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Noise and Vibration Impact Assessment
Wollongong Stabling Yard and Platform Extension

5 September 2019

JACOBS

TK877-01F03 MTMS B2 Wollongong Stabling NVIA (r7).docx

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Executive summary

This noise and vibration impact assessment was conducted on behalf of Transport for NSW (TfNSW) in support of the proposed Wollongong Stabling Yard and Platform Extension as part of the More Trains, More Services (MTMS) program of work packages required to support the introduction of the 10 car New Intercity Fleet (NIF) trains on the South Coast Line.

The assessment considers the following impacts on nearby sensitive receivers:

- Construction noise and vibration impacts from the Wollongong Stabling Yard upgrade and Wollongong Station platform extension works in accordance with:
  - NSW *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Conservation 2009)
  - NSW *Assessing Vibration: A Technical Guideline* (AVTG) (Department of Environment and Climate Change, 2006)
  - TfNSW *Construction Noise and Vibration Strategy* (CNVS) (Document reference: 7TP-ST-157/4.0, Transport for NSW 2018).
- Railway noise impact from the removal and replacement or relocation of existing turnouts and associated signalling, in accordance with the:
  - NSW *Rail Infrastructure Noise Guideline* (RING) (Environment Protection Authority 2013)
- Operational industrial noise impact from the upgraded Stabling Yard in accordance with the:
  - NSW *Noise Policy for Industry* (NPfI) (Environment Protection Authority 2017).

Construction noise and vibration

The construction noise assessment found that residential receivers that are located near to the Stabling Yard and Station would be noise affected by the construction works, with some potentially highly affected as a result of noisier construction activities. Receivers further away from the Stabling Yard and Station may be noise affected during higher noise impact works, however construction noise levels are likely to comply with noise management levels for other activities.

Works outside standard construction hours are likely to be highly intrusive to residential receivers with direct line-of-sight to the works, depending on the specific task being undertaken. Recommendations are provided in Section 4.4 to reduce noise levels, in particular where works are completed outside standard construction hours during rail possession periods. Where all reasonable and feasible mitigation measures have been applied and noise levels are still unable to meet relevant noise objectives, additional noise management measures are provided to manage the impact on the community surrounding the stations.

Potential vibration impact to residential, commercial/ industrial and heritage receivers has been assessed against the relevant guidelines for structural damage from vibration and for human disturbance. The risk of structural damage to property is assessed as very low to negligible for most receivers, with the exception of heritage structures on the station platforms themselves. Further

assessment of vibration impact will be required at the detailed design and construction phases to ensure vibration impact is managed and mitigated where feasible.

Railway noise

The Wollongong Stabling Yard upgrade requires a reconditioning of three stabling tracks within the yard and the removal and replacement of three turnouts (back to the same location) and accompanying signalling equipment. No change in noise impact is expected. The noise impact from changes to Stabling Yard operations are assessed separately.

At Wollongong Station, two turnouts (up and down lines) and accompanying signalling equipment is being relocated 12-13 metres south of the station to accommodate the platform extension for the 10-car NIF trains. The change in noise level at the nearest residential receivers is low to negligible.

The risk of potential noise impact from changes to the operational rail is considered low and further detailed assessment of noise mitigation measures is not required.

Operational noise – Stabling Yard

Noise impacts from both the existing and future Wollongong Stabling Yard operations have been assessed. The Wollongong Stabling Yard is an existing Stabling Yard which has been operating for more than 10 years. The future operations of the Stabling Yard are not proposed to substantially change from the existing situation. The only differences that influence the noise emissions from the stabling activities are:

- New trains – 10-car NIF trains
- Trains would now be stabled in the new electrified siding No.2 in the Up yard
- As the LNIF trains are 10-car sets, compared with the existing 4-car or 8-car sets, the stabling locations of trains has been reconfigured.

Noise goals were established in accordance with the NSW Noise Policy for Industry. Section 6 of the policy acknowledges that many existing industrial sources and facilities were designed for higher noise emission levels than the project trigger levels derived in accordance with the policy, as is the case for Wollongong Stabling Yard.

Noise measurements were undertaken of the existing Stabling Yard activities in order to quantify noise levels from existing significant noise generating stabling activities. The key source of noise emissions during stabling operations is the preparation activities such as brake testing and horn testing that are required prior to trains departing the facility. The period of train preparation is when the activities with the greatest noise emissions from the Stabling Yard occur. Train preparation typically starts from about 3 am, which is the most sensitive part of the night-time period for nearby noise sensitive receivers.

The outcomes of the assessment have identified that even though the noise emissions are unlikely to significantly change, they significantly exceed the project trigger noise level.

Based upon the outcomes of this assessment, it is recommended that a noise reduction program, as outlined in Section 6.2 of the NPfI, be developed in order to provide a formal and structured approach to reduce noise from the Stabling Yard to acceptable levels over time, by applying reasonable and feasible control measures. It is noted that as an existing site, the feasible and reasonable possibilities for noise mitigation are more limited than for a new site.

