaluate whether temperature inversions are a feature of the project area, winter 2015 data from the Bureau of Meteorology (BoM) Dubbo Airport automatic weather station (AWS) (No. 065070) were processed to determine the frequency of stability Class F and G conditions with wind speeds less than 2 metres per second (m/s). This was completed using the ‘sigma-theta’ method described in Section D1.4 of the *Noise Policy for Industry* (NPI) (Environment Protection Authority, 2017).

Table 3.1: Review of significance of temperature inversions

Stability Class	Percentage of occurrence
A	0%
B	0%
C	0%
D	25.4%
E	56.6%
F and G	18%

3.3.2 Wind-enhancing effects

Data collected in 2015 at the BoM Dubbo Airport AWS (No. 065070) were reviewed to determine whether low wind speeds are a 'significant' feature of the local meteorological environment during any season and time of day.

Table 3.2: Review of significance of wind-enhancing effects

Wind sector	Percentage (%) occurrence of wind speeds less than 3 m/s by direction (including +/- 45 degrees) and time of day for Pasquill stability class conditions A to D											
	Day				Evening				Night			
	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
NNE	18.6	7.0	8.1	12.3	5.0	2.2	2.7	2.7	3.7	1.8	1.2	2.0
NE	18.9	9.4	9.0	12.5	5.8	1.4	3.0	4.1	6.9	2.4	2.1	4.3
ENE	20.5	10.6	10.5	13.9	6.7	1.6	3.0	5.8	9.0	3.7	2.9	7.3
E	19.9	15.2	15.8	17.5	7.2	1.9	3.5	6.6	12.1	4.7	6.2	12.3
ESE	19.3	20.1	20.9	19.6	6.4	2.4	3.5	7.1	13.2	4.9	7.0	15.4
SE	16.3	20.6	20.9	18.0	5.6	2.7	2.7	9.1	11.6	5.7	7.5	14.7
SSE	13.2	18.5	20.0	15.2	5.6	3.3	3.0	7.7	8.9	5.7	7.7	12.8
S	10.3	18.6	18.8	13.0	5.8	4.1	4.3	6.0	6.7	4.3	7.6	10.0
SSW	8.1	16.3	14.5	10.0	4.4	3.5	4.1	5.5	3.5	4.0	5.6	5.0
SW	6.7	11.6	10.4	8.7	4.4	3.5	3.5	5.8	1.5	3.6	5.3	2.1
WSW	6.8	11.2	12.7	10.3	3.9	3.0	4.3	3.3	1.0	2.8	4.8	2.1
W	6.9	11.5	13.2	12.5	2.8	3.8	3.8	3.6	1.0	2.3	4.1	1.7
WNW	9.9	10.2	14.8	15.2	1.9	3.8	2.4	3.3	0.9	1.9	3.5	1.3
NW	11.7	8.6	13.9	15.3	1.7	3.5	2.7	2.7	0.9	1.6	2.3	1.3
NNW	14.4	7.3	12.7	14.1	2.8	3.5	2.7	2.2	1.1	1.4	1.2	1.1
N	16.3	7.1	9.4	12.4	3.6	3.3	2.2	2.7	2.1	1.6	1.1	0.6

3.4 Background noise monitoring

Existing levels of noise were monitored at five receiver locations between 12 and 23 February 2018. These monitoring locations are presented on Figure 2.1 and were selected to be representative of background noise levels at the nearest residential receivers to the Proposal.

3.4.1 Noise monitoring methodology

Logger locations were selected with consideration to other noise sources which may influence readings and security issues for noise monitoring equipment.

Long-term unattended noise monitoring was carried out using Acoustic Research Labs Environmental Noise Loggers, Type NGARA, fitted with microphone windshields. Calibration of the loggers was checked prior to and following measurements using a B&K Calibrator. Drift in calibration did not exceed 0.5 dB(A) which is considered satisfactory for ambient noise measurements.

Instrument sets were calibrated by a NATA accredited laboratory and comply with Australian Standard AS-1259: *Sound Level Meters*.

3.4.2 Unattended noise monitoring results

A summary of the unattended continuous noise monitoring, performed during the NPI (Noise Policy for Industry) defined time periods is presented in Table 3.3. Detailed results at the monitoring location are presented in graphical format in Appendix E. The graphs show measured values of L_{A1}, L_{A10}, L_{A90} and L_{Aeq} for each 15-minute monitoring period.

Table 3.3: Unattended noise monitoring results

ID	Location	Measurement descriptor	Measured Noise Level – dB(A)		
			Daytime 7.00am - 6.00pm	Evening 6.00pm - 10.00pm	Night-time 10.00pm - 7.00am
NM1	White Street	L_{Aeq}	58.4	52.2	50.4
		RBL (Background)	37.0	38.1	35.4
NM2	MacDonald Street	L_{Aeq}	54.6	51.8	46.8
		RBL (Background)	44.0	41.7	32.4
NM3	Maple Court	L_{Aeq}	47.9	47.2	48.5
		RBL (Background)	33.9	36.4	34.9
NM4	Hopkins Parade	L_{Aeq}	51.0	47.1	46.7
		RBL (Background)	39.5	38.9	36.0
NM5	Grevillea Close	L_{Aeq}	63.4	67.6	60.4
		RBL (Background)	40.1	40.8	36.5

Notes: All values expressed as dB(A) and rounded to nearest 1 dB(A);

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound.

L_{A90} Noise level present for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).

RBL Rating Background Level – The overall, single figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period.

The results of monitoring at all locations are considered representative of the surrounding noise environment. It is noted that L_{Aeq} noise levels at the Grevillea Close monitoring site are influenced by frequent barking dogs, and whilst these have affected L_{Aeq} and L_{A1} noise statistics (refer to Appendix E), the L_{A90} noise level has been unaffected by this noise source.

Noise levels throughout the area are generally influenced by local noise sources and the location's proximity to road traffic noise from local and regional road corridors.

It is noted that at most monitoring locations, L_{A90} noise levels are marginally higher during the evening hours than during the daytime period. As the recording of audio files was not carried out during this monitoring program, the precise source of this increase is not known. However, as the effect is widespread it is considered a characteristic feature of the acoustic environment in the vicinity of the project, likely due to increased heavy vehicle movements on regional highways.

The noise levels measured at location NM3 (Maple Court) are also used to monitor the existing rail noise. This monitoring location is selected because it is closest to the existing Main Western Line and is not vastly impeded by any structure other than a 1.8 metre high Colorbond fence. Ambient daytime (7am to 10pm) and night-time (10pm to 7am) noise levels at the logger location have been summarised in Table 3.4 below.

Table 3.4: Ambient noise levels at monitoring location NM3 (Maple Court)

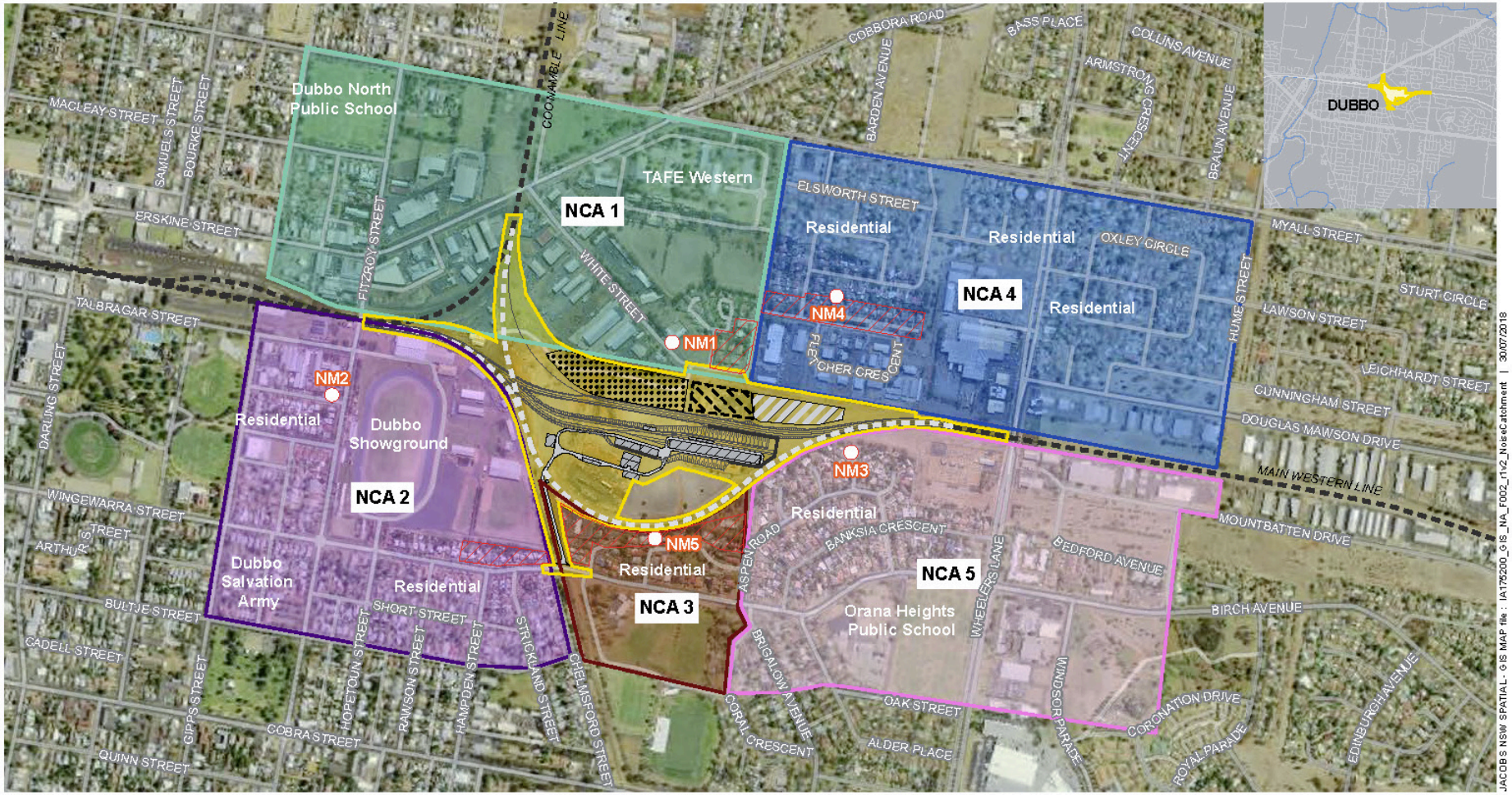
Day / date of measurement	Measured Noise Level – dB(A) re 20 µPa	
	$L_{Aeq\ (15hr)}$ Daytime (7am-10pm)	$L_{Aeq\ (9hr)}$ Night-time (10pm-7am)
Mon 12-Feb-18	47.7	48.6
Tues 13-Feb-18	47.5	47.7
Wed 14-Feb-18	47.2	49.9
Thurs 15-Feb-18	47.3	46.3
Fri 16-Feb-18	47.0	47.7
Sat 17-Feb-18	48.4	48.4
Sun 18-Feb-18	46.5	48.6
Mon 19-Feb-18	50.5	47.2
Tues 20-Feb-18	51.3	49.2
Wed 21-Feb-18	49.5	50.4
Thurs 22-Feb-18	53.4	-
Overall Levels	**47.7**	**48.5**

3.5 Noise Catchment Areas (NCAs)

The receivers considered by this assessment have been grouped into Noise Catchment Areas (NCAs) for the consideration of noise impacts. These NCAs allow for a logical grouping of receivers according the local existing noise environment and their potential to be affected by noise impacts. These NCAs are indicated in Figure 3.1 and are described in Table 3.5.

Table 3.5: Noise Catchment Areas

Noise Catchment Area	Representative noise monitoring location	Description
NCA 1	White Street (NM1)	Receivers north of the site along Darby Close, White Street and Welchman Street. The nearest receiver within this NCA is the RFBI Dubbo Masonic Retirement Village located approximately 35m from the site boundary.
NCA 2	MacDonald Street (NM2)	Receivers to the west along Fitzroy Street. The nearest receivers within this NCA are located approximately 450m from the site boundary.
NCA 3	Maple Court (NM3)	Receivers to the south along Wingewarra Street, Hakea Place, Grevillea Close, Aspen Road and Boronia Place. The nearest receiver within this NCA are located approximately 30m from the site boundary and 200m from the facility.
NCA 4	Hopkins Parade (NM4)	Receivers to the north east off Hopkins Parade and Bonner Crescent. The nearest receiver within this NCA are located approximately 35m from the facility.
NCA 5	Grevillea Close (NM5)	Receivers to the south west along Aspen Road, Mulga Court, Cedar Court, Maple Court and Kurrajong Court. The nearest receiver within this NCA are located approximately 35m from the site boundary and 150m from the facility.



Legend

- Existing rail line
- Existing rail line to be removed
- Proposed new track
- Approximate location of retaining wall
- Construction footprint
- Construction compound
- Project building or facility
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension
- Sensitive receiver
- Noise monitoring location

Noise catchment areas (NCA)

- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 5

Figure 3.1: Noise catchment areas

4. Policy setting and criteria

4.1 Construction noise criteria

4.1.1 Interim Construction Noise Guideline

The following sections detail the applicable site specific construction noise objectives based on the NSW Environment Protection Authority's *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change NSW, 2009).

4.1.2 Recommended standard construction hours

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

- Monday to Friday: 7am to 6pm;
- Saturday: 8am to 1pm; and
- No work on Sundays or public holidays

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

- The delivery of oversized plant or structures that police or other authorities determine requires special arrangements to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the Proposal and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- Works which maintain noise levels at receivers to below the noise management levels outside of the recommended standard construction hours.

Outside of standard construction hours is also addressed by the ICNG with a strong justification required and a lower noise management level compared with standard hours.

4.1.3 Construction noise management levels

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

Table 4.1 details the ICNG construction noise management levels for residential receivers including for works outside of standard hours.

Table 4.1: Construction noise management level at residential receivers

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours (SH): Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected Rating Background Level (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 (OOH) - All other times including public holidays	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 ICNG.

Table 4.2 details the construction noise management levels for non-residential land uses. No separate criteria for out-of-hours construction works is provided for non-residential sensitive receivers as it is assumed that the buildings would be vacated during the evening and night-time.

Table 4.2: Construction noise management level at non-residential sensitive land use

Land use	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level – 45 dB(A)
Hospital wards and operating theatres	Internal noise level – 45 dB(A)
Place 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)

Land use	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
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)
Industrial premises	External noise level – 75 dB(A)
Offices, retail outlets	External noise level – 70 dB(A)

Noise sensitive non-residential receivers including educational, medical and places of worship are located within the study area. Internal criteria of 45 dB(A) $L_{Aeq(15\text{-}minute)}$ apply for these receiver types. However, as the building envelopes of these receivers is not known, an external to internal correction of 10 dB has been adopted to provide an external construction noise criterion of 55 dB(A) $L_{Aeq(15\text{-}minute)}$. This level is generally accepted as typical of a standard building façade with windows open.

4.1.4 Sleep disturbance

Operational and construction noise during the night have the potential to disturb people's sleep patterns.

Section 4.3 of the ICNG discusses the method for assessing and managing sleep disturbance. This guidance references further information in the NSW *Road Noise Policy* (RNP) (NSW EPA, 2013) that discusses criteria for the assessment of sleep disturbance.

The RNP suggests a screening level of $L_{1(1min)}$ dB(A), equivalent to the RBL + 15 dB. Where this level is exceeded, further analysis would be carried out. In addition, Section 5.4 of the RNP also states that:

- Maximum internal noise levels below 50-55 dB(A) would be unlikely to result in people's sleep being disturbed
- If the noise exceeds 65-70 dB(A) once or twice each night-time the disturbance would be unlikely to have any notable health or wellbeing effects.

The guidance within the RNP indicates that internal noise levels of 50-55 dB(A) are unlikely to cause sleep awakenings. Therefore, at levels above 55 dB(A), sleep disturbance would be considered likely. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside to inside correction has been adopted as indicated in the ICNG. Based on the above, the noise level RBL + 15 dB has been adopted as sleep disturbance screening criterion for assessment purposes. Feasible and reasonable safeguards would be considered where there are night-time predicted exceedances above this limit.

The sleep disturbance criteria would also apply to the operational noise of the maintenance facility.

4.1.5 Construction noise criteria summary

Using the guidance in Sections 4.1 and the background monitoring results outlined in Section 3.4, the following NML's (refer Table 4.3) would apply to the identified residential receivers.

Table 4.3: Construction Noise Management Levels

Receiver	Noise management level, L_{Aeq} - dB(A)					Sleep disturbance $L_{A1(1\ minute)}$
	Standard hours	Outside of standard hours			Highly affected	
		OOHW1 Day	OOHW1 Eve	OOHW2 Night		
NCA 1	47	42	43	40	75	50
NCA 2	54	49	47	37	75	47

Receiver	Noise management level, L_{Aeq} - dB(A)					Sleep disturbance $L_{A1(1\ minute)}$
	Standard hours	Outside of standard hours			Highly affected	
		OOHW1 Day	OOHW1 Eve	OOHW2 Night		
NCA 3	44	39	41	40	75	50
NCA 4	50	45	44	41	75	51
NCA 5	50	45	46	42	75	52
Place of worship, classrooms at school and other educational institutions	55 External (or 45 internal)	n/a			n/a	n/a
All industrial premises	70	n/a			n/a	n/a
All offices and retail outlets	65	n/a			n/a	n/a
Active recreation areas	65	n/a			n/a	n/a
Passive recreation areas	60	n/a			n/a	n/a

4.2 Construction vibration criteria

There are two types of vibration criteria that are used when assessing impacts. The first is the human comfort criteria, which as the name suggests is designed to minimise impacts that may disrupt day to day activities of humans. The other form of vibration criteria is designed to avoid damage to buildings and structures.

Section 2.6 of the Rail Infrastructure Noise Guideline (RING) refers to the NSW Department of Environment and Conservation (DEC) *Assessing Vibration: A Technical Guideline* (2006) for a consideration of acceptable vibration levels from rail developments.

4.2.1 Human Comfort

Vibration from construction activities with regard to human comfort within a building should comply with *Assessing Vibration: A Technical Guideline*. It is not always possible to undertake major infrastructure projects in very close proximity to residential dwellings and comply with the more stringent human comfort criterion. However, this should always be used as the objective to aim for, and be the basis of assessment.

When assessing vibration, the Office of Environment and Heritage (OEH, formerly the DEC) classifies vibration as one of three types:

- Continuous – where vibration occurs uninterrupted and can include sources such as machinery and constant road traffic
- Impulsive – where vibration occurs over a short duration (typically less than two seconds) and occurs less than three times during the assessment period, which is not defined. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities
- Intermittent – occurs where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and heavy vehicle or train passbys.

4.2.2 Intermittent Criteria

Where vibration is classed as intermittent, the DEC uses a vibration dose value (VDV) to assess levels of vibration (refer Table 4.4). VDV is calculated using the acceleration rate of the vibration event and the time over which it occurs. This method is more sensitive to the level of vibration than its duration, and is a measure of the total quantity of vibration perceived. The VDV method is the most suitable for assessing human comfort amenity from intermittent vibration sources.

Table 4.4: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75) 1- 80 Hz

Location	Daytime (7am-10pm)		Night-time (10pm-7am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas (e.g. Hospitals)	0.10	0.20	0.10	0.20
Residential buildings	0.20	0.40	0.13	0.26
Offices, schools, churches, etc.	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.6

4.2.3 Criteria for Building Structures (including heritage)

When assessing potential vibration impacts on building structures, the velocity and direction of the movement is measured. The measurement is referred to as the Peak Particle Velocity (PPV), presented in mm/s.

Vibration from construction activities, with regard to building damage, is assessed using the German standard DIN 4150: Part 3 – 1999 *Effects of Vibration on Structures* (DIN Guideline). The DIN Guideline values for PPV measured at the foundation of various structures are summarised in Table 4.5.

Table 4.5: Guideline Values of Vibration Velocity, for Evaluating the Effects of Short Term Vibration DIN Guideline

Type of structure	Guideline values for velocity, v_i (mm/s)			
	Vibration at the foundation at a frequency of:			Vibration at horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (eg heritage structures / buildings that are under a preservation order)	3	8 to 10	8 to 10	8
* For frequencies above 100Hz, at least the values specified in this column shall be applied				

Due to the intervening distances between the project site and the surrounding receivers, vibration from construction activities is considered to not have any impacts on surrounding receivers. Therefore, construction vibration is not assessed in this report.

4.3 Operational rail noise criteria

The acceptability of rail noise from train operations in NSW is assessed in accordance with the NSW *Rail Infrastructure Noise Guidelines* (RING). This document presents noise trigger levels for a project. If these levels are likely to be exceeded as a result of the rail development, noise mitigation measures would need to be considered.

Trigger levels are presented for new rail developments and re-developments of existing rail lines. The redevelopment of existing rail lines generally applies to developments which are intended to increase rail traffic or alter the track alignment through design or engineering changes.

The Proposal includes the realignment of the Main Western Line to the north of the proposed rail yard, which is within the existing and operational rail corridor. Based on this understanding, the realignment would be assessed as a redeveloped rail line against the RING. The RING recommended the airborne noise criteria for redeveloped rail line are presented in Table 4.9 below.

Table 4.6: Airborne residential noise trigger levels for redevelopment of existing rail line

Type of development	Noise trigger levels (external) – dB(A)	
	Day (7am – 10pm)	Night (10pm – 7am)
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$[1] rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more ***and*** predicted rail noise levels exceed:	
	65 $L_{Aeq(15h)}$	60 $L_{Aeq(9h)}$
	85 L_{AFmax}[2]	85 L_{AFmax}

Note 1: LAeq(period) means LAeq(15h) for the daytime period and LAeq(9h) for the night-time period.

Note 2: LAFmax refers to the maximum noise level not exceeded for 95 per cent of rail pass-by events and is measured using the "fast" response setting on a sound level meter.

The document also presents trigger levels for sensitive receivers other than residential. These are presented in Table 4.7 below.

Table 4.7: Airborne noise trigger levels for non residential land uses

Other sensitive land uses	Noise trigger levels dB(A)
	Redevelopment of existing rail line
	Development increases rail noise by 2 dB(A) or more in any hour and rail noise exceeds:
Schools, educational facilities and child care centres (internal)	45 $L_{Aeq(1\ hour)}$
Places of worship (internal)	45 $L_{Aeq(1\ hour)}$
Hospitals wards (internal)	40 $L_{Aeq(1\ hour)}$
Hospitals – other uses	65 $L_{Aeq(1\ hour)}$
Open space - passive use	65 $L_{Aeq(15\ hour)}$
Open space - active use	65 $L_{Aeq(24\ hour)}$

In assessing noise levels emitted by the project at residential receiver locations, the outdoor noise level to be addressed is that prevailing at a location 1 metre in front of the most affected building facade. Any 'internal

noise level' refers to the noise level at the centre of the habitable room that is most exposed to the noise source and applies with windows open sufficiently to provide adequate ventilation.

For redeveloped rail projects, the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period (ten years or similar) into the future to represent the expected future level of rail traffic usage. For this assessment, it is understood that the traffic volumes are to remain the same. Hence, the volumes for immediately after operations commencement and for future operations are the same.

The RING acknowledges the need to protect the community from rail-noise related sleep disturbance at night and therefore encourages a greater volume of rail movements to take place during daytime as reflected by the airborne rail noise trigger levels presented in Table 4.6.

The RING noise triggers for non-residential sensitive receivers in Table 4.7 are applicable when the building or premise is in use. All noise trigger levels are external levels except where otherwise stated. Sensitive receivers in the project area (other than residential) are listed in Table 4.7. Commercial and industrial receivers are not considered sensitive to operational airborne noise impacts.

In consideration noise generated by the maintenance facility itself, Section 1.5 of the RING states that:

…Projects involving maintenance facilities for rolling stock (including stabling yards and shunting operations) should be assessed in accordance with the NSW Industrial Noise Policy (INP).

The INP has been superseded in NSW by the Noise Policy for Industry (2017).

4.4 Operational rail vibration criteria

Vibration criteria have been determined in accordance with *Assessing Vibration: A Technical Guideline* (DEC, 2006). Rail traffic is generally classified as an intermittent vibration source. Vibration criteria for both construction and operational vibration are presented below:

Table 4.8: Vibration criteria for rail traffic

Receiver type	Time period	Intermittent vibration dose value (VDV $ms^{1.75}$)	
		Preferred	Maximum
Residential	Day (7am to 10pm)	0.2	0.4
	Night (10pm to 7am)	0.13	0.26
Office, schools, educational institutions and places of worship	When in use	0.4	0.8

4.5 Operational noise of the maintenance facility - Noise Policy for Industry

The *NSW Noise Policy for Industry* (NPI) provides the framework and process for deriving the noise limits for assessments under the *Protection of the Environment Operations Act 1997*.

The procedure specifies that there are two aspects of environmental noise that require assessment. The first relates to the **intrusiveness** of a noise source, and allows for the noise under assessment to be a margin above the background, whilst the other procedure relates to the acceptability of the resulting noise, in relation to maintaining the **amenity** of the surrounding area. The more stringent of the amenity or intrusive criteria would define the appropriate criteria for a project.

4.5.1 *Project intrusiveness noise level*

A noise source would be deemed to be non-intrusive if the monitored $L_{Aeq\ (period)}$ noise level of the development does not exceed the RBL by more than 5 dB(A). The RBL is the median of the measured L_{A90} noise level during the day, evening and night periods during periods when the development is not in operation.

Based on the results of monitoring outlined in Section 3.4.2, the following intrusive noise criteria have been calculated.

Table 4.9: Project intrusiveness noise levels

Location	Time period	RBL	Allowance	Intrusive noise level L_{Aeq} dB(A)
NCA 1	Day	37	+5dB(A)	**42**
	Evening	38		**42***
	Night	35		**40**
NCA 2	Day	44		**49**
	Evening	42		**47**
	Night	32		**37**
NCA 3	Day	34		**39**
	Evening	36		**39***
	Night	35		**39***
NCA 4	Day	40		**45**
	Evening	39		**44**
	Night	36		**41**
NCA 5	Day	40		**45**
	Evening	41		**45***
	Night	37		**42**

** In accordance with Section 2.3 of the NSW NPI, evening noise levels have been reduced to be no more than daytime noise levels.*

4.5.2 *Project amenity noise levels*

The project amenity noise levels applicable to an activity are defined by the recommended noise levels listed below (Table 2.2 of the *EPA Noise Policy for Industry*) minus 5 dB(A). In the selection of these noise levels, all residential areas have been defined as 'Urban residential'. This classification is based on existing noise levels in the immediate surrounding area during the more sensitive night-time hours and the description of noise environments in the NPI.

Table 4.10: Amenity noise levels – Recommended noise levels

Receiver type	Time of day [1]	Recommended noise level L_{Aeq} dB(A)	Project amenity noise level L_{Aeq} dB(A)
Urban residential	Day	60	55
	Evening	50	45
	Night	45	40
School classroom - internal	When in use	35	30 (or 40 external)
Places of worship - internal		40	35 (or 45 external)

Receiver type	Time of day [1]	Recommended noise level L_{Aeq} dB(A)	Project amenity noise level L_{Aeq} dB(A)
Commercial premises		65	60
Industrial premises		70	65

Note 1: Day: 7:00am – 6:00pm, Evening: 6:00pm – 10:00pm and Night: 10:00pm – 7:00am periods.

4.5.3 *Road traffic noise criteria*

Application notes for the *NSW Road Noise Policy* (RNP), (DECCW, 2011) state the following (http://www.epa.nsw.gov.au/noise/roadnoiseappnotes.htm):

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

In general terms, an increase of this magnitude would occur where traffic volumes increase by approximately 60 per cent as a result of the development.

4.5.4 *Effects of meteorology on noise levels*

Certain meteorological conditions can enhance the propagation of noise, and their influence is required to be accounted for where they are found to be a feature of the Proposal setting. These conditions are summarised in **Table 4.11**.

Table 4.11: Standard and noise-enhancing meteorological conditions

Meteorological conditions	Meteorological parameters
Standard meteorological conditions	Day/evening/night: Stability categories A-D with wind speed up to 0.5 m/s at 10m above ground level.
Noise-enhancing meteorological conditions	Day/evening/night: Stability categories A-D with light winds (up to 3 m/s at 10m above ground level) Night: Stability categories A-D with light winds (up to 3 m/s at 10m above ground level) and/or stability category F with winds up to 2 m/s at 10m above ground level.

Where the occurrence of noise-enhancing conditions is 'significant', noise levels from the development must also be assessed under these conditions. The occurrence of noise-enhancing conditions is considered to be 'significant' when:

- Temperature inversions (F and G class stability categories) with wind speeds up to 2 m/s occur 30 per cent or more during night-time winter periods; or
- Light winds up to and including 3m/s occurring 30 per cent of the time or more during A, B, C or D class stability category conditions during day, evening or night-time periods in all seasons. Where a 16-direction wind rose is used, the NPI requires that the frequency of occurrence of the direction reported is the arithmetic sum of this direction and the four closest directions (i.e., two on either side) to account for the reporting direction plus or minus 45 degrees.

For the consideration of whether temperature inversions are 'significant', the NPI defines night-time as the 'period between 1 hour before sunset to 1 hour after sunrise, taken to be 6pm to 7am'. This definition covers both the night (10pm to 7am) and evening (6pm to 10pm) periods as otherwise defined in Section 2.4 of the NPI.

Based on the findings of the meteorological review provided in Section 3.3, the following relevant features were observed:

- F and G stability class conditions were found to occur 18 per cent of the time
- Wind-enhancing conditions were not to found to occur 30 per cent or the time or more in direction, during any season and for any time of day.

As such it was determined that neither noise-enhancing weather conditions (temperature inversions or wind-enhancing circumstances) are 'significant' at the site and that 'standard meteorological conditions' should be applied in the Noise and Vibration Assessment for this Proposal.

4.5.5 *Summary of NPI noise criteria*

In consideration of these factors, the criteria in Table 4.12, has been determined for the Proposal.

Table 4.12: NPI Proposal noise criteria

Receiver	Time of Day	Intrusive noise criteria L_{Aeq} dB(A)	Amenity noise criteria	Applicable NPI noise criteria
NCA 1	Day	**42**	55	**42**
	Evening	**43**	45	**42**
	Night	**40**	40	**40**
NCA 2	Day	**49**	55	**49**
	Evening	47	**45**	**45**
	Night	**37**	40	**37**
NCA 3	Day	**39**	55	**39**
	Evening	**41**	45	**39**
	Night	**40**	40	**40**
NCA 4	Day	**45**	55	**45**
	Evening	**44**	45	**44**
	Night	41	**40**	**40**
NCA 5	Day	**45**	55	**45**
	Evening	46	**45**	**45**
	Night	42	**40**	**40**

5. Construction noise and vibration assessment

5.1 Construction noise assessment

5.1.1 Introduction

Construction of the Proposal is anticipated to start mid-2019 and take around 30 months to complete.

Activities during construction of the Proposal may generate noise impacts at nearby sensitive receivers. These are assessed in the following section.

5.1.2 Construction noise modelling inputs

Potential noise levels at these receptors have been modelled using the CONCAWE algorithm within SoundPLAN v8.0. This method is commonly used and accepted by regulatory agencies in NSW.

Terrain has been based on two metre LIDAR scans of the area sourced from NSW Department of Lands. Noise sources and receivers have been based on aerial imagery sourced from AusImage (2016). Building footprints and heights have been based on a combination of aerial imagery, street level photography and site inspections.

The parameters used and values adopted in the noise modelling are presented in Table 5.1 below.

Table 5.1: Operational noise modelling parameters

Parameter	Input data
Façade corrections	Standard façade correction +2.5 dB(A)
Buildings	• Footprints taken from aerial photography • Typical building heights have been estimated from Google Street View and site inspections as follows: per floor 3m, pitched roof 3m • Number of floors taken from Google Street View and site inspections.
Terrain	2 metre ground contours from Ausimage.
Ground surface / absorption	Ground coverage in the study area has been assumed to be hard (0.0 ground absorption) in the maintenance facility and a mixture of suburban soft and hard surfaces (0.5 ground absorption) in the off-site environment.
Receiver heights	Surrounding buildings have been digitised into the model. Ground floor receivers have been placed at an elevation of 1.5m and first floor receivers at an elevation of 4.5m.
SoundPLAN module	CONCAWE industrial module.
Train data	4 wagons / 200 metres in length.
Meteorological condition	Neutral meteorological conditions only. In accordance with the NPI, adverse meteorological conditions are not a feature of the area and have not been assessed. • Pasquill category D • No wind • 70% relative humidity • 20°C temperature • 1013 mbar air pressure.

5.1.3 Construction method

Construction staging

An overview of the indicative construction activities anticipated to occur during construction of track work for the maintenance facility is presented below:

1) Land clearing
2) Demolition
3) Earthworks
4) Services and drainage installation
5) Track work
6) Building construction
7) Utility installation
8) Landscaping.

This staging is based on the current design and may change once the detailed design methodology is finalised. The construction methodology and equipment list would be further developed during the detailed design of the Proposal by the nominated Contractor in consultation with Transport for NSW.

Construction hours

The majority of works would be undertaken during standard construction hours, however work adjoining the existing rail corridor may need to coincide with track possessions and therefore may require some night-time works. For any work outside of standard hours during construction phase, an Out of Hours Work Application has to be submitted through TfNSW OOHW online system for approval prior to commencement of works.

Some delivery of oversized plant and equipment via road or rail, may also be scheduled during night-time hours in order to minimise impacts to standard timetabling and road traffic.

Based on our understanding of the Proposal, all construction activities except for ‘services and drainage installation’ and ‘track work’ would be assessed against the standard hours criteria only. ‘Services and drainage installation’ and ‘track work’ would be assessed against the standard hours and out-of-hours criteria, as well as the sleep disturbance screening criteria.

Construction staging and equipment

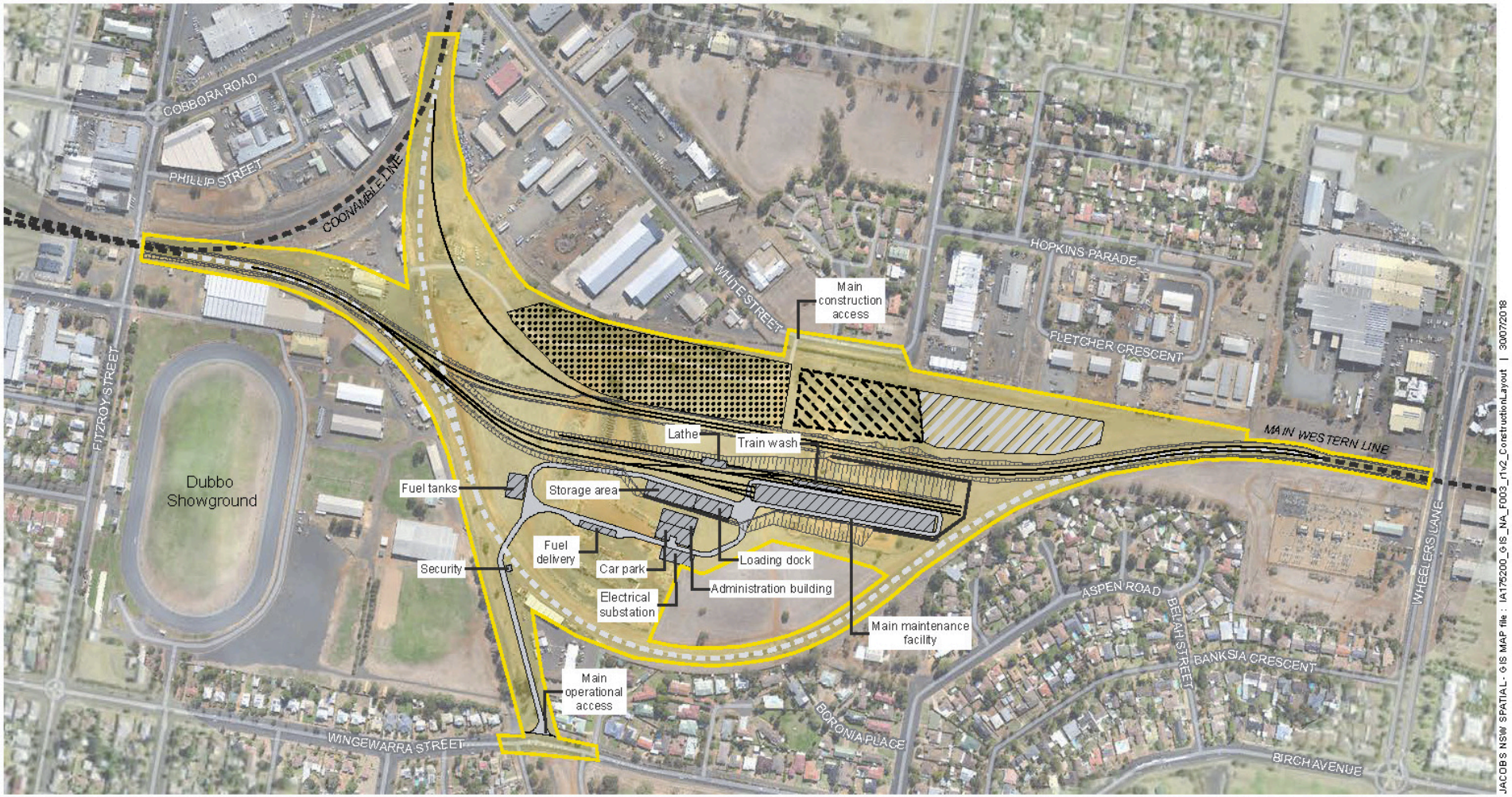
An overview of the indicative construction activities and proposed equipment is provided in Table 5.2 and shown on Figure 5.1. Noise levels provided in this table are based on the likely usage of each piece of equipment during a worst case 15-minute period.

A construction compound for the works would be located along the northern site boundary. In order to predict potential noise impacts associated with activities in this area, the equipment detailed under the construction compound scenario has been modelled. The compound would accommodate a combination of site offices, staff facilities, staff parking, laydown area, materials delivery, plant and equipment storage. It is assumed that the site would operate under mains power. Potential noisy activities associated with this site may be generated during activities at the stockpile locations or unloading of materials. These impacts have been included in the discussion of overall site noise outlined above. Other activities proposed for the construction compounds are generally quiet in nature and are unlikely to generate noise impacts for nearby receivers.

Table 5.2: Acoustically significant construction plant and equipment

Scenario	Plant / equipment	Sound power level $L_{Aeq(15\ minute)}$ (dBA)
Demolition	Excavator 10T – 20T	105
	Dump trucks (x2)	112
	TOTAL	**112**
Land clearing	Chainsaw	105
	Trailer mounter wood chipper	115
	Excavator 10T – 20T	105
	TOTAL	**116**
Earthworks	Dozer 50T – 70T (D10) (x2)	117
	Excavator 70T – 80T (x2)	105
	Dump trucks (x4)	114
	Water Cart	107
	Excavator 10T – 20T	105
	TOTAL	**119**
Service and drainage installation	Excavator 10T – 20T	105
	Truck mounted crane 20T – 50T	91
	Angle grinder	105
	Welder	98
	Concrete truck and pump (x2)	106
	Concrete tamper (x4)	104
	TOTAL	**111**
Track work	Hi rail tipper	91
	Track laying machine	104
	Ballast tamper	101
	Idling locomotives (x1)	89
	TOTAL	**106**
Building construction	Truck mounted crane 100T – 200T	99
	Angle grinder	105
	Welder	98
	Concrete truck and pump (x2)	106
	Scissor lifts (x4)	89
	TOTAL	**109**
Utility installation	Truck mounted crane 20T – 50T	94
	Angle grinder	105
	Welder	98

Scenario	Plant / equipment	Sound power level $L_{Aeq(15\ minute)}$ (dBA)
	TOTAL	**106**
Landscaping	Backhoe	97
	Delivery truck	93
	Light vehicle	85
	TOTAL	**99**
Construction compound	Truck mounted crane 20T – 50T	91
	Dump trucks (x2)	112
	Rattle gun	105
	Compressor	96
	Light vehicles (x6)	99
	TOTAL	**112**



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

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N

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Existing rail line to be removed
- Proposed new track
- Approximate location of retaining wall
- Proposed batter
- Construction footprint
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Figure 5.1 : Construction site layout

5.1.4 Predicted construction noise results

Detailed noise contours predicted at a height of 1.5 metres with a grid spacing of 20 metres are presented for each work stage in Appendix B, and a summary of the results is produced in Table 5.3 to Table 5.7 below. These tables detail the predicted worse case construction noise impacts at nearest sensitive receivers to the Proposal. Construction plant would be mobile and operate at multiple locations within the Proposal site. The predicted noise impacts have been determined for worst case noise levels where required plant are in operation at or near the boundaries of the Proposal site.

Whilst the 75 dB(A) $L_{Aeq,15min}$ highly noise affected noise management level is predicted to only exceeded at nearest residential receivers in NCA 5, the predicted noise impacts for construction works are likely to cause annoyance and disturbance at nearest receivers.

During construction, TfNSW would implement all standard noise management measures outlined in the *Construction Noise Strategy* (CNS) (TfNSW, 2018). Where the noise management levels are predicted to be exceeded, TfNSW would investigate and implement all feasible and reasonable noise management and mitigation measures, as recommended in Section 8.1.