The noise reduction program should focus on operational procedures and prioritising noise-control measures that provide the greatest benefits to residents at the least cost. The noise reduction program would review the site-specific activities and investigate and identify feasible and reasonable noise mitigation and management measures that can be adopted as part of the site activities, taking into consideration the community preferences and expectations in order to provide noise reduction benefits for nearby noise sensitive receivers. The assessment identifies a number of potential mitigation and management measures to control the noise at the source, along the transmission path, and at the receivers. These mitigation and management measures should be considered as part of this program when determining feasible and reasonable mitigation and management measures.

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1 Introduction

1.1 Scope

More Trains, More Services (MTMS) is a program of staged investments that will progressively transform the Sydney Trains network into a modern and reliable mass transit system using world-class digital technology. The MTMS program will simplify and modernise the rail network, creating high capacity and turn up and go services for many customers. It will do this by upgrading and modernising signalling and control systems, using digital technology that, when combined with other infrastructure upgrades, will deliver a major increase in capacity and reliability of the network.

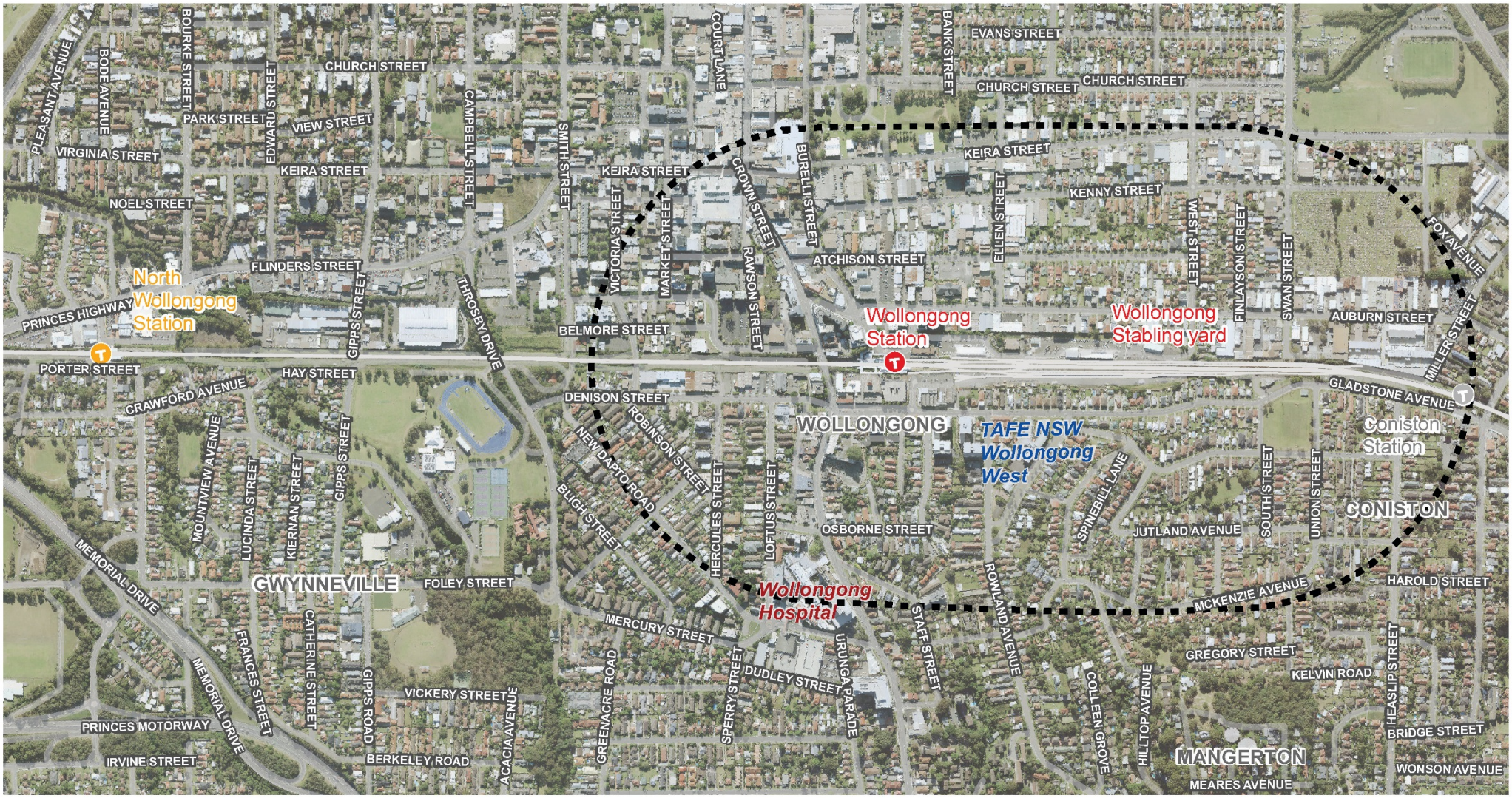
The next stage of MTMS will deliver service improvements on the T4 Illawarra, T8 Airport and South Coast Lines. These are some of the busiest lines on the Sydney Trains network, catering for 410,000 round trips in a typical day, which is one third of daily Sydney Trains customers. The scope of works are to enable the introduction of a new fleet of intercity trains on the South Coast Line. The new intercity fleet (NIF) will improve accessibility, enhance safety and improve comfort by providing a range of modern features.

The NSW Government proposes to upgrade Wollongong Stabling Yard and extend the platforms at Wollongong Station (the 'Proposal') as part of the enabling works for the introduction of the NIF.

Subject to approval, construction of the Proposal is expected to commence in mid 2020 and be completed by December 2021. The works will include possession critical work and work activities during non-possession periods, which will mean construction work will take place both within and outside standard construction hours.

This noise and vibration impact assessment has been prepared as part of the review of environmental factors (REF) to describe and assess the noise and vibration impacts associated with the Proposal.

Presented in Figure 1 is the Proposal study area.



Legend

- Wollongong Station and Stabling Yard Study Area
- Station within the Wollongong Study Area
- Station within the Wollongong Study Area where other MTMS works are proposed
- Railway station
- Existing railway track
- Roads

0 250 500 Metres

1:12,000 at A4

Data sources

Jacobs 2018
Ausimage 2018
NSW Spatial Services 2018

GDA94 MGA56

Figure 1: Wollongong Station and Stabling Yard – Study Area

1.2 Proposal description and aim of study

The NIF has been procured in four and six car units. It is proposed to operate 10-car NIF trains by combining a six-car unit and a four-car unit.

A 10-car NIF train would be longer than the eight-car Oscar trains currently operating on the South Coast Line. The existing Wollongong Stabling Yard would have the capacity to stable a maximum of four 10-car NIF trains on the existing Up and Down sidings. TfNSW proposes to upgrade the Stabling Yard to accommodate up to eight 10-car NIF trains concurrently. It is proposed to upgrade an existing disused siding to increase the yard's stabling capacity.

It is an operational requirement that all doors of a train, including the driver's door, must be able to open to a platform to allow all customers and the driver to egress. Also, amalgamation and division of four and six-car units to form and divide a 10-car NIF train is required at Wollongong Station. An extension of the platforms at Wollongong Station is required to meet this operational requirement and to enable formation and division of 10-car NIF trains.

The key features of the Proposal are described in the following sections.

This study aims to quantify and assess noise and vibration impacts during the construction and operational stages of the Stabling Yard and Station upgrades. The noise and vibration assessment has been carried out in accordance with the policies, guidelines and standards presented in Section 3 of this report for construction noise and vibration and operational noise, respectively.

Presented in Figure 2 and Figure 3 are the locations of the proposed works for the Proposal.

1.2.1 Wollongong Stabling Yard

The works proposed at the Wollongong Stabling Yard include:

- Rebuild of the No. 2 Up Siding (currently unused) including new overhead wiring structures (OHWSs) and upgrading the existing hand throw points to a mechanised system.
- Reconditioning of the No. 1 Up Siding.
- Cleaning and tamping of ballast on all other sidings.
- Relocation of two signals along the Up Refuge.
- Relocation of overhead wiring masts and new overhead wiring over No. 2 Up Siding.
- Installation of eight walkways between tracks including stairway linkages, ranging in length from about 220 metres to about 500 metres and between about 1.2 metres and 2.8 metres in width and demarcation fencing.
- Installation of bollard lighting at eight metre spacing.
- Adjustments to fencing and a combined services route.

- Installation of new fencing between the main line and yard line.
- Drainage works along walkways including catch pits and underground drainage pipes.
- Provide new and adapted cleaning sinks, occupational health and safety eyewashes and showers using existing water and drainage connections where possible, or otherwise providing new connections.

Presented in Figure 2 are the locations of the proposed 10-car NIF train stabling locations for the proposed works.

1.2.2 Wollongong station

The Wollongong Station platform extension works include:

- Extension of the southern (Country) ends of Platforms 1 and 2 by about nine metres.
- Installation of lighting including lamp posts and associated cabling and foundations on the platform extensions.
- Reconfiguration of the railway track between the station and the Stabling Yard because of the extended platforms by providing two crossovers and associated turnouts.
- Associated modifications/additions to overhead wiring (OHW), a combined services route (CSR) and under line crossing (ULX).
- Signal relocation next to Platform 1 by about 12 metres to the southern (Country) end.

Presented in Figure 3 are the key locations for the proposed works for the Proposal.

Legend

- Existing railway track
- Roads
- 1 Platform number
- Access gate
- Proposed 10-car NIF train stabling