Table 5.3: Predicted construction noise impacts at surrounding residential receivers

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted daytime impact – dB(A)		Predicted out-of-hours day impact – dB(A)		Predicted out-of-hours evening impact – dB(A)		Predicted night-time impact – dB(A)	
			Standard Hours NML	Exceedance	OOHW Day NML	Exceedance	OOHW Evening NML	Exceedance	OOHW Night NML	Exceedance
Demolition	NCA 1	27 to 46	47	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	16 to 52	54	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	37 to 71	44	**Up to 27**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	27 to 51	50	**Up to 1**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 5	32 to 67	50	**Up to 17**	n/a	n/a	n/a	n/a	n/a	n/a
Land clearing	NCA 1	42 to 61	47	**Up to 14**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	31 to 59	54	**Up to 5**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	48 to 63	44	**Up to 19**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	42 to 61	50	**Up to 11**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 5	47 to 73	50	**Up to 23**	n/a	n/a	n/a	n/a	n/a	n/a
Earthworks	NCA 1	45 to 64	47	**Up to 17**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	34 to 62	54	**Up to 8**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	51 to 66	44	**Up to 22**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	45 to 64	50	**Up to 14**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 5	50 to 76	50	**Up to 26**	n/a	n/a	n/a	n/a	n/a	n/a
Service and drainage installation	NCA 1	37 to 56	47	**Up to 9**	42	**Up to 14**	43	**Up to 13**	40	**Up to 16**
	NCA 2	26 to 54	54	-	49	**Up to 5**	47	**Up to 7**	37	**Up to 17**
	NCA 3	43 to 58	44	**Up to 14**	39	**Up to 19**	41	**Up to 17**	40	**Up to 18**
	NCA 4	37 to 56	50	**Up to 6**	45	**Up to 11**	44	**Up to 12**	41	**Up to 15**

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted daytime impact – dB(A)		Predicted out-of-hours day impact – dB(A)		Predicted out-of-hours evening impact – dB(A)		Predicted night-time impact – dB(A)	
			Standard Hours NML	Exceedance	OOHW Day NML	Exceedance	OOHW Evening NML	Exceedance	OOHW Night NML	Exceedance
	NCA 5	42 to 68	50	**Up to 18**	45	**Up to 23**	46	**Up to 22**	42	**Up to 26**
Track work	NCA 1	32 to 51	47	**Up to 4**	42	**Up to 9**	43	**Up to 8**	40	**Up to 11**
	NCA 2	21 to 49	54	-	49	-	47	**Up to 2**	37	**Up to 12**
	NCA 3	37 to 49	44	**Up to 5**	39	**Up to 10**	41	**Up to 8**	40	**Up to 9**
	NCA 4	32 to 51	50	**Up to 1**	45	**Up to 6**	44	**Up to 7**	41	**Up to 10**
	NCA 5	36 to 60	50	**Up to 10**	45	**Up to 15**	46	**Up to 14**	42	**Up to 22**
Building construction	NCA 1	29 to 49	47	**Up to 2**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	23 to 49	54	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	40 to 53	44	**Up to 9**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	28 to 45	50	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 5	27 to 59	50	**Up to 9**	n/a	n/a	n/a	n/a	n/a	n/a
Utility installation	NCA 1	32 to 51	47	**Up to 4**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	21 to 49	54	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	38 to 53	44	**Up to 9**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	32 to 51	50	**Up to 1**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 5	37 to 63	50	**Up to 13**	n/a	n/a	n/a	n/a	n/a	n/a
Landscaping	NCA 1	25 to 44	47	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 2	14 to 42	54	-	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 3	31 to 46	44	**Up to 2**	n/a	n/a	n/a	n/a	n/a	n/a
	NCA 4	25 to 44	50	-	n/a	n/a	n/a	n/a	n/a	n/a

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted daytime impact – dB(A)		Predicted out-of-hours day impact – dB(A)		Predicted out-of-hours evening impact – dB(A)		Predicted night-time impact – dB(A)	
			Standard Hours NML	Exceedance	OOHW Day NML	Exceedance	OOHW Evening NML	Exceedance	OOHW Night NML	Exceedance
	NCA 5	30 to 56	50	**Up to 6**	n/a	n/a	n/a	n/a	n/a	n/a
Site compound	NCA 1	30 to 53	47	**Up to 6**	42	**Up to 11**	43	**Up to 10**	40	**Up to 13**
	NCA 2	21 to 47	54	-	49	-	47	-	37	**Up to 10**
	NCA 3	34 to 50	44	**Up to 6**	39	**Up to 11**	41	**Up to 9**	40	**Up to 10**
	NCA 4	28 to 47	50	-	45	**Up to 2**	44	**Up to 3**	41	**Up to 6**
	NCA 5	28 to 49	50	-	45	**Up to 4**	46	**Up to 3**	42	**Up to 7**

Table 5.4: Predicted construction noise impacts at commercial receivers

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Commercial NML	Exceedance
Demolition	NCA 1	28 to 69	65	**Up to 4**
	NCA 2	33 to 70	65	**Up to 5**
	NCA 3	43	65	-
	NCA 4	35 to 66	65	**Up to 1**
	NCA 5	35 to 37	65	-
Land clearing	NCA 1	39 to 71	65	**Up to 6**
	NCA 2	45 to 77	65	**Up to 12**
	NCA 3	53	65	-
	NCA 4	46 to 72	65	**Up to 7**
	NCA 5	47 to 48	65	-
Earthworks	NCA 1	42 to 74	65	**Up to 9**
	NCA 2	48 to 80	65	**Up to 15**
	NCA 3	56	65	-
	NCA 4	49 to 75	65	**Up to 10**
	NCA 5	50 to 51	65	-
Service and drainage installation	NCA 1	34 to 66	65	**Up to 1**
	NCA 2	40 to 72	65	**Up to 7**
	NCA 3	48	65	-
	NCA 4	41 to 67	65	**Up to 2**
	NCA 5	42 to 43	65	-
Track work	NCA 1	29 to 61	65	-
	NCA 2	35 to 67	65	**Up to 2**
	NCA 3	42	65	-
	NCA 4	36 to 62	65	-
	NCA 5	37 to 60	65	-
Building construction	NCA 1	20 to 43	65	-
	NCA 2	24 to 43	65	-
	NCA 3	45	65	-
	NCA 4	33 to 43	65	-
	NCA 5	32 to 34	65	-
Utility installation	NCA 1	29 to 61	65	-
	NCA 2	35 to 67	65	**Up to 2**
	NCA 3	43	65	-
	NCA 4	36 to 62	65	-

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Commercial NML	Exceedance
	NCA 5	37 to 38	65	-
Landscaping	NCA 1	22 to 54	65	-
	NCA 2	28 to 60	65	-
	NCA 3	36	65	-
	NCA 4	29 to 55	65	-
	NCA 5	30 to 31	65	-
Site compound	NCA 1	20 to 45	65	-
	NCA 2	22 to 44	65	-
	NCA 3	43	65	-
	NCA 4	34 to 43	65	-
	NCA 5	34 to 36	65	-

Table 5.5: Predicted construction noise impacts at industrial receivers

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Industrial NML	Exceedance
Demolition	NCA 1	41 to 63	70	-
	NCA 2	34 to 77	70	**Up to 7**
	NCA 3	72 to 87	70	**Up to 17**
	NCA 4	32 to 64	70	-
	NCA 5	31 to 66	70	-
Land clearing	NCA 1	51 to 62	70	-
	NCA 2	45 to 81	70	**Up to 11**
	NCA 3	60 to 69	70	-
	NCA 4	47 to 70	70	-
	NCA 5	44 to 72	70	**Up to 2**
Earthworks	NCA 1	54 to 65	70	-
	NCA 2	48 to 84	70	**Up to 18**
	NCA 3	63 to 72	70	**Up to 2**
	NCA 4	50 to 73	70	**Up to 3**
	NCA 5	47 to 75	70	**Up to 5**
Service and drainage installation	NCA 1	46 to 57	70	-
	NCA 2	40 to 76	70	**Up to 6**
	NCA 3	55 to 64	70	-
	NCA 4	42 to 65	70	-

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Industrial NML	Exceedance
	NCA 5	39 to 67	70	-
Track work	NCA 1	42 to 52	70	-
	NCA 2	35 to 71	70	**Up to 1**
	NCA 3	46 to 48	70	-
	NCA 4	37 to 60	70	-
	NCA 5	34 to 62	70	-
Building construction	NCA 1	32 to 50	70	-
	NCA 2	38 to 48	70	-
	NCA 3	53 to 56	70	-
	NCA 4	32 to 48	70	-
	NCA 5	28 to 42	70	-
Utility installation	NCA 1	41 to 52	70	-
	NCA 2	35 to 71	70	**Up to 1**
	NCA 3	50 to 59	70	-
	NCA 4	37 to 60	70	-
	NCA 5	34 to 62	70	-
Landscaping	NCA 1	34 to 45	70	-
	NCA 2	28 to 64	70	-
	NCA 3	43 to 52	70	-
	NCA 4	30 to 53	70	-
	NCA 5	27 to 55	70	-
Site compound	NCA 1	33 to 63	70	-
	NCA 2	35 to 48	70	-
	NCA 3	48 to 49	70	-
	NCA 4	30 to 48	70	-
	NCA 5	30 to 39	70	-

Table 5.6: Predicted construction noise impacts at educational receivers (Dubbo TAFE - Myall Street)

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Educational NML	Exceedance
Demolition	NCA 1	30 to 69	55	**Up to 14**
	NCA 2	32 to 37	55	-
	NCA 5	40	55	-
Land clearing	NCA 1	43 to 55	55	-

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Educational NML	Exceedance
	NCA 2	43 to 49	55	-
	NCA 5	50	55	-
Earthworks	NCA 1	46 to 58	55	**Up to 3**
	NCA 2	46 to 52	55	-
	NCA 5	53	55	-
Service and drainage installation	NCA 1	38 to 50	55	-
	NCA 2	38 to 44	55	-
	NCA 5	45	55	-
Track work	NCA 1	33 to 45	55	-
	NCA 2	32 to 38	55	-
	NCA 5	40	55	-
Building construction	NCA 1	30 to 43	55	-
	NCA 2	35 to 40	55	-
	NCA 5	41	55	-
Utility installation	NCA 1	33 to 45	55	-
	NCA 2	33 to 39	55	-
	NCA 5	40	55	-
Landscaping	NCA 1	26 to 38	55	-
	NCA 2	26 to 33	55	-
	NCA 5	33	55	-
Site compound	NCA 1	26 to 47	55	-
	NCA 2	36 to 41	55	-
	NCA 5	41	55	-

Table 5.7: Predicted construction noise impacts at place of worship (Salvation Army - Gipps St)

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Educational NML	Exceedance
Demolition	NCA 2	36	55	-
Land clearing	NCA 2	47	55	-
Earthworks	NCA 2	50	55	-
Service and drainage installation	NCA 2	42	55	-
Track work	NCA 2	37	55	-
Building construction	NCA 2	35	55	-

Construction activity	Receiver location	Predicted noise – dB(A)	Predicted impact – dB(A)	
			Educational NML	Exceedance
Utility installation	NCA 2	37	55	-
Landscaping	NCA 2	30	55	-
Site compound	NCA 2	37	55	-

5.1.5 Sleep disturbance noise assessment

Noise from intermittent high level noise events has the potential to cause sleep disturbance at the nearest residential receivers if conducted during the night-time hours. The events were assessed assuming the L_{max} is approximately 5 dB(A) higher than the total sound power level of each scenario that takes place during the night-time period. Table 5.8 presents an assessment of the likelihood of sleep disturbance, based on guidance provided by the RNP as discussed in Section 4.1.4.

Table 5.8: Predicted Lmax construction noise levels during night-time period

Construction activity	Receiver location	Predicted night-time L_{max} noise – dB(A)	Predicted sleep disturbance impact – dB(A)	
			Screening criteria	Exceedance
Service and drainage installation	NCA 1	42 to 61	50	**Up to 11**
	NCA 2	31 to 59	47	**Up to 12**
	NCA 3	48 to 63	50	**Up to 13**
	NCA 4	42 to 61	51	**Up to 10**
	NCA 5	47 to 73	52	**Up to 21**
Track work	NCA 1	37 to 56	50	**Up to 6**
	NCA 2	26 to 54	47	**Up to 7**
	NCA 3	42 to 54	50	**Up to 4**
	NCA 4	37 to 56	51	**Up to 5**
	NCA 5	41 to 65	52	**Up to 13**
Site compound	NCA 1	35 to 58	50	**Up to 8**
	NCA 2	26 to 52	47	**Up to 5**
	NCA 3	39 to 55	50	**Up to 5**
	NCA 4	33 to 52	51	**Up to 1**
	NCA 5	33 to 54	52	**Up to 2**

5.1.6 Discussion of predicted construction noise impacts

The predicted construction noise levels at residential receivers indicate that:

- The residential receiver at 7 Mulga Court, Dubbo has been identified to exceed the 'highly noise affected' NML during earthworks. Construction noise at the adjacent neighbour, 10 Mulga Court, has been predicted to be 75 dB(A) which meets the 'highly noise affected' NML. No other receivers have been identified to exceed the 'highly noise affected' NML

- During ‘Demolition’, residences in NCAs 1 and 2 are predicted to comply with the standard hours NMLs. However, residences in NCA 3 at Hakea Place, Grevillea Close, Boronia Place, Aspen Road and Wingewarra Street, in NCA 4 at Hopkins Parade and in NCA 5 at Mulga Court, Cedar Court and Aspen Road are predicted to exceed the standard hours NMLs
- During ‘Land clearing’ and ‘Earthworks’, residences in all NCAs are predicted to exceed the standard hours NMLs. Residences in each NCA that have been identified to be most impacted are as follow:
  - NCA 1 – residences at White Street and Welchman Street
  - NCA 2 – residences at Fitzroy Street and Wingewarra Street
  - NCA 3 – residences at Hakea Place, Grevillea Close, Boronia Place, Aspen Road and Wingewarra Street
  - NCA 4 – residences at Hopkins Parade
  - NCA 5 – residences at Mulga Court, Cedar Court, Maple Court, Kurrajong Court, Aspen Road and Banksia Crescent
- During ‘Service and drainage installation’, residences in NCAs 1, 3, 4 and 5 are predicted to exceed the standard hours and all OOHW NMLs. Residences in NCA 2 are predicted to comply with the standard hours NML, but predicted to exceed all OOHW NMLs. Residences in NCAs 1, 3, 4 and 5 that have been identified to be most impacted are as follow:
  - NCA 1 – residences at White Street and Welchman Street
  - NCA 3 – residences at Hakea Place, Grevillea Close, Boronia Place and Aspen Road
  - NCA 4 – residences at Hopkins Parade
  - NCA 5 – residences at Mulga Court, Cedar Court, Maple Court, Kurrajong Court and Aspen Road
- During ‘Track work’, residences in residences in NCAs 1, 3, 4 and 5 are predicted to exceed the standard hours and all OOHW NMLs. Residences in NCA 2 are predicted to comply with the standard hours and OOHW day NMLs, but predicted to exceed the OOHW evening and night NMLs. Residences in NCAs 1, 3, 4 and 5 that have been identified to be most impacted are as follow:
  - NCA 1 – residences at White Street and Welchman Street
  - NCA 3 – residences at Hakea Place, Grevillea Close, Boronia Place and Aspen Road
  - NCA 4 – residences at Hopkins Parade
  - NCA 5 – residences at Mulga Court, Cedar Court, Maple Court, Kurrajong Court and Aspen Road
- During ‘Building construction’, residences in NCAs 2 and 4 are predicted to comply with the standard hours NMLs. However, residences in NCAs 1, 3 and 5 are predicted to exceed the standard hours NMLs. Residences in NCAs 1, 3 and 5 that have been identified to be most impacted are as follow:
  - NCA 1 – residences at White Street and Welchman Street
  - NCA 3 – residences at Hakea Place, Grevillea Close and Boronia Place
  - NCA 5 – residences at Mulga Court, Cedar Court and Maple Court
- During ‘Utility construction’, residences in NCA 2 are predicted to comply with the standard hours NML. However, residences in NCAs 1, 3, 4 and 5 are predicted to exceed the standard hours NMLs. Residences in NCAs 1, 3, 4 and 5 that have been identified to be most impacted are as follow:
  - NCA 1 – residences at White Street and Welchman Street
  - NCA 3 – residences at Hakea Place, Grevillea Close, Boronia Place and Aspen Road
  - NCA 4 – residences at Hopkins Parade
  - NCA 5 – residences at Mulga Court, Cedar Court, Maple Court, Kurrajong Court and Aspen Road

- During ‘Landscaping’, residences in NCAs 1, 2 and 4 are predicted to comply with the standard hours NMLs. However, residences in NCAs 3 and 5 are predicted to exceed the standard hours NMLs. Residences in NCAs 3 and 5 that have been identified to be most impacted are as follow:
  - NCA 3 – residences at Hakea Place, Grevillea Close and Boronia Place
  - NCA 5 – residences at Mulga Court, Cedar Court and Maple Court
- Works carried out within the site compound are predicted to:
  - exceed with the standard hours and all OOHW NMLs in NCAs 1 and 3
  - comply with the standard hours, OOHW day and OOHW evening NMLs, but exceed the OOHW night NML 2
  - comply with the standard hours NMLs, but exceed all OOHW NMLs in NCAs 4 and 5
- Exceedances of the sleep disturbance screening criteria have been predicted at all NCAs.

The predicted construction noise levels at commercial receivers indicate that:

- During ‘Demolition’, ‘Land clearing’, ‘Earthworks’ and ‘Service and drainage installation’, commercial receivers within NCAs 3 and 5 are predicted to comply with the NML but receivers in NCAs 1, 2 and 4 are predicted to exceed the NML
- During ‘Track work’ and ‘Utility installation’, commercial receivers within NCAs 1, 3, 4 and 5 are predicted to comply with the NML but receivers in NCA 2 are predicted to exceed the NML
- During ‘Building construction’, ‘Landscaping’ and construction of the ‘Site compound’, commercial receivers within all NCAs are predicted to comply with the NML.

The predicted construction noise levels at industrial receivers indicate that:

- During ‘Demolition’, industrial receivers in NCAs 1, 4 and 5 are predicted to comply with the NML but receivers in NCAs 2 and 3 are predicted to exceed the NML
- During ‘Land clearing’, industrial receivers in NCAs 1, 3 and 4 are predicted to comply with the NML but receivers in NCAs 2 and 5 are predicted to exceed the NML
- During ‘Earthworks’, industrial receivers in NCA 1 are predicted to comply with the NML but receivers in NCAs 2, 3, 4 and 5 are predicted to exceed the NML
- During ‘Service and drainage installation’, ‘Track work’ and Utility installation’, industrial receivers in NCAs 1, 3, 4 and 5 are predicted to comply with the NML but receivers in NCA 2 are predicted to exceed the NML
- During ‘Building construction’, ‘Landscaping’ and ‘Site compound’, industrial receivers within all NCAs are predicted to comply with the NML.

The predicted construction noise levels at educational facilities indicate that:

- During ‘Demolition’ and ‘Earthworks’, educational facilities in NCAs 2 and 5 are predicted to comply with the NML but facilities in NCA 1 are predicted to exceed the NML. The educational facility in NCA 1 that has been predicted to exceed the NML is the TAFE Western Dubbo
- During ‘Land clearing’, ‘Service and drainage installation’, ‘Building construction’, ‘Utility installation’ ‘Landscaping’ and ‘Site compound’, educational facilities within all NCAs are predicted to comply with the NML.

The predicted construction noise levels at place of worship indicate that:

- During all construction activities, the place of worship identified in NCA 2 has been predicted to comply with the NML.

5.2 Construction traffic noise assessment

It is anticipated that most deliveries of equipment and material to the site would be carried out via the existing Main Western Line.

It is estimated that approximately 20 heavy vehicle trips and up to 100 light vehicle trips may be required each day during the construction period.

Access to the site would be via the northern entry located on White Street.

Indicative heavy vehicle construction access routes are expected to be primarily from the east along the Golden Highway / Cobbora Road and then along White Street.

Fill would be retained on site where possible.

Based on the existing traffic numbers and composition along this route, and the proximity to residential properties, off site traffic noise impacts are highly unlikely. In order for traffic noise to increase by more than the permissible 2dB, road traffic on these streets would need to increase by more than 60 per cent. Given the forecast construction traffic numbers an increase of this magnitude is highly unlikely to occur.

A short term increase in noise is likely to be restricted to the area of the main site gate at the start and end of shifts due to workers arriving and departing. As most traffic would turn west onto White Street, this impact would reduce as vehicles move away from residential receivers.

Noise management measures to address potential traffic noise impacts have been provided in Section 8.1.

5.3 Construction vibration assessment

5.3.1 Introduction

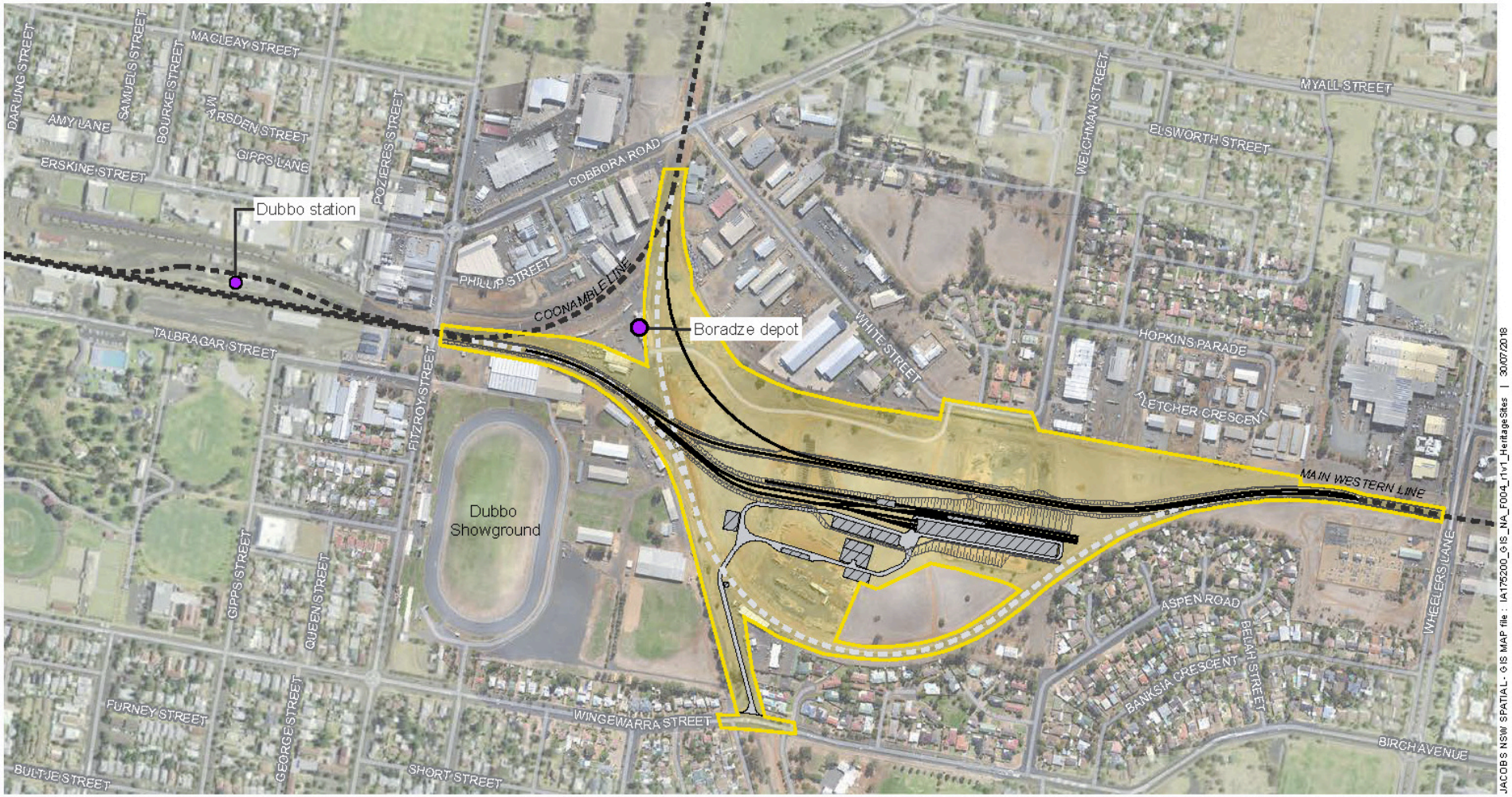
The effects of vibration can be divided into three main categories:

- Occupants or users of the building are disturbed or inconvenienced
- Building contents may be affected
- The integrity of the building or the structure itself may be compromised.

There are two types of vibration criteria that are used when assessing impacts. The first is the human comfort criteria, which as the name suggests is designed to minimise impacts that may disrupt day to day activities of humans. The other form of vibration criteria is designed to avoid damage to buildings and structures.

5.3.2 Heritage items

Heritage structures can be particularly susceptible to damage from ground vibration. The Dubbo Railway Station and Yard Group are heritage listed and are located 370 metres to the west of the Proposal site boundary. No other vibration sensitive heritage structures are located within the study area, although it is noted that the Boradze depot may be of local heritage value. The locations of these sites are shown below in Figure 5.2.



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 100 200 m
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N

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Existing rail line to be removed
- Proposed new track
- Proposed batter
- Construction footprint
- Proposed vehicle access track
- Project building or facility

Figure 5.2 : Heritage sites

5.4 Vibration assessment

Factors that affect the estimated vibration levels include the type of activity that needs to be undertaken in some areas, the actual equipment used to undertake the work and the site specific geology, which has the greatest influence on ground borne vibration levels.

Predicted vibration levels based on proposed vibration intensive equipment types and distance from the works are shown in Table 5.9 and Table 5.10. These predicted levels are based on typical ground conditions and provide an indication of the expected vibration impacts for the works.

Table 5.9: Estimated construction vibration levels (building damage)

Plant description	Building damage				
	Vibration level (mm/s)[1]				
	5m	10m	25m	50m	100m
Criterion	*5 (typical) / 3 (heritage)*				
Vibratory roller (3-8 tonne)[2]	7	**3**	0.7	0.3	0.1
Vibratory roller (8-13 tonne)[2]	19	**9**	2	1	0.4
Vibratory roller (13-18 tonne)[2]	22	**10**	**3**	1	0.4
Vibratory roller (>18 tonne)[2]	28	**13**	**4**	1	0.5
Hydraulic hammer	6	2	0.5	0.2	0.1

Table 5.10: Estimated construction vibration levels (human comfort)

Plant description	Human comfort				
	VDV ($mm/s^{1.75}$)[4]				
	5m	10m	25m	50m	100m
Criterion	*0.2 daytime / 0.13 night-time*				
Vibratory roller (3-8 tonne)[2]	5.9	2.3	0.6	0.2	0.1
Vibratory roller (8-13 tonne)[2]	16.2	7.3	2.2	**0.8**	**0.3**
Vibratory roller (13-18 tonne)[2]	18.2	8.2	2.5	**0.9**	**0.3**
Vibratory roller (>18 tonne)[2]	23.7	10.7	3.2	**1.2**	**0.4**

1 - Calculated in accordance with *BS5228 – Code of practice for noise and vibration control on construction and open sites (95% confidence) / FTA Guidance Manual for Transit Noise and Vibration Impact Assessment*
2 - Mid amplitude setting

Potential exceedances of the heritage criteria have been identified for the Boradze depot buildings where vibratory rolling is carried out within 25 metres of the structures. Smaller plant should be used as the distances outlined in Table 5.9 are approached.

The nearest residential receivers are located approximately 50 metres from the northern site boundary and the use of larger vibratory roller in this area may impact levels of human comfort as the Masonic Retirement Village is approached. Smaller units would be used within the vicinity of this property and this equipment would not be used during night-time hours.

Where structures that are not heritage listed are considered, structural damage limits may be increased to 5 mm/s, and shows a risk to building structures located within 25 metres of most other large vibratory rollers. This is a conservative estimate and may be increased further, depending upon the frequency spectrum of the

equipment in use. This spectrum and site specific operating distances may be determined through vibration monitoring.

A building condition survey and vibration monitoring is recommended for the Boradze depot buildings prior to the commencement of construction works.

Additionally, where work staging differs from the equipment presented on Table 5.2 and Table 5.9, further assessment of potential vibration impacts would be carried out.

6. Operational rail noise assessment

To determine whether the noise levels are likely to increase at nearby receivers by 2 dB(A) or more for L_{Aeq} levels or 3 dB(A) or more for L_{AFmax} levels as a result of the Proposal, operational noise was assessed by developing a Proposal specific 3D noise prediction model.

6.1 Rail noise prediction modelling

Noise modelling was undertaken using SoundPLAN (version 8.0) noise modelling software and the adoption of the Nord2000 noise prediction method. SoundPLAN is recognised and accepted by both TfNSW and the EPA.

The Nord2000 noise prediction method adopted by SoundPLAN is based on a method developed by DELTA (Denmark), SINTEF (Norway) and SP (Sweden), and was financed by The Nordic Council of Ministers and other Nordic authorities. This method has been adapted to Australian conditions and extensively used to predict rail noise in Australia.

The most significant factors in determining the level of noise received from a railway are the receiver's distance from the railway line, shielding, ground absorption, and the type and volume of trains. The parameters used and values adopted in the noise modelling are presented in Table 6.1 below.

Table 6.1: Operational noise modelling parameters

Parameter	Input data
Façade corrections	Standard façade correction +2.5 dB(A).
Traffic speeds	70 km/hr.
Buildings	• Footprints taken from aerial photography • Typical building heights have been estimated from Google Street View and site inspections as follows: per floor 3m, pitched roof 3m • Number of floors taken from Google Street View and site inspections.
Terrain	2 metre ground contours from Ausimage.
Ground surface / absorption	Ground coverage in the study area has been assumed to be hard (0.0 ground absorption) in the maintenance facility and a mixture of soft and hard surfaces (0.5 ground absorption) in the off-site environment.
Receiver heights	Ground floor receivers have been placed at an elevation of 1.5m and first floor receivers at an elevation of 4.5m.
SoundPLAN module	Nord2000 rail module.
Meteorological condition	Neutral meteorological conditions only. In accordance with the NPI, adverse meteorological conditions are not a feature of the area and have not been assessed. • Pasquill category D • No wind • 70% relative humidity • 20°C temperature • 1013 mbar air pressure

6.2 Rail traffic data

Rail traffic frequency on the existing rail line during the noise monitoring is the same as the freight and passenger trains timetables which are provided by TfNSW. The rail traffic frequency used in the model noise is presented in Table 6.2 below.

Table 6.2: Maximum service frequency on the Proposal line

Type	Maximum number of trains in each period per day	
	Day (7am – 10pm)	Night (10pm – 7am)
XPT trains	4	nil
Freight trains	1	3

6.3 Noise model validation

To validate the noise model, receiver point representing the measurement location described in Section 3.4.2 was established in the model. The model was then used to calculate noise levels at this location. Table 6.3 presents the comparison between the model results and the measured noise levels. Noise model validation outputs include L_{Aeq} noise levels. The L_{Aeq} noise levels provide a validation of the assumed L_{AE} train source levels and the number of trains assumed for a given period.

Table 6.3: Modelling predictions and measured noise levels

Location	Noise level – dB(A)					
	$L_{Aeq(15h)}$ Day			$L_{Aeq(9h)}$ Night		
	Measured	Modelled	Difference	Measured	Modelled	Difference
Logger location NM3 (Maple Court)	47.7	47.9	+ 0.2	48.5	47.5	- 1.0

The results presented in Table 6.3 indicate the agreement between the model results and the measurements is well within 2 dB for $L_{Aeq(15h)}$ and $L_{Aeq(9h)}$ noise levels.

It should be noted that train pass-bys were observed to not exhibit any significant level of flanging noise or curve squeal at this location. Therefore, no correction was applied to the modelled results. Overall the model is considered to be suitable for predicting the rail noise levels from the Proposal.

6.4 Predicted operational airborne rail noise levels

To assist the understanding of operational noise impacts, noise level contours have been calculated with a grid spacing of 20 metres and are presented in Appendix C. The contour plots for the daytime, night-time and maximum noise levels are calculated at a height of 1.5 metres above the local ground level.

A detailed presentation of the airborne noise predictions is provided by precinct area in Sections 6.4.1 and 6.4.2 for each NCA as defined in Section 3.5. Where exceedances of the noise trigger levels are identified, the RING requires additional noise mitigation to be considered.

6.4.1 Residential receivers

A summary of the predicted rail noise levels for residential receivers are presented in Table 6.4 for receivers with a predicted exceedance of the RING noise trigger levels. The results are shown as the worst-case impact for the residential receiver potentially most affected by the Proposal alignment of the railway line in each NCA. Where exceedance of the RING trigger levels was not predicted within a NCA, the highest overall residential rail noise levels are displayed for non-triggered residential receivers.

Where the Proposal is seen to increase noise levels by 2 dB or more for L_{Aeq} or 3 dB or more for L_{Amax} in these areas, an exceedance of the RING trigger levels occurs. The results presented in Table 6.4 indicate that operational noise levels from the existing alignment are well below the RING L_{Aeq} and L_{Amax} overall noise trigger levels.

The L_{Aeq} rail noise levels of the Proposal alignment are higher at receivers to the north of the project site than at receivers to the south of the Proposal site. This is consistent with the existing rail line being re-aligned to the north.

Although there is an increase of the L_{max} noise levels at most affected residences in NCA 1 by 3 dB(A), an exceedance of the RING trigger levels does not occur due to the rail noise levels at these receivers being well below the day and night-time L_{Aeq} and L_{max} limits.

A decrease in train noise of up to 8dB(A) is predicted for residential properties to the south of the Proposal.

6.4.2 Other sensitive receivers

A summary of the highest overall rail noise levels for the existing alignment and Proposal realignment of the rail line are presented in Table 6.5 for other sensitive receivers where a noise level increase trigger is predicted. The results are shown as the worst-case prediction in each NCA. Where a RING trigger is not predicted within a NCA, the highest overall rail noise levels are displayed for non-triggered other sensitive receivers.

Although there is an increase of the L_{Aeq} noise levels at the most affected non-residential receivers in NCA 1 by more than 2 dB(A), the RING trigger still does not occur due to the rail noise levels at these receivers being well below the day and night-time L_{Aeq} limits.

6.4.3 Statement of rail airborne noise impacts

The predicted rail airborne noise levels at surrounding residential and other sensitive receivers in Table 6.4 and Table 6.5 show that the RING trigger would not occur. Based on this assessment, mitigation measures to the realignment Main Western Line would not be required.

Table 6.4: Summary of rail noise impacts at most affected residential receivers

NCA	Predicted rail noise level at most affected residential receiver – dB(A)									
	Existing alignment			Proposal alignment			Noise level increase			RING triggers (Yes/No)
	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	
NCA1	39.1	38.4	70.4	40.1	39.7	73.4	1.0	1.3	3.0	No
NCA2	34.7	34.2	68.4	33.9	33.4	68.4	-0.8	-0.8	0	No
NCA3	47.0	46.7	83.8	35.5	34.9	68.0	-11.5	-11.8	-15.8	No
NCA4	37.2	36.4	68.2	37.5	36.8	67.6	0.3	0.4	0.6	No
NCA5	47.6	47.2	84.3	44.0	43.9	80.0	-3.6	-3.3	-4.3	No

Table 6.5: Summary of rail noise impacts at most affected other sensitive receivers

NCA	Predicted rail noise level at most affected residential receiver – dB(A)						
	Existing alignment		Proposal alignment		Noise level increase		RING triggers
	L_{Aeq} Day	L_{Aeq} Night	L_{Aeq} Day	L_{Aeq} Night	L_{Aeq} Day	L_{Aeq} Night	
NCA1	39.5	38.8	42.0	41.8	2.5	3.0	No
NCA2	48.8	48.7	47.8	47.8	-1.0	-0.9	No
NCA3	35.7	35.0	34.0	33.1	-1.7	-1.9	No
NCA4	39.5	38.9	39.9	39.5	0.4	0.6	No
NCA5	33.2	32.3	32.5	31.5	-0.7	-0.8	No

7. Operational maintenance facility noise assessment

7.1 Introduction

Activities carried out at the facility may generate noise impacts at nearby sensitive receivers. This section details the assessment of the operational impacts from the Proposal. Operational noise impacts predicted at nearest residential receivers have been assessed against the adopted NPI noise objectives.

7.2 Noise assessment methodology

Potential operational noise impacts from the maintenance facility at surrounding receptors have been modelled using the CONCAWE algorithm within SoundPLAN v8.0. This method is commonly used and accepted by regulatory agencies in NSW.

Terrain has been based on 2 metre LIDAR scans of the area sourced from NSW Department of Lands. Noise sources and receivers have been based on aerial imagery sourced from AusImage (2016). Building footprints and heights have been based on a combination of aerial imagery, street level photography and site inspections.

The parameters used and values adopted in the noise modelling are presented in Table 7.1 below.

Table 7.1: Operational noise modelling parameters

Parameter	Input data
Façade corrections	Standard façade correction +2.5 dB(A).
Buildings	• Footprints taken from aerial photography • Typical building heights have been estimated from Google Street View and site inspections as follows: per floor 3m, pitched roof 3m • Number of floors taken from Google Street View and site inspections.
Terrain	2 metre ground contours from Ausimage.
Ground surface / absorption	Ground coverage in the study area has been assumed to be hard (0.0 ground absorption) in the maintenance facility and a mixture of soft and hard surfaces (0.5 ground absorption) in the off-site environment.
Receivers	Surrounding buildings have been digitised into the model. Ground floor receivers have been placed at an elevation of 1.5m and first floor receivers at an elevation of 4.5m.
Sources	• Noise emission scenarios and sources associated with the maintenance facility as detailed in Sections 7.3 and 7.4 • The railway tracks, main maintenance facility building, stores building and admin building have been digitised into the model as shown in Figure 2.1 • All noise emitting equipment in each operational scenario has been modelled to operate simultaneously.
SoundPLAN module	CONCAWE industrial module.
Noise contours	The noise contours height has been set at 1.5m.
Meteorological condition	Neutral meteorological conditions only. In accordance with the NPI, adverse meteorological conditions are not a feature of the area and have not been assessed. • Pasquill category D • No wind

Parameter	Input data
	• 70% relative humidity • 20°C temperature • 1013 mbar air pressure.
Assessment	• The assessment has been broken into two components: - L_{Aeq} assessment against NPI criteria to consider long term noise sources such as idling trains, maintenance, air conditioning units, wash facilities etc - L_{Amax} assessment to consider potential sleep disturbance impacts associated with short term noise sources including horns, brake releases, bunching and stretching events.

7.3 Operational noise scenarios

To assist the understanding of operational noise impacts, noise level contours have been calculated with a grid spacing of 20 metres and are presented in Appendix D. The contour plots for the daytime, night-time and maximum noise levels are calculated at a height of 1.5 metres above the local ground level.

The maintenance facility is expected to have a number of activities take place that generate noise which has the potential to impact the surrounding receivers. Operational scenarios based on discussions with the project team, as well as previous project experiences, have been presented in Table 7.2. These operational scenarios have been modelled.

Table 7.2: Operational noise scenarios

Scenario ID	Name	Description	Noise sources	Noise descriptor
L_{Aeq} noise scenarios				
1	Trains arrival	Two trains arrive at the facility. Both trains travel at 5 km/h within the facility. One train travels to the train wash and the other train travels to the main maintenance facility. Modelled trains are outside the shed.	Two trains travelling at 5 km/h	L_{Aeq}
2	Trains departure	Two trains departing the facility. Both trains travel at 5 km/h within the facility. One train travels from the train wash and the other train travels from the main maintenance facility. Modelled trains are outside the shed.	Two trains travelling at 5 km/h	L_{Aeq}
3	Wash facility	One train idling at train wash, while washing is being carried out. Second train idling in the main maintenance facility. Roller door is assumed to be open.	Two trains idling and wash facility	L_{Aeq}
4	Wheel lathe	One train idling at the wheel lathe, while the wheel lathe is in use. Second train idling outside the main maintenance facility. Roller door is assumed to be open.	Two trains idling and wheel lathe	L_{Aeq}
5	Maintenance facility	One train idling in main maintenance facility, while maintenance work is being carried out. Second train idling at the train wash track. Roller doors are assumed to be open.	Two trains idling and maintenance facility	L_{Aeq}

Scenario ID	Name	Description	Noise sources	Noise descriptor
L_{Aeq} noise scenarios				
6	Trains idling	One train idling in main maintenance facility and the other train idling at the train wash track.	Two trains idling	L_{Aeq}
7	Car park activities and building services	Four cars travelling at 40 km/h in the car park area and air conditioning units operating.	Four cars travelling at 40 km/h and building air conditioning units	L_{Aeq}
7a	Substation	Substation operating	Substation	L_{Aeq}
L_{max} noise scenarios				
8	Yard horn activation	Horn sound when train approaching facility outdoors	Yard horn	L_{Amax}
9	Brake release test	Brake release test outdoors	Brake release/test	L_{Amax}
10	Country horn test	Country horn test outdoors	Country horn	L_{Amax}
11	Car park activities	Maximum noise events associated with car parking	Door slams and engine starts	L_{Amax}
12	Substation	Circuit breakers triggering	Substation circuit breakers	L_{Amax}

7.4 Operational noise sources

Operation of the Proposal would generate noise with the potential to impact nearby surrounding receivers. Noisy activities and plant located on site have been provided in Table 7.3.

Except where noted, low frequency or other NPI 'annoyance' penalties have not been applied to these noise levels.

Table 7.3: Operational sound power levels

Source	Sound Power Level dB(A)	Location
Train entering / leaving facility	77 L_E	Based on measured value of XPT countrylink passby at 25 km/hr.
Idling trains (external)	75 $L_{Aeq(15\ minute)}$ per wagon	2 locomotives per train. Based on attended monitoring of diesel locomotives on the HVCN.
Wash facility	75 (walls) / 84 (open ends) $L_{Aeq(period)}$	9dB(A) attenuation across sheet steel walls.
Maintenance facility	84 (walls) / 105 (open western end) $L_{Aeq(period)}$	Includes acoustic insulation of 26dB R_w.
Building air conditioning unit	82 $L_{Aeq(15\ minute)}$	6 units on maintenance facility roof 2 units on stores building roof 1 unit on administration building roof
Car travelling at 40 km/h	65 $L_{Aeq(15\ minute)}$	In car park.
Wheel lathe	93 $L_{Aeq(15\ minute)}$	Located underneath train in housing.

Source	Sound Power Level dB(A)	Location
Brake release/test	105 L_{Amax}	At end of train underneath.
Yard horn	110 L_{Amax}	At end of train underneath.
Country horn	133 L_{Amax}	At end of train underneath.
Car door slam	100 L_{Amax}	In car park.
Car engine start	90 L_{Amax}	In car park.
Substation	85 $L_{Aeq(15\ minute)}$*	Substation.
Substation circuit breakers	118 L_{Amax}	Substation.

** The substation includes a +5dB penalty in accordance with Section 3 of the NPI for the tonal and low frequency components of this source.*

7.5 Predicted operational noise results

Table 7.4 presents the predicted noise levels associated with the operation of the Proposal, along with a comparison with the relevant operational noise criteria (refer Table 4.12). The assessment is limited to receivers located within the NCAs identified in Figure 3.1. Predicted noise levels have been based on continuous operation of the noise sources as per the assumed scenarios detailed in Table 7.2. Predictions are considered to represent the highest potential noise impacts.

The results presented in Table 7.4 indicate that where work is carried out within the maintenance work sheds (Scenarios 3, 4 and 5) noise levels would frequently exceed criteria at the nearest receivers within NCAs 1, 2, 3 and 5. Exceedances of the criteria are generally less than 10dB, however during Scenario 5, exceedances of up to 15dB have been predicted.