0 50 100 Metres

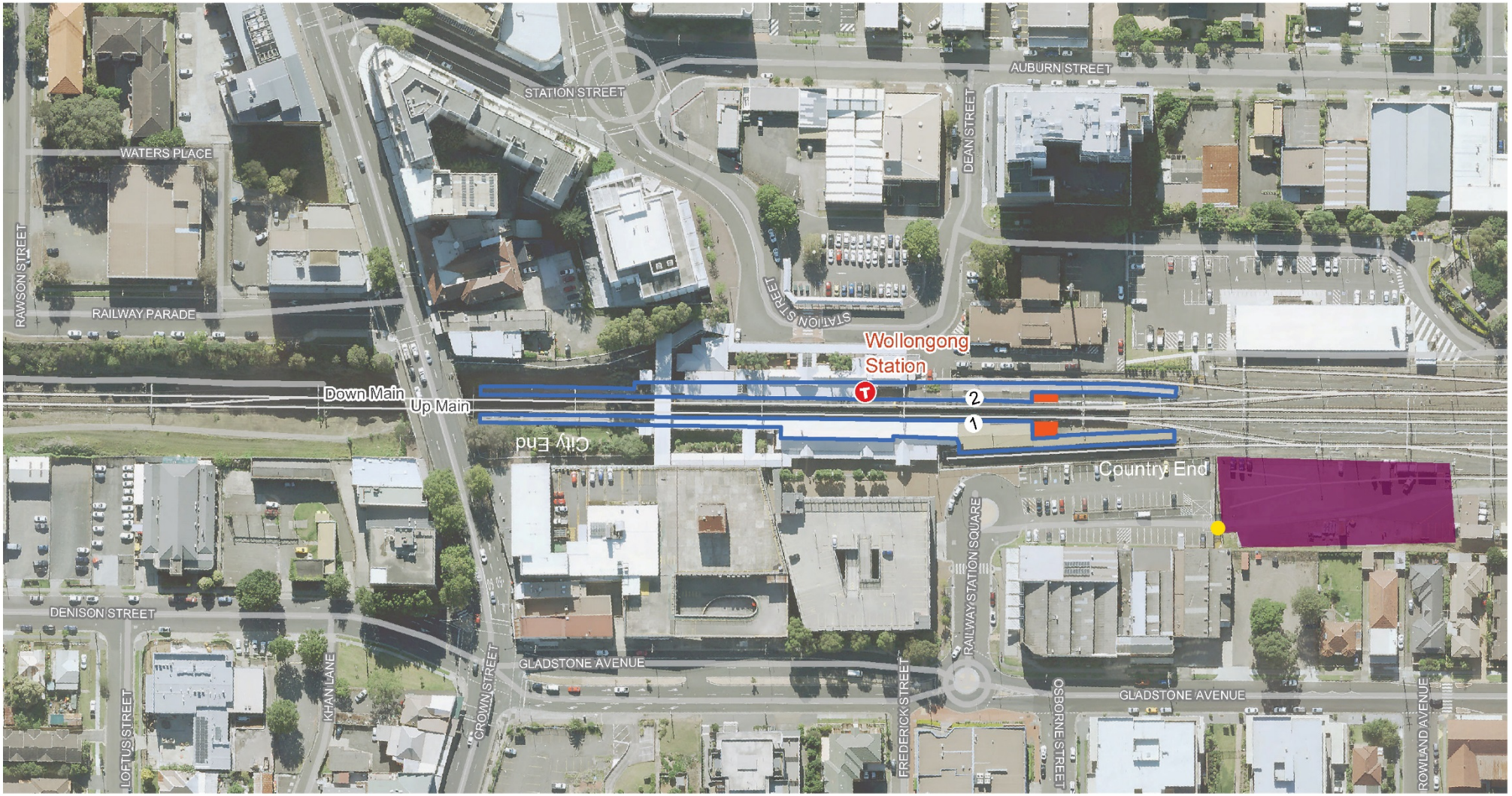
1:2,000 at A4

Data sources

Jacobs 2018
Ausimage 2018
NSW Spatial Services 2018

GDA94 MGA56

Figure 2: Wollongong Stabling Yard – Proposed works and 10-car NIF train stabling locations



Legend

- Station within the Wollongong Study Area
- 1 Platform number
- Existing railway track
- Roads
- Access gate
- Platform extent
- Proposed platform extension
- Proposed construction compounds / laydown area

0 50 100 Metres

1:2,000 at A4

Data sources

Jacobs 2018
Ausimage 2018
NSW Spatial Services 2018

GDA94 MGA56

Figure 3: Wollongong Railway Station – Proposed works

1.3 Assessment objectives

This study aims to quantify the noise and vibration impact associated with the construction works associated with the upgrade Wollongong Stabling Yard and extend the platforms at Wollongong Station, in particular in relation to out-of-hours construction work during rail possessions. This assessment also aims to quantify the change in operational noise levels associated with the modifications, including the change in platforms servicing the trains from the Illawarra Local tracks to the Illawarra Main tracks.

The assessment objectives are to determine the levels of noise and vibration impact on sensitive receivers located near the Proposal and determine the levels of mitigation that would be required to enable compliance with the current NSW requirements.

This assessment considers the following policies and guidelines:

- NSW *Rail Infrastructure Noise Guideline* (RING) (EPA 2013) [1]
- NSW *Noise Policy for Industry* (NPfI) (EPA 2016) [2]
- NSW *Construction Noise and Vibration Strategy* (CNVS) (Document reference: 7TP-ST-157/4.0, TfNSW 2018) [3]
- NSW *Interim Construction Noise Guideline* (ICNG) (DECC 2009) [4]
- NSW *Assessing Vibration – A Technical Guideline* (AVTG) (DEC 2006) [5].

In undertaking the assessment, attended and unattended noise monitoring was conducted to measure noise from the existing acoustic environment. Three-dimensional noise modelling software was used to create a noise model of the proposal to predict noise levels and assess the need for noise mitigation.

1.4 Site description and nearby noise sensitive receivers

Wollongong Stabling Yard and Wollongong Station are located in Wollongong, NSW, on the South Coast Line, and are located to the east of Gladstone Avenue, Wollongong and west of Auburn Street, Wollongong.

Residential receivers largely occupy the landuse to the west of the Proposal. While a mixture of commercial, industrial and residential properties occupies the area east of the Proposal.

The nearest affected residential locations to the Proposal include:

- Residential receivers along Gladstone Avenue, Wollongong to the west of the Proposal
- Residential receivers along Auburn Street, Wollongong to the east of the Proposal

The nearest non-residential noise sensitive receiver locations to the Proposal include:

Table 1-1: Other noise sensitive receivers

Receiver type	Description	Address	Approximate distance to the Proposal, metres
Childcare	City Cottage Kindergarten	32 Atchison Street Wollongong	250
Education	TAFE NSW - Wollongong West	1 Rowland Avenue Wollongong	100
	Computer training school	50-52 Auburn Street Wollongong	60
Medical	Doctors surgery	76 Auburn Street Wollongong	60
Recreation (Active)	Coniston Junior Soccer Club	92 Gladstone Avenue Coniston	100
Recreation (Passive)	South Street Park	South Street Wollongong	230
Place of worship	Serbian Orthodox Church	82 Kenny Street Wollongong	290
	St Elias Church	86 Kenny Street Wollongong	290

The Proposal location, noise monitoring locations and key sensitive receivers are shown in APPENDIX B.

1.5 Acoustic terms & quality

Appendix A of this report presents a description of acoustic terms.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Existing noise environment

Background noise varies over the course of any 24-hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW Noise Policy for Industry (NPfI, Environment Protection Authority 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NPfI defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

2.1 Noise monitoring locations

Unattended noise monitoring was conducted for a continuous period between the Monday 6th and Monday 13th May 2019 to measure ambient and background noise levels. Calibration of the noise monitors was conducted before and after the monitoring period, with no significant calibration drift observed. The unattended noise monitoring locations and observed noise environment are summarised in the tables below.

Table 2-1: Unattended noise monitoring locations

Noise logger #	Location description	Observed noise environment
B2 M1	39 Gladstone Street, Wollongong Noise logger was located behind the property in the free field. The microphone was located 1.4 metres above ground level and approximately 40 metres from the South Coast railway line.	General urban hum with distant traffic audible. Railway was the dominant source when trains were passing. No mechanical plant from industrial areas could be identified from the general urban hum.
B2 M2	81 Gladstone Street, Wollongong Noise logger was located in the free field in the backyard. The microphone was located 1.4 metres above ground level and approximately 22 metres from the South Coast railway line.	General urban hum with traffic on Gladstone Avenue audible. Railway was the dominant source when trains were passing. Distant mechanical plant was audible from the direction of the industrial area east of the railway.
B2 M3	80 Auburn Street, Wollongong Noise logger was located in the free field in the backyard. The microphone was located 1.4 metres above ground level and approximately 75 metres from the South Coast railway line.	Day: General urban hum with traffic on Auburn Street audible. Distant mechanical plant could be heard from an industrial unit to the north. No noise heard from railway except for passing trains. Night: Background controlled by industrial and distant traffic hum from the south, with local traffic contributing to ambient noise levels.

The locations of the unattended noise monitoring locations are presented in Figure 4.