The following impacts have been predicted during each assessed scenario where exceedances have been forecast:

- Scenario 3:
  - 3 exceedances are predicted at residential properties during day and evening hours within NCA 1, and up to 5 properties during night time hours
  - 5 exceedances are predicted at residential properties within NCA 2 during night time hours only
  - 16 exceedances are predicted at residential properties within NCA 3 during all hours
  - 7 exceedances are predicted at residential properties during day and evening hours within NCA 5, and up to 21 properties during night time hours
- Scenario 4:
  - 4 exceedances are predicted at residential properties during day and evening hours within NCA 1, and up to 8 properties during night time hours
  - 9 exceedances are predicted at residential properties within NCA 2 during night time hours only
  - 17 exceedances are predicted at residential properties within NCA 3 during all hours
  - 8 exceedances are predicted at residential properties during day and evening hours within NCA 5, and up to 24 properties during night time hours
- Scenario 5:
  - 8 exceedances are predicted at residential properties during day and evening hours within NCA 1, and up to 14 properties during night time hours
  - 74 exceedances are predicted at residential properties within NCA 2 during night time hours only and potentially 6 properties during evening hours

- 24 exceedances are predicted at residential properties within NCA 3 during all hours
- 3 exceedances are predicted at residential properties during day and evening hours within NCA 5, and up to 10 properties during night time hours

- Scenario 10:
  - Exceedances of sleep disturbance criteria of up to 28dB are predicted during horn testing activities. These exceedances are predicted to occur in all NCAs
- Scenario 12:
  - Exceedances of sleep disturbance criteria are predicted where the substation circuits breakers are used during night time hours. These exceedances are predicted in NCAs 1, 2, and 3. Although the predicted noise levels in NCA 1 are lowest, lower existing background noise levels have caused have resulted in higher noise impacts.

Exceeding properties are generally located in the following locations:

- NCA 1 - Exceedances are predicted at properties on Fitzroy Close, Darby Close and Welchman Street
- NCA 2 - Exceeding properties are located on located on Chelmsford, Hopetown, Macdonald, Kennedy, Strickland, Short, Bultje, Fitzroy, Hampden and Wingewarra Streets
- NCA 3 - Exceeding locations include Boronia Place, Hakea Place, Grevillea Close and Wingewarra Street
- NCA 5 – Exceeding properties are located on Cedar Court, Maple Court and Mulga Court.

Table 7.4 presents the predicted noise impacts from the operations on nearby residential receivers.

Table 7.5 presents the predicted noise impacts from the operations on nearby commercial receivers. The predicted impacts show that the operations of the maintenance facility are well within the 60 dB(A) noise criteria for commercial receivers.

Table 7.6 presents the predicted noise impacts from the operations on nearby industrial receivers. The predicted impacts show that the operations of the maintenance facility are well within the 65 dB(A) noise criteria for industrial receivers.

Table 7.7 presents the predicted noise impacts from the operations on nearby educational facilities. The predicted impacts show that the operations of the maintenance facility may exceed the 40 dB(A) external noise criteria for educational facility.

Table 7.8 presents the predicted noise impacts from the operations at the Salvation Army on Gipps Street. The predicted impacts show that the operations of the maintenance facility are well within the 45 dB(A) external noise criteria for the place of worship.

Table 7.4: Predicted operational noise levels at residential receivers

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) Day/Evening/Night	Exceedance dB(A) Day/Evening/Night	Compliance Yes/No Day/Evening/Night
Scenario 1 - L_{Aeq}				
NCA 1	4 to 26	42 / 42 / 40	- / - / -	Yes / Yes / Yes
NCA 2	9 to 23	49 / 45 / 37	- / - / -	Yes / Yes / Yes
NCA 3	16 to 23	39 / 39 / 39	- / - / -	Yes / Yes / Yes
NCA 4	8 to 24	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	5 to 22	45 / 45 / 40	- / - / -	Yes / Yes / Yes
Scenario 2 - L_{Aeq}				
NCA 1	4 to 26	42 / 42 / 40	- / - / -	Yes / Yes / Yes
NCA 2	8 to 23	49 / 45 / 37	- / - / -	Yes / Yes / Yes
NCA 3	16 to 23	39 / 39 / 39	- / - / -	Yes / Yes / Yes

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) Day/Evening/Night	Exceedance dB(A) Day/Evening/Night	Compliance Yes/No Day/Evening/Night
NCA 4	8 to 24	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	5 to 22	45 / 45 / 40	- / - / -	Yes / Yes / Yes
Scenario 3 - L_{Aeq}				
NCA 1	13 to 46	42 / 42 / 40	**4 / 4 / 6**	**No / No / No**
NCA 2	7 to 39	49 / 45 / 37	- / - / **2**	Yes / Yes / **No**
NCA 3	25 to 47	39 / 39 / 39	**8 / 8 / 8**	**No / No / No**
NCA 4	13 to 37	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	16 to 49	45 / 45 / 40	**4 / 4 / 9**	**No / No / No**
Scenario 4 - L_{Aeq}				
NCA 1	13 to 47	42 / 42 / 40	**5 / 5 / 7**	**No / No / No**
NCA 2	8 to 40	49 / 45 / 37	- / - / **3**	Yes / Yes / **No**
NCA 3	25 to 47	39 / 39 / 39	**8 / 8 / 8**	**No / No / No**
NCA 4	14 to 38	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	17 to 49	45 / 45 / 40	**4 / 4 / 9**	**No / No / No**
Scenario 5 - L_{Aeq}				
NCA 1	20 to 49	42 / 42 / 40	**7 / 7 / 9**	**No / No / No**
NCA 2	15 to 48	49 / 45 / 37	**- / 3 / 9**	Yes / **No / No**
NCA 3	23 to 54	39 / 39 / 39	**15 / 15 / 15**	**No / No / No**
NCA 4	14 to 39	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	22 to 48	45 / 45 / 40	**3 / 3 / 8**	**No / No / No**
Scenario 6 – L_{Aeq}				
NCA 1	3 to 37	42 / 42 / 40	- / - / -	Yes / Yes / Yes
NCA 2	0 to 28	49 / 45 / 37	- / - / -	Yes / Yes / Yes
NCA 3	15 to 37	39 / 39 / 39	- / - / -	Yes / Yes / Yes
NCA 4	6 to 29	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	9 to 41	45 / 45 / 40	- / - / 1[1]	Yes / Yes / Yes
Scenario 7 – L_{Aeq}				
NCA 1	0 to 34	42 / 42 / 40	- / - / -	Yes / Yes / Yes
NCA 2	0 to 28	49 / 45 / 37	- / - / -	Yes / Yes / Yes
NCA 3	15 to 37	39 / 39 / 39	- / - / -	Yes / Yes / Yes
NCA 4	0 to 26	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	3 to 41	45 / 45 / 40	- / - / 1[1]	Yes / Yes / Yes
Scenario 7a – L_{Aeq}				
NCA 1	0 to 23	42 / 42 / 40	- / - / -	Yes / Yes / Yes
NCA 2	0 to 26	49 / 45 / 37	- / - / -	Yes / Yes / Yes
NCA 3	0 to 33	39 / 39 / 39	- / - / -	Yes / Yes / Yes
NCA 4	0 to 16	45 / 44 / 40	- / - / -	Yes / Yes / Yes
NCA 5	0 to 27	45 / 45 / 40	- / - / -	Yes / Yes / Yes
Scenario 8 – L_{max} *				
NCA 1	13 to 46	- / - / 50	- / - / -	- / - / Yes
NCA 2	4 to 33	- / - / 47	- / - / -	- / - / Yes
NCA 3	15 to 44	- / - / 50	- / - / -	- / - / Yes
NCA 4	13 to 36	- / - / 51	- / - / -	- / - / Yes
NCA 5	3 to 41	- / - / 52	- / - / -	- / - / Yes
Scenario 9 – L_{max} *				
NCA 1	5 to 39	- / - / 50	- / - / -	- / - / Yes
NCA 2	0 to 24	- / - / 47	- / - / -	- / - / Yes
NCA 3	6 to 41	- / - / 50	- / - / -	- / - / Yes
NCA 4	10 to 35	- / - / 51	- / - / -	- / - / Yes
NCA 5	7 to 52	- / - / 52	- / - / -	- / - / Yes
Scenario 10 – L_{max}*				
NCA 1	33 to 67	- / - / 50	- / - / **17**	- / - / **No**

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) Day/Evening/Night	Exceedance dB(A) Day/Evening/Night	Compliance Yes/No Day/Evening/Night
NCA 2	24 to 52	- / - / 47	- / - / **5**	- / - / **No**
NCA 3	34 to 69	- / - / 50	- / - / **19**	- / - / **No**
NCA 4	39 to 63	- / - / 51	- / - / **12**	- / - / **No**
NCA 5	35 to 80	- / - / 52	-/ - / **28**	- / - / **No**
Scenario 11 – L_{max} *				
NCA 1	1 to 20	- / - / 50	- / - / -	- / - / Yes
NCA 2	1 to 35	- / - / 47	- / - / -	- / - / Yes
NCA 3	18 to 39	- / - / 50	- / - / -	- / - / Yes
NCA 4	0 to 6	- / - / 51	- / - / -	- / - / Yes
NCA 5	0 to 32	- / - / 52	- / - / -	- / - / Yes
Scenario 12 – L_{max}				
NCA 1	29 to 56	- / - / 50	- / - / 6	**- / - / No**
NCA 2	24 to 59	- / - / 47	- / - / -	- / - / Yes
NCA 3	42 to 66	- / - / 50	- / - / 16	**- / - / No**
NCA 4	19 to 49	- / - / 51	- / - / -	- / - / Yes
NCA 5	37 to 60	- / - / 52	- / - / 8	**- / - / No**

Note 1: A 1 dB exceedance is not considered to be acoustically significant due to the average human hearing not able to detect sound levels of 1 dB difference.

Note 2: Exceedances are highlighted in bold

* LAmax predictions have been assessed against the sleep disturbance criteria which is during the night time period only

Table 7.5: Predicted operational noise levels at commercial receivers

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 1 - L_{Aeq}				
NCA 1	1 to 21	60	-	Yes
NCA 2	5 to 19		-	Yes
NCA 3	20 to 21		-	Yes
NCA 4	11 to 22		-	Yes
NCA 5	5 to 8		-	Yes
Scenario 2 – L_{Aeq}				
NCA 1	1 to 21	60	-	Yes
NCA 2	5 to 19		-	Yes
NCA 3	20 to 21		-	Yes
NCA 4	11 to 22		-	Yes
NCA 5	5 to 8		-	Yes
Scenario 3 - L_{Aeq}				
NCA 1	10 to 35	60	-	Yes
NCA 2	10 to 32		-	Yes
NCA 3	34 to 34		-	Yes
NCA 4	19 to 37		-	Yes
NCA 5	18 to 24		-	Yes

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 4 - L_{Aeq}				
NCA 1	10 to 36	60	-	Yes
NCA 2	11 to 33		-	Yes
NCA 3	34 to 34		-	Yes
NCA 4	20 to 38		-	Yes
NCA 5	19 to 24		-	Yes
Scenario 5 - L_{Aeq}				
NCA 1	18 to 43	60	-	Yes
NCA 2	17 to 40		-	Yes
NCA 3	45 to 45		-	Yes
NCA 4	21 to 37		-	Yes
NCA 5	15 to 21		-	Yes
Scenario 6 – L_{Aeq}				
NCA 1	0 to 24	60	-	Yes
NCA 2	1 to 23		-	Yes
NCA 3	23 to 24		-	Yes
NCA 4	11 to 28		-	Yes
NCA 5	10 to 16		-	Yes
Scenario 7 – L_{Aeq}				
NCA 1	0 to 19	60	-	Yes
NCA 2	0 to 18		-	Yes
NCA 3	23 to 24		-	Yes
NCA 4	6 to 23		-	Yes
NCA 5	5 to 13		-	Yes
Scenario 7a – L_{Aeq}				
NCA 1	0 to 20	60	-	Yes
NCA 2	0 to 15		-	Yes
NCA 3	0 to 20		-	Yes
NCA 4	0 to 17		-	Yes
NCA 5	0 to 10		-	Yes

Table 7.6: Predicted operational noise levels at industrial receivers

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 1 - L_{Aeq}				
NCA 1	18 to 29	65	-	Yes
NCA 2	16 to 28		-	Yes
NCA 3	22 to 25		-	Yes

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) When in use	Exceedance dB(A)	Compliance Yes/No
NCA 4	7 to 23		-	Yes
NCA 5	3 to 12		-	Yes
Scenario 2 – L_{Aeq}				
NCA 1	18 to 29	65	-	Yes
NCA 2	16 to 28		-	Yes
NCA 3	22 to 25		-	Yes
NCA 4	7 to 23		-	Yes
NCA 5	3 to 12		-	Yes
Scenario 3 - L_{Aeq}				
NCA 1	17 to 45	65	-	Yes
NCA 2	16 to 16		-	Yes
NCA 3	42 to 42		-	Yes
NCA 4	20 to 45		-	Yes
NCA 5	15 to 36		-	Yes
Scenario 4 - L_{Aeq}				
NCA 1	18 to 46	65	-	Yes
NCA 2	17 to 17		-	Yes
NCA 3	42 to 43		-	Yes
NCA 4	21 to 45		-	Yes
NCA 5	15 to 36		-	Yes
Scenario 5 - L_{Aeq}				
NCA 1	25 to 54	65	-	Yes
NCA 2	24 to 24		-	Yes
NCA 3	49 to 51		-	Yes
NCA 4	22 to 46		-	Yes
NCA 5	15 to 36		-	Yes
Scenario 6 – L_{Aeq}				
NCA 1	8 to 34	65	-	Yes
NCA 2	7 to 25		-	Yes
NCA 3	29 to 30		-	Yes
NCA 4	11 to 28		-	Yes
NCA 5	7 to 28		-	Yes
Scenario 7 – L_{Aeq}				
NCA 1	4 to 33	65	-	Yes
NCA 2	5 to 23		-	Yes
NCA 3	31 to 33		-	Yes
NCA 4	6 to 23		-	Yes
NCA 5	1 to 22		-	Yes

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 7a – L_{Aeq}				
NCA 1	0 to 23	65	-	Yes
NCA 2	12 to 12		-	Yes
NCA 3	34 to 35		-	Yes
NCA 4	0 to 19		-	Yes
NCA 5	0 to 16		-	Yes

Table 7.7: Predicted operational noise levels at educational facilities

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) (external) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 1 - L_{Aeq}				
NCA 1	12 to 24	40	-	Yes
NCA 2	16 to 21		-	Yes
NCA 5	15 to 16		-	Yes
Scenario 2 – L_{Aeq}				
NCA 1	12 to 24	40	-	Yes
NCA 2	16 to 21		-	Yes
NCA 5	15 to 16		-	Yes
Scenario 3 - L_{Aeq}				
NCA 1	10 to 49	40	**9**	**No**
NCA 2	16 to 25		-	Yes
NCA 5	34 to 34		-	Yes
Scenario 4 - L_{Aeq}				
NCA 1	11 to 49	40	**9**	**No**
NCA 2	17 to 26		-	Yes
NCA 5	35 to 35		-	Yes
Scenario 5 - L_{Aeq}				
NCA 1	20 to 44	40	**4**	**No**
NCA 2	24 to 44		4	No
NCA 5	28 to 28		-	Yes
Scenario 6 – LAeq				
NCA 1	2 to 27	40	-	Yes
NCA 2	7 to 17		-	Yes
NCA 5	25 to 26		-	Yes
Scenario 7 – L_{Aeq}				
NCA 1	0 to 22	40	-	Yes
NCA 2	2 to 12		-	Yes

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) (external) When in use	Exceedance dB(A)	Compliance Yes/No
NCA 5	22 to 23		-	Yes
Scenari 7a – L_{Aeq}				
NCA 1	0 to 11	40	-	Yes
NCA 2	0 to 22		-	Yes
NCA 5	15 to 15		-	Yes

Table 7.8: Predicted operational noise levels at place of worship (Salvation Army)

NCA	Predicted range of operational noise level – dB(A)	Noise criteria dB(A) (external) When in use	Exceedance dB(A)	Compliance Yes/No
Scenario 1 - L_{Aeq}				
NCA 2	17 to 18	45	-	Yes
Scenario 2 – L_{Aeq}				
NCA 2	17 to 18	45	-	Yes
Scenario 3 - L_{Aeq}				
NCA 2	20 to 21	45	-	Yes
Scenario 4 - L_{Aeq}				
NCA 2	21 to 22	45	-	Yes
Scenario 5 - L_{Aeq}				
NCA 2	28 to 32	45	-	Yes
Scenario 6 – L_{Aeq}				
NCA 2	11 to 13	45	-	Yes
Scenario 7 – L_{Aeq}				
NCA 2	7 to 9	45	-	Yes
Scenario 7a – L_{Aeq}				
NCA 2	4 to 5	45	-	Yes

8. Noise management measures

8.1 Construction noise mitigation

8.1.1 Standard noise mitigation measures

Standard techniques for controlling noise impacts during construction are presented in the ICNG and the TfNSW CNS. A Construction noise and vibration management plan (CNVMP) would be prepared during construction which considers these measures, relevant noise mitigation recommendations have been summarised below. Additional measures and further details are contained in Section 8.1 of the CNS.

Table 8.1: Standard construction noise management measures (ICNG and CNS)

Control measure	Details
Time constraints	• Limit noisy work to daylight or less sensitive hours where possible.
Scheduling	• Perform noisy work during less sensitive time periods, particularly early hours of the evening • Carry out construction activities during standard working hours when reasonable and feasible.
Equipment restrictions	• Select low noise options for plant and equipment. Ensure equipment mufflers operate in a proper and efficient manner.
Substitute methods	• Where possible, use quieter construction methods.
Limit equipment use	• Only have necessary equipment on-site and turn off when not in use.
Limit activity duration	• Where possible, concentrate noisy activities at one location and move to another as quickly as possible • Provide respite periods during noisy activities such as piling or demolition.
Equipment maintenance	• Ensure all plant and equipment is well maintained and where possible, fitted with silencing devices.
Reduce equipment power	• Use only the necessary size and powered equipment for tasks.
Quieter working practices	• Implement training to induct staff on noise sensitivities • Ensure that sleep disturbance impacts are minimised by reducing maximum noise events from sources such as ballast dumping, metal/metal contact, yelling and other short term peak events.
Reversing alarms	• Where possible, consider the application of less intrusive alternatives to reverse beepers such as 'squawker' or 'broadband' alarms • Minimise horn and detonator use where possible.
Use and siting of plant	• The offset distance between noisy plant and sensitive receivers should be maximised.
Plan work sites and activities to minimise noise and vibration	• Plan traffic flow, parking and loading/unloading areas to minimise reversing movements and remove noisy activities from the vicinity of noise sensitive receivers *(such as the Masonic Retirement village on White Street).*
Minimise disturbance arising from delivery of goods to construction sites	• Delivery and loading / unloading of materials should occur as far as possible from sensitive receivers • Select site access points and roads as far as possible from sensitive receivers • Do not allow the use of Engine compression braking in the vicinity of noise sensitive receivers *(such as the Masonic Retirement village on White Street)*.

Control measure	Details
Implement stakeholder consultation measures	• Periodic notification detailing all upcoming construction activities should be delivered to sensitive receivers at least seven days prior to the commencement of relevant works.
Development of a register for noise sensitive receivers	• This should be kept on site and would contain information including the address and contact details for each noise sensitive receiver.
Noise monitoring	• Carry out noise monitoring in response to complaints or as recommended in the Construction Noise Management Plan.
Prefabrication of materials off site	• Where reasonable and feasible, fabricate materials off site to reduce construction noise at the work location.

8.1.2 Transport for NSW additional mitigation measures

The CNS recommends practical measures for the control of noise and vibration from construction activity on transport projects. Where noise impacts are apparent, the measures referred to in this document would be implemented and are summarised in the mitigation section (Section 8.1).

In addition, where noise management levels are exceeded after implementation of these standard control measures, the CNS recommends further measures such as notification, by letterbox drops and individual briefings; monitoring, respite and alternative accommodation in some circumstances. The thresholds at which these measures are required are summarised in Table 8.2, taken from the CNS.

Table 8.2: Additional mitigation measures to be implemented – TfNSW CNS

Construction hours	Receiver perception	dB(A) above RBL*	dB(A) above NML	Additional management measures
Standard hours	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
	75dB or greater	N/A	N/A	PN, V, SN
OOHW Period 1	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	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 V - Verification monitoring RP – Respite period AA – Alternative accommodation		SN – Specific notification DR – Duration reduction RO – Project specific respite offer	

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

 # Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 day onl,y (ie Saturday 6am – 7am and 1pm – 6pm, Sundays / public holidays (8am – 6pm).

8.2 Construction vibration mitigation

Where earthworks are carried out in the vicinity of the Boradze depot buildings, potential exceedances of heritage ground vibration criteria may occur. Building inspections of these sites would be carried out prior to the commencement of construction activities.

In addition, where works are carried out in the vicinity of Boradze depot, low vibration methods would be considered. This may include smaller or non-vibratory rollers or the use of concrete cutting or grinding methods instead of hydraulic rockbreaking, where required. Where earthworks or other vibration intensive activities are carried out within 10 metres of the structures, vibration monitoring would be undertaken.

8.3 Operational noise mitigation

The predicted noise levels indicate exceedances of the L_{eq} and L_{max} noise levels are expected at the closest receivers to the Proposal. As a result, mitigation measures have been investigated to reduce the potential noise impact of the Proposal, primarily from:

- The operation of the main maintenance facility (scenarios 3,4 and 5)
- During country horn testing (scenario 10).

The mitigation measures were investigated in the preference order of at the source, along the propagation path and finally at the receiver. The adoption of mitigation measures would be subject to further detailed design and where reasonable and feasible.

Management measures to be considered could include:

- Management of the location, time of day and manner in which activities are carried out
- Modifying operating procedures to reduce noise intensive activities during the evening and night at locations exposed to receivers
- The installation of sound insulation within the walls of the maintenance shed. The noise model was prepared assuming an Rw of 26dB. Where this can be increased by 10dB, most exceedances to the north, west and south of the shed would be eliminated (exceedances to the west of the site are associated with the open shed doors and would not be affected by the installation of acoustic insulation)
- It is understood that the Proposal would produce an excess of fill material. This material could be used to construct a noise mound along the southern and south western site boundaries, where the most impacted receivers are located. The highest noise levels have been predicted to occur along the rear of properties on Hakea Place and Grevillea Close and a noise mound interrupting a direct line of sight between the door of the maintenance shed and these properties would be effective in reducing noise impacts. This would mean that the most effective locations for a noise barrier would be along the fenceline of Grevillea / Hakea Close or directly to the south of the maintenance shed door / parallel to the shed itself
- Specifying noise emission limits for certain equipment or activities.

8.3.1 The use and testing of horns

The country horn test is the most dominant source and alternatives to testing or use of the country horn at the site should be considered, particularly during night time hours. This could include testing horns elsewhere on the network or developing alternative testing techniques. These measures would be considered as part of further stages of the development in the detailed design phase and as part of the operational noise management plan for the site.

The yard horn (train movement alarm system) was not predicted to exceed the sleep disturbance criteria at any of the assessed residences. However experience with other maintenance facilities and stabling yards indicates that the noise produced can be a source of annoyance for nearby sensitive receivers. As a result it is recommended that as part of the detailed design, alternative systems are investigated for vehicle movement alarms. Alternative systems similar to those implemented at other rail facilities could include visual alarms and ground based warning systems.

8.3.2 Controls at sensitive receivers

Provision of noise control at the receiver is the least preferred option for noise mitigation. Controls at the source and the propagation path are preferable to treatments applied to individual receivers.

This type of treatment usually forms the final resolution should other mitigation options not be appropriate or sufficient in mitigating the noise impact. This typically involves providing architectural upgrades at the dwellings such as sealing windows and doors, providing mechanical ventilation and façade upgrades. However, these controls only improve amenity inside the dwelling and do not reduce noise impacts outside.

This type of mitigation can be effective where sleep disturbance impacts are predicted after noise control at the source and along the transfer path have been investigated. The adoption of treatments at residential receivers would be subject to further consideration as part of the detailed design process.

8.3.3 Operational noise and vibration management plan

An operational noise and vibration management plan would be prepared and implemented. This plan would include:

- Development of mitigation strategies and management measures for the identified activities and sources that contribute to exceedances of applicable sleep disturbance guidelines and policies.
- Development of management strategies to ensure compliance with applicable sleep disturbance guidelines and policies for horn usage, warning signals and horn testing at the facility. Management measures would include:
  - Management of the location, time of day and manner in which activities are carried out.
  - Modifying operating procedures to reduce noise intensive activities during the evening and night at locations exposed to receivers.
  - Specifying noise emission limits for certain equipment or activities.
  - Developing further the mitigations strategies outlined in the Noise and Vibration Assessment.

Where noise levels are greater than those listed in Table 7.3 or their locations differ significantly from those assessed in this report, additional assessment would be carried out.

9. Summary noise impacts

The predicted impacts with the mitigation recommended in Section 8 as a result of the Proposal have each been assigned a rating. The rating considers the likelihood of the impact occurring and the magnitude of the impact on the receiving environment.

Further noise management would be considered where the assessed impacts are considered '*Moderate*' or '*Major'*.

The ratings are defined where one or more of the following conditions are satisfied:

- *Negligible*: where the predicted changes are not sufficient to affect ambient noise or vibration levels beyond natural variations
- *Minor*: where there is predicted to be some level of generated noise and vibration or there is a perceptible change that would occur for less than a week during construction and is generally below the operational criteria
- *Moderate*: where there is predicted to be a perceptible change in noise and vibration lasting more than a week, an exceedance of the 'noise affected' noise management levels, the potential for sleep disturbance to occur at some point or the potential for ground-borne vibration to cause cosmetic damage or to result in 'annoyance' at some point during construction
- *Major*: where there is predicted to be a notable change in noise and vibration lasting more than three weeks, an exceedance of the 'highly noise affected' construction noise management levels, the risk of long-term sleep disturbance or an accepted certainty that ground-borne vibration would have an impact on people or buildings.

Table 9.1: Summary of noise and vibration impacts

Source	Assessed impact	Recommended mitigation
Construction noise: standard hours	Major	Section 8.1
Construction noise: outside of standard hours	Moderate	Section 8.1
Construction vibration: building damage	Minor to negligible	Section 8.2
Construction vibration: human comfort	Minor to negligible	Section 8.2
Construction road traffic	Minor	Not applicable
Operational rail noise	Minor	Not applicable
Operational facility noise: daytime	Moderate	Section 8.3
Operational facility noise: evening	Major	Section 8.3
Operational facility noise: night-time	Major	Section 8.3
Operational facility noise: sleep disturbance	Moderate	Section 8.3

10. References

Transport for NSW, 2016. *Construction Noise Strategy*

NSW EPA, 2017. *Noise Policy for Industry*

NSW EPA, 2013. *Rail Infrastructure Noise Guideline*

DECCW, 2011. *NSW Road Noise Policy*

DECC, 2009. *Interim Construction Noise Guideline*

DEC, 2006. *Assessing Vibration: a technical guideline*

Gowan, Karantonis and Rofail, 2004. *Converting Bureau of Meteorology Wind Speed Data to Local Wind Speeds at 1.5m Above Ground Level*

Australia Standard AS2436-2010. *Guide to noise and vibration control on construction, demolition and maintenance sites*

British Standard 6472-1: 2008. *Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting [BS 6472-1: 2008]*

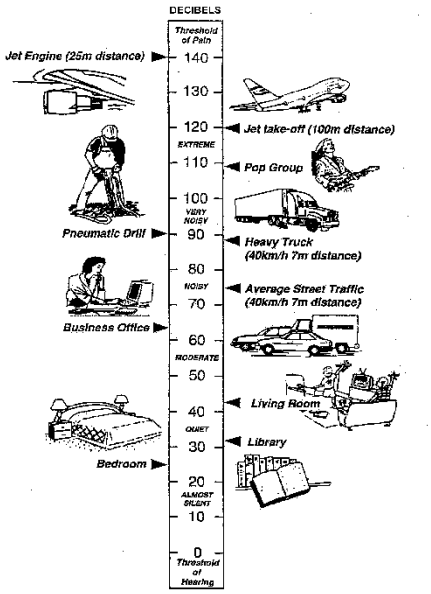
British Standard BS7385: 1990. *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration*

DIN 4150-3 Structural vibration Part 3: *Effects of vibration on structures*

Appendix A. Acoustic terminology

A-weighted sound pressure	The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic '*A-weighting*' frequency filter is applied to the measured sound level *dB(A)* to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted dB(linear).
Ambient noise	The total noise in a given situation, inclusive of all noise source contributions in the near and far field.
Community annoyance	Includes noise annoyance due to: ▪ character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content) ▪ character of the environment (e.g. very quiet suburban, suburban, urban, near industry) ▪ miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations) ▪ human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio/TV, recreation).
Compliance	The process of checking that source noise levels meet with the noise limits in a statutory context.
Cumulative noise level	The total level of noise from all sources.
Extraneous noise	Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Feasible and reasonable measures	Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors: ▪ Noise mitigation benefits (amount of noise reduction provided, number of people protected). ▪ Cost of mitigation (cost of mitigation versus benefit provided). ▪ Community views (aesthetic impacts and community wishes). ▪ Noise levels for affected land uses (existing and future levels, and changes in noise levels).

Impulsiveness	Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.
Low frequency	Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.
Noise criteria	The general set of non-mandatory noise levels for protecting against intrusive noise (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).
Noise level (goal)	A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.
Noise limits	Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.
Performance-based goals	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Rating Background Level (RBL)	The rating background level is the overall single figure background level representing each day, evening and night-time period. The rating background level is the 10th percentile min L_{A90} noise level measured over all day, evening and night-time monitoring periods.
Receiver	The noise-sensitive land use at which noise from a development can be heard.
Sleep disturbance	Awakenings and disturbance of sleep stages.
Sound and decibels (dB)	Sound (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which should cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2 x 10-5 Pa. The picture below indicates typical noise levels from common noise sources.



dB is the abbreviation for decibel – a unit of sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Sound power Level (SWL)

The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in *dB(A)*.

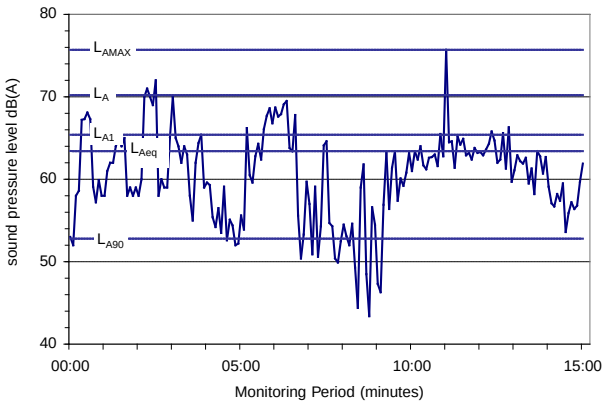
Sound Pressure Level (SPL)

The level of noise, usually expressed as SPL in *dB(A)*, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in *dB(A)* gives a close indication of the subjective loudness of the noise.

Statistic noise levels

Noise levels varying over time (e.g. community noise, traffic noise, construction noise) are described in terms of the statistical exceedance level.

A hypothetical example of A weighted noise levels over a 15-minute measurement period is indicated in the following figure:



Key descriptors:

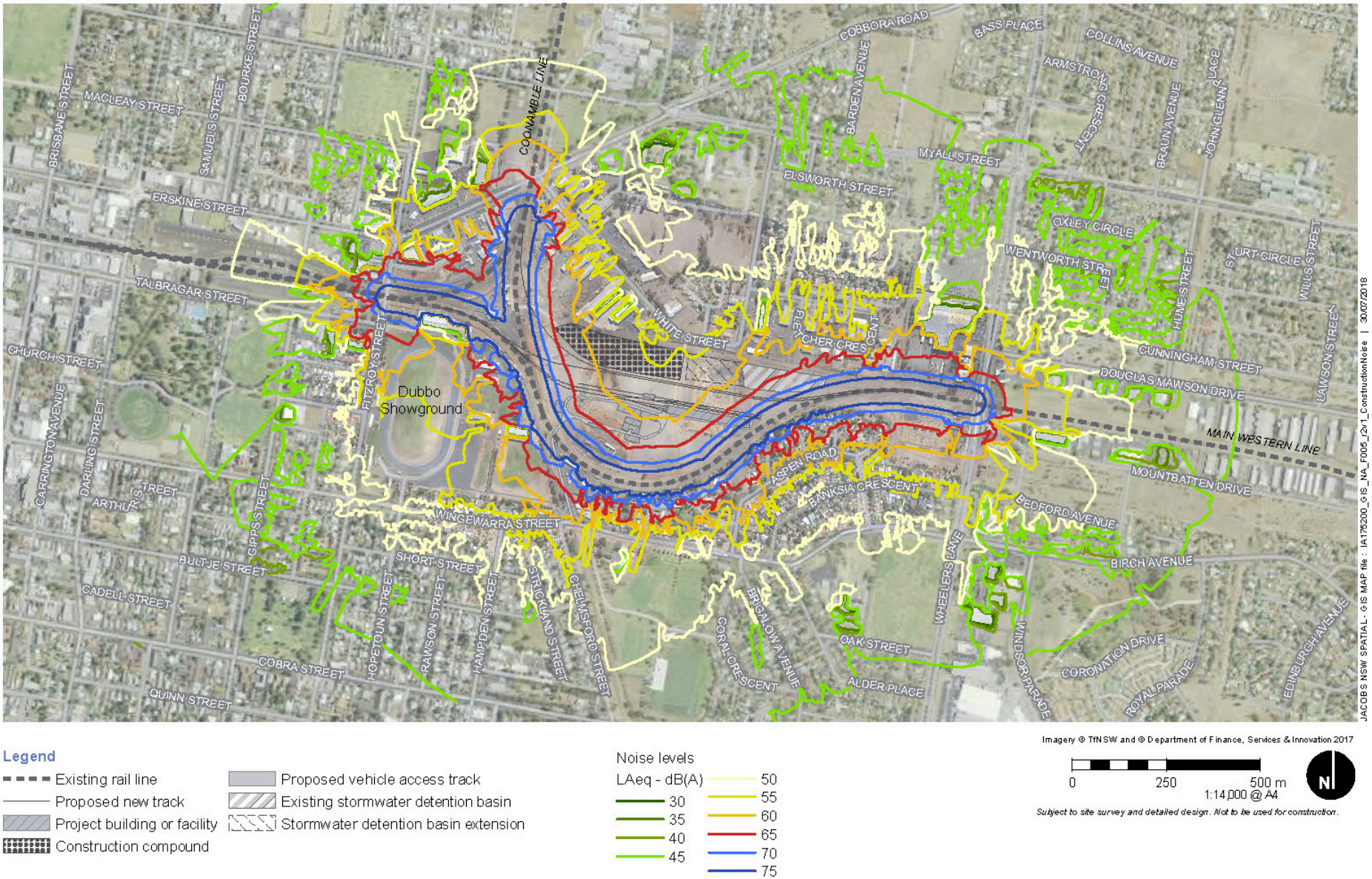
L_{Amax} Maximum recorded noise level.

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level.

	L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound. L_{A90} Noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).
Threshold	The lowest sound pressure level that produces a detectable response (in an instrument/person).
Tonality	Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 2 to 5 dB(A) penalty is typically applied to noise sources with tonal characteristics.

Appendix B. Construction noise contours



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0 250 500 m
1:14 000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

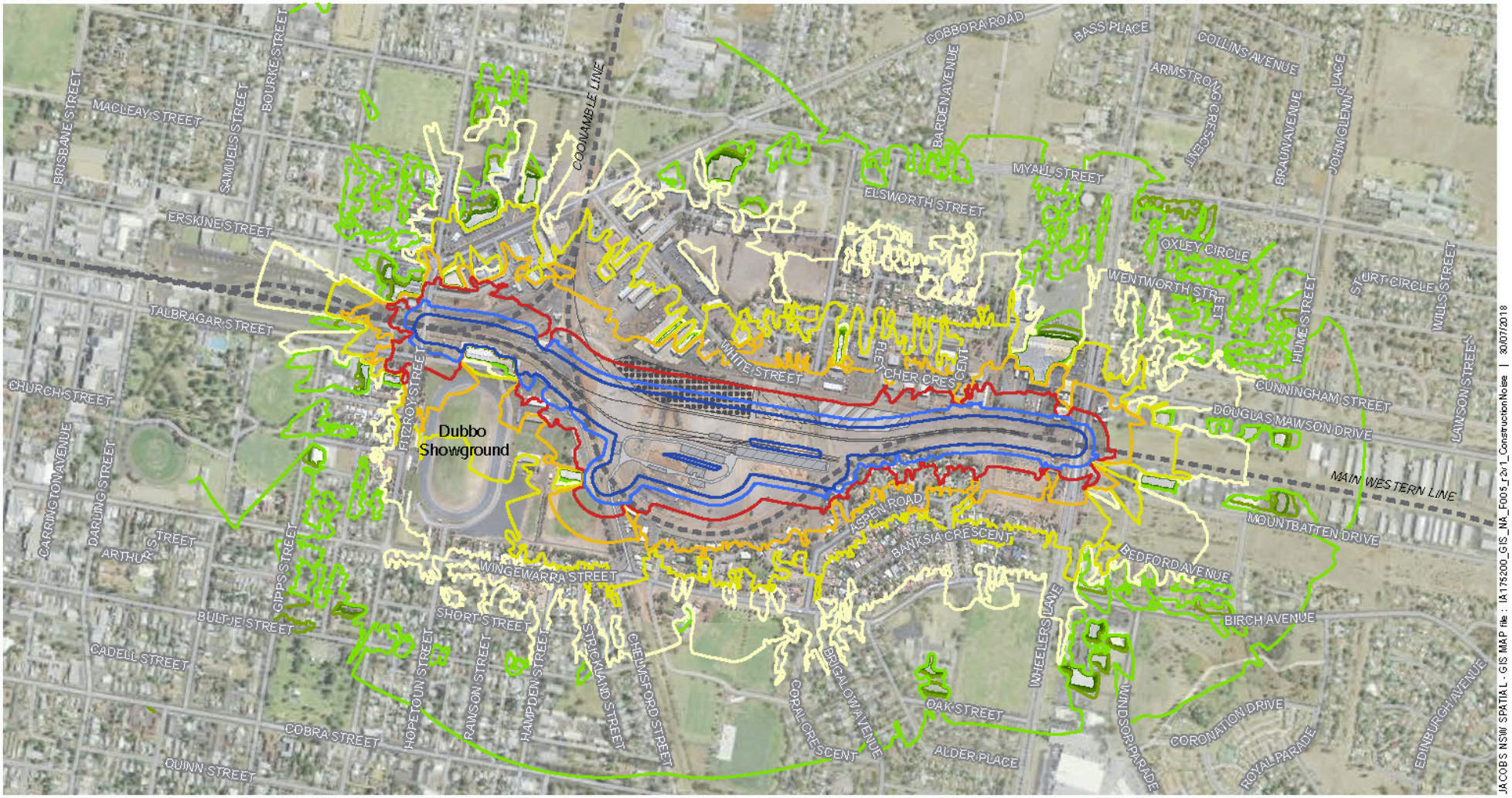
Legend

- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels
LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Appendix B – Figure B1 | Demolition



Legend

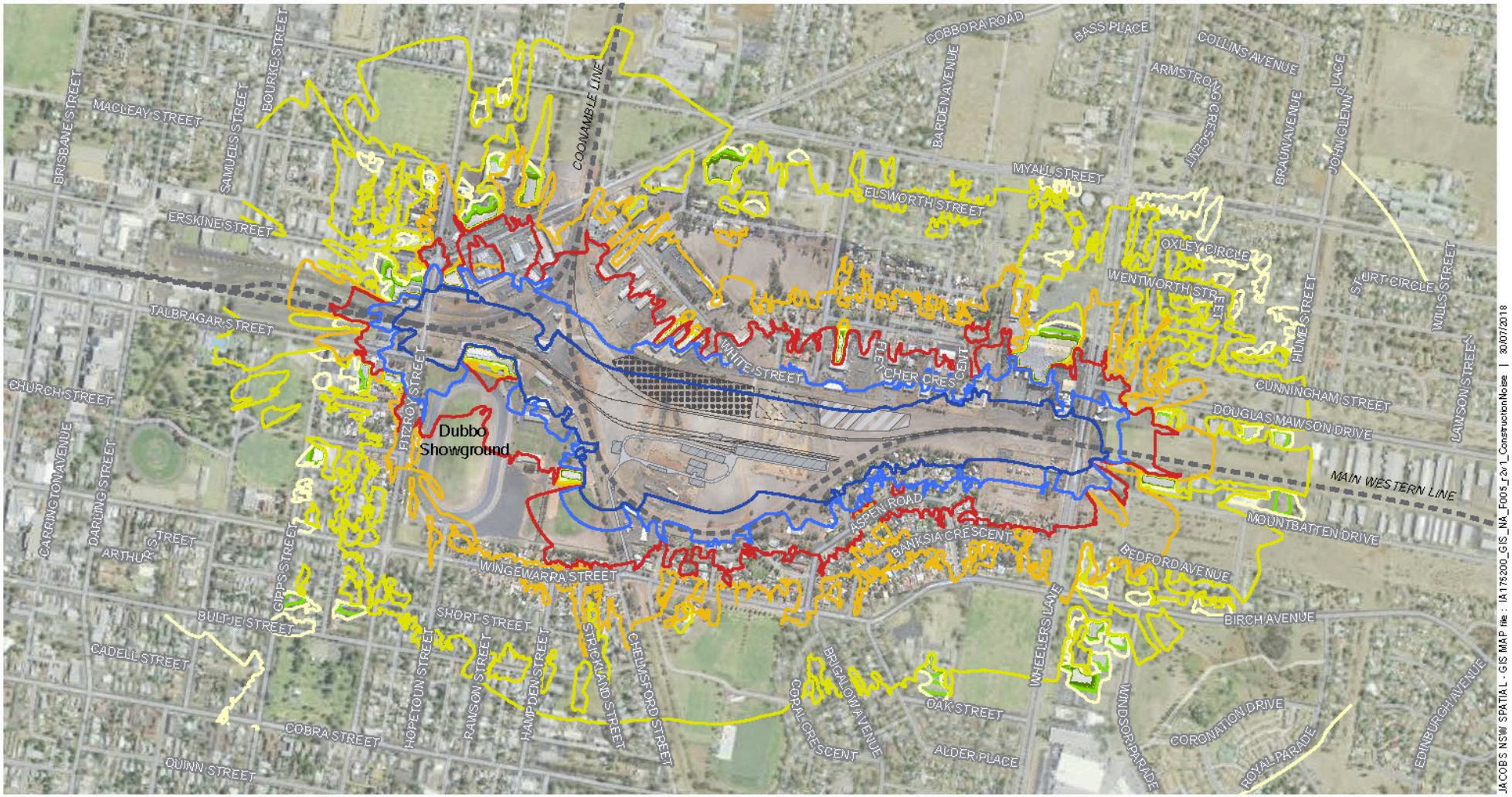
- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Appendix B – Figure B2 | Land clearing



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0 250 500 m
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Subject to site survey and detailed design. Not to be used for construction.

Legend

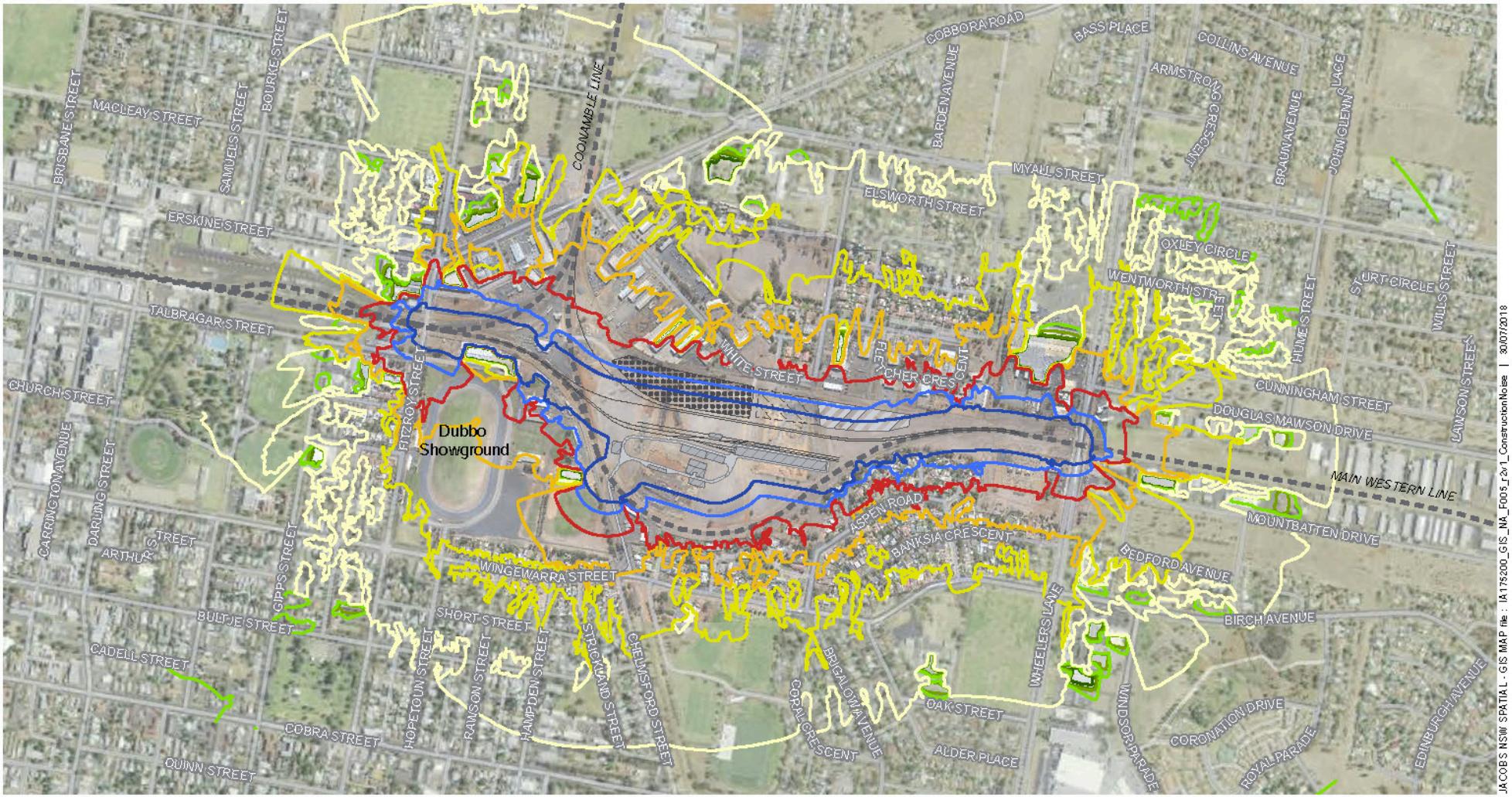
- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

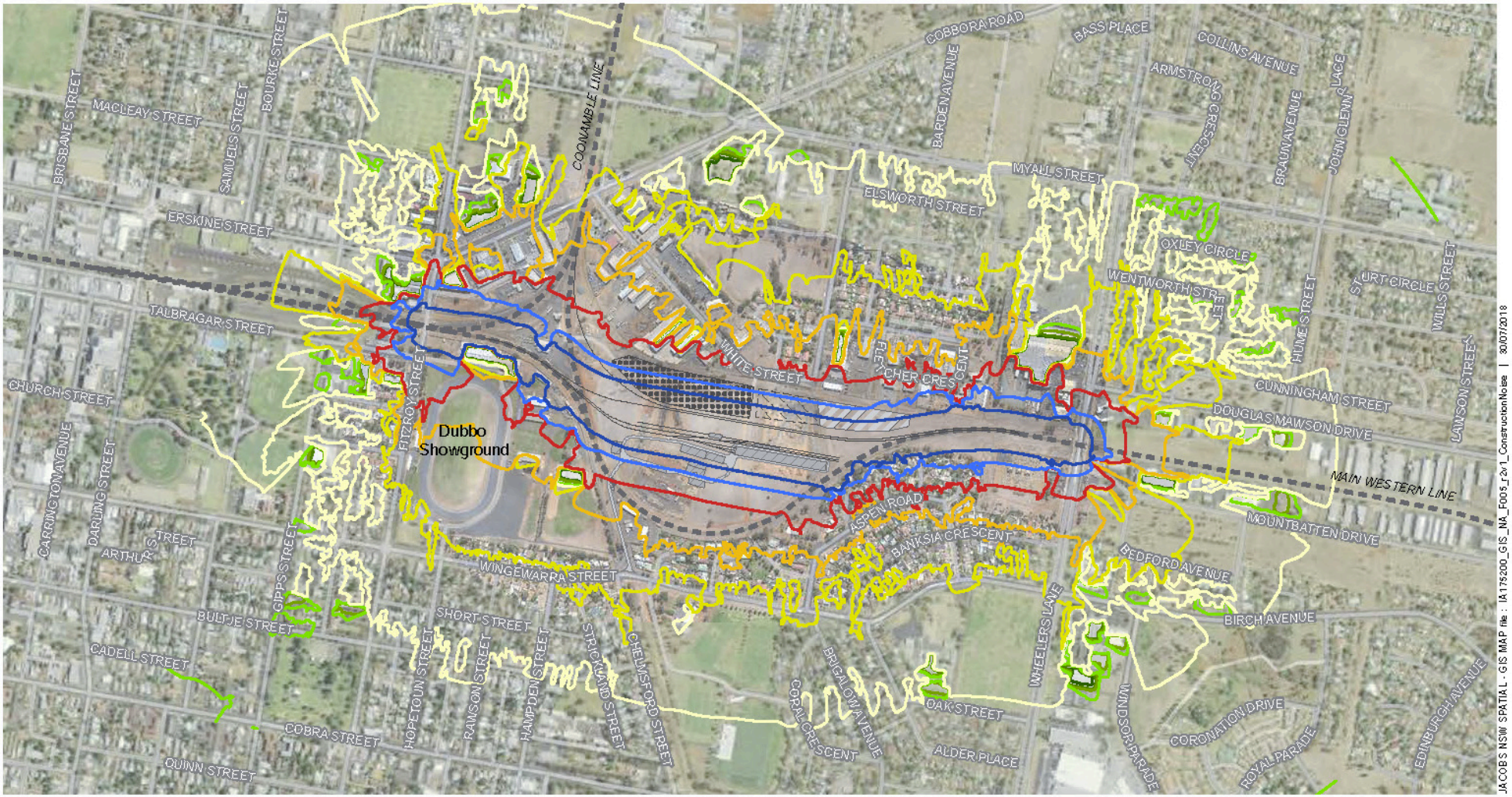
LAeq - dB(A)

35, 40, 45, 50, 55, 60, 65, 70, 75

Appendix B – Figure B3 | Earthworks



Appendix B – Figure B4 | Service and drainage installation



Legend

- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Appendix B – Figure B5 | Track work

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0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

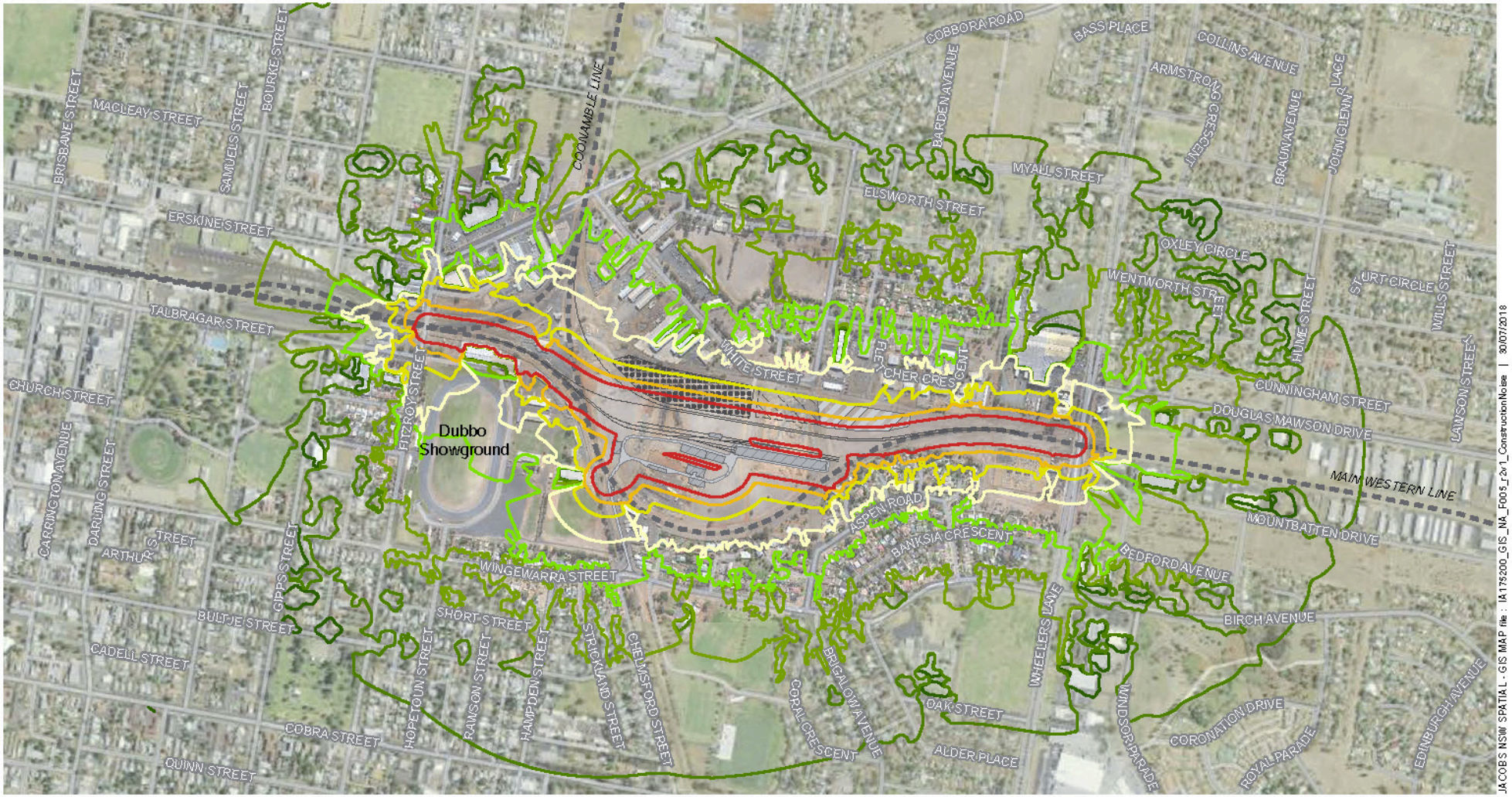
- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix B – Figure B6 | Building construction



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0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix B – Figure B7 | Utility installation

Legend

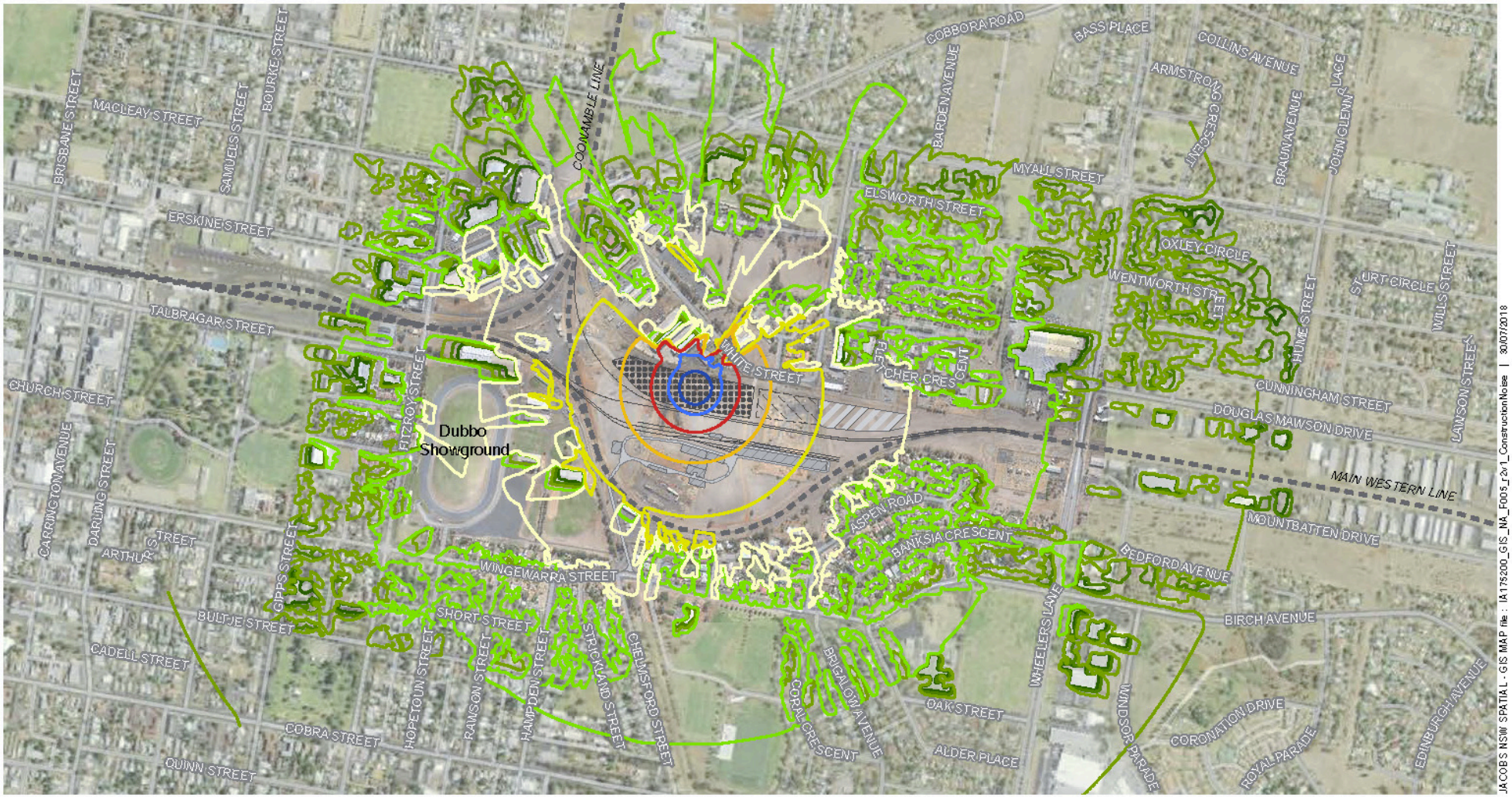
- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix B – Figure B8 | Landscaping



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0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Project building or facility
- Construction compound
- Proposed vehicle access track
- Existing stormwater detention basin
- Stormwater detention basin extension

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Appendix B – Figure B9 | Site compound

Appendix C. Operational noise contours – realigned rail line

JACOBS

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50

Appendix C – Figure C1 | Day LAeq rail noise contours

Legend

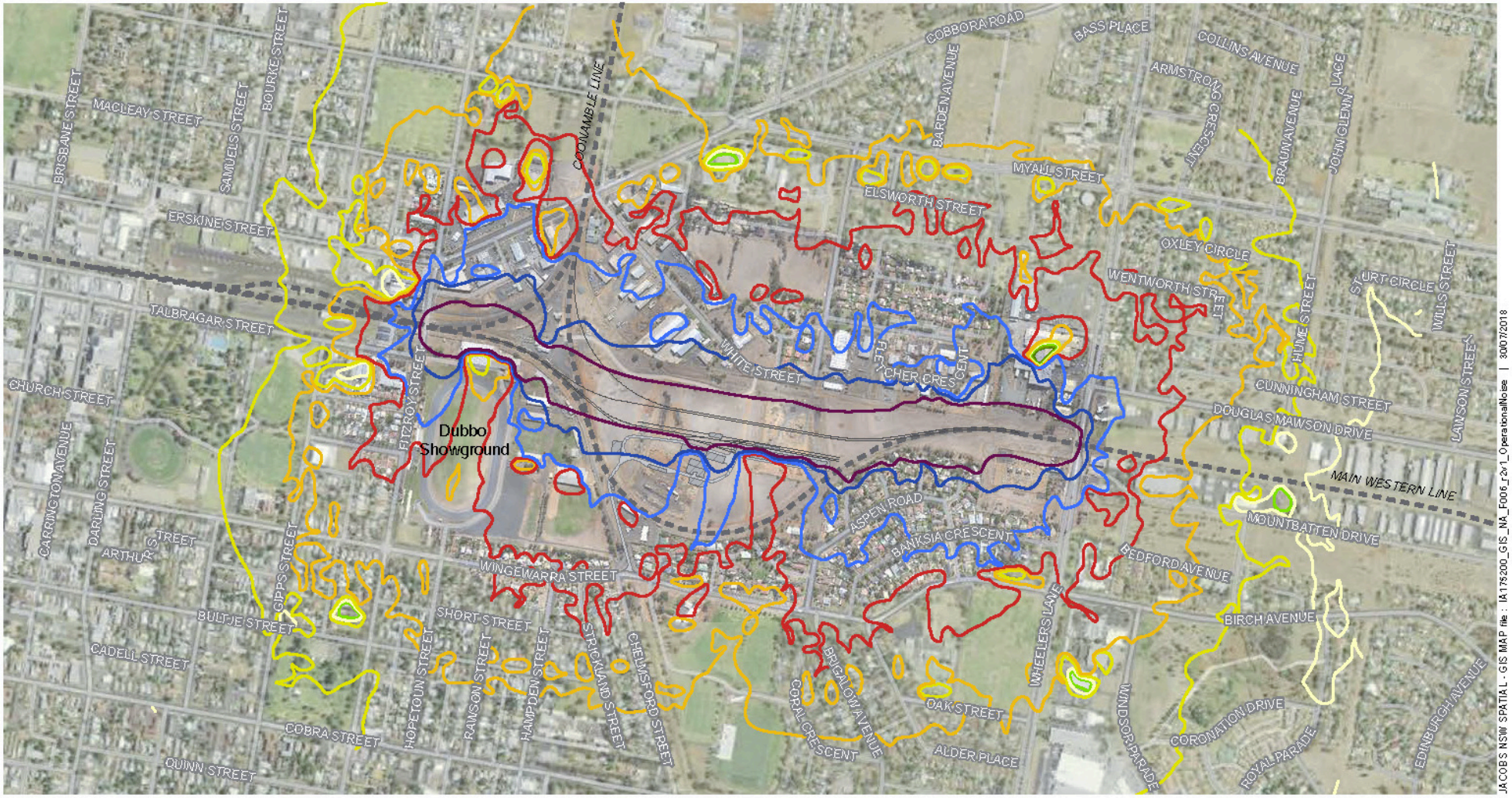
- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50

Appendix C – Figure C2 | Night LAeq rail noise contours



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75
- 80

Appendix C – Figure C3 | LAmax rail noise contours

Appendix D. Operational noise contours – maintenance facility

JACOBS

JACOBS NSW SPATIAL - GIS MAP file : IA175200_GIS_NA_F007_r2v1_OperationalNoiseMaintenance | 30/07/2018

Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

N

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels
LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50

Appendix D – Figure D1 | Facility operation scenario 1

Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

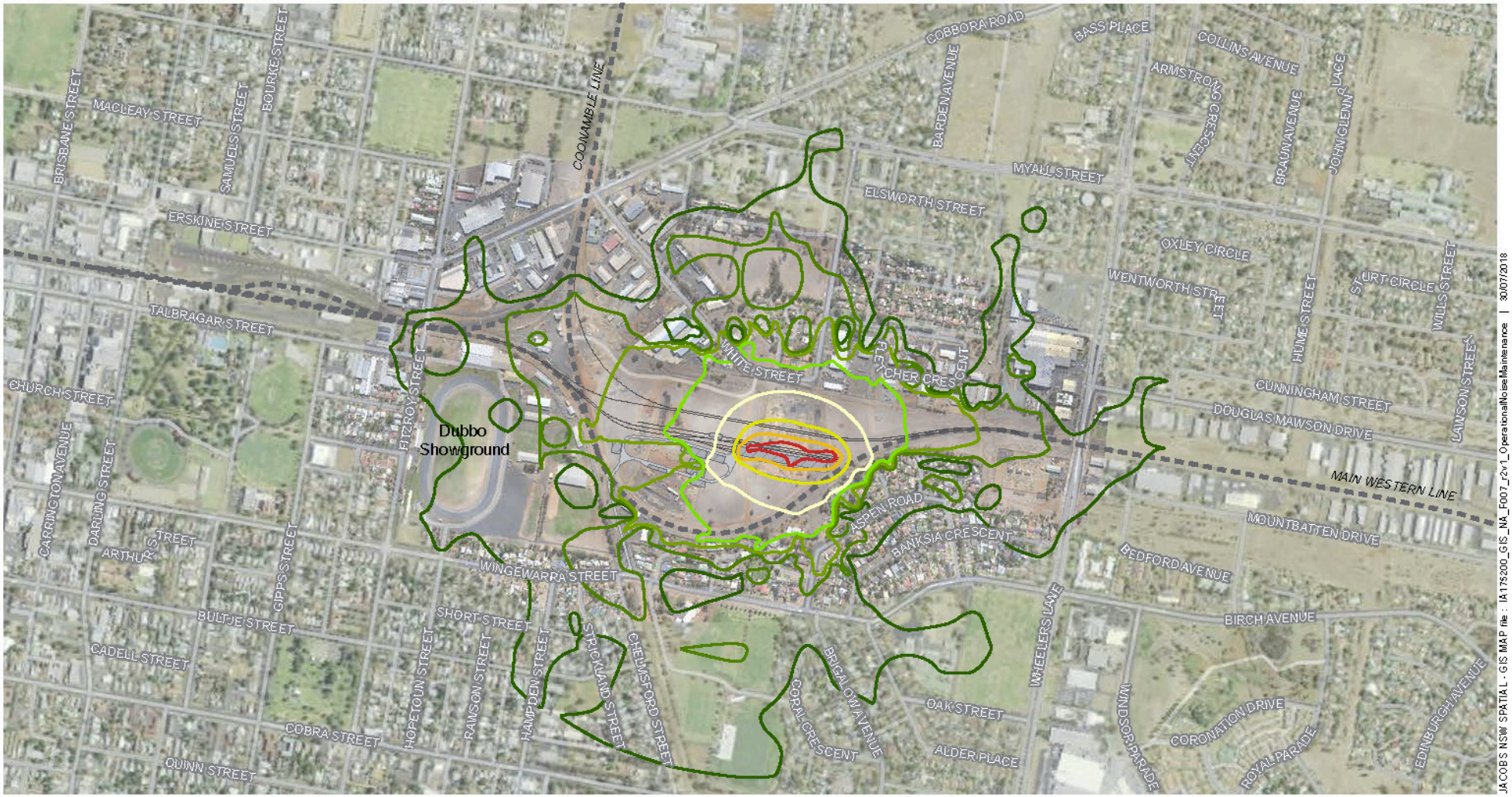
Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels
LAeq - dB(A)

- 30
- 35
- 40
- 45

Appendix D – Figure D2 | Facility operation scenario 2



Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

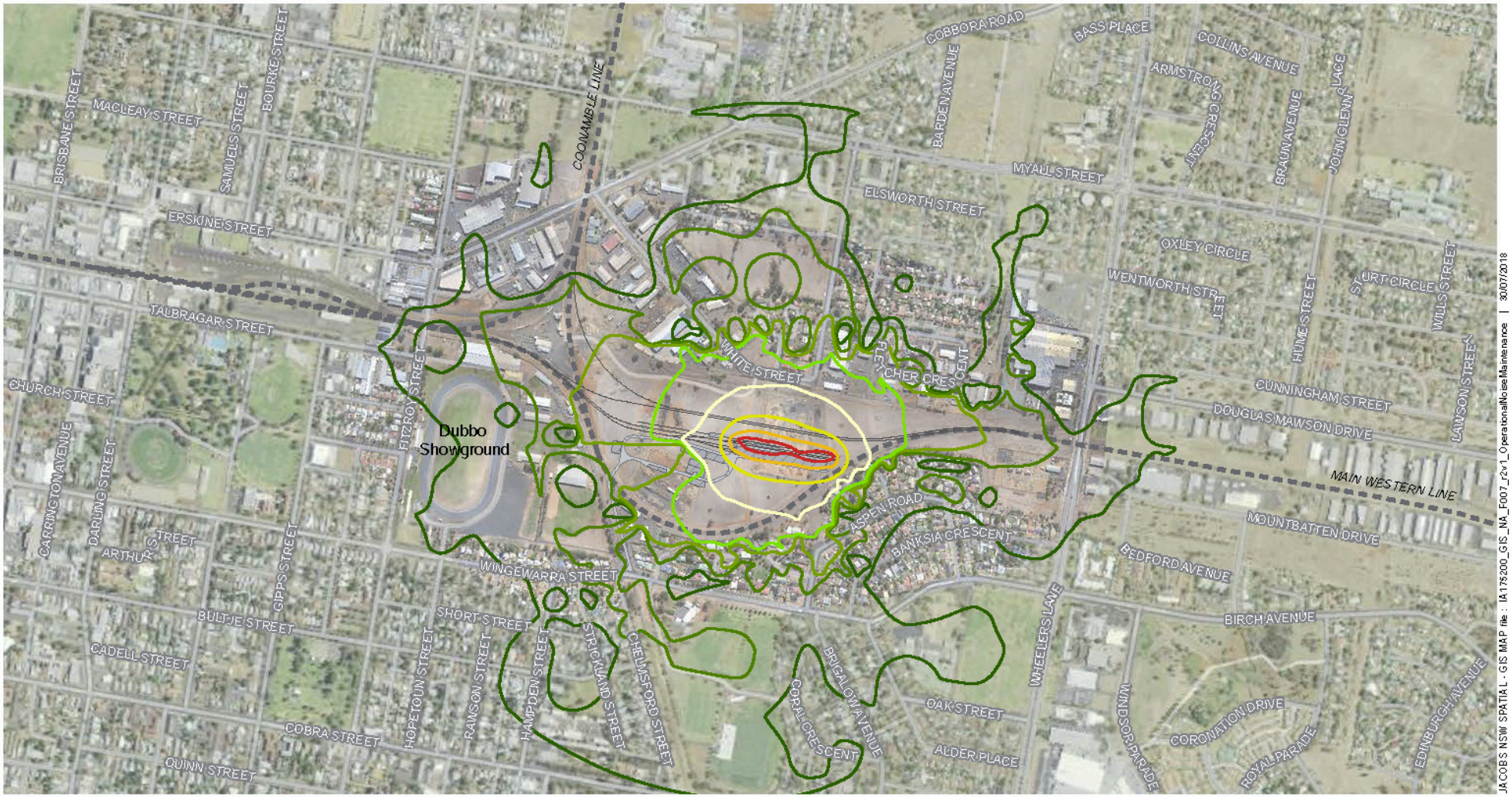
Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m

1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Appendix D – Figure D3 | Facility operation scenario 3



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix D – Figure D4 | Facility operation scenario 4

Legend

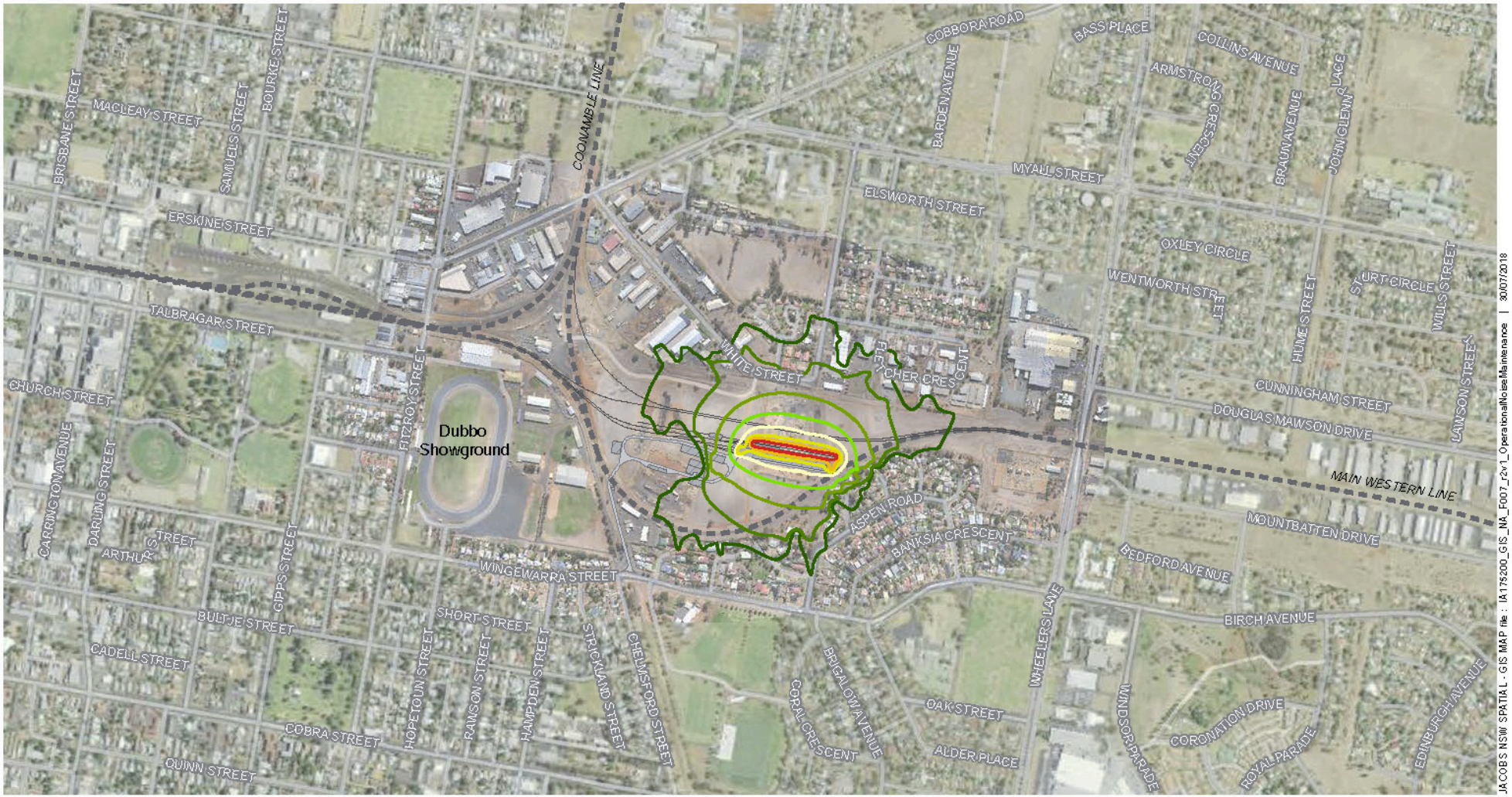
- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70

Appendix D – Figure D5 | Facility operation scenario 5



Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix D – Figure D6 | Facility operation scenario 6

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels
LAeq - dB(A)

- 30
- 35
- 40

Appendix D – Figure D7 | Facility operation scenario 7

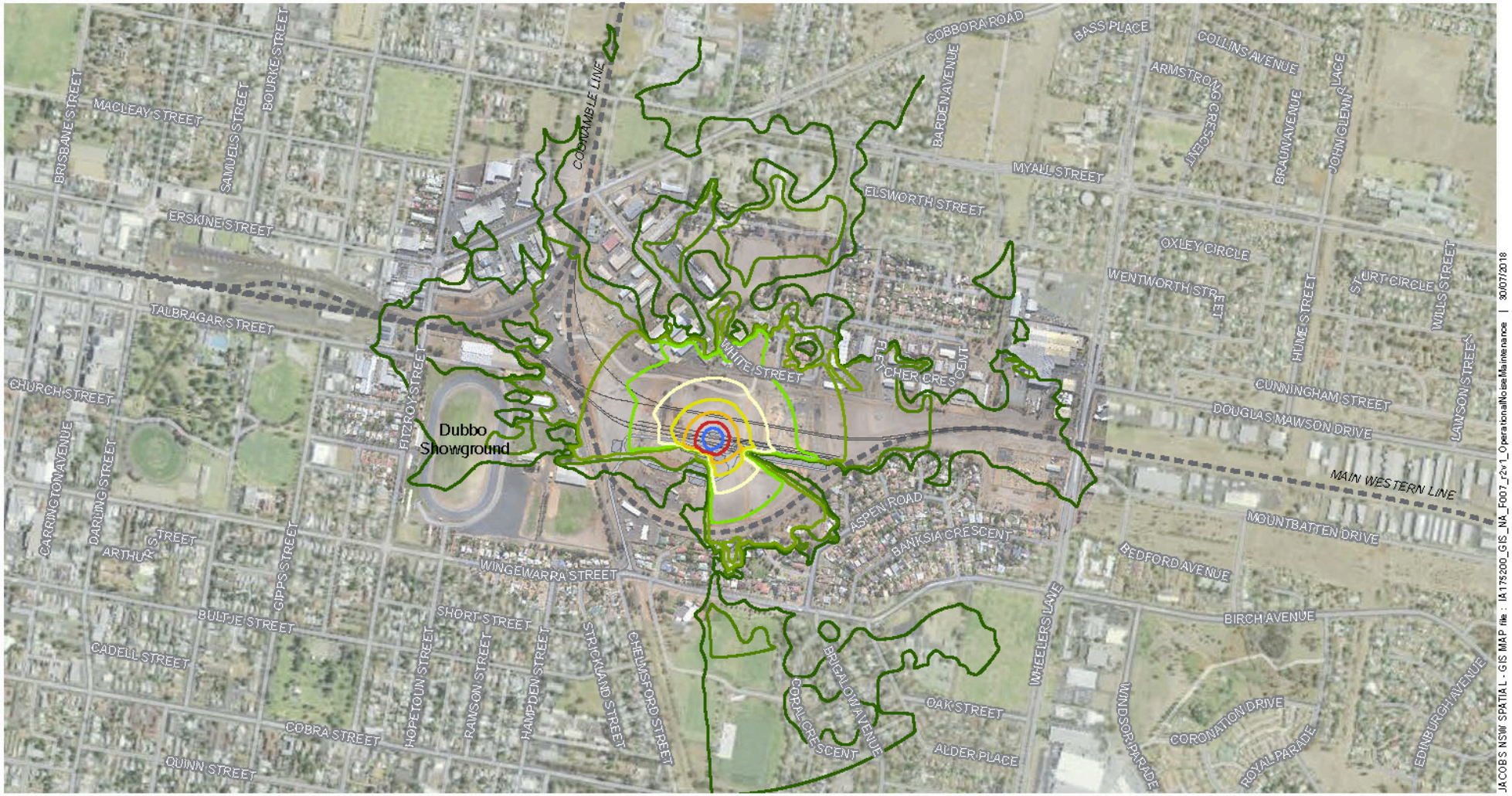
Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels
LAeq - dB(A)

- 30
- 35
- 40
- 45

Appendix D – Figure D8 | Facility operation scenario 7a



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

N

Subject to site survey and detailed design. Not to be used for construction.