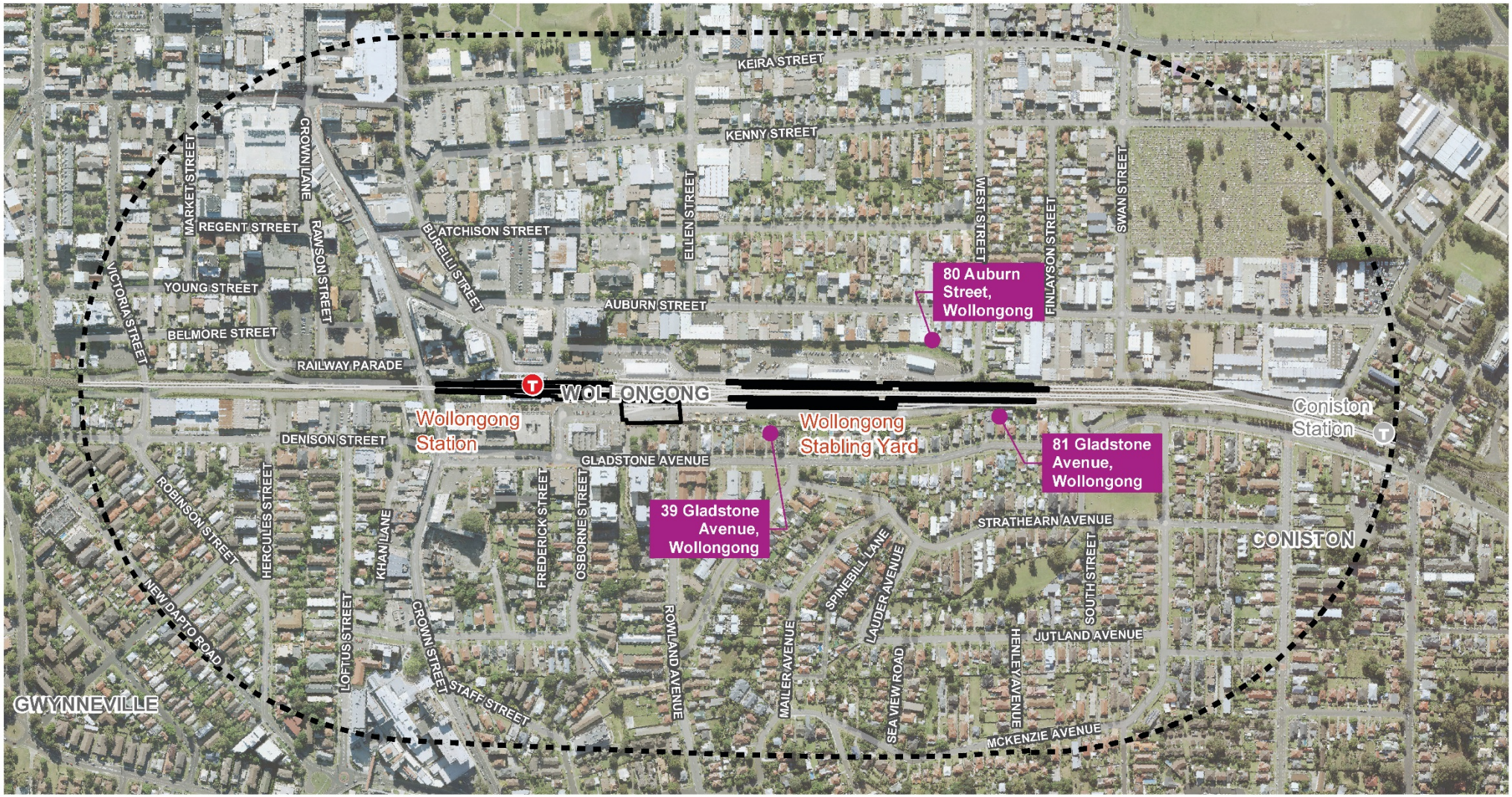


Figure 4: Unattended noise monitoring locations

2.2 Existing background noise levels

The existing background noise levels measured are presented in Table 2-2 below.

Appendix A of this report presents a description of noise terms. A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring is included in Appendix B. The graphs in Appendix B were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24-hour period of noise monitoring. Based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NPfI.

Table 2-2: Measured existing ambient and background noise levels, dB(A)

Noise monitor #	Location description	Rating background noise levels (RBL), $L_{A90,\ 15\ minute}$			Ambient noise levels, $L_{Aeq,\ 15\ minute}$		
		Day	Evening	Night	Day	Evening	Night
B2 M1	39 Gladstone Street, Wollongong	41	41[1] (42)	41[1] (42)	54	53	53
B2 M2	81 Gladstone Street, Wollongong	40	39	37	49	52	49
B2 M3	80 Auburn Street, Wollongong	39	38	37	49	47	55

Notes: 1. As outlined in the NPfI, the evening and night crtieria or management levels are set no louder than that daytime levels. Number in brackets (XX) represents actual measured RBL determined for assessment period.

Weather information for the unattended noise logging was obtained from the Bureau of Meteorology (Bellambi AWS, 068228) for the monitoring period and any data adversely affected by rain, wind (more than 5 m/s as per NPfI) or extraneous noise were discarded.

2.3 Attended noise measurements

2.3.1 Measurement methodology

Short-term attended noise measurements were undertaken within the Stabling Yard and at locations external to the Stabling Yard in proximity to receivers around the Stabling Yard.

Measurements were undertaken during night-time of Friday, 9 July 2019, in order to supplement the long-term noise monitoring and provide greater detail of the surrounding noise environment and the existing facility noise levels.

Observations made during operator-attended noise measurements confirm that during the night period, ambient noise levels at all residential receiver locations predominantly consists of an industrial hum to the south, with contributions from traffic on local roads. The long-term noise monitoring results were therefore considered representative and suitable for the determination of noise goals for the site.

The equipment used for noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having accuracy suitable for field and laboratory use. The instrument was field checked for calibration prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

2.3.2 Measurements external to the facility

Over the night period on Tuesday 9th / Wednesday 10th of July, 2019, measurements were undertaken of the ambient noise environment at receivers in proximity to the Stabling Yard in order to determine the contribution from existing stabling activities and the noise sources that make up the existing noise environment. A summary of the short-term measurement results is presented in Table 2-3.

Table 2-3: Short-term noise monitoring results – External to the facility

Location / Time	Measured noise level, dB(A)		Comments on measured noise levels
	L_{Aeq}	L_{A90}	
9/10 July 2019			
S1 - 36 Gladstone Avenue 10:52pm, 9 July 2019	58	40	The background LA90 was controlled by industrial hum to the S/SSE ~40dB(A). The ambient LAeq noise level was determined by industrial noise to the S/SSE and car movements on Gladstone Ave, with distant train horns occasionally to the S. Train Stabling Yard noise was not audible.
S2 - 2A Strathearn Avenue 11:11pm, 9 July 2019	42	40	The background LA90 was controlled by industrial hum to the S/SSE ~40dB(A). The ambient LAeq noise level was determined by industrial noise to the S/SSE and car movements on Gladstone Ave, with distant train horns occasionally to the S. Train Stabling Yard noise was not audible.
S3 - 53 Gladstone Avenue 11:25pm, 9 July 2019	51	40	The background LA90 was controlled by industrial hum to the S/SSE ~39/40dB(A). The ambient LAeq noise level was determined by car movements on Gladstone Ave and train pass-by on mainline. Train compressed air release ~ 45/46dB(A). Train HVAC occasionally just audible when noise levels were 39/40dB(A), estimated train noise level 38/39dB(A).
S4 - 71 Gladstone Avenue 11:34pm, 9 July 2019	56	42	The background LA90 was controlled by industrial hum to the S/SSE ~42/43dB(A). The ambient LAeq noise level was determined by car movements on Gladstone Ave. Train HVAC occasionally just audible when noise levels were 40dB(A), estimated train noise level 38/39dB(A). Train Stabling Yard noise was not audible.