JACOBS NSW SPATIAL - GIS MAP file : IA175200_GIS_NA_F007_r2v1_OperationalNoiseMaintenance | 30/07/2018

Legend

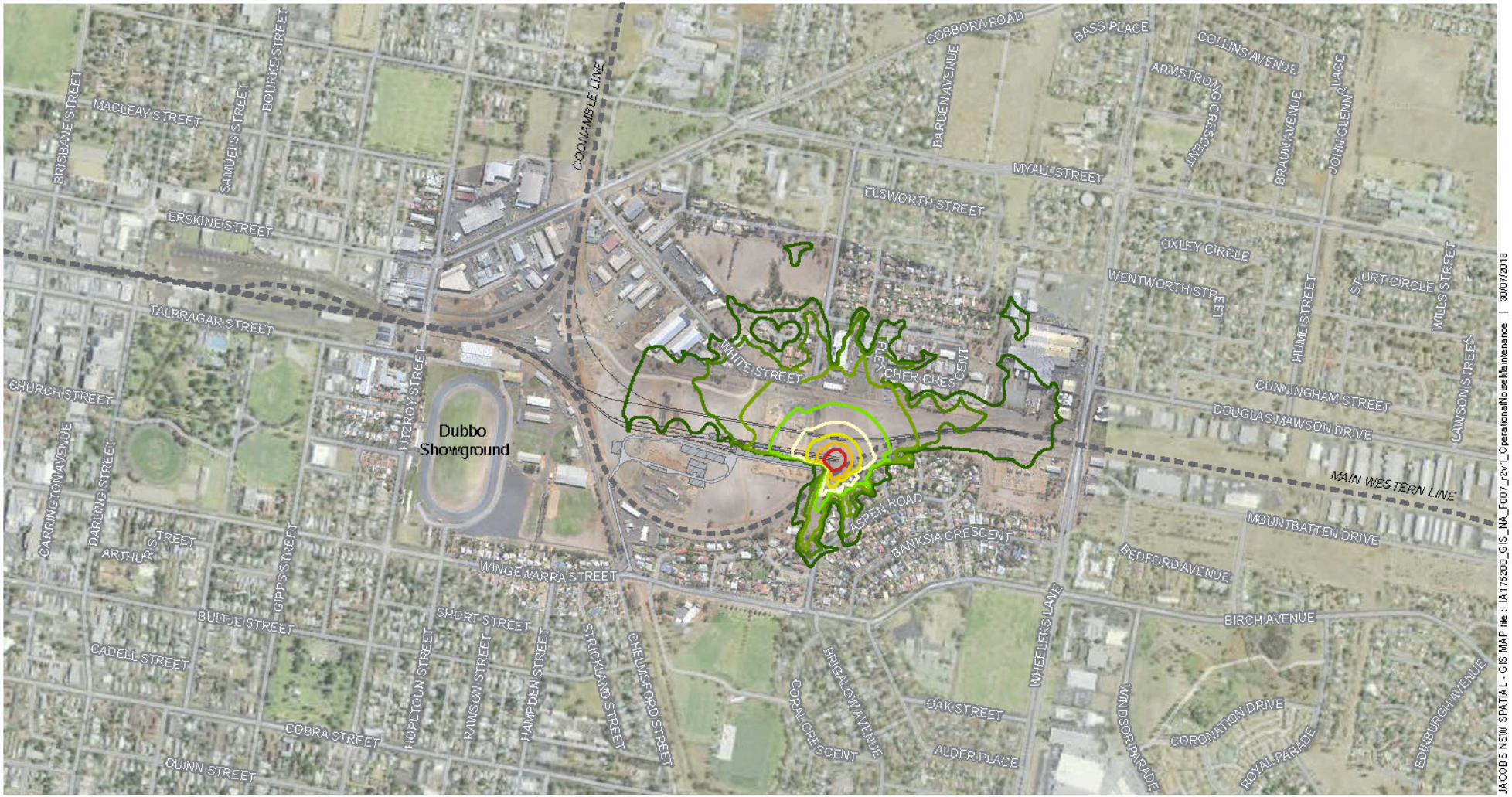
- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70

Appendix D – Figure D9 | Facility operation scenario 8



JACOBS NSW SPATIAL - GIS MAP file : IA175200_GIS_NA_F007_r2v1_OperationalNoiseMaintenance | 30/07/2018

Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

N

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

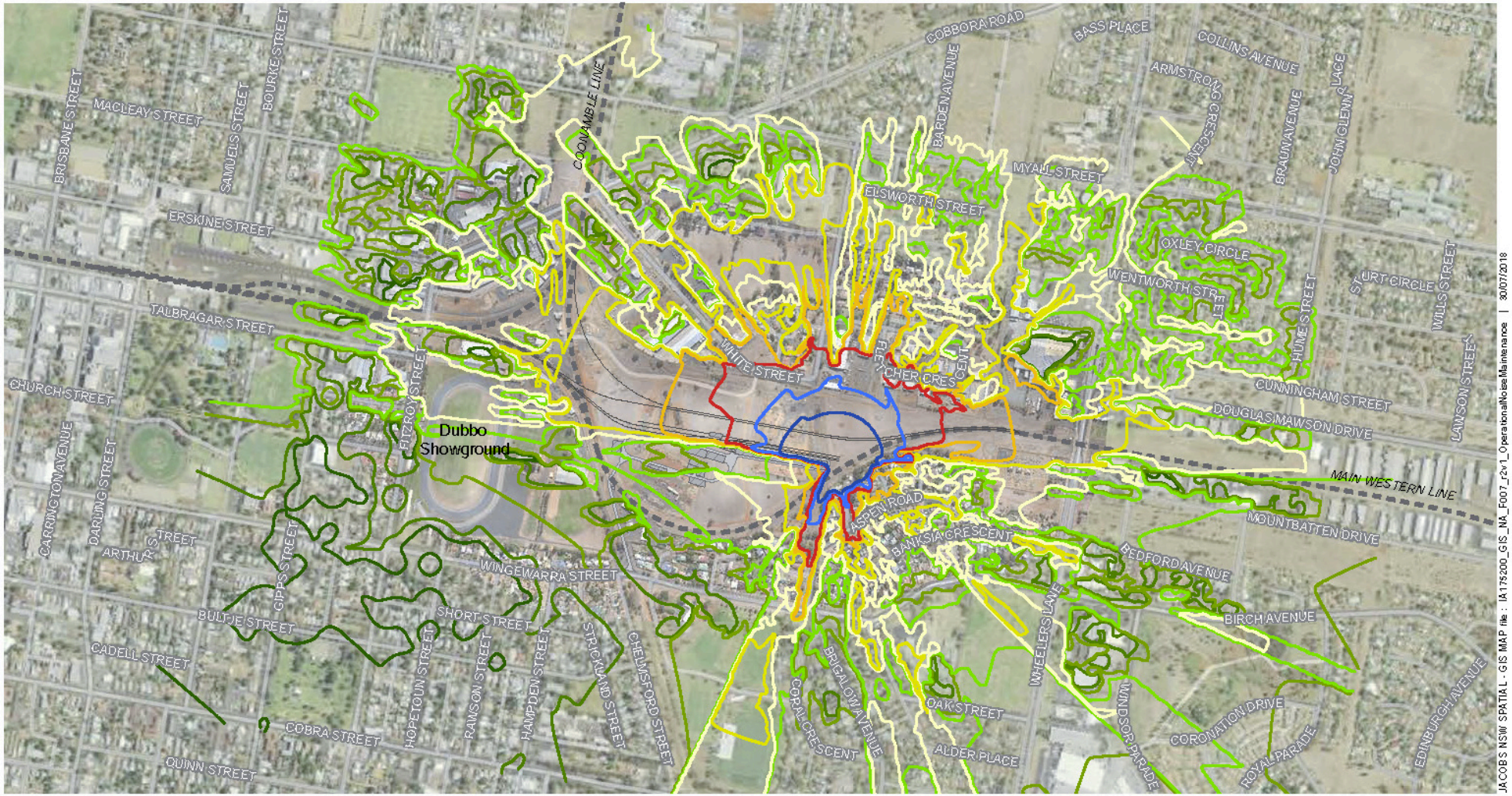
Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix D – Figure D10 | Facility operation scenario 9

JACOBS



Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

N

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Appendix D – Figure D11 | Facility operation scenario 10

Legend

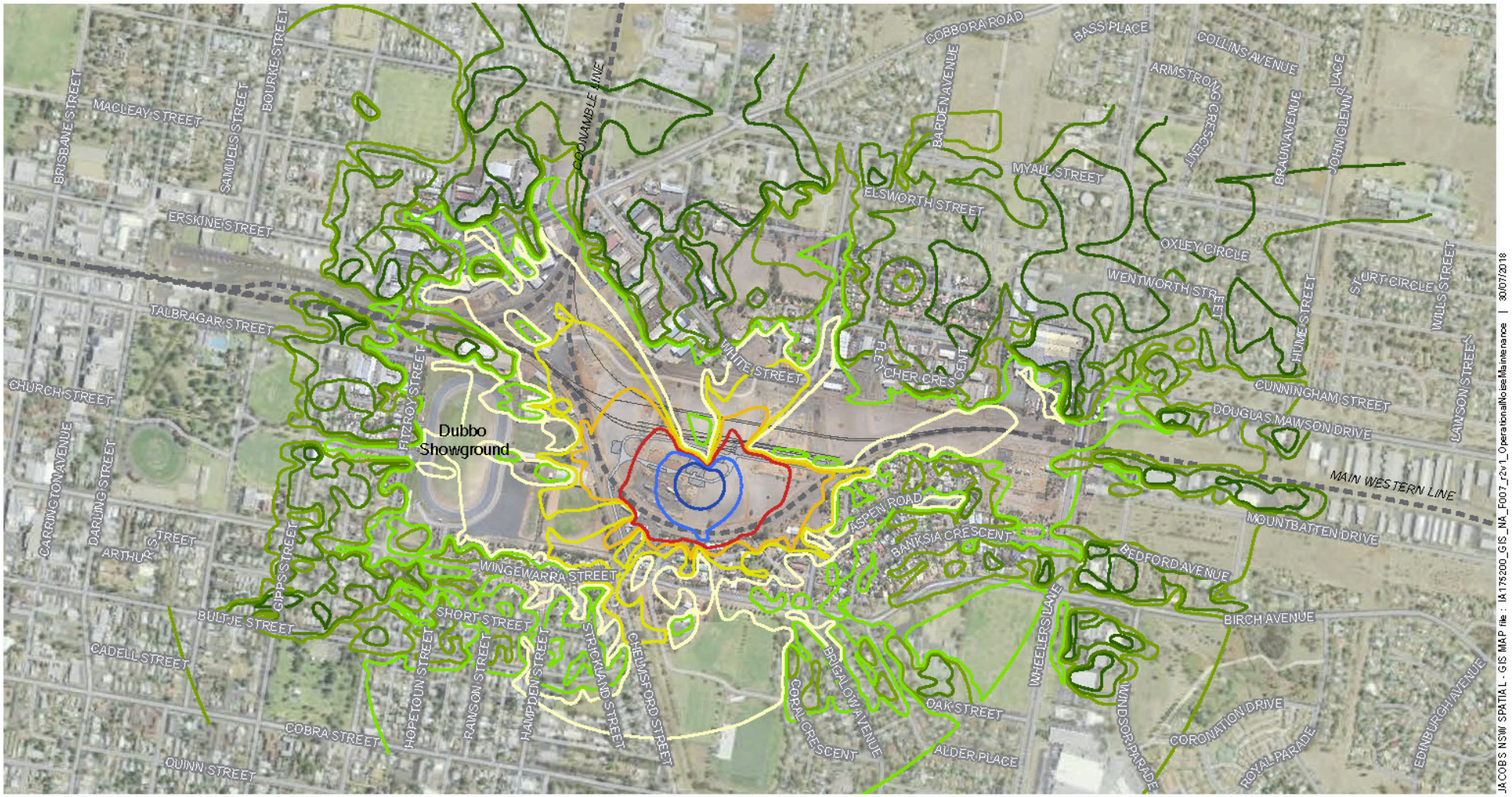
- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

LAeq - dB(A)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65

Appendix D – Figure D12 | Facility operation scenario 11



JACOBS NSW SPATIAL - GIS MAP file : IA175200_GIS_NA_F007_r2v1_OperationalNoiseMaintenance | 30/07/2018

Imagery © TfNSW and © Department of Finance, Services & Innovation 2017

0 250 500 m
1:14,000 @ A4

Subject to site survey and detailed design. Not to be used for construction.

Legend

- Existing rail line
- Proposed new track
- Proposed vehicle access track
- Project building or facility

Noise levels

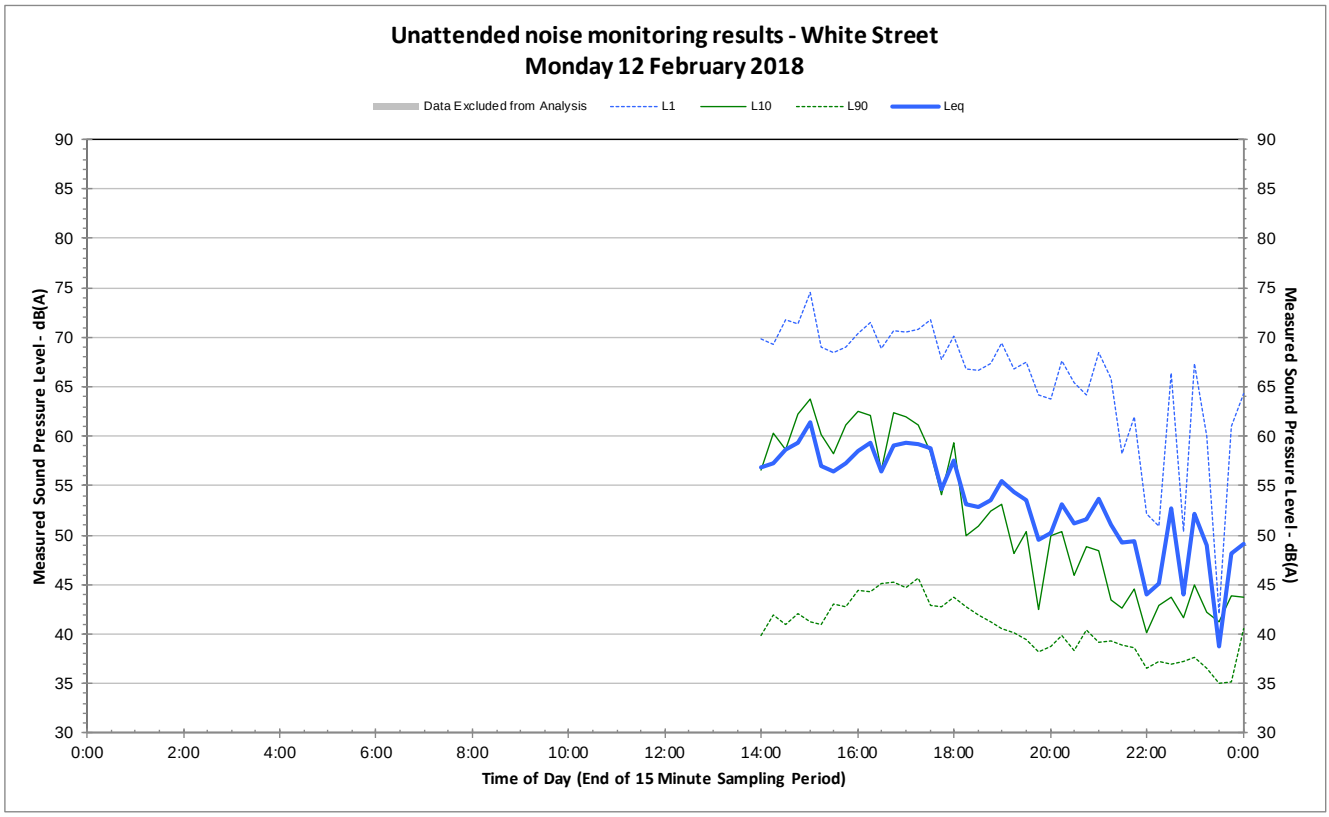
LAeq - dB(A)

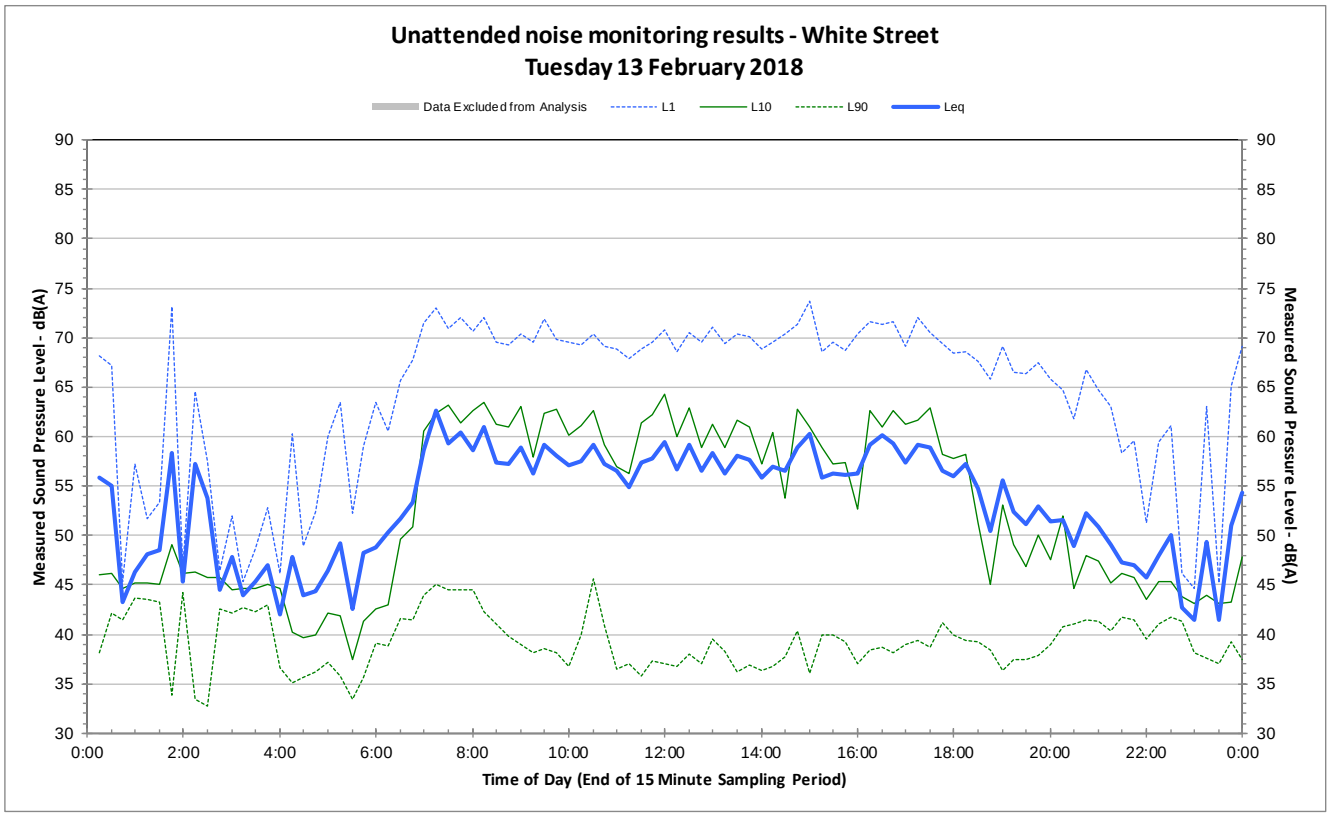
- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

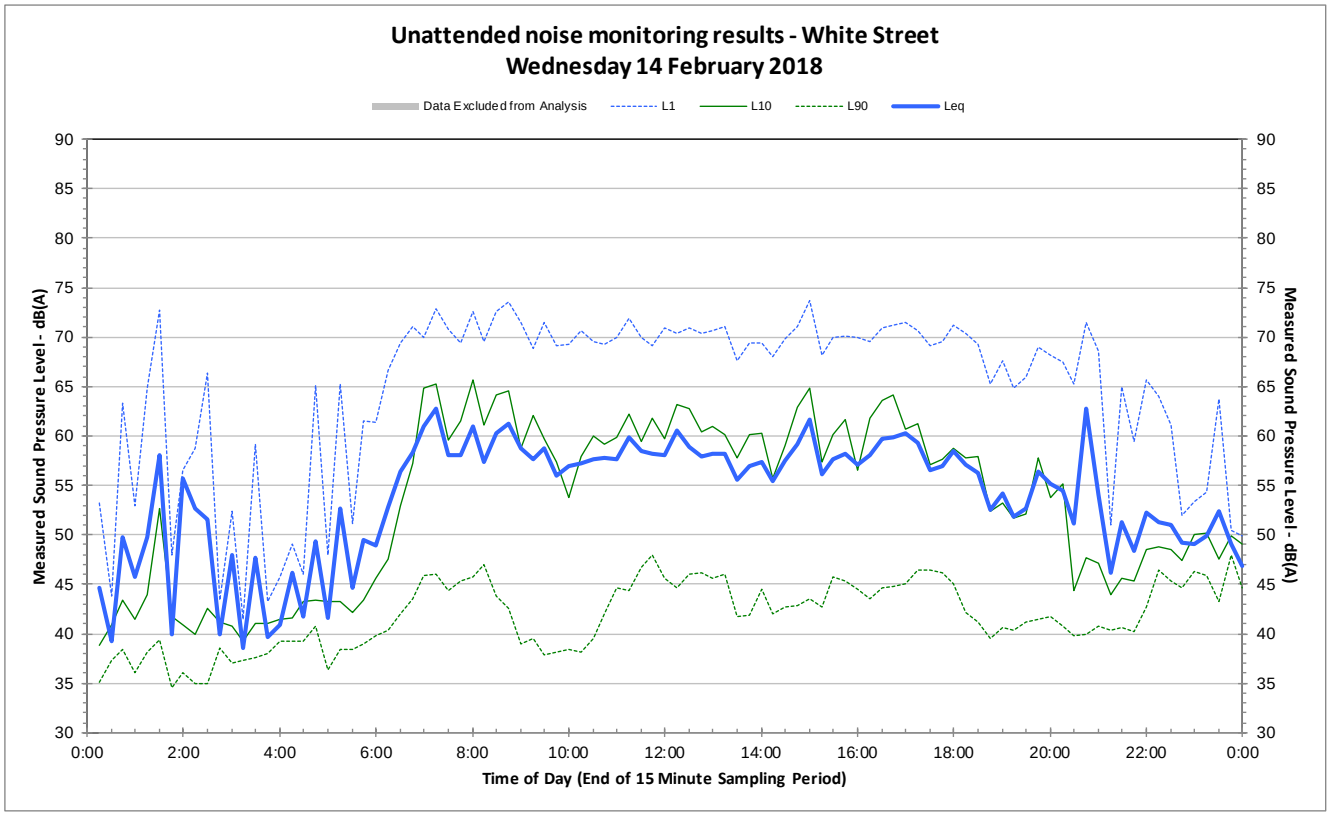
Appendix D – Figure D13 | Facility operation scenario 12

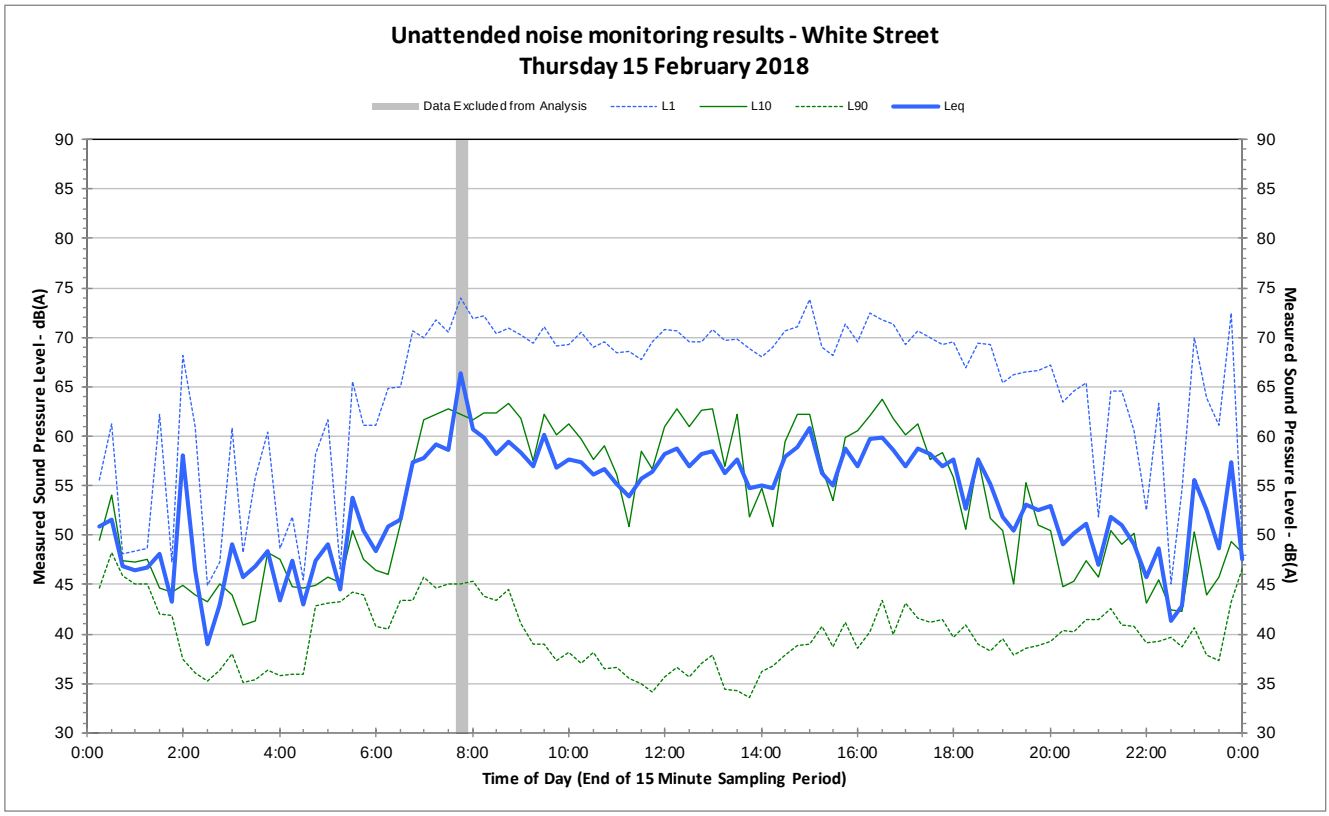
Appendix E. Noise monitoring results

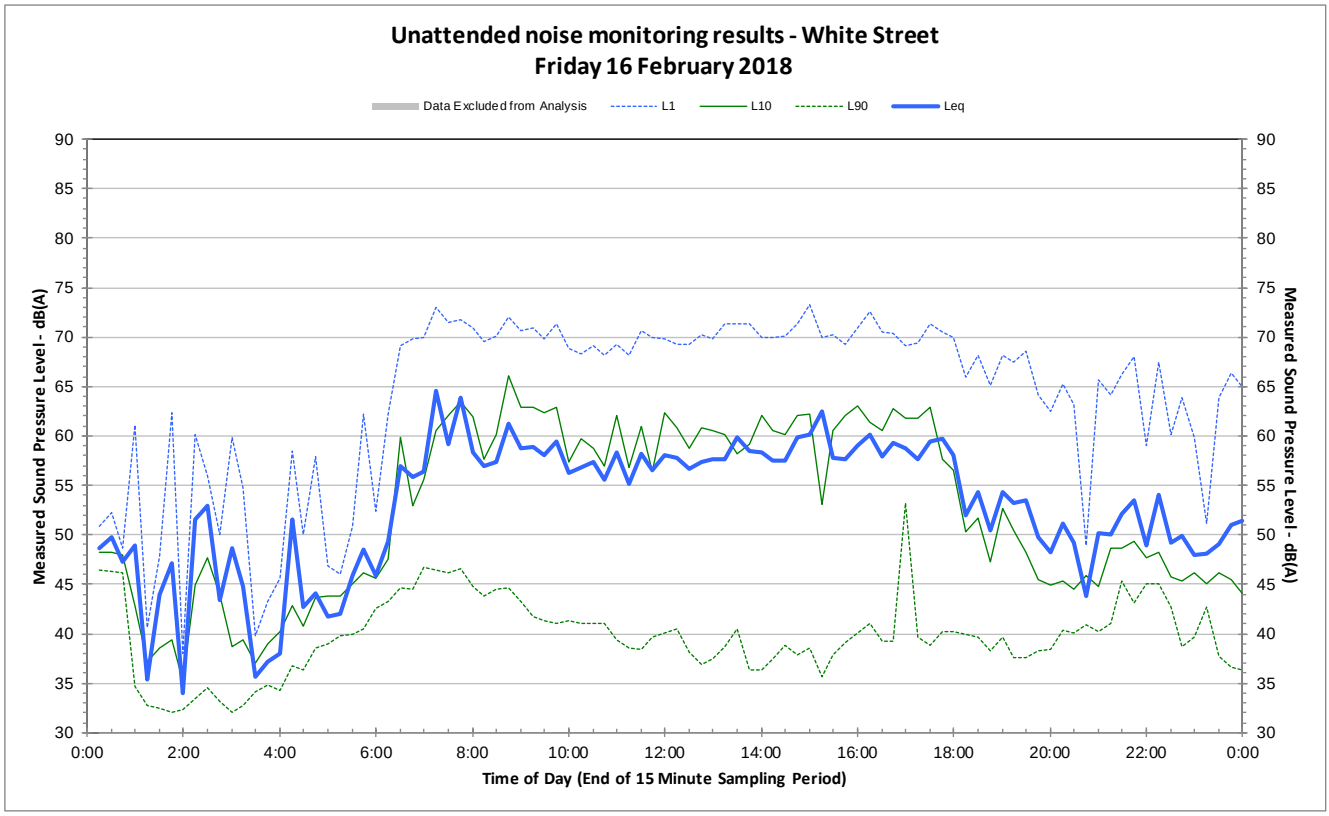
E.1 White Street

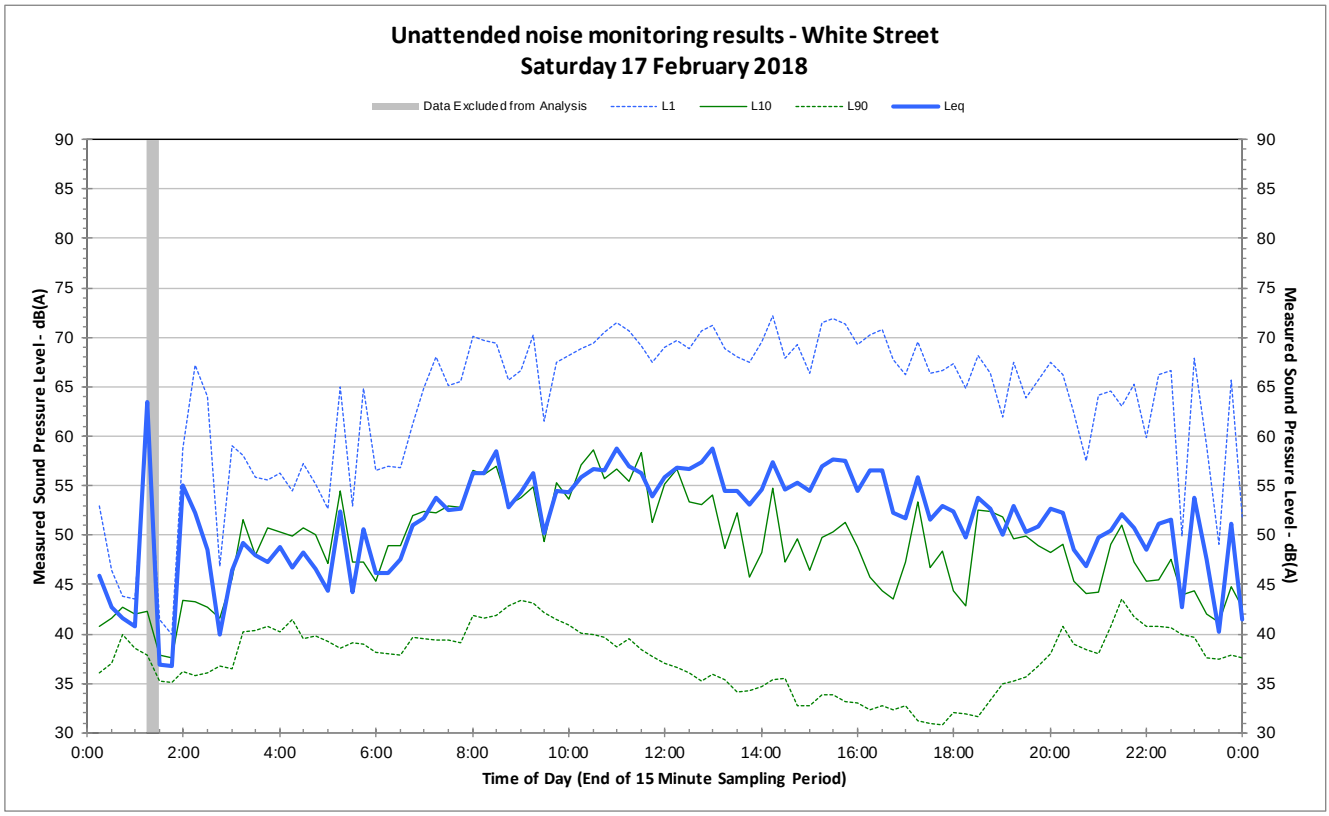


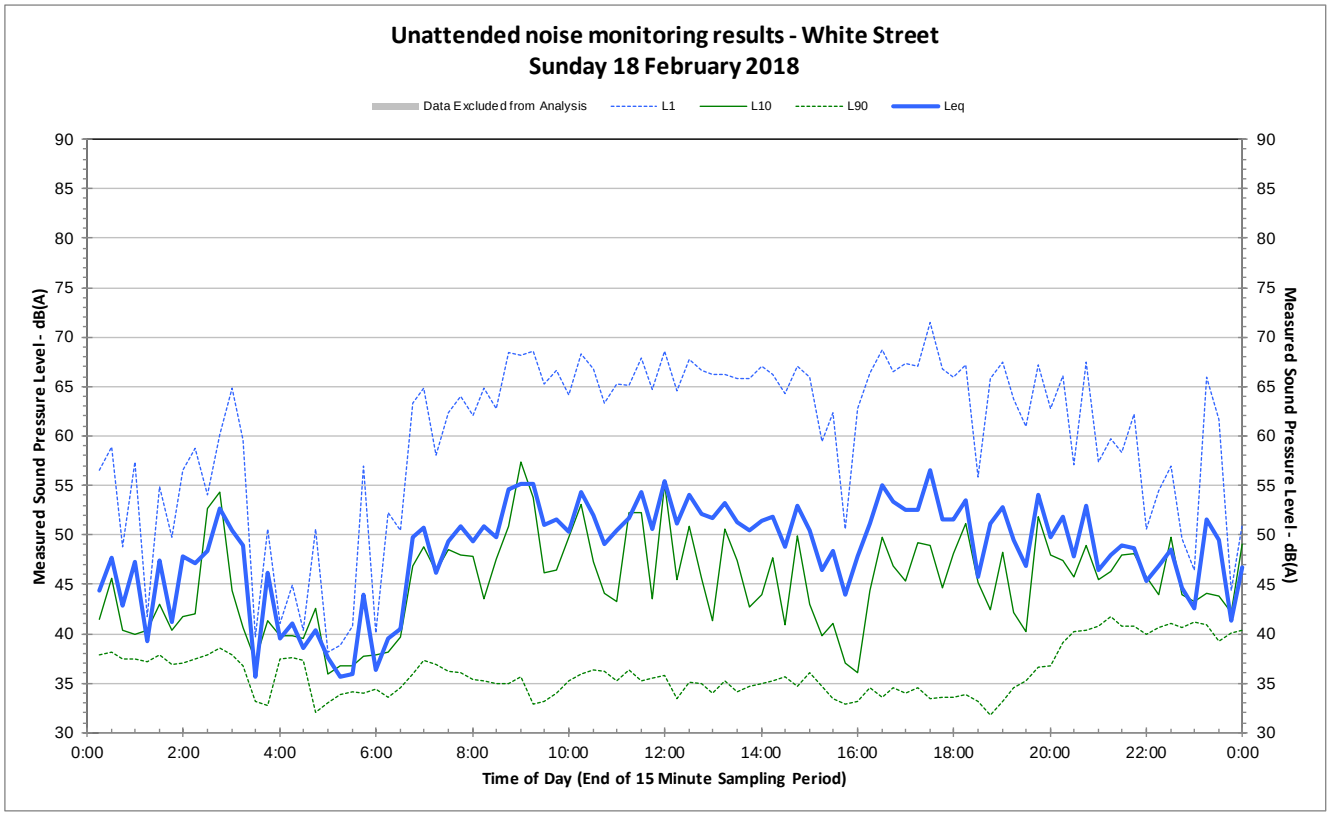


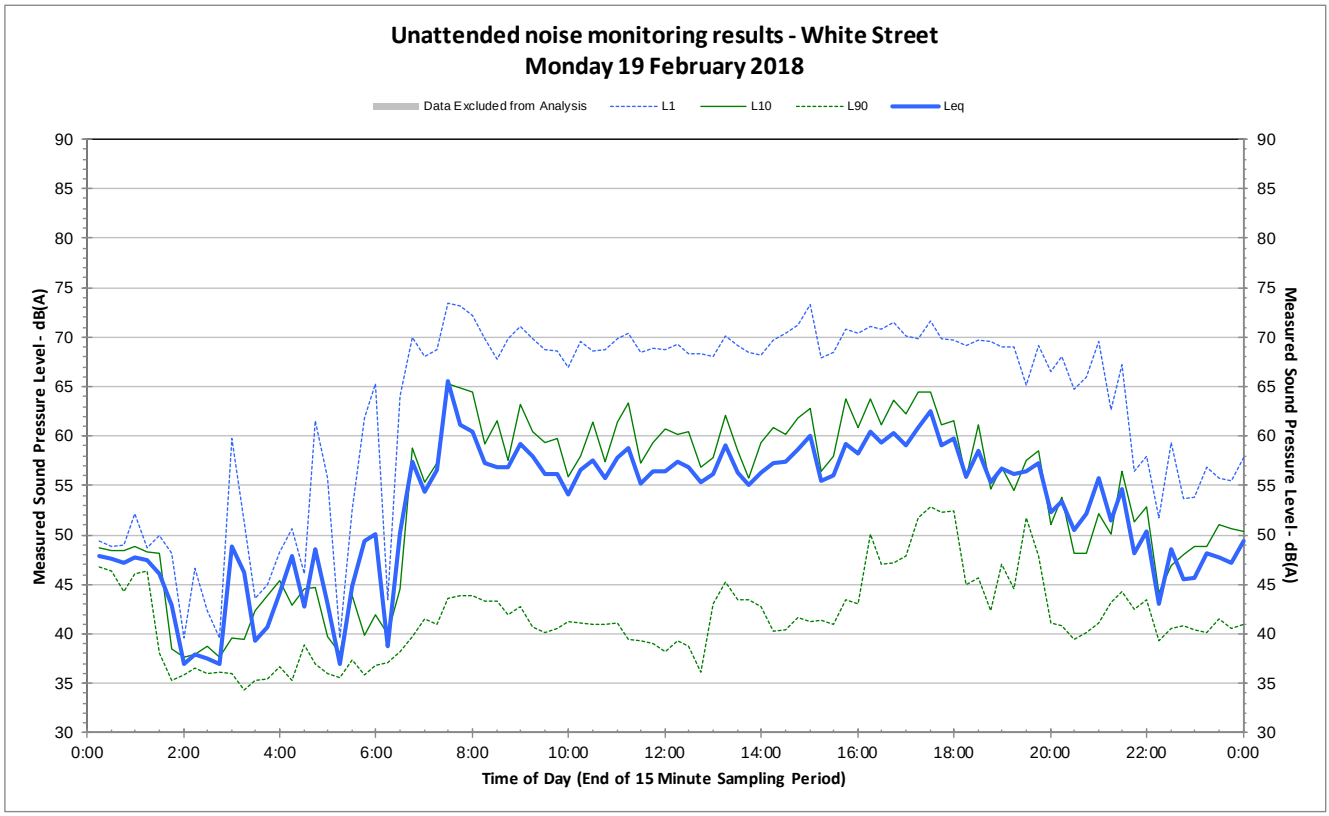

Unattended noise monitoring results - White Street
Wednesday 14 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - White Street
Thursday 15 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

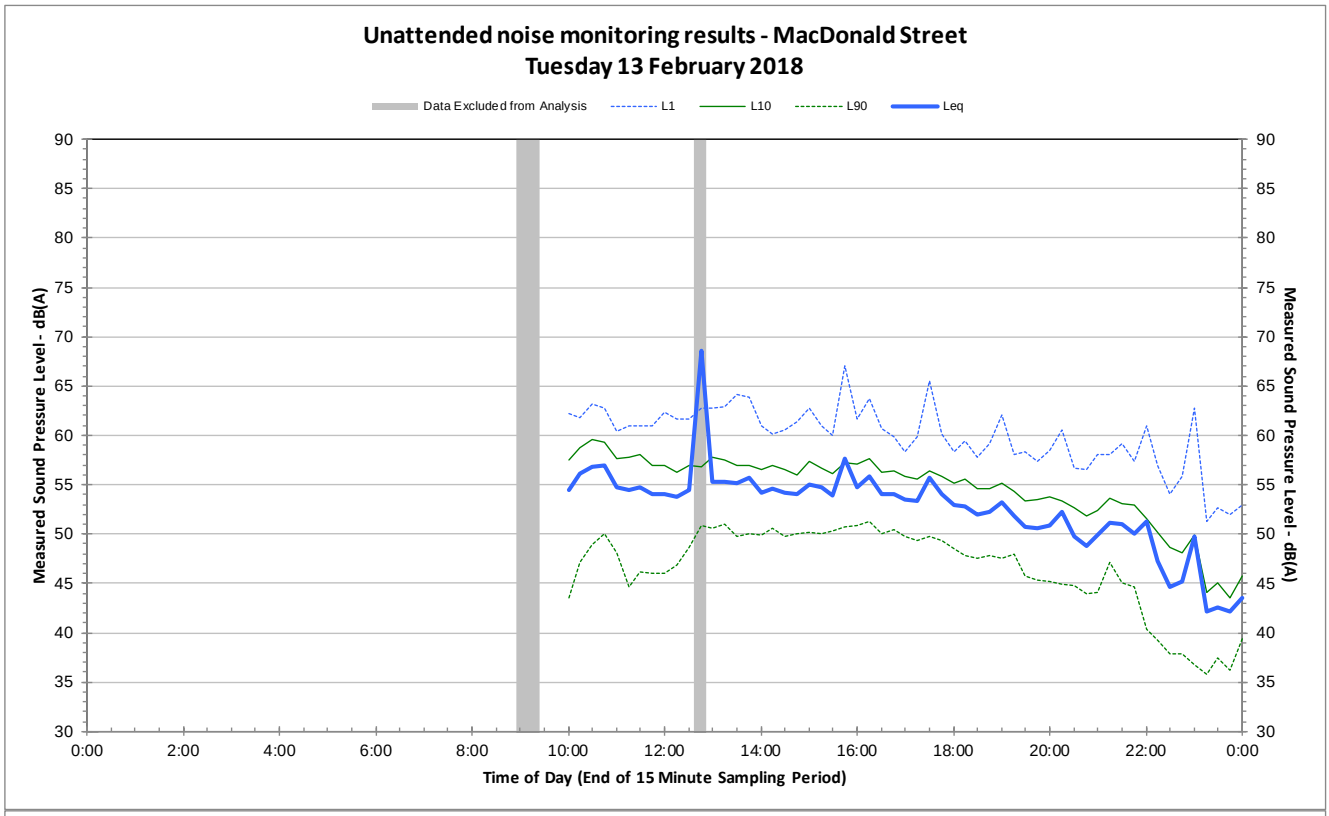

Unattended noise monitoring results - White Street
Friday 16 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

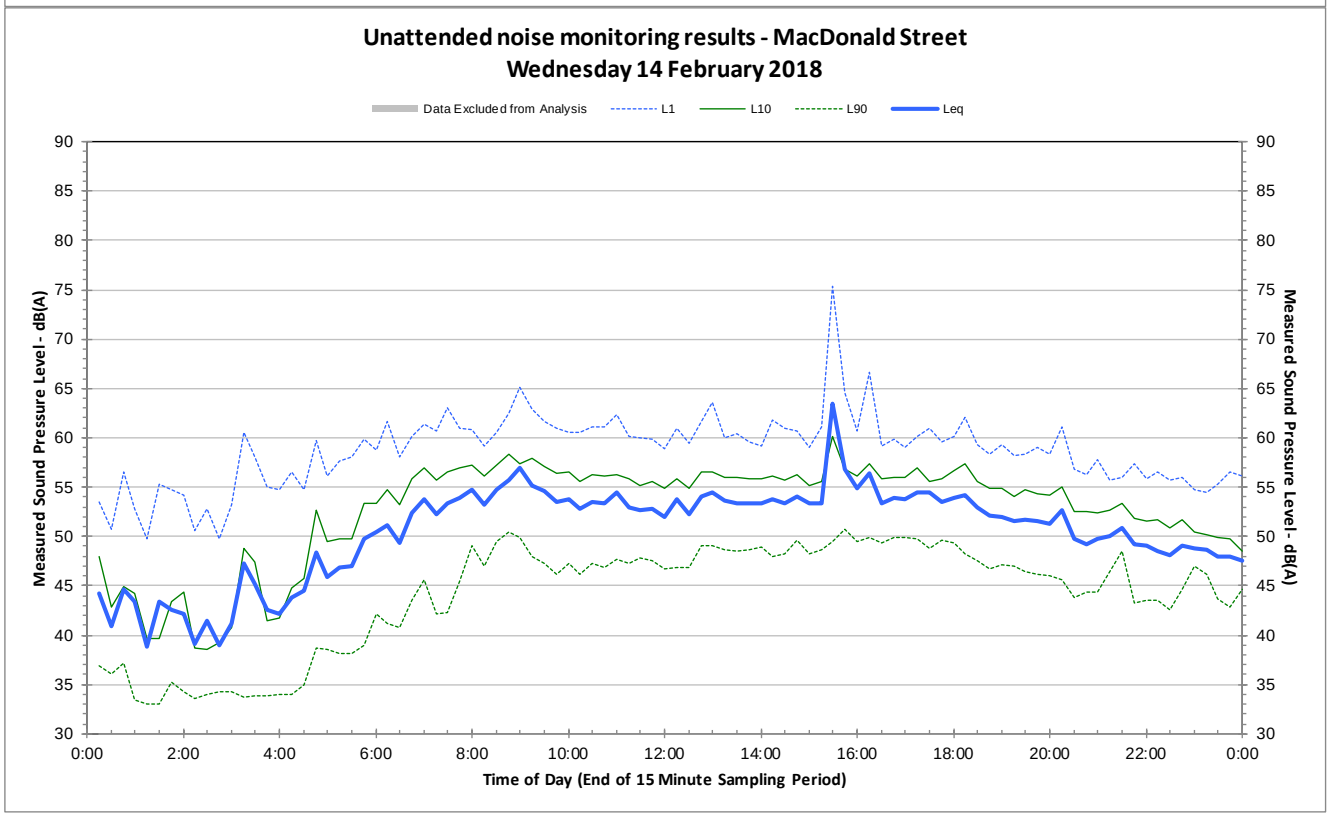

Unattended noise monitoring results - White Street
Saturday 17 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