Location / Time	Measured noise level, dB(A)		Comments on measured noise levels
	L_{Aeq}	L_{A90}	
S5 – TAFE, Gladstone Avenue 11:40pm, 9 July 2019	43	40	The background LA90 was controlled by industrial hum to the S/SSE ~39/40dB(A). The ambient LAeq noise level was determined by industrial noise to the S/SSE and train pass-by on mainline. Train HVAC occasionally just audible when noise levels were 40dB(A), estimated train noise level 38/39dB(A). Train Stabling Yard noise was not audible.
S6 - 47 Auburn Street 11:48pm, 9 July 2019	43	42	The background LA90 was controlled by industrial hum to the S ~43/44dB(A). The ambient LAeq noise level was determined by industrial noise to the S. Train HVAC occasionally just audible when noise levels were 42/43dB(A), estimated train noise level 36/37dB(A).
S7 - 69 Auburn Street 11:54pm, 9 July 2019	55	41	The background LA90 was controlled by industrial hum to the S ~40/41dB(A). The ambient LAeq noise level was determined by industrial noise to the S and occasional traffic to N on Auburn Street. Train HVAC occasionally just audible when noise levels were 42/43dB(A), estimated train noise level 36/37dB(A).
S8 - 53 West Street 5:08am, 10 July 2019	42	40	The background LA90 was controlled by industrial hum to the S ~40dB(A). The ambient LAeq noise level was determined by industrial noise to the S and occasional cars on Auburn Street. No train was visible or audible during the measurement.
S9 - 47 Auburn Street 5:20am, 10 July 2019	45	45	The background LA90 was controlled by industrial hum and distant traffic to the S ~45dB(A). The ambient LAeq noise level was determined by industrial hum and distant traffic to the S. Train HVAC occasionally just audible when noise levels were 42/43dB(A), estimated train noise level 36/37dB(A).
S10 - 45 Gladstone Avenue 5:28am, 10 July 2019	57	43	The background LA90 was determined by industrial hum to S and distant traffic to the S and NW ~43dB(A). The ambient LAeq noise level was determined by car movements on Gladstone Ave. Train compressed air release ~ 44-47dB(A). Train HVAC occasionally just audible when noise levels were 43dB(A), estimated train noise level 35-37dB(A).
S11 - 93 Gladstone Avenue 5:38am, 10 July 2019	51	45	The background LA90 was controlled by a train (H-Set) in the down yard directly east of the measurement location ~45dB(A) and distant traffic to the S. The ambient LAeq noise level was determined by car movements on Gladstone Ave and train passbys on the mainline. Train HVAC clearly audible, estimated train noise level 44/45dB(A). No compressor noise audible.

2.3.3 Train stabling noise measurements

Measurements of existing stabling activities at the Wollongong Stabling Yard were undertaken between 12:30am and 4:45am on Wednesday 10 July 2019. These included trains in various conditions during arrival, idling while stabled, train preparation and train departure.

Both attended and unattended noise monitoring was undertaken simultaneously at various locations around the trains in order to quantify the noise levels of individual activities and components of the trains, while also determining the overall noise level in the direction of the nearest residential receivers.

This information was then used to develop the noise modelling scenarios for the existing stabling situation. It was also then used to determine the potential future noise impacts, for activities that are not quantified as part of the noise prediction report for the NIF ('Noise Prediction Report' (Doc. No. REDE207532, Rev. No.6, 6 February 2019)) such as for the preparation activities.

A summary of the short-term measurement results is presented in Table 2-4.

Table 2-4: Short-term noise monitoring results - Train stabling activities

Train type	Activity	Measurement distance, metres	Duration, (mm:ss)	Measured noise level, dB(A)			Comments on measured noise levels
				L_{Amax}	$L_{Aeq,t}$	$L_{A90,t}$	
Oscar (H-Set)	Preparation procedure	3	6:08	109	84	62	Single driver cab, including country and town horn tests
	HVAC	18	1:08	-	52	47	-
	Compressor cycling	7.5	1:16	74	60	57	-
	Compressor cycling	18	0:49	64	55	-	-
	Brake test air release	3.5	0:05	99	-	-	Trip test
Tangara (T-Set)	Preparation procedure	7.5	8:54	102	75	49	Single driver cab, including country and town horn tests
	HVAC/SIV	12	0:30	-	54	-	-
	Arriving	9	1:33	92	73	52	Includes air dump
	Compressor cycling	7.5	1:10	82	65	-	-
	Compressor cycling	7.5	3:15	82	64	-	Two compressor cycles
	Compressor cycling and exhausting	7.5	1:46	85	71	63	Forced air release and cycle
	Compressor (without air exhausting)	7.5	0:30	58	57	57	-
	Brake test air release	7.5	0:07	93	87	57	-
	Country horn	9	0:04	104	91	-	Measured at 60 degrees off train centre
	Town horn	9	0:07	101	88	-	Measured at 60 degrees off train centre

2.4 Meteorological factors

In general, meteorological factors such as wind and temperature inversions can significantly influence noise levels even at distant locations.