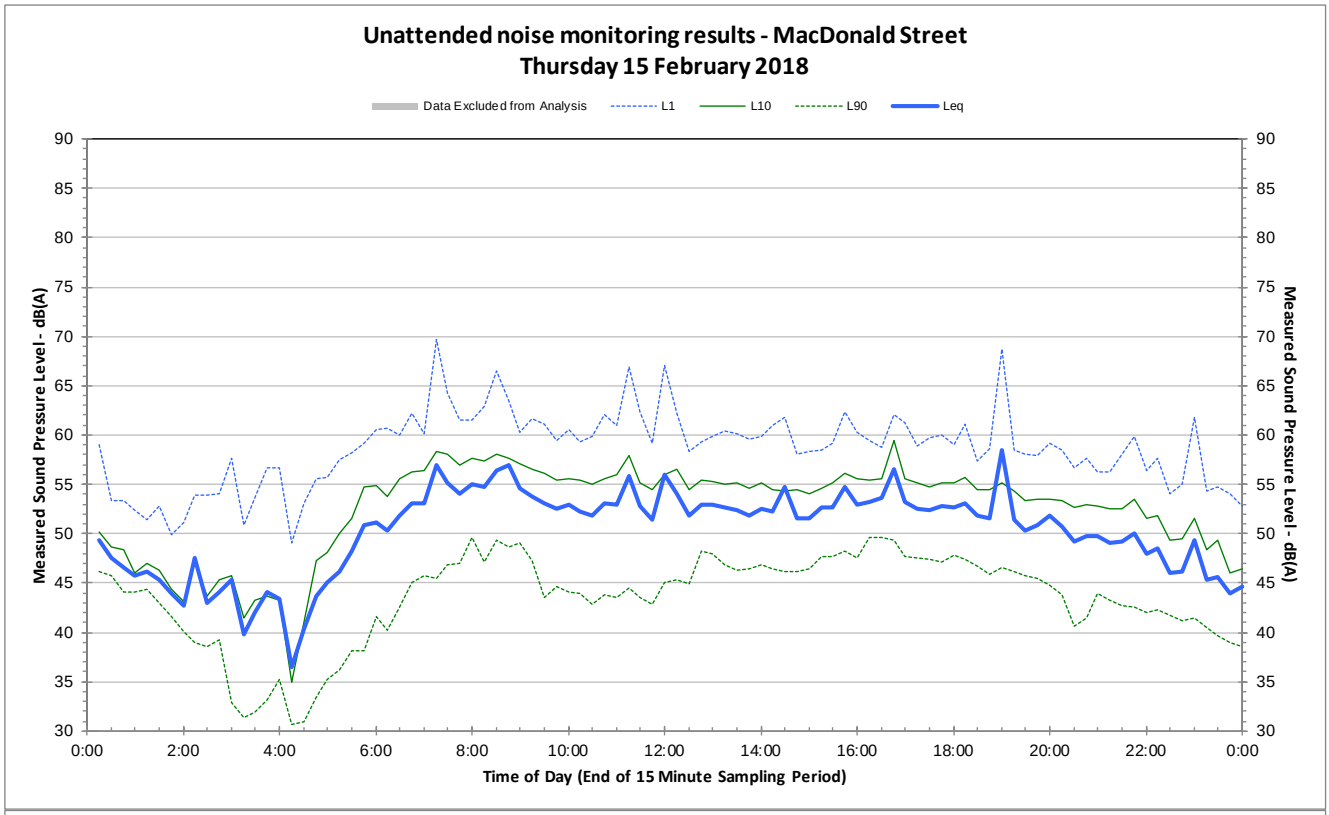

Unattended noise monitoring results - White Street
Sunday 18 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

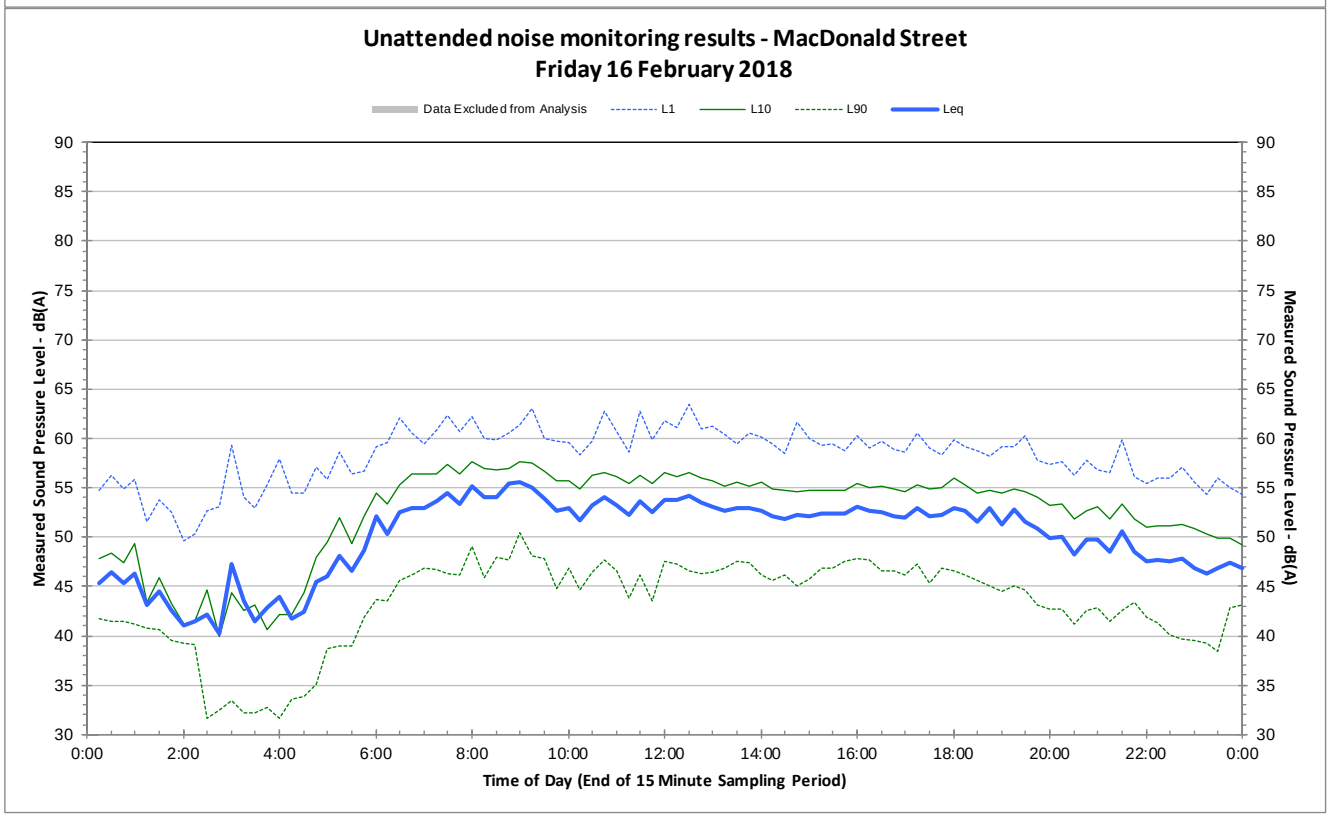

Unattended noise monitoring results - White Street
Monday 19 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

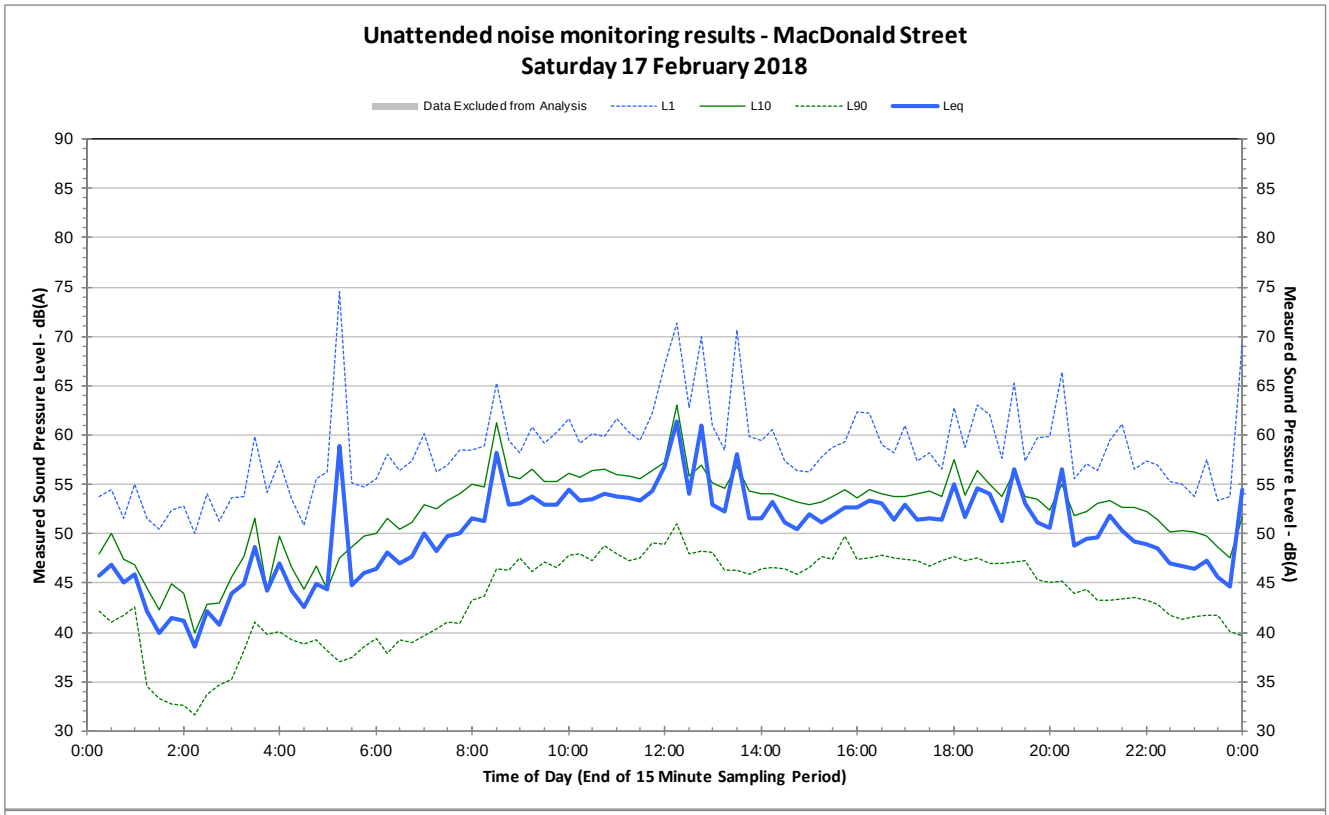
E.2 MacDonald Street

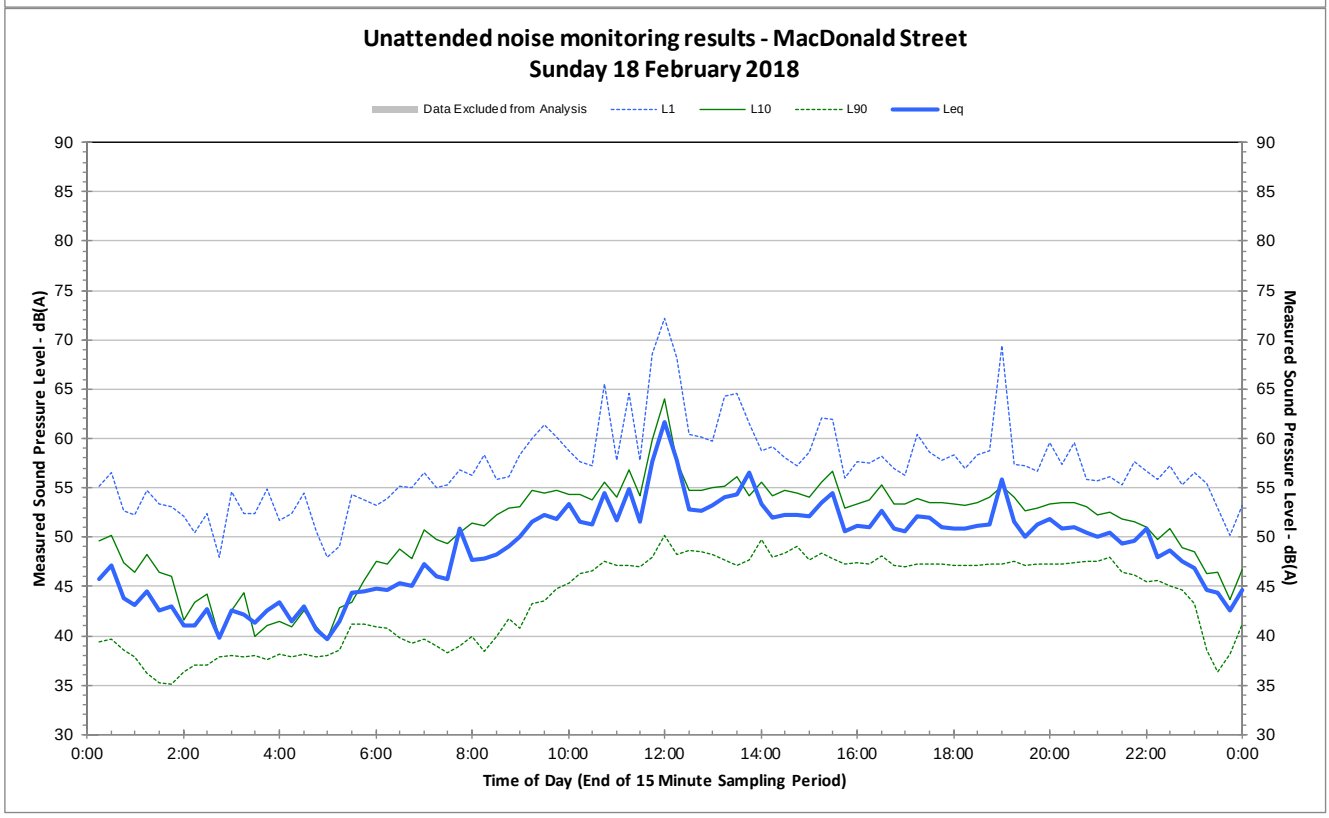


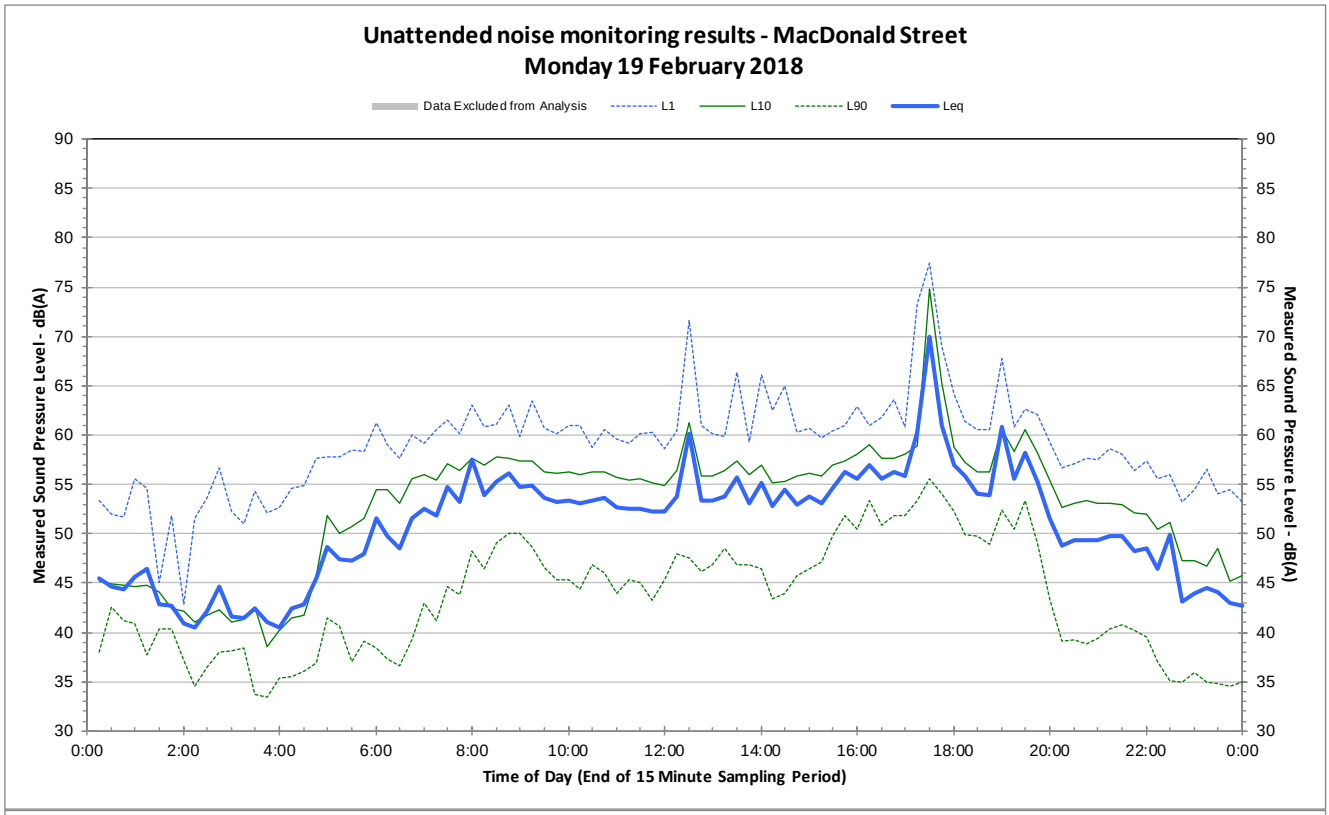


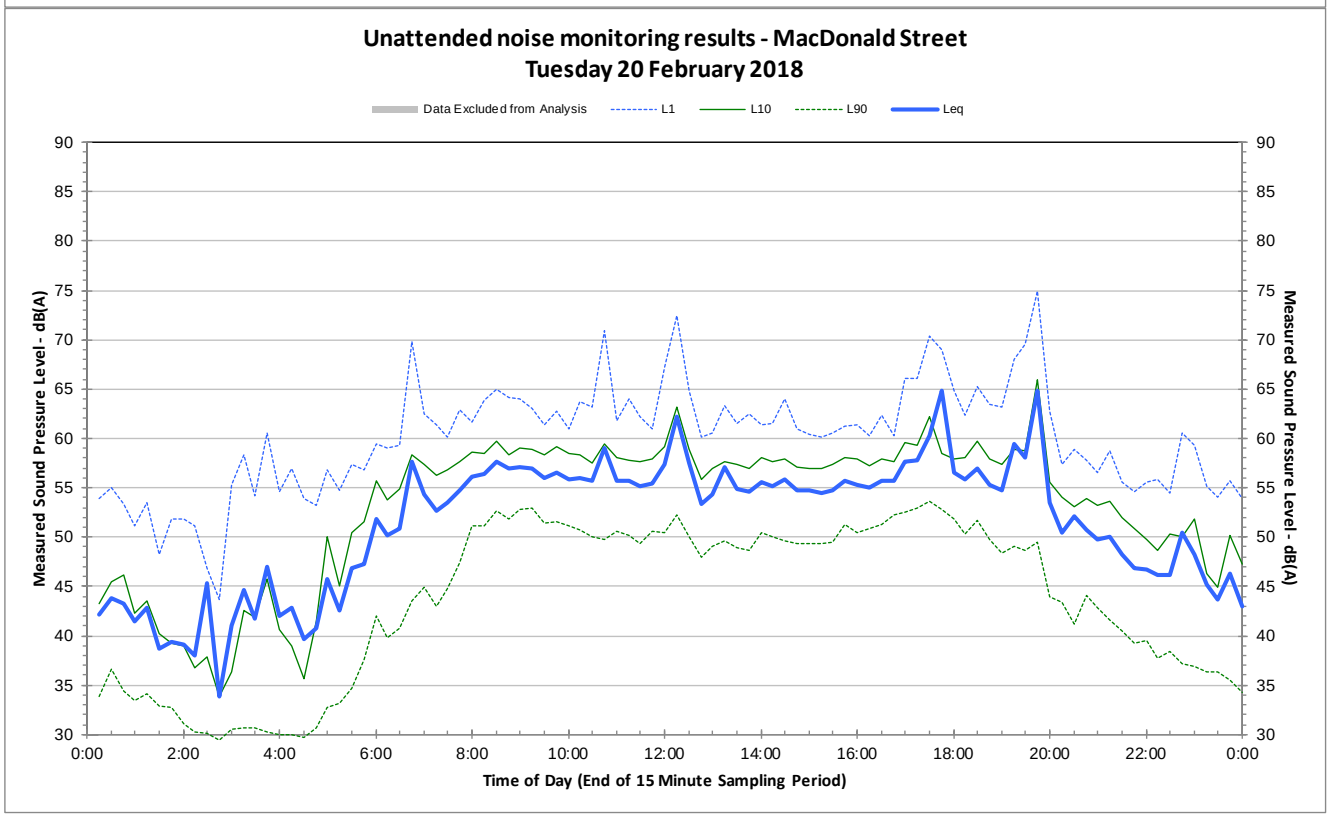

Unattended noise monitoring results - MacDonald Street
Thursday 15 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

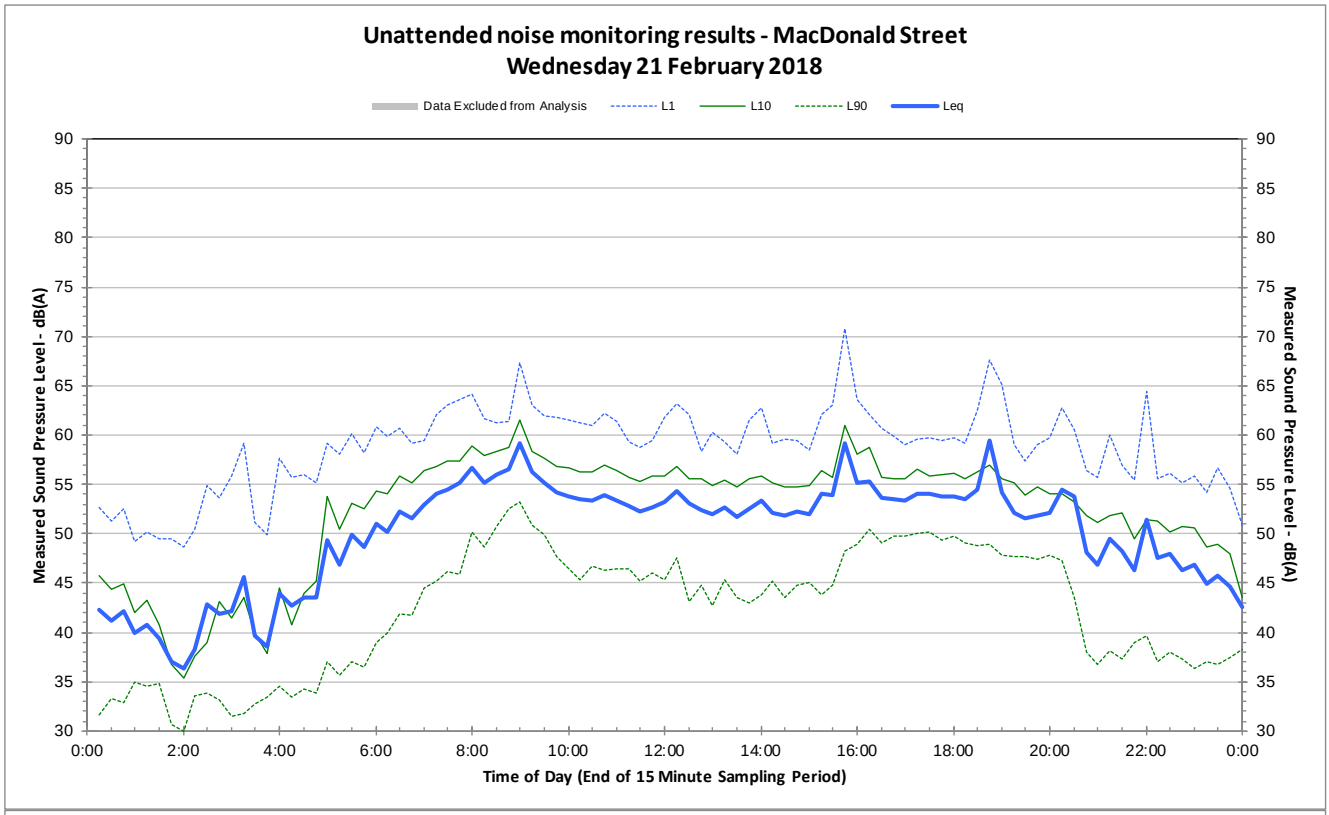

Unattended noise monitoring results - MacDonald Street
Friday 16 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

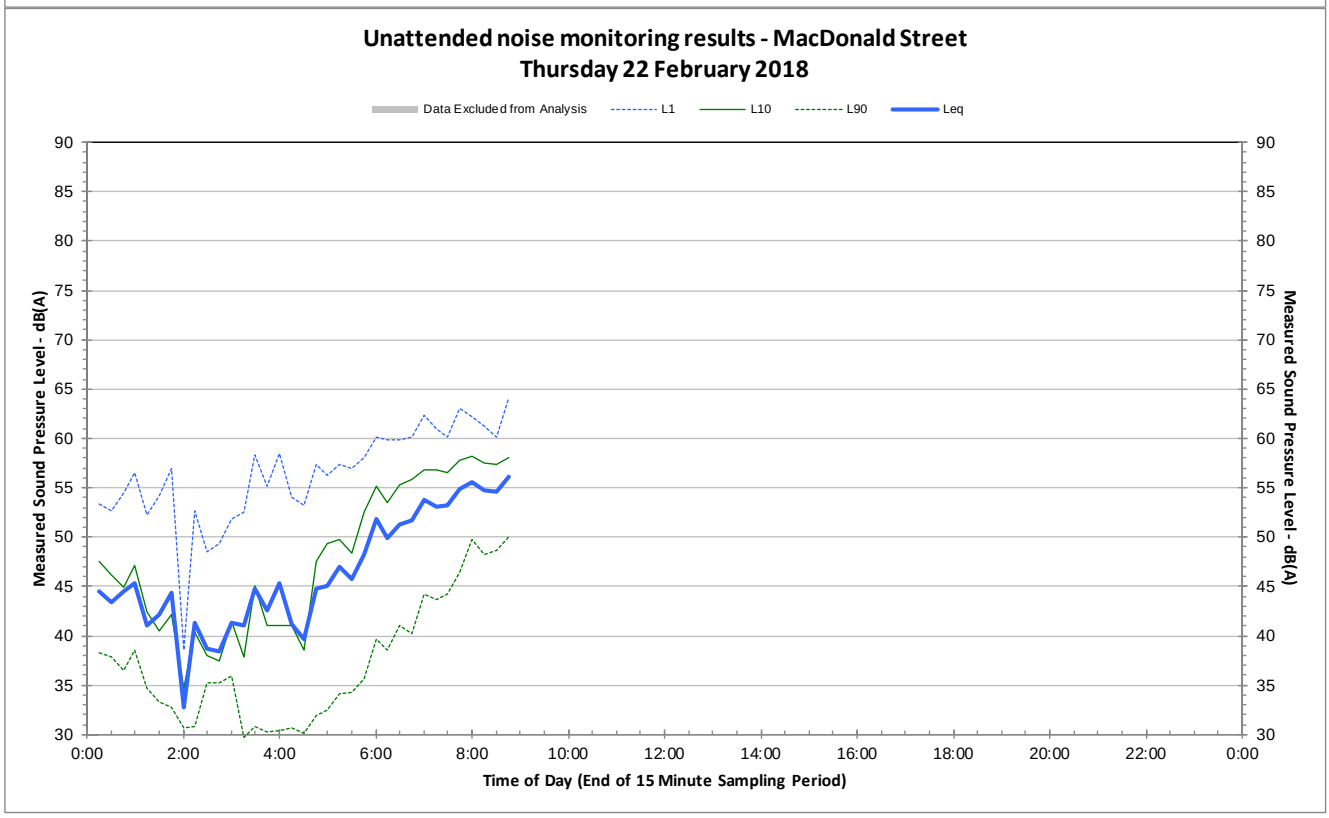

Unattended noise monitoring results - MacDonald Street
Saturday 17 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - MacDonald Street
Sunday 18 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

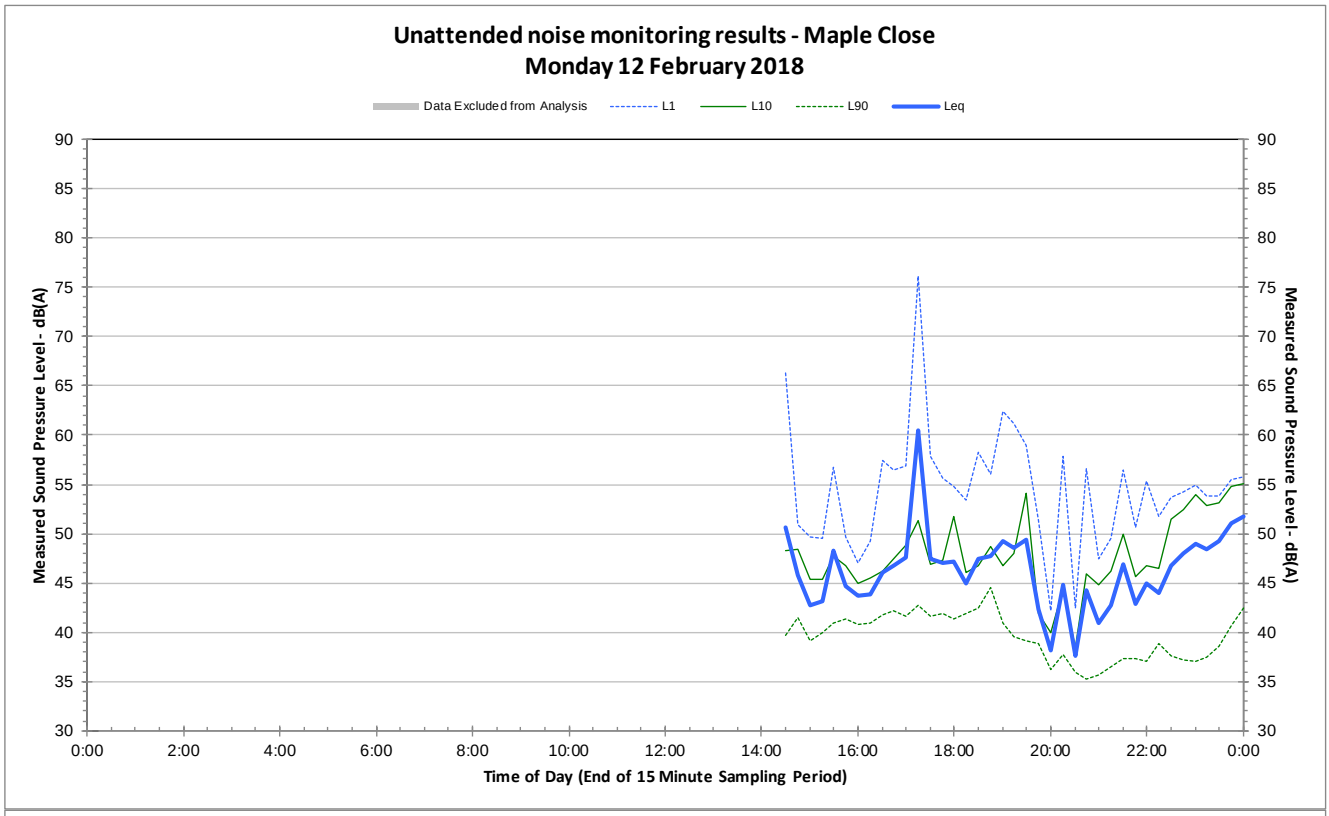

Unattended noise monitoring results - MacDonald Street
Monday 19 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

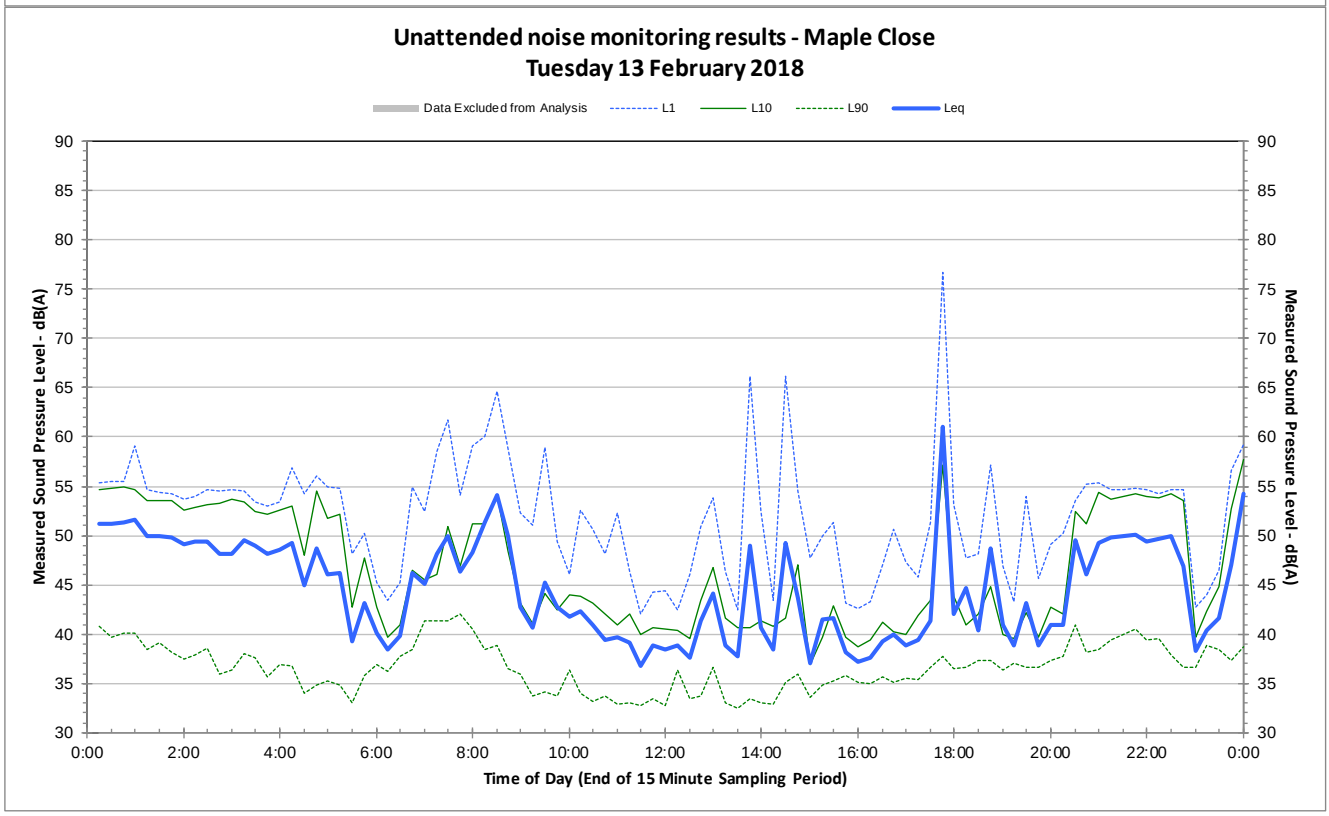

Unattended noise monitoring results - MacDonald Street
Tuesday 20 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

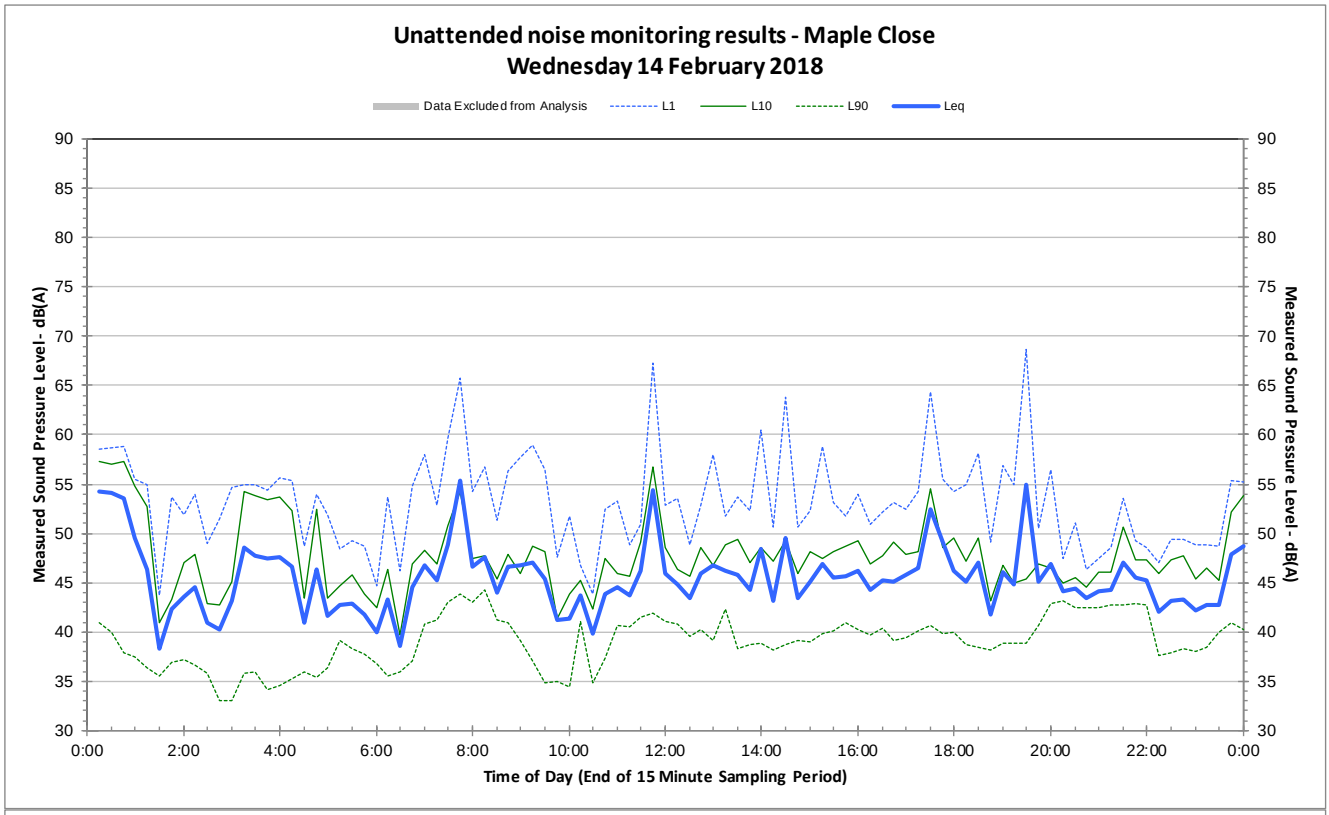

Unattended noise monitoring results - MacDonald Street
Wednesday 21 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

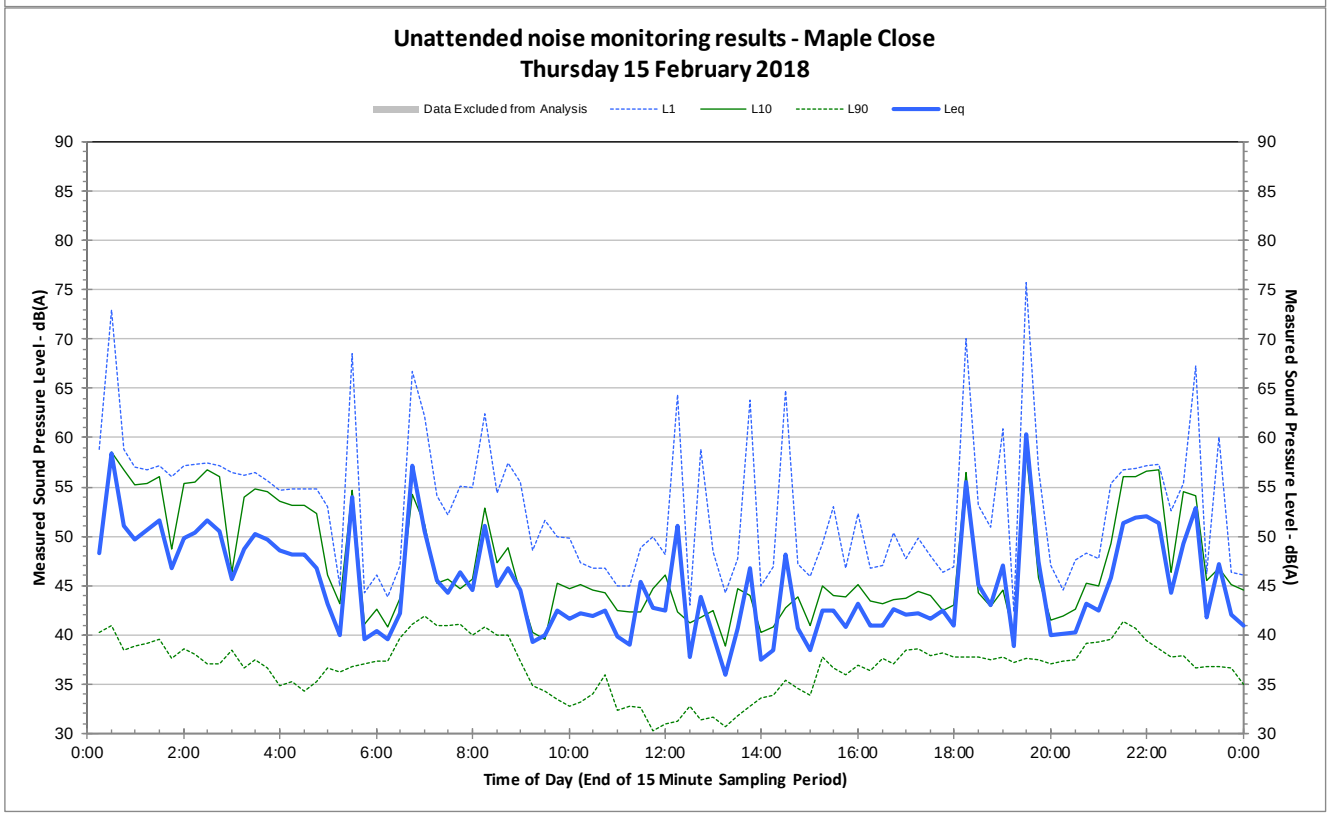

Unattended noise monitoring results - MacDonald Street
Thursday 22 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

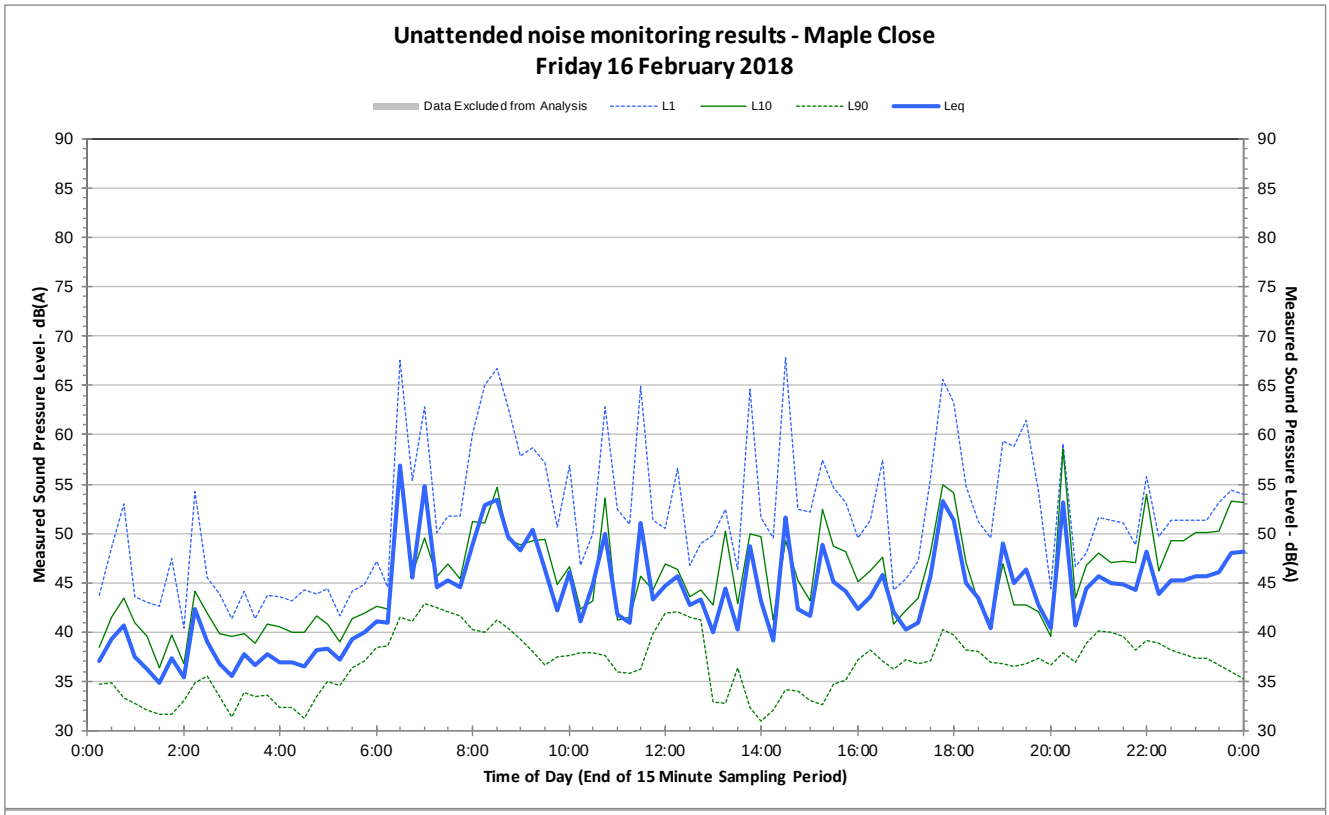
E.3 Maple Court

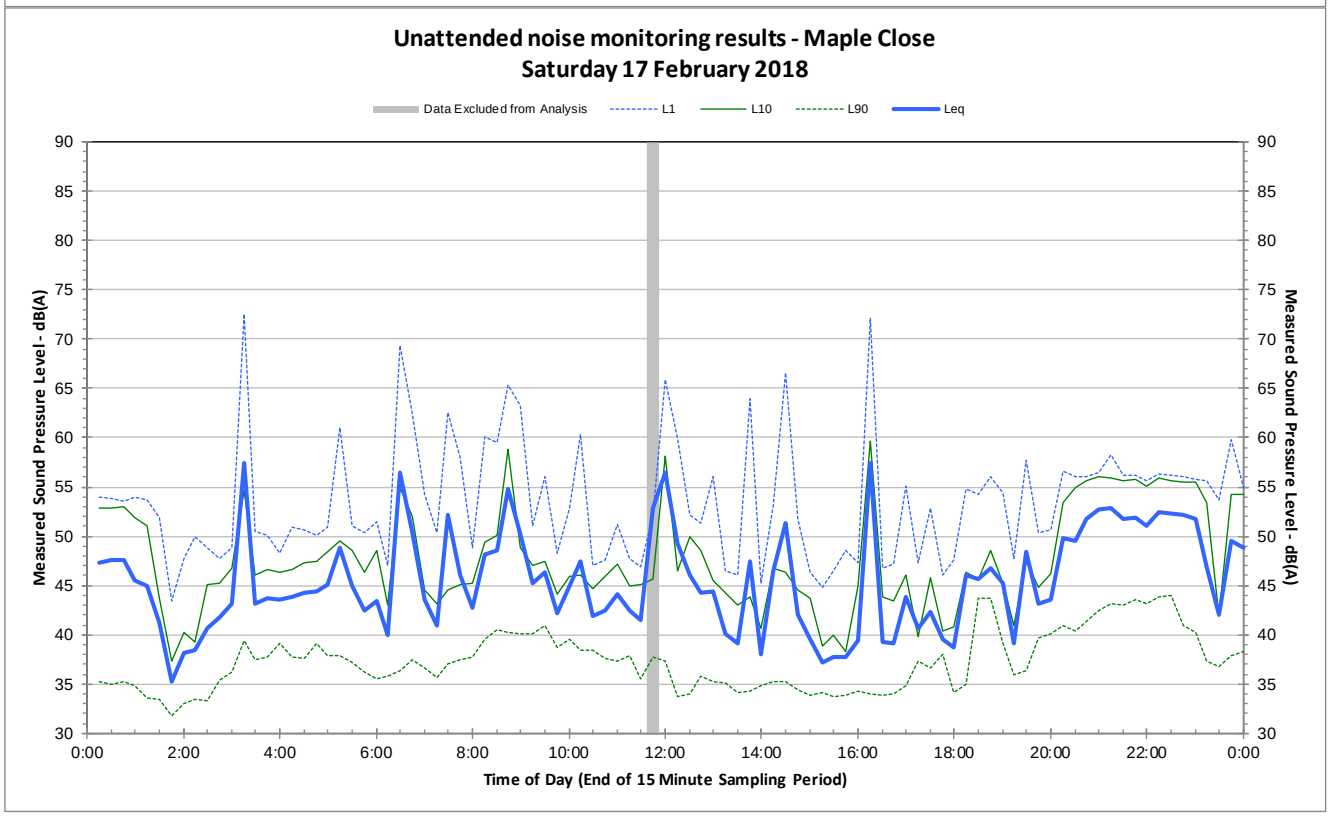


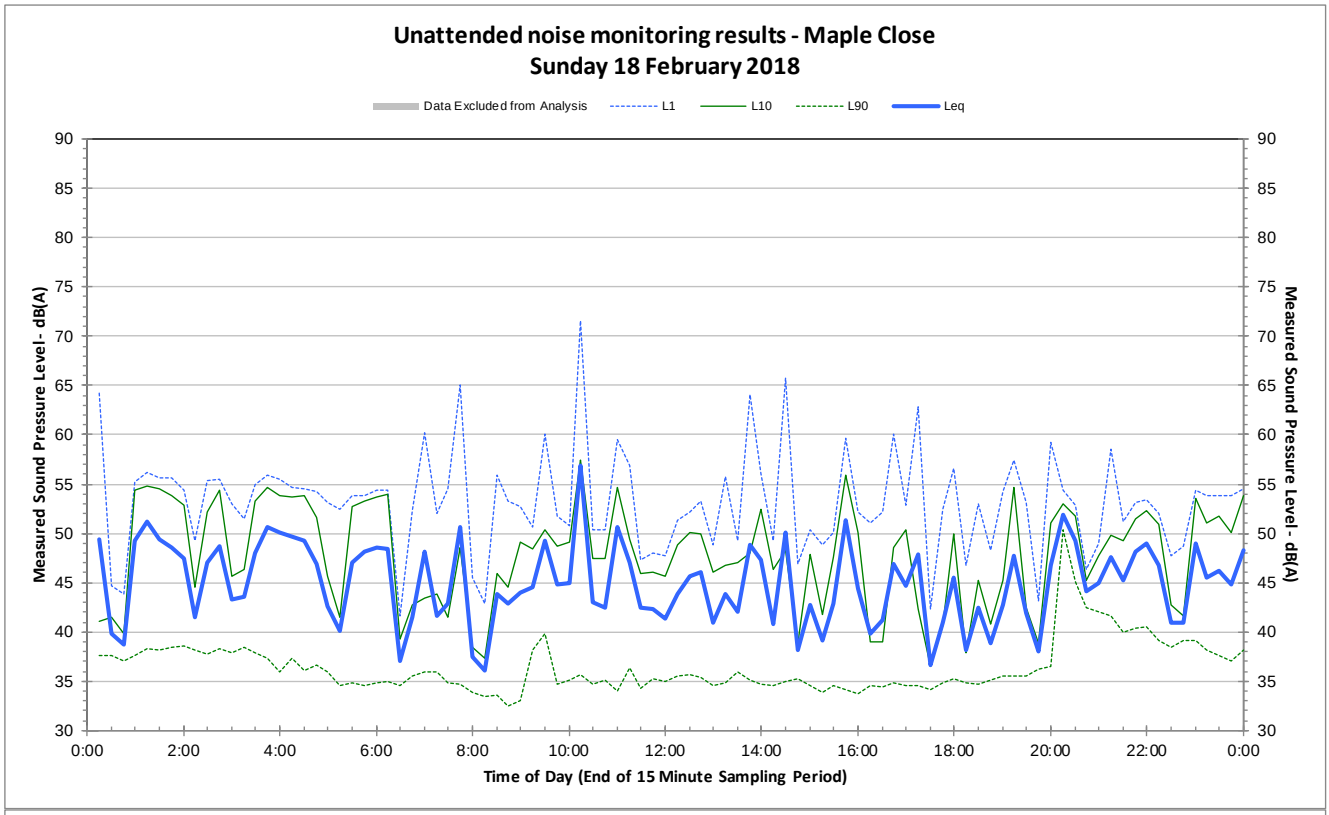


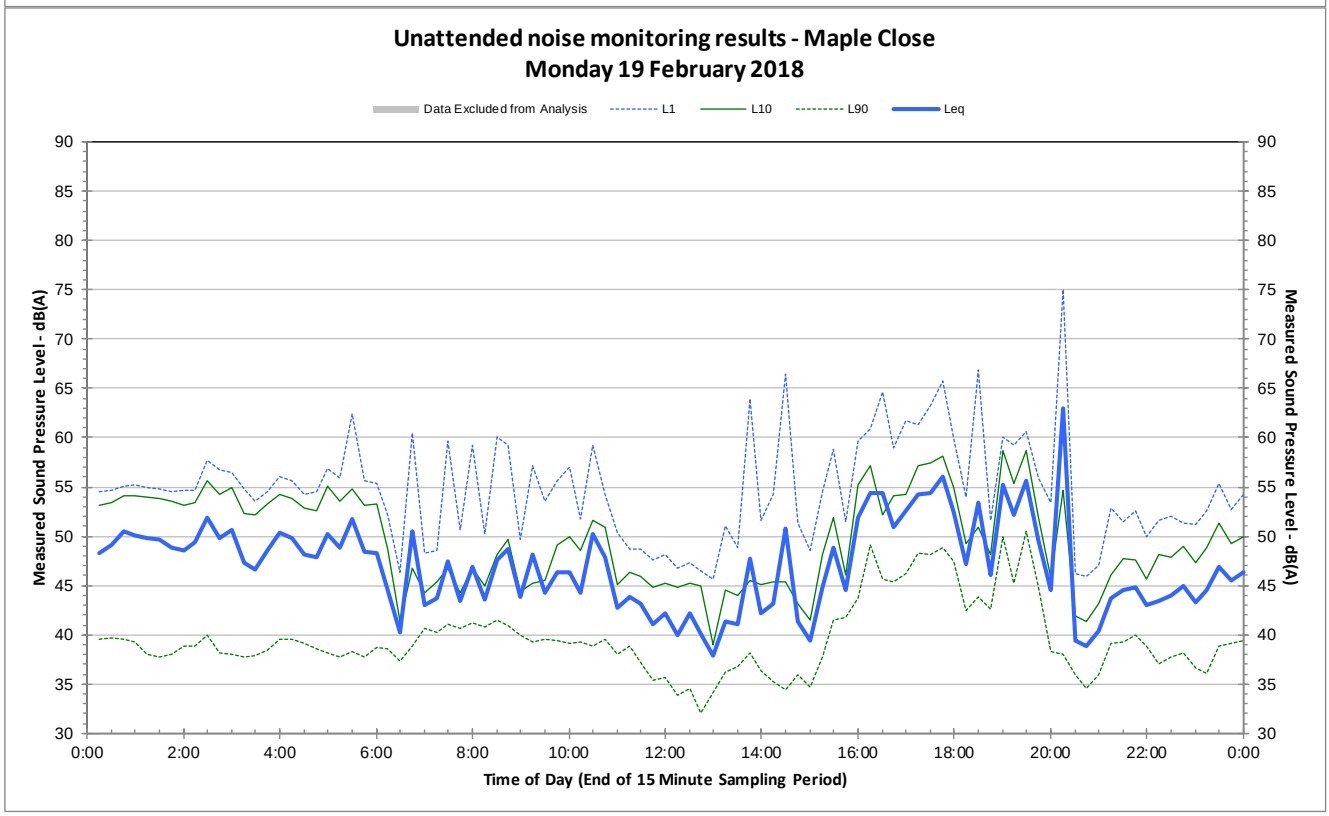

Unattended noise monitoring results - Maple Close
Wednesday 14 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

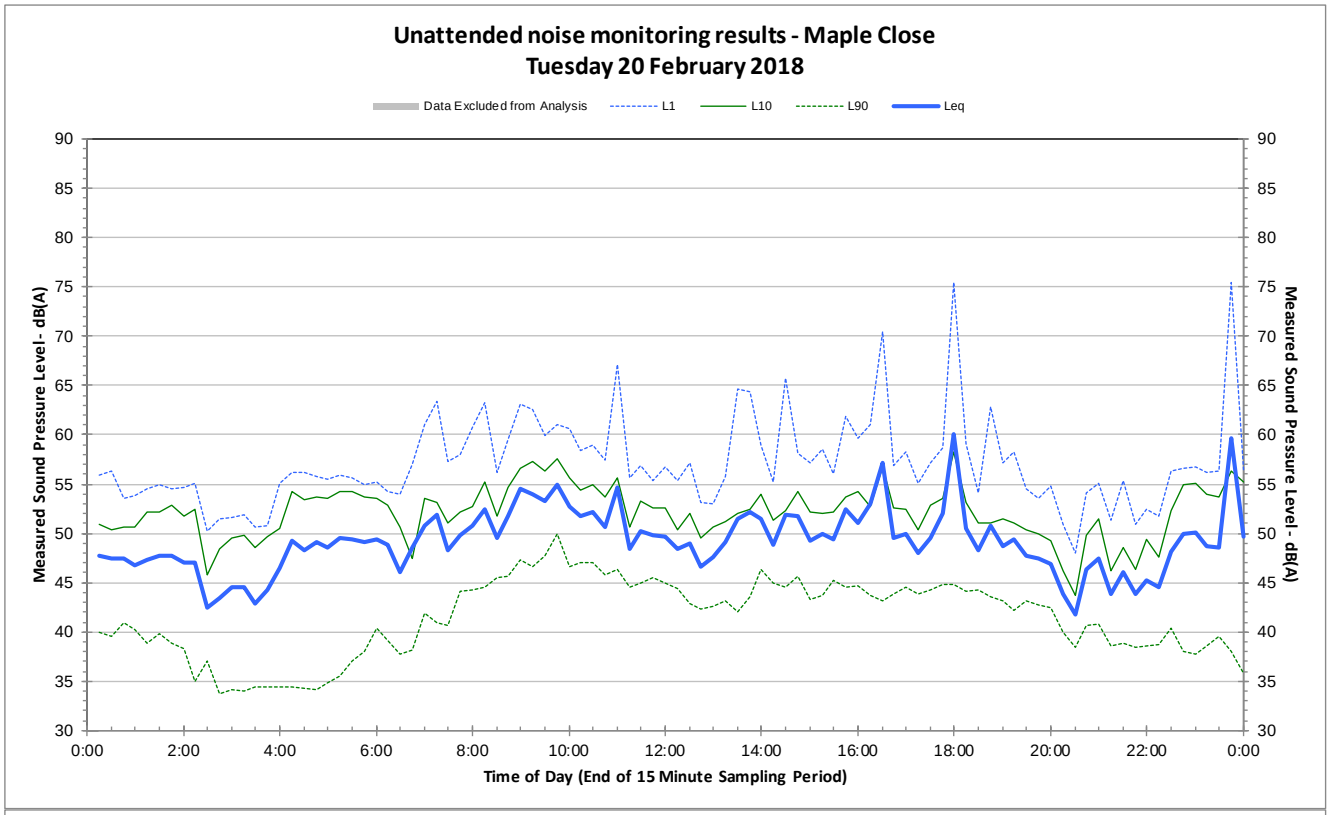

Unattended noise monitoring results - Maple Close
Thursday 15 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

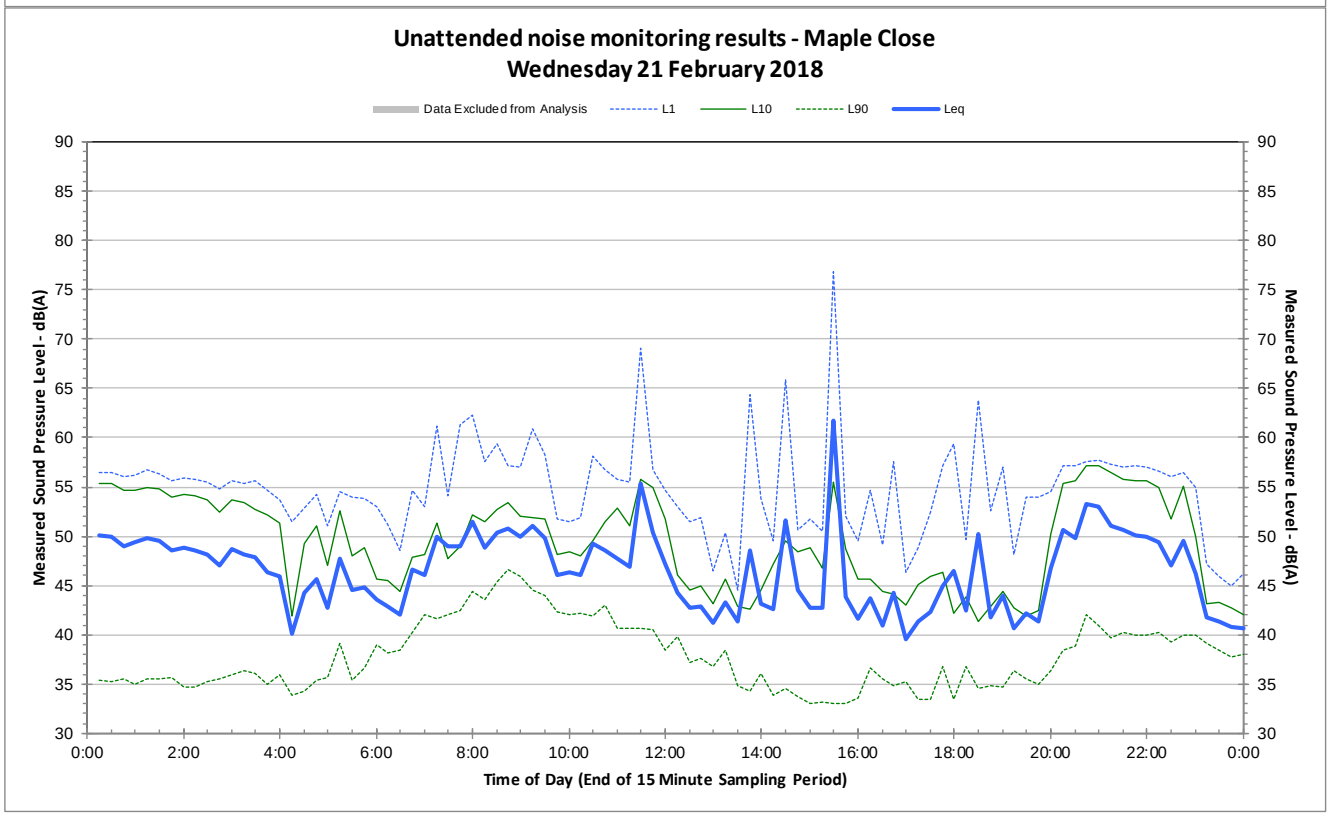

Unattended noise monitoring results - Maple Close
Friday 16 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

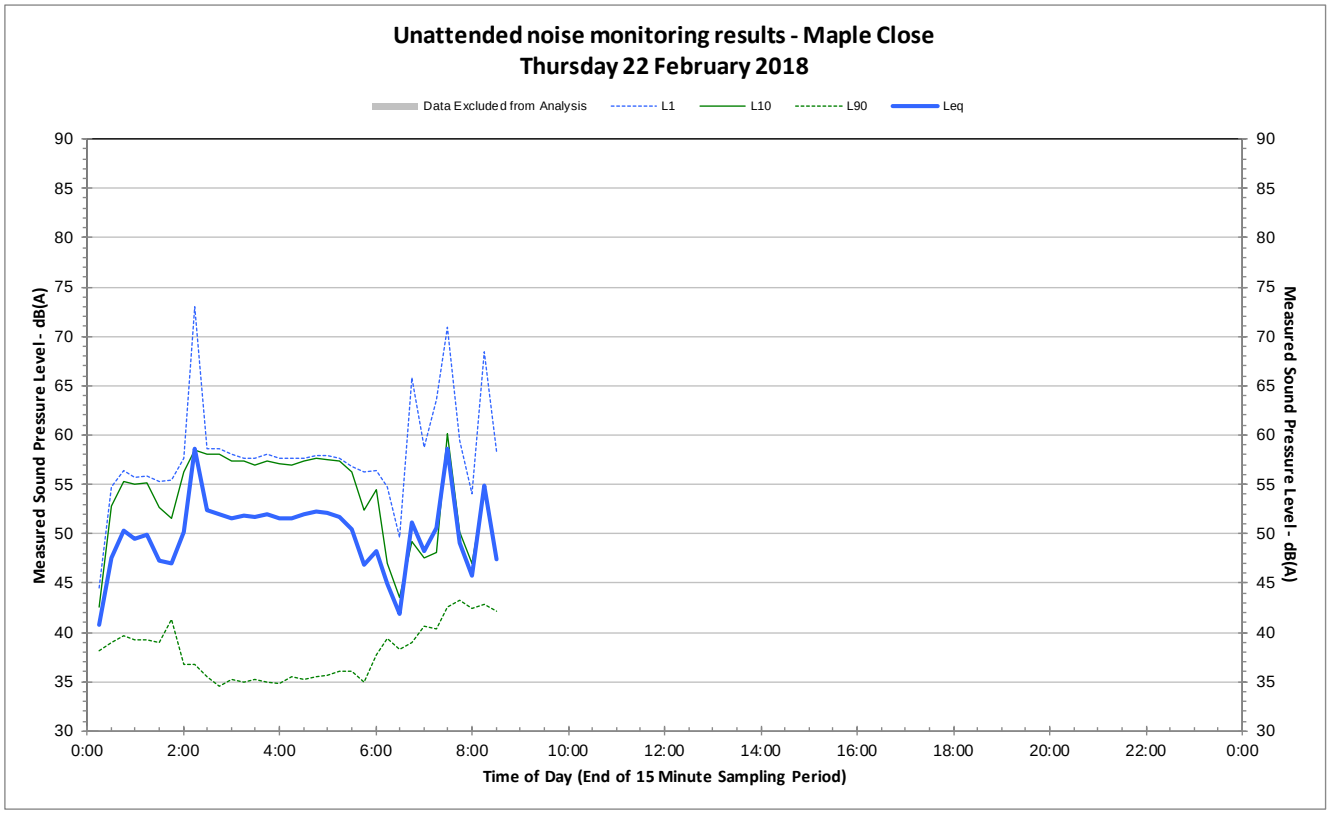

Unattended noise monitoring results - Maple Close
Saturday 17 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Maple Close
Sunday 18 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

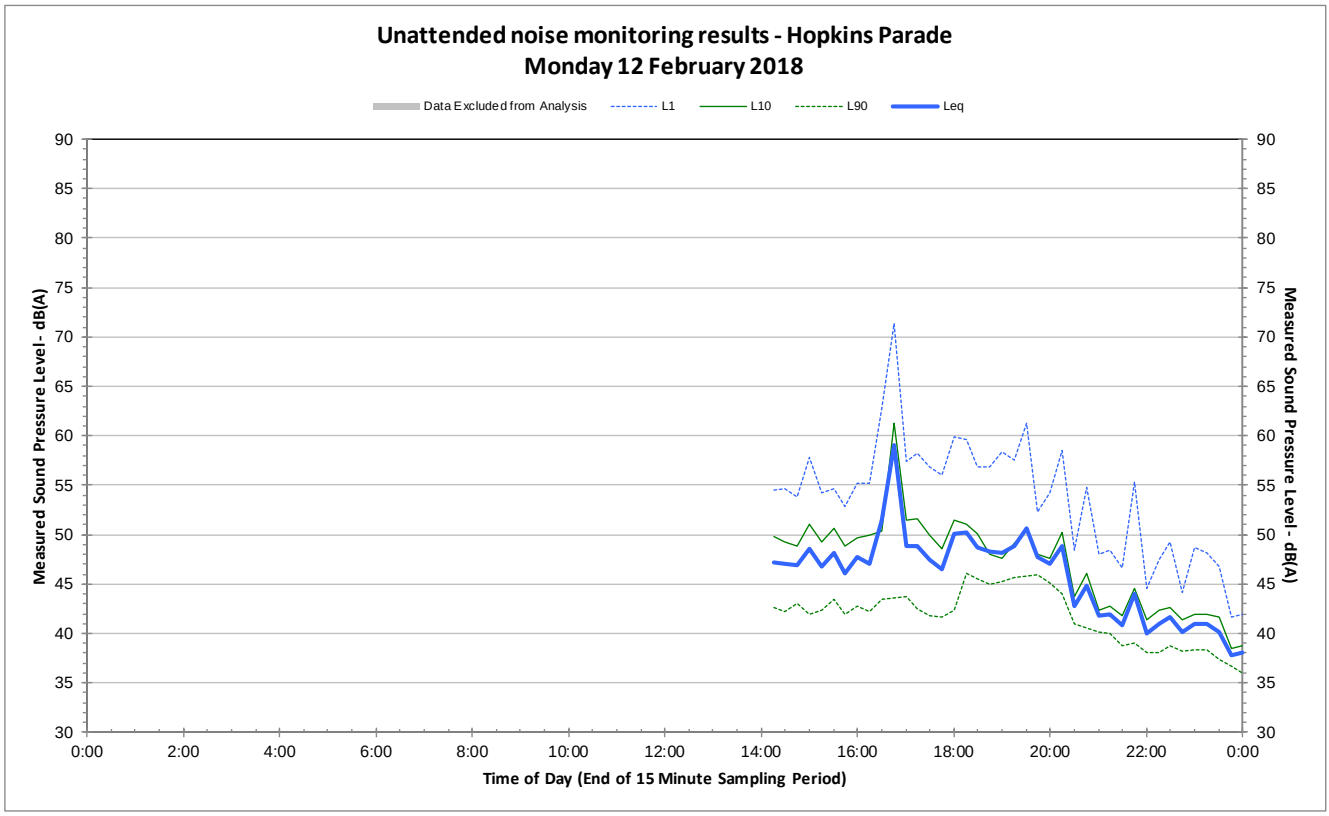

Unattended noise monitoring results - Maple Close
Monday 19 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

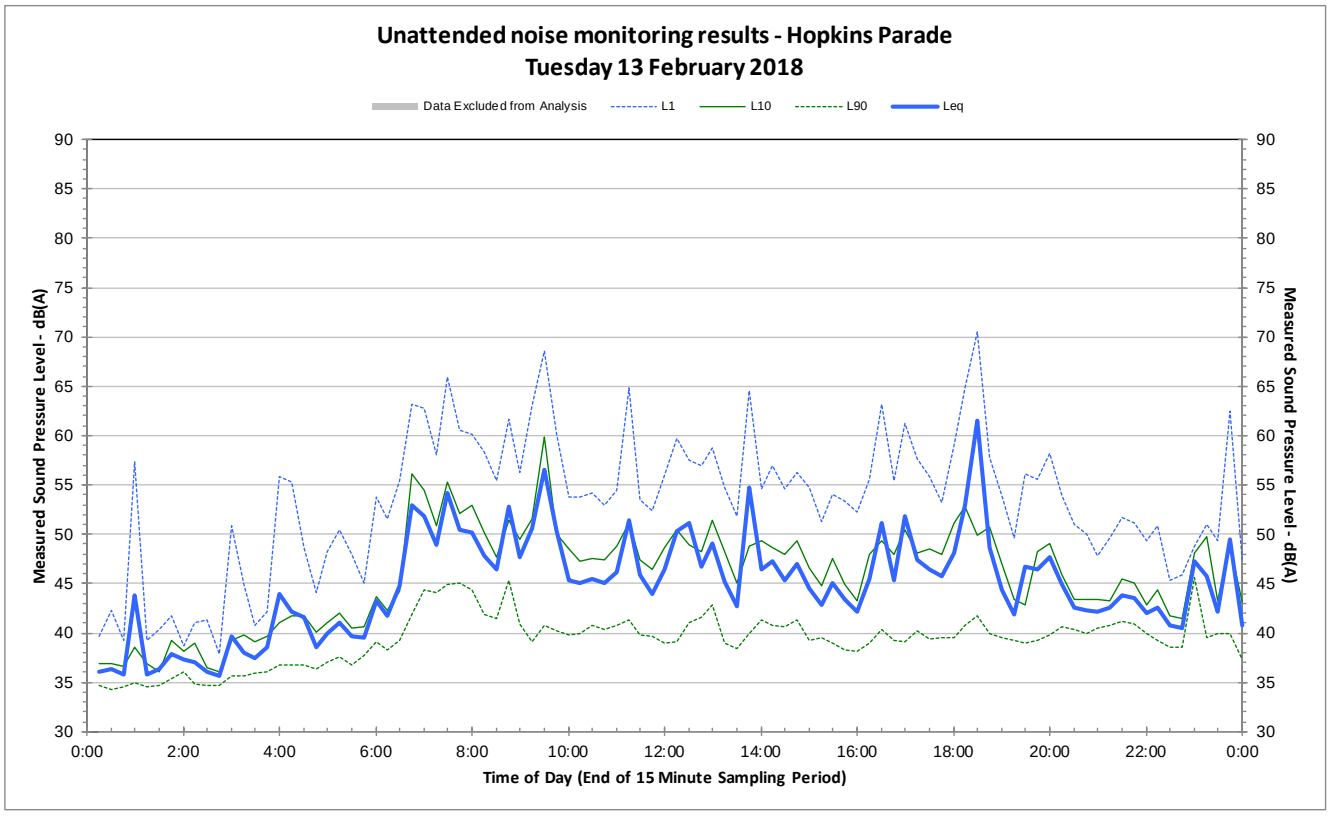

Unattended noise monitoring results - Maple Close
Tuesday 20 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

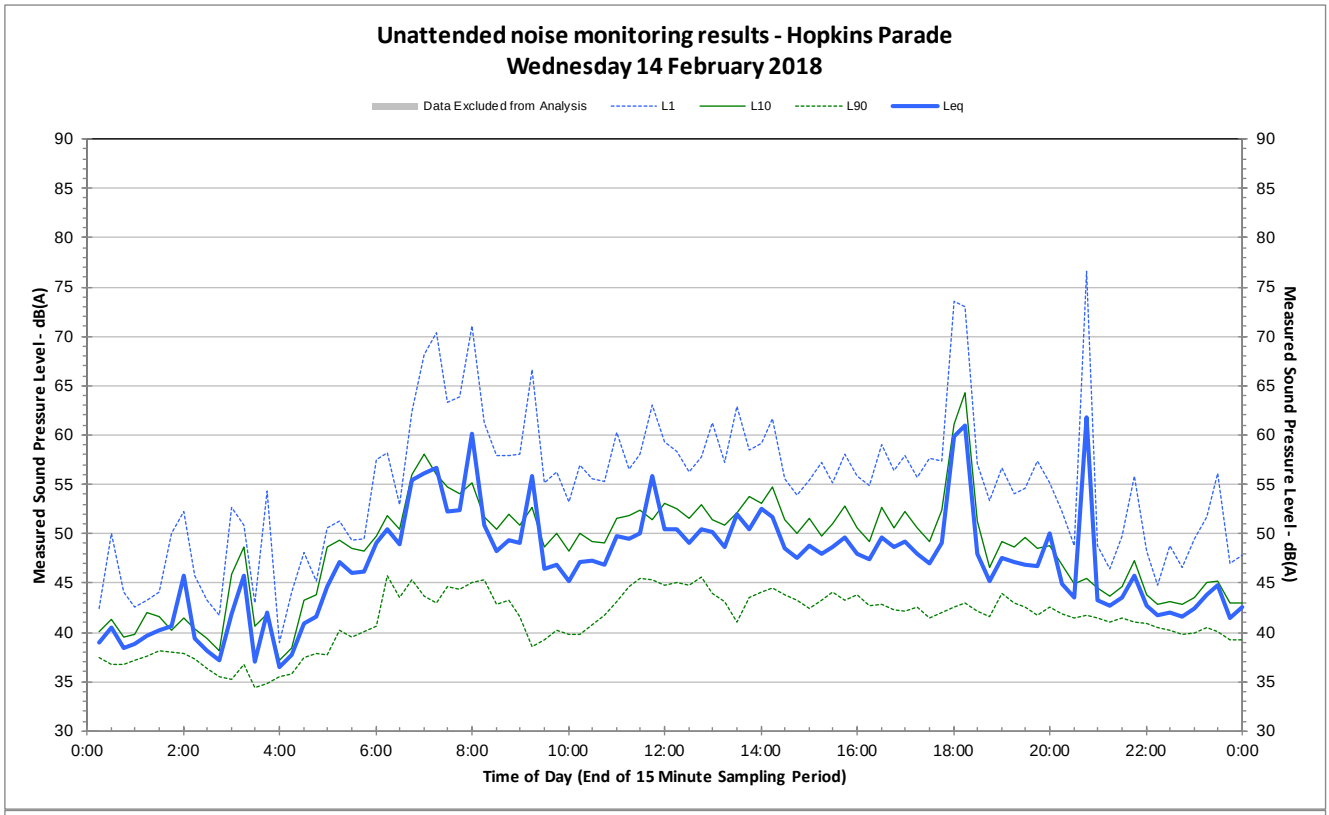

Unattended noise monitoring results - Maple Close
Wednesday 21 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

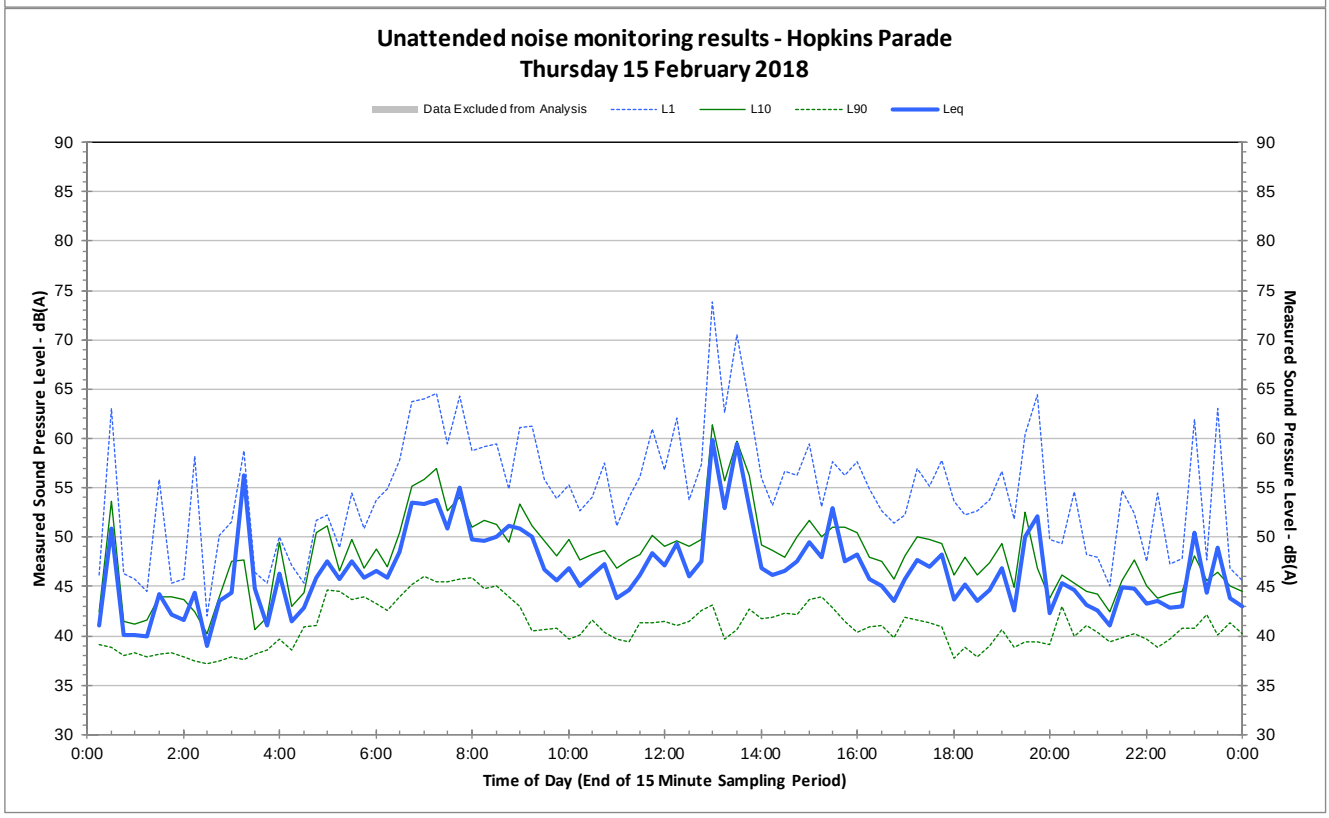

Unattended noise monitoring results - Maple Close
Thursday 22 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

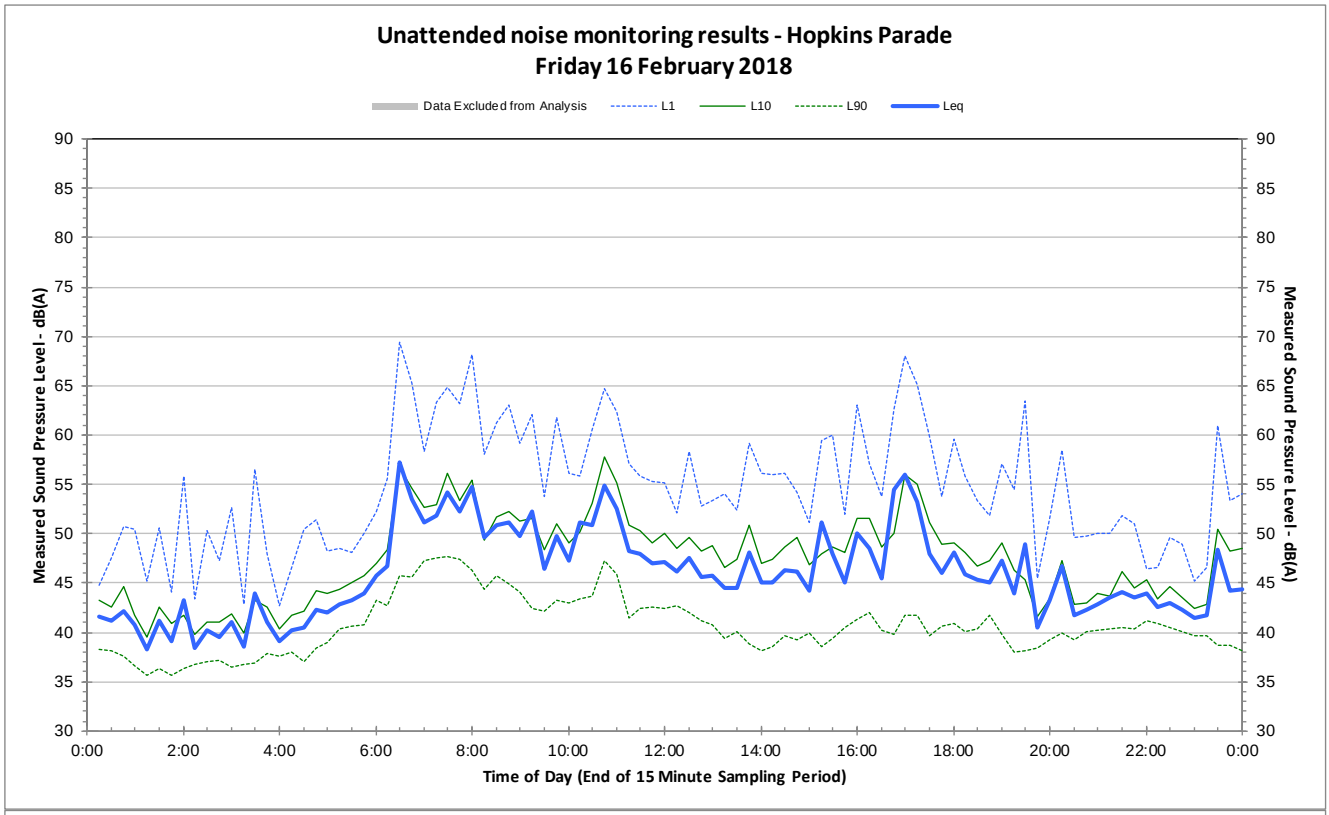
E.4 Hopkins Parade

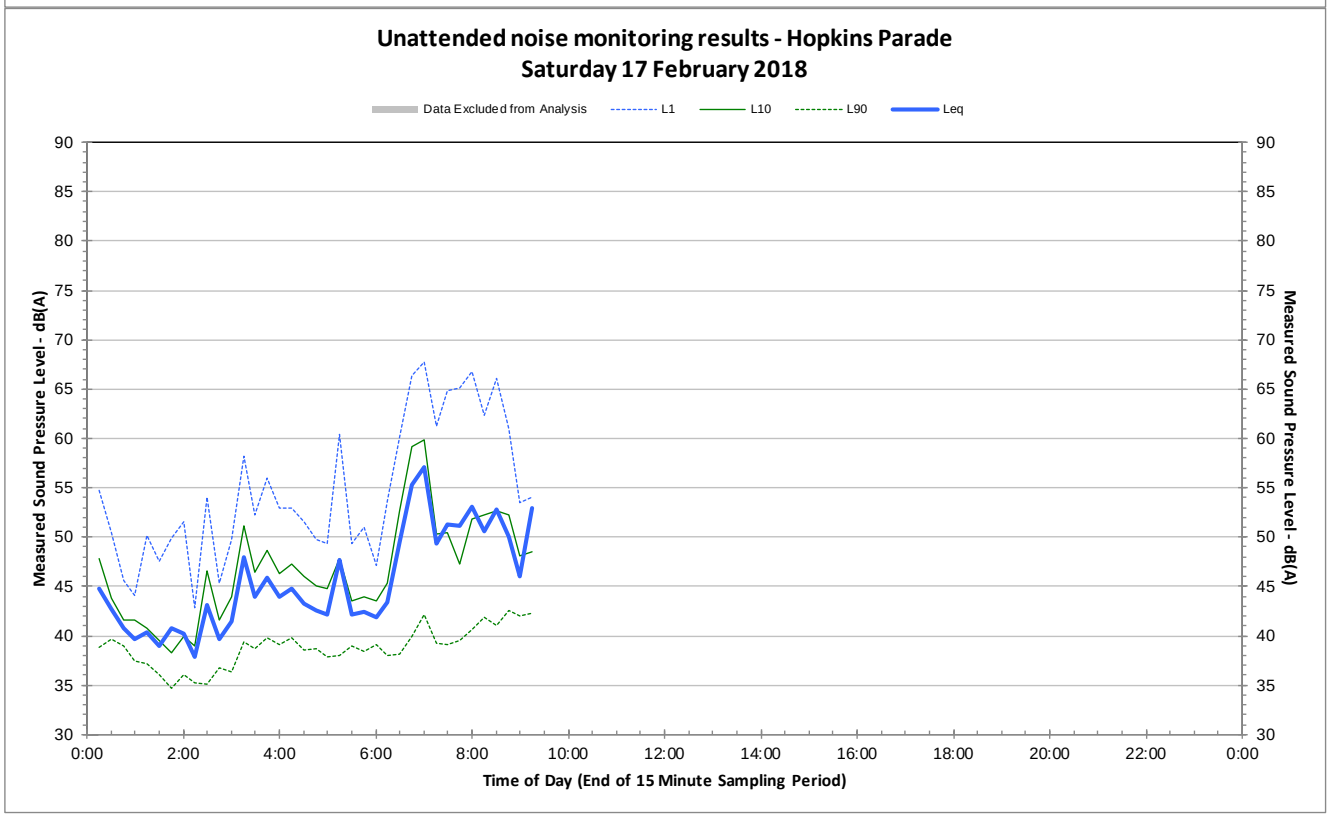




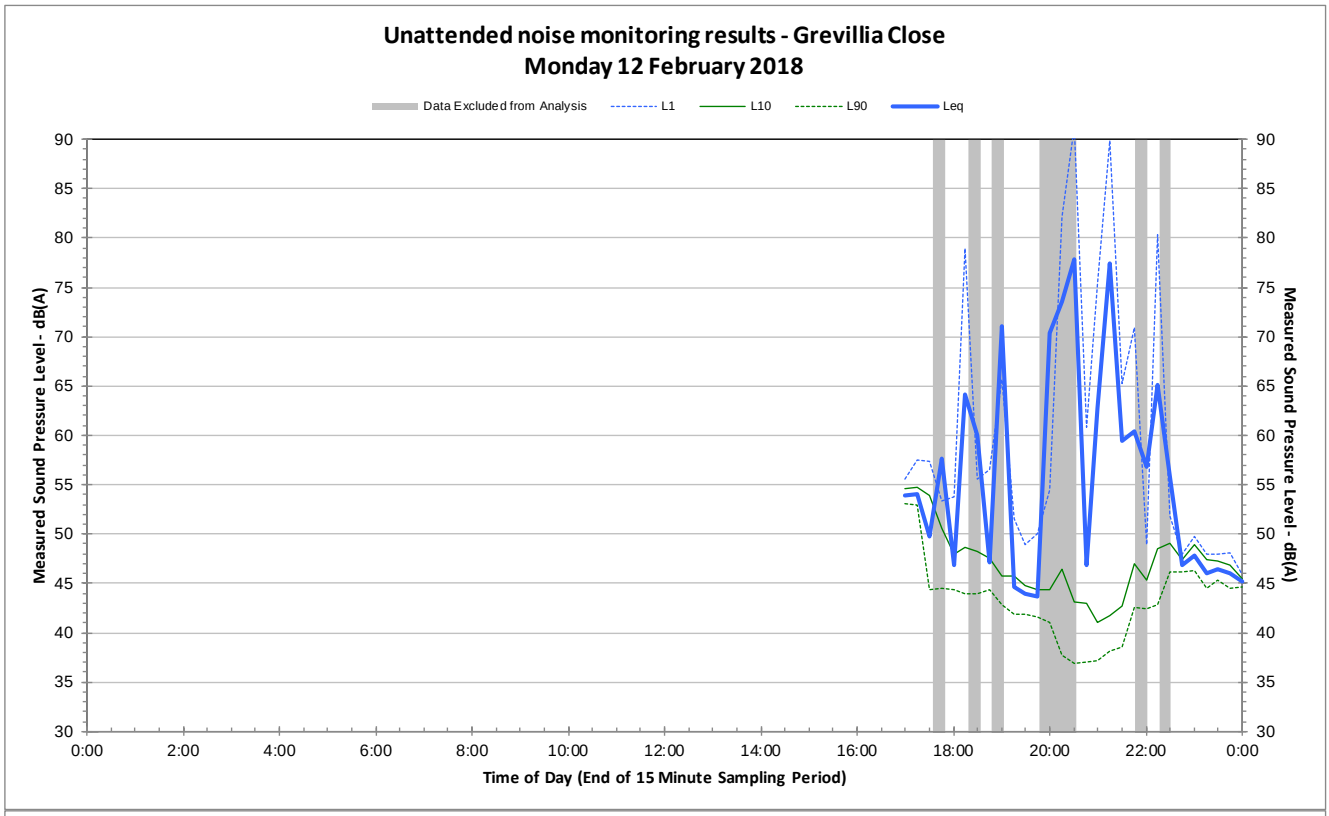

Unattended noise monitoring results - Hopkins Parade
Wednesday 14 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

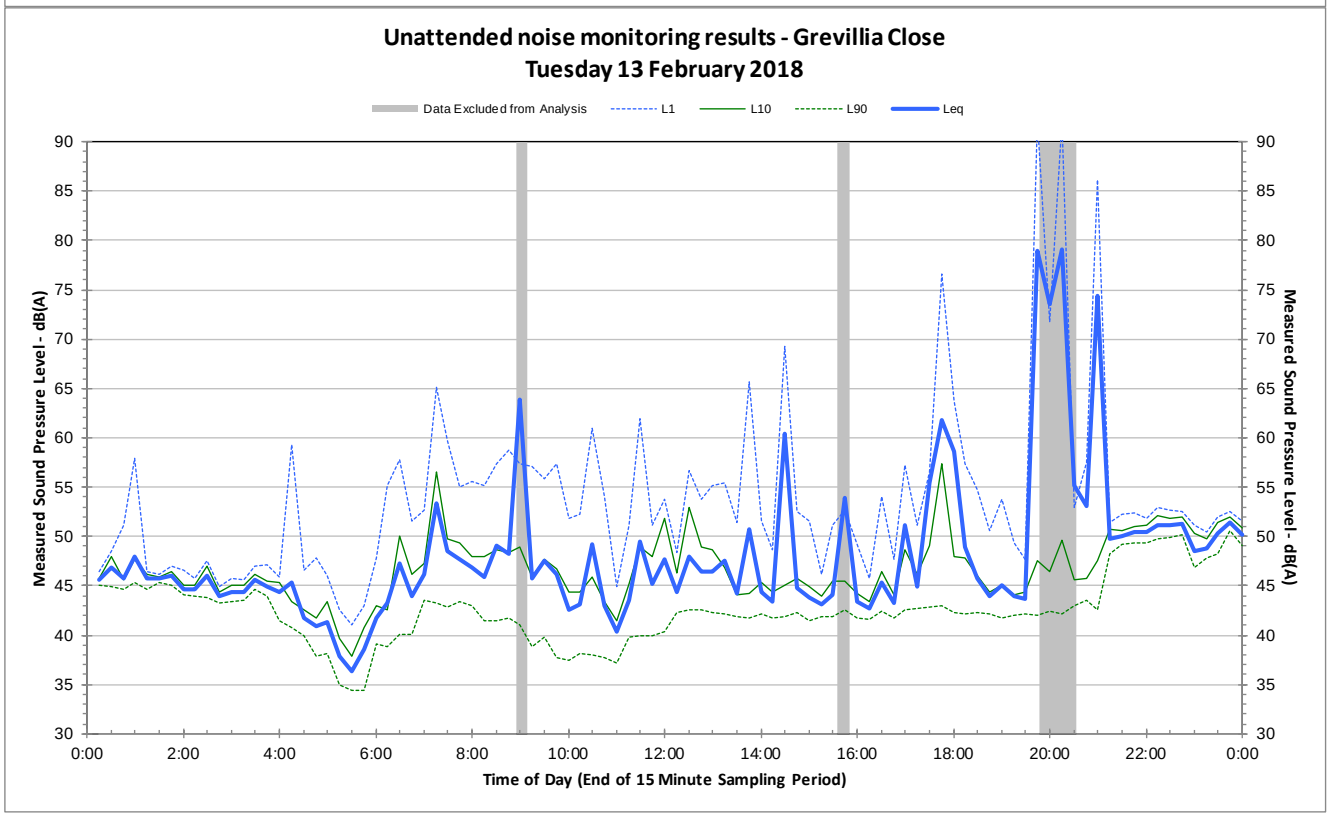

Unattended noise monitoring results - Hopkins Parade
Thursday 15 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

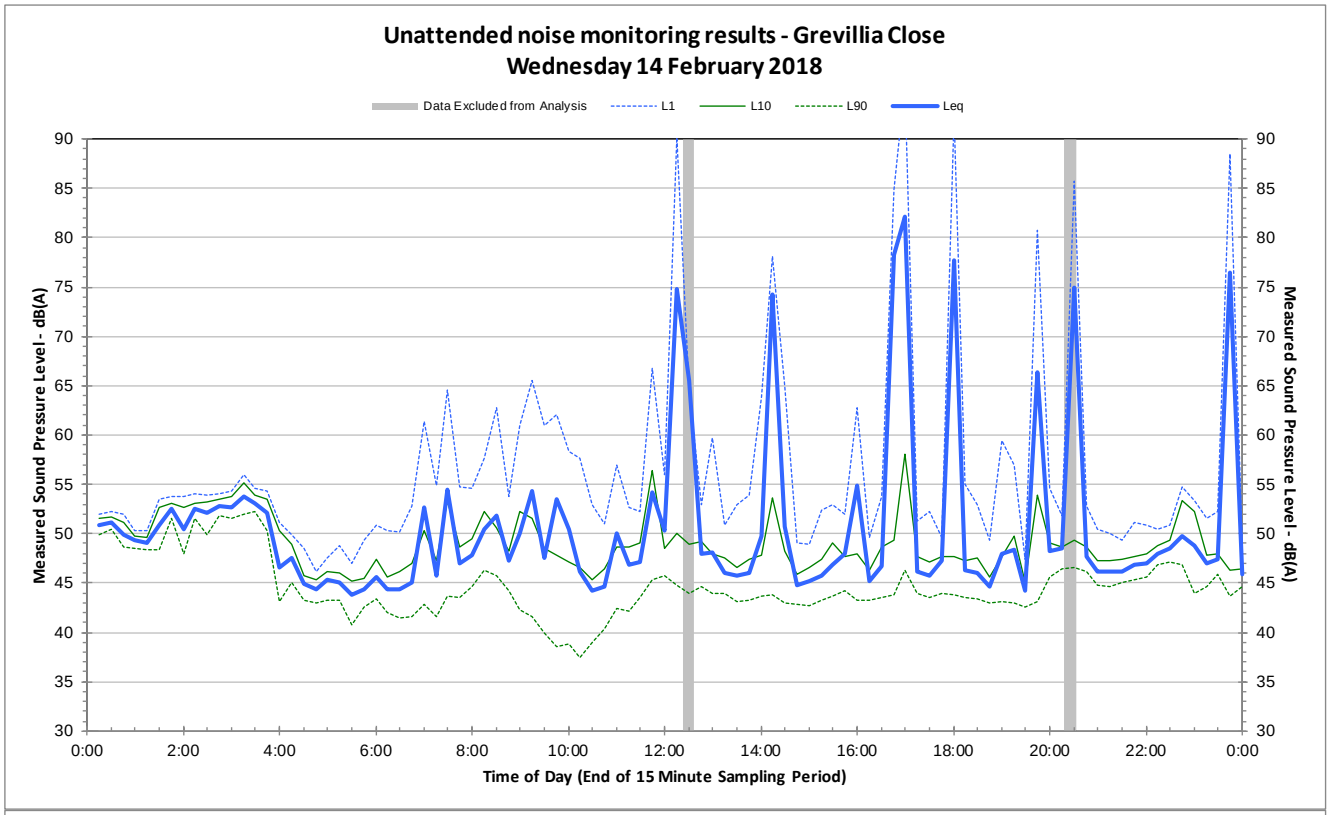

Unattended noise monitoring results - Hopkins Parade
Friday 16 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

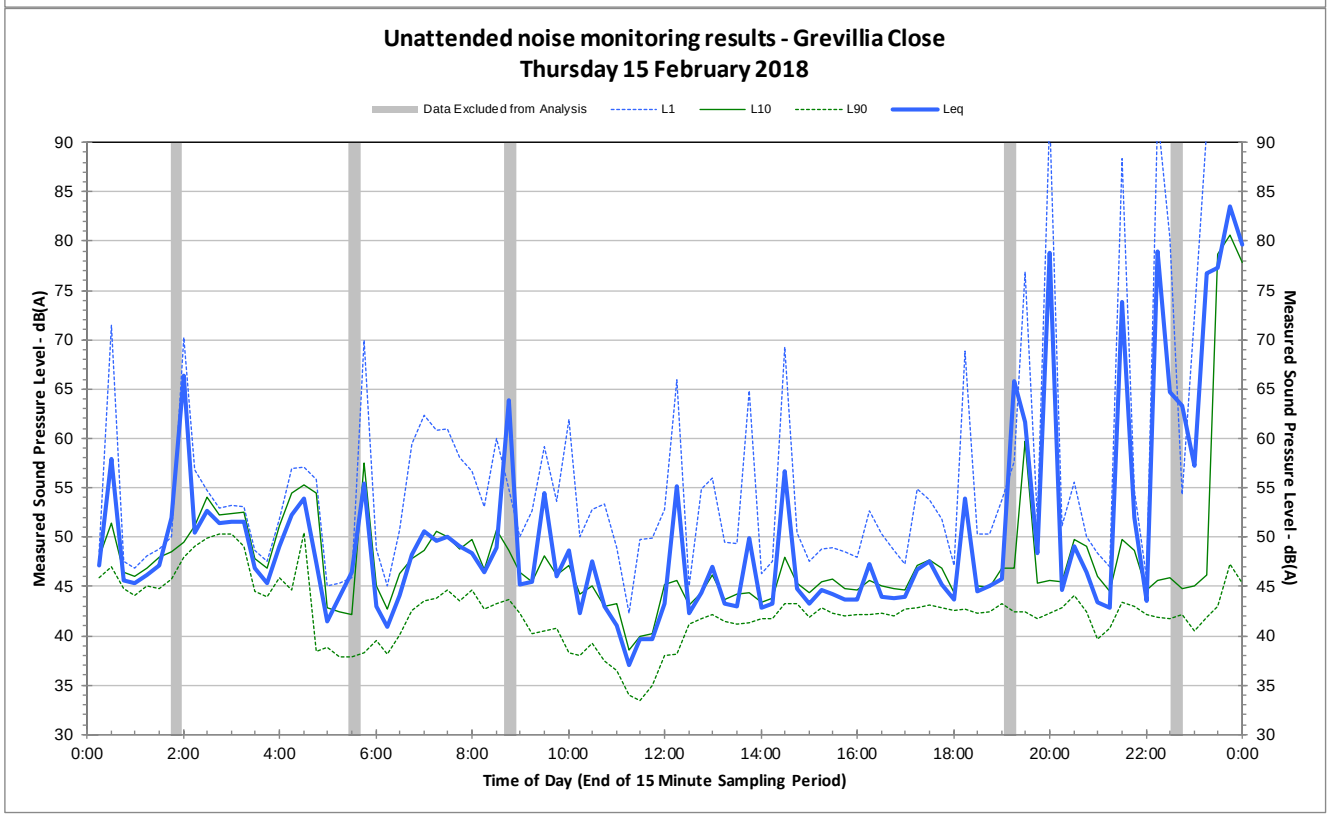

Unattended noise monitoring results - Hopkins Parade
Saturday 17 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

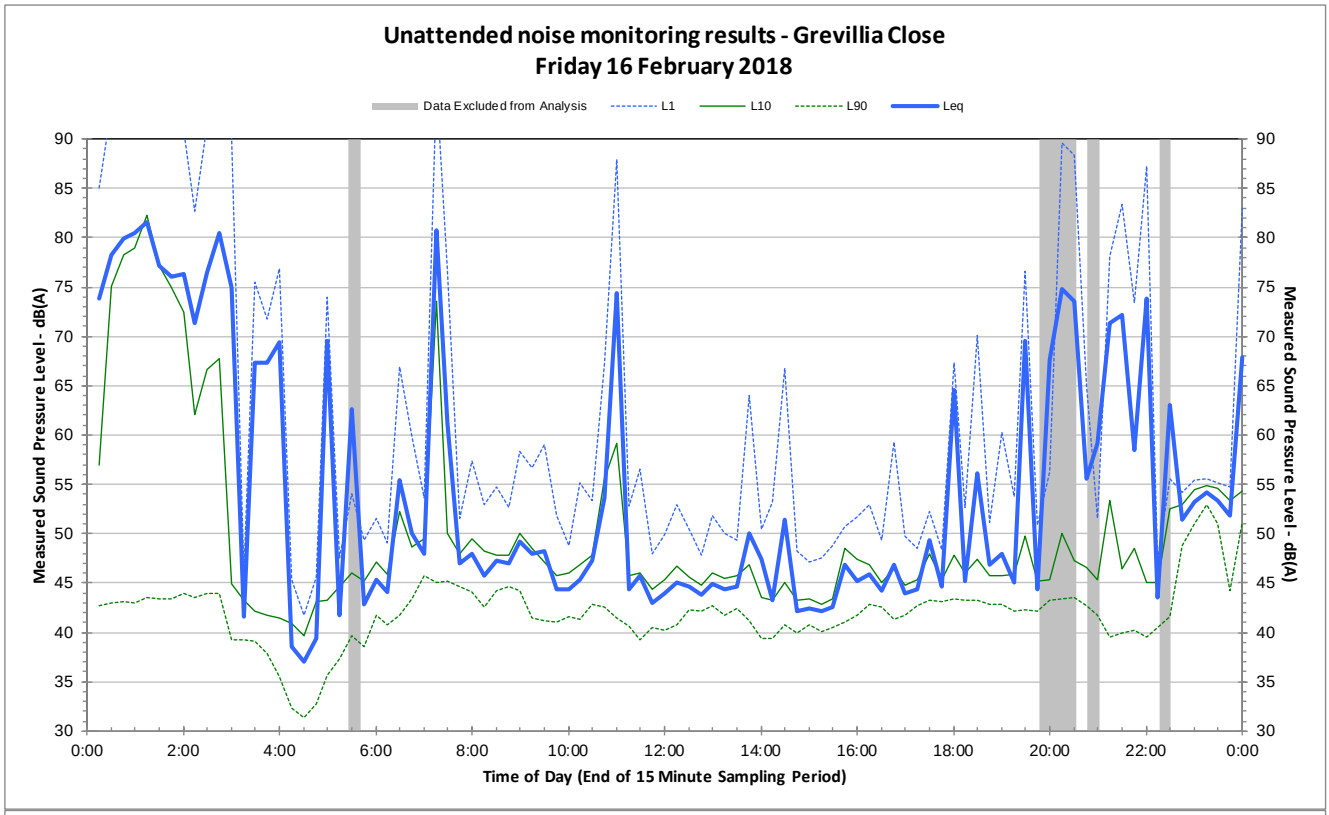
E.5 Grevillea Close

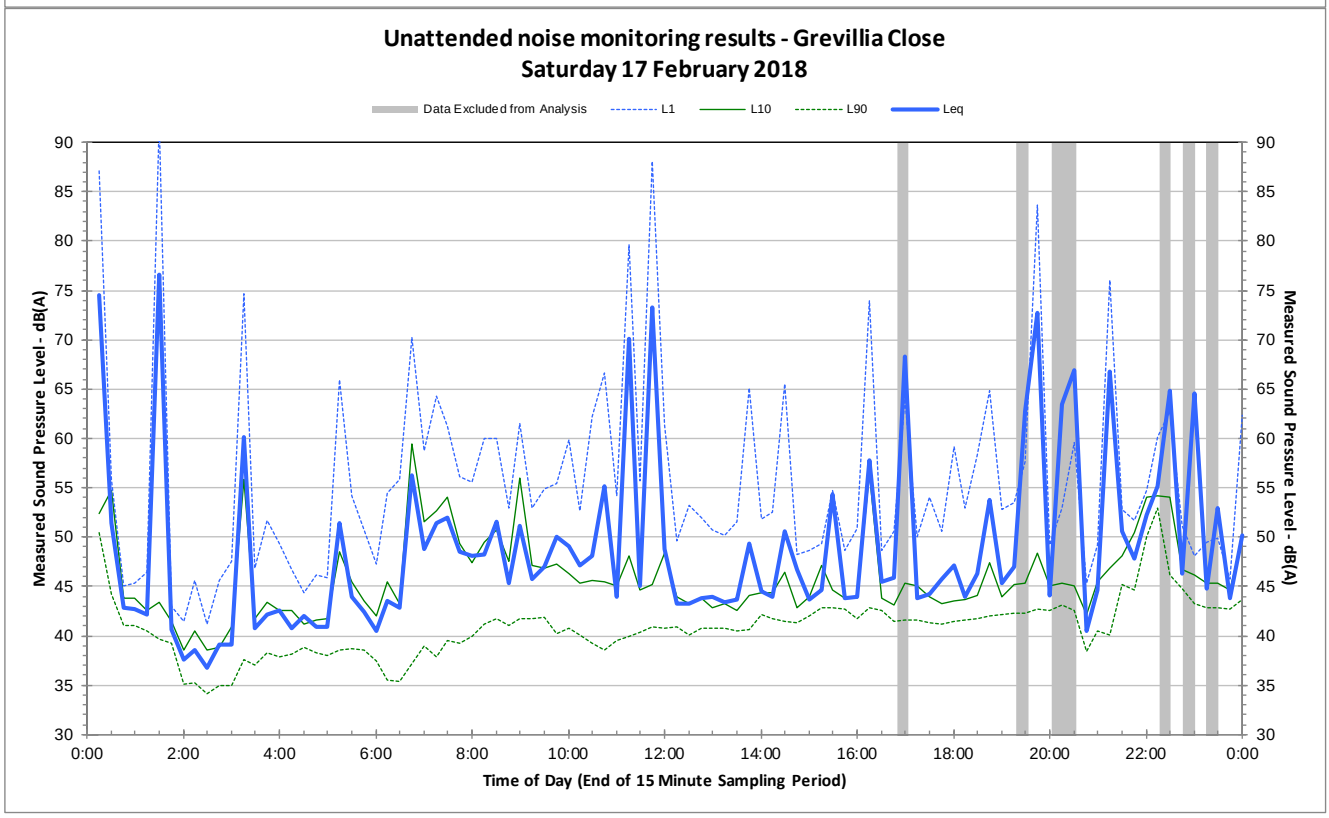


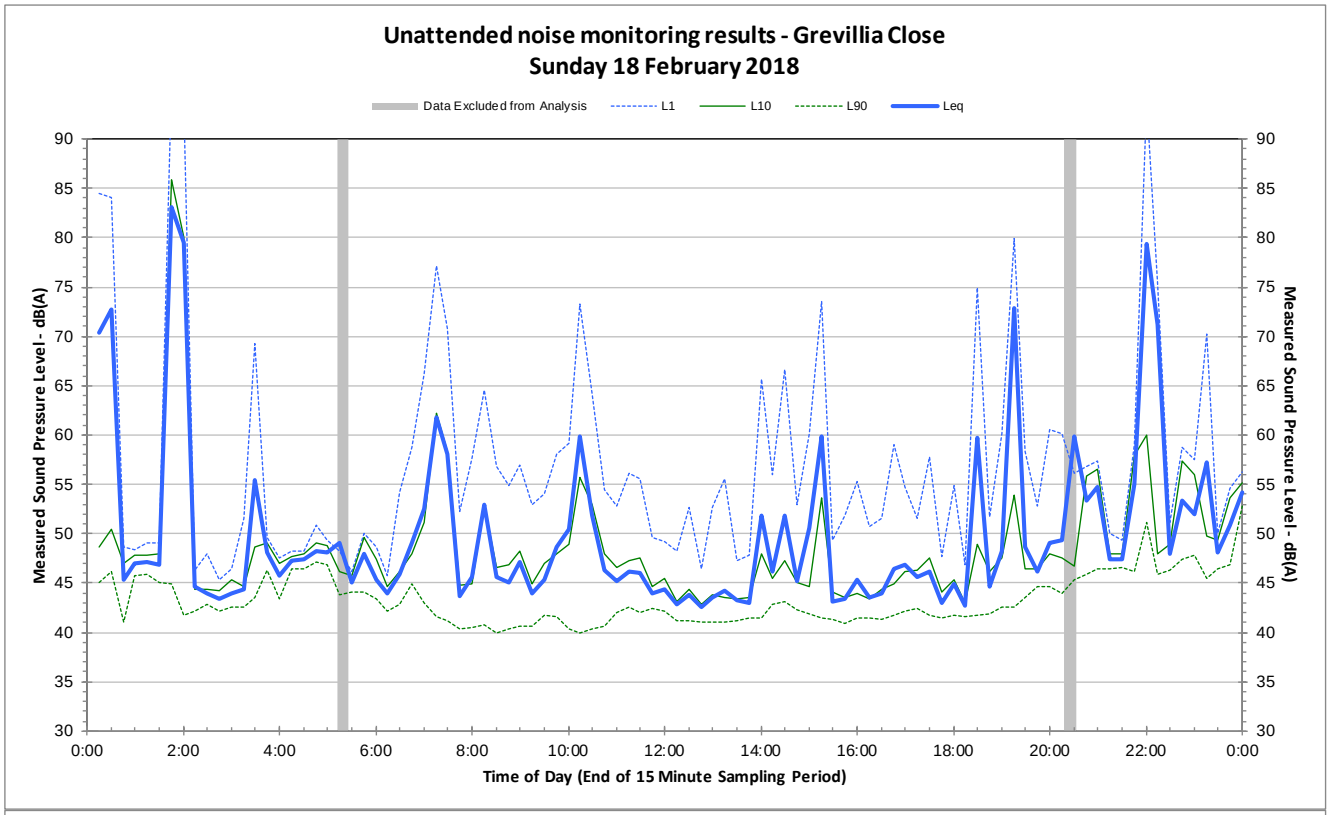


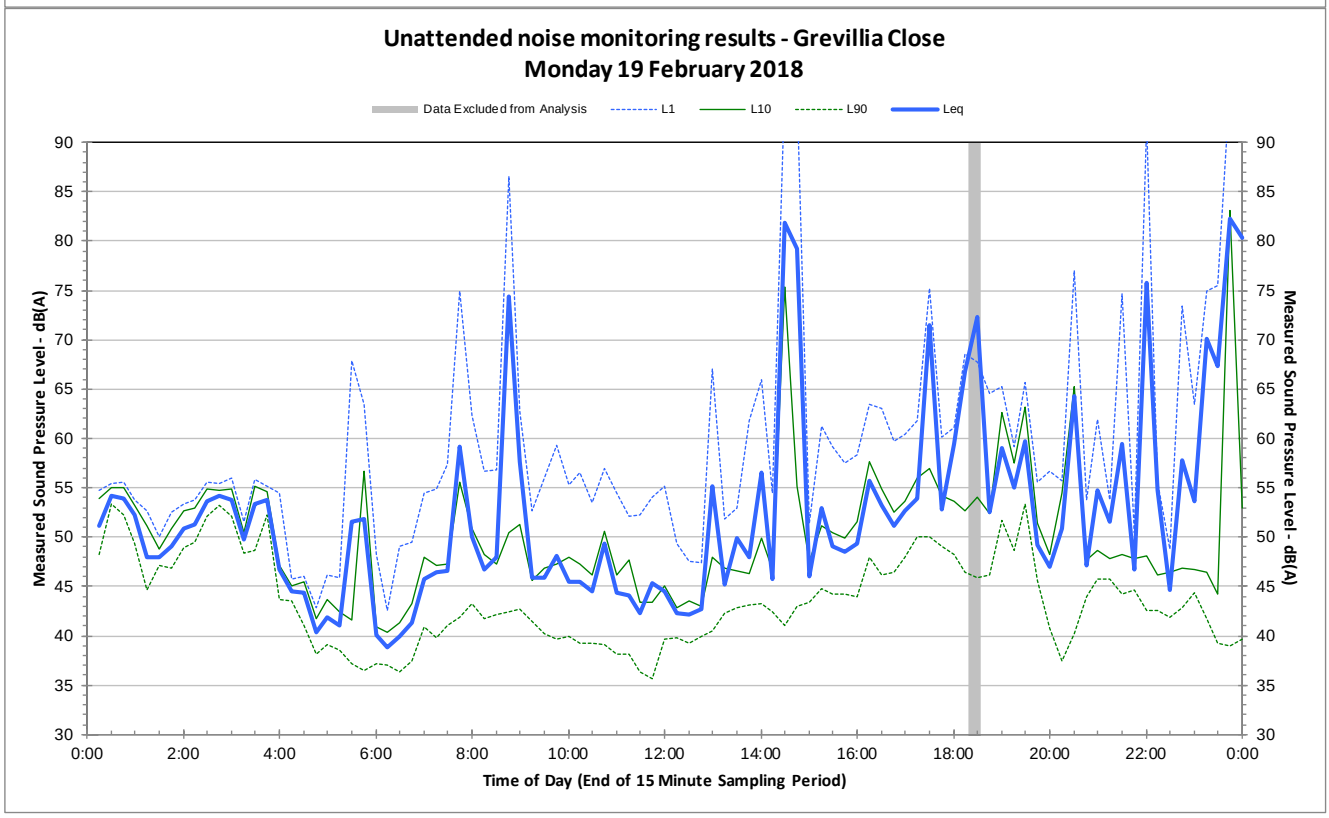

Unattended noise monitoring results - Grevillia Close
Wednesday 14 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

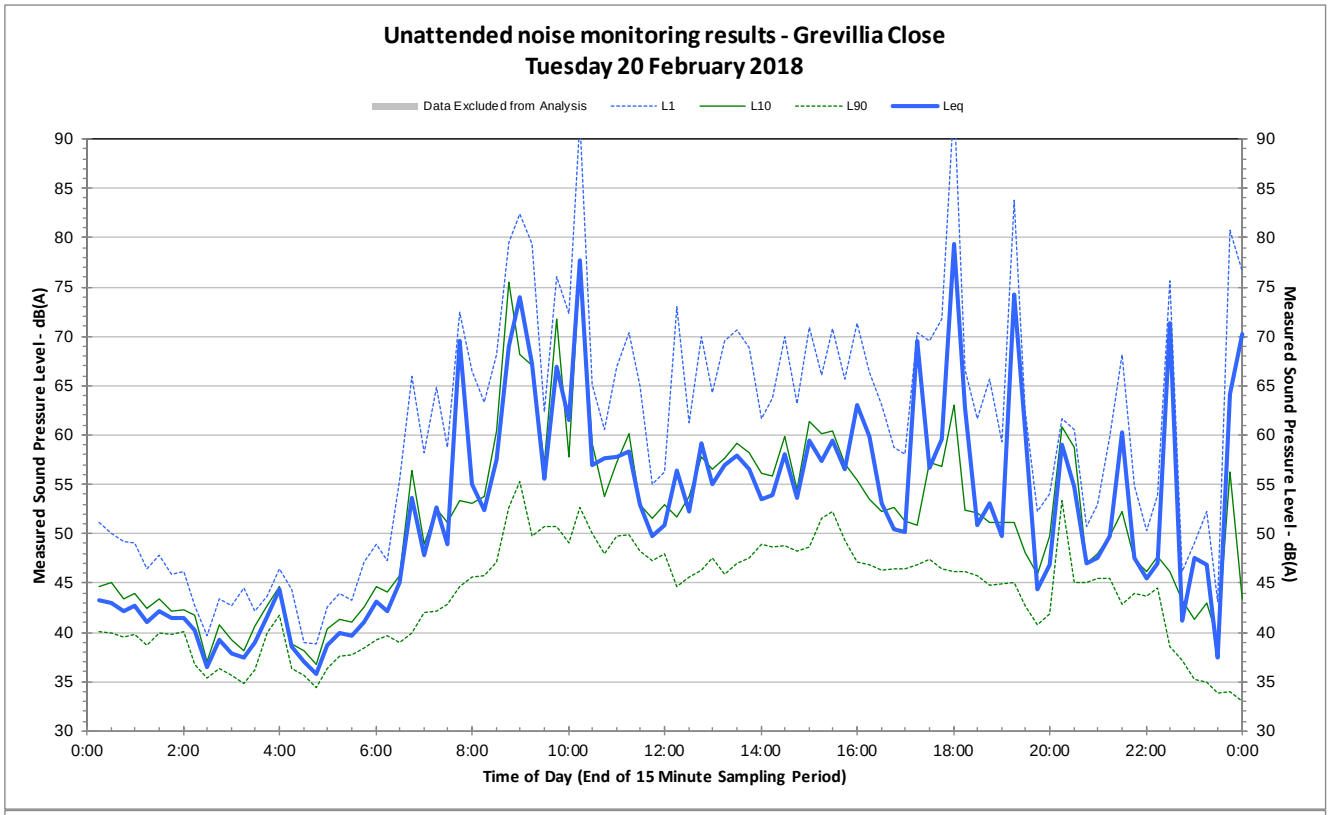

Unattended noise monitoring results - Grevillia Close
Thursday 15 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

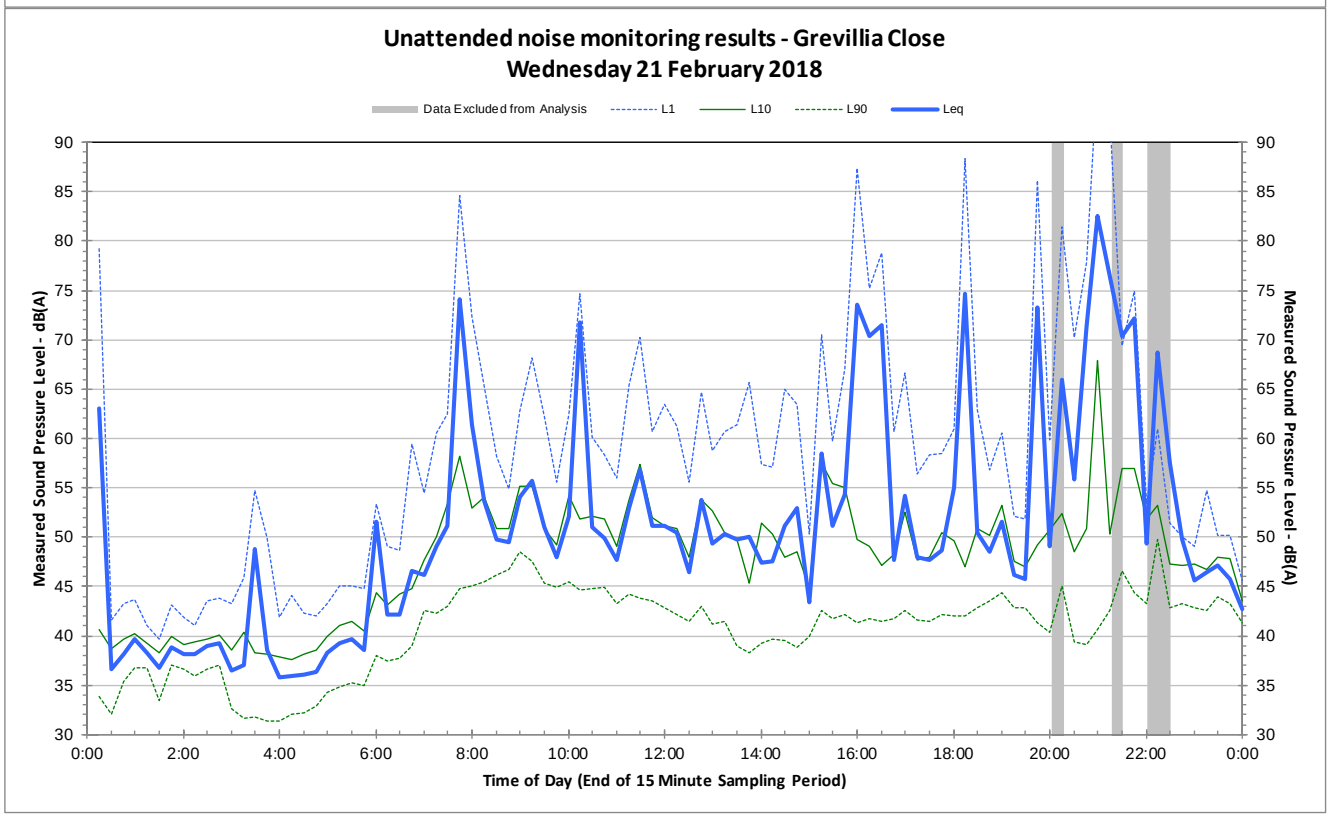

Unattended noise monitoring results - Grevillia Close
Friday 16 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

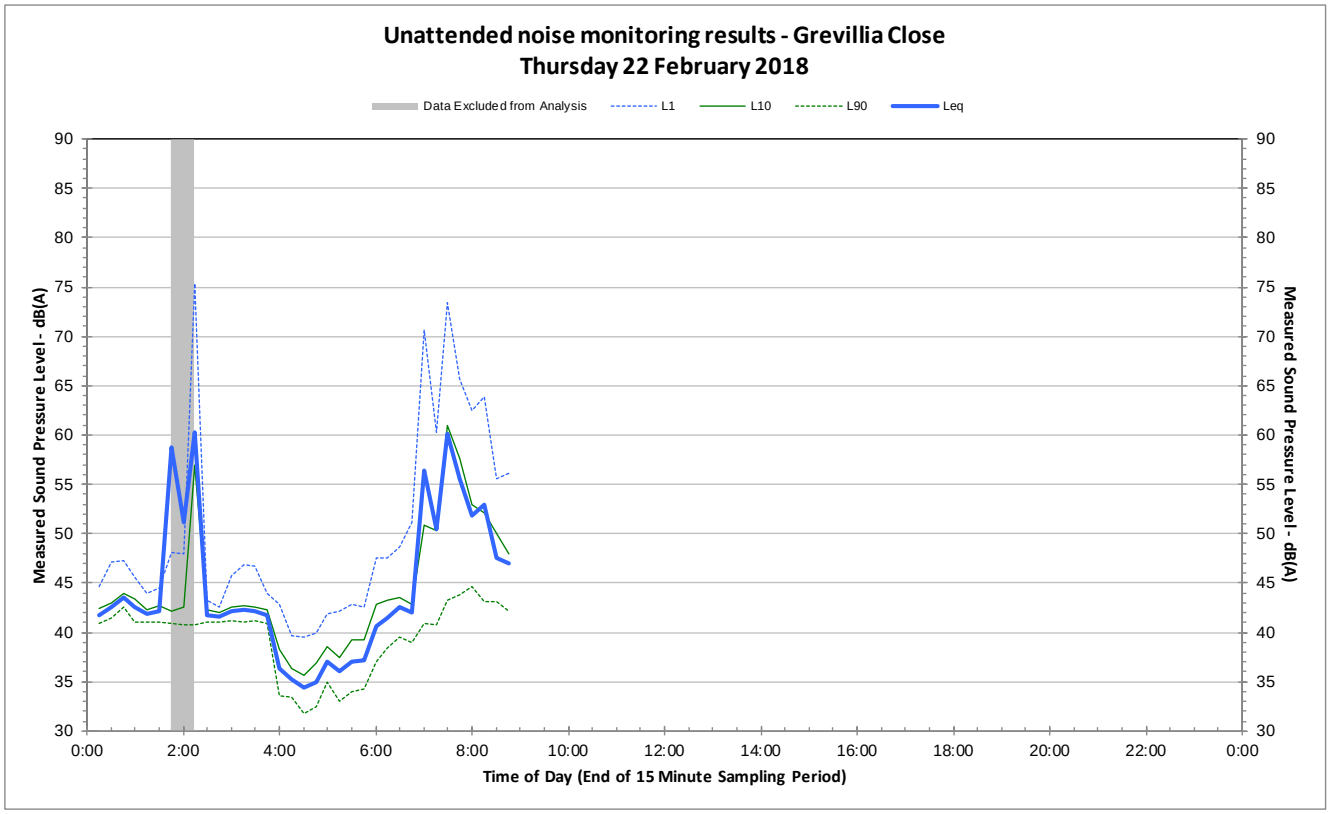

Unattended noise monitoring results - Grevillia Close
Saturday 17 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Grevillia Close
Sunday 18 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Grevillia Close
Monday 19 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Grevillia Close
Tuesday 20 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Grevillia Close
Wednesday 21 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Grevillia Close
Thursday 22 February 2018
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)