Meteorological results have been taken from the Wollongong Office of Environment and Heritage (OEH) automatic meteorological station at Gipps Street, Wollongong. A review of data from 2016, 2017, 2018 and 2019 was undertaken to determine typical years. Meteorological conditions representative for the assessment have been reviewed to determine the prevailing wind and temperature inversion conditions. The analyses of the meteorological conditions are summarised as follows:

- The prevailing wind conditions around the Proposal were evaluated using the EPA NEWA program for 2018/2019 wind data, to determine the prevailing assessment wind speed and direction to be considered in the noise assessment, as defined by the NPfI. The results showed that noise enhancing wind speeds between 0.5 m/s to 3 m/s can occur for greater than 30% of the time in any season for the periods presented in Table 2-5.

Table 2-5: Prevailing wind directions assessment

Assessment period	Wind direction with noise enhancing wind speeds between 0.5 m/s to 3 m/s can occur for greater than 30% of the time in any season															
Wind direction	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
Day (7am – 6pm)		■	■	■	■						■	■				
Evening (6pm – 10pm)		■	■	■						■	■	■	■			
Night (10pm – 7am)										■	■	■	■			

- During the night-time period temperature inversion conditions were calculated based upon the sigma-theta method referred to in Fact Sheet D to the NPfI. Based upon this method the temperature inversions (Stability Class F and G) occurrence for winter nights ranged between 53% to 55%.

Based on the assessment of meteorological data, the following noise enhancing adverse meteorological effects are considered in the noise assessment scenarios, in accordance with the NPfI requirements.

Table 2-6: Prevailing noise-enhancing assessment meteorological conditions

Assessment period	Assessment meteorological condition	
	Temperature inversion	**Source-to-receiver wind**
Day (7am – 6pm)	Class D	Class D with 3 m/s (SW to WSWS & NNE to E)
Evening (6pm – 10pm)	Class F with 2 m/s winds	Class D with 3 m/s (SSW to W & NNE to ENE)
Night (10pm – 7am)	Class F with 2 m/s winds	Class D with 3 m/s (SSW to W)

However, at distances of less than 100 metres the impact of meteorological effects is minimal. As the closest affected receivers to the stabling activities are directly adjacent to the Wollongong Stabling Yard the impact of adverse meteorological conditions is unlikely to change the noise impacts at the most affected receivers.

3 Noise and vibration objectives

3.1 Construction noise objectives

3.1.1 Noise management levels (NMLs)

The ICNG provides guidelines for assessing noise generated during the construction phase of developments. There are two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement and prediction of noise levels and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the scale of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG and Transport for NSW's Construction Noise and Vibration Strategy (CNVS) requirements.

Table 3-1 reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

Table 3-1: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (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: 1. times identified by the community when they are less sensitive to noise (such as before/ after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see *ICNG* section 7.2.2.

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

Table 3-2 sets out the ICNG noise management levels for other noise sensitive receiver locations. As identified for residential receivers, a 'highly affected' noise objective of $L_{Aeq(15min)}$ 75 dB(A) is adopted for all noise sensitive receivers.

Table 3-2: Noise management levels at other noise sensitive land uses

Land use	Time of day	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Hospital wards and operating theatres	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Places of worship	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Active recreation areas	When in use	Outdoor noise level	65 dB(A)
Passive recreation areas	When in use	Outdoor noise level	60 dB(A)
Commercial premises	When in use	Outdoor noise level	70 dB(A)
Industrial premises	When in use	Outdoor noise level	75 dB(A)

Notes: 1. Outdoor noise level based on internal noise level in ICNG and assumes 10 dB loss through an open window

3.1.2 Sleep disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the Proposal should consider maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL. The potential for both sleep disturbance and awakenings should be considered in the assessment.

To assess the likelihood of sleep disturbance, an initial screening level of ($L_{Amax} \leq L_{A90(15min)}$ + 15 dB(A) is used. In situations where this results in an external screening level of less than 55 dB(A), a minimum screening level of 55 dB(A) is set. Note that this is equivalent to a maximum internal noise level of 45 dB(A) with windows open.

Where there are noise events found to exceed the initial screening level, further analysis is made to identify:

- the likely number of events that might occur during the night assessment period, and
- whether events exceed an 'awakening reaction' level of $L_{A1(1min))}$ 65 dB(A).

The sleep disturbance assessment levels for the Proposal are presented in Table 3-3.

3.1.3 Summary of construction noise management levels

Table 3-3 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 2.

Table 3-3: Construction noise management levels at residential receivers

Noise monitor #	Receiver area surrounding station	L_{A90} rating background level (RBL)			Noise management level $L_{Aeq(15min)}$				Sleep disturbance $L_{A1(1min)}$
		Day	Evening	Night	Day (Standard) [1]	Day (OOH) [2]	Evening (OOH) [2]	Night (OOH) [2]	Night (OOH) [2]
B2 M2	Stabling Yard (Up side)	40	39	37	50	45	44	42	55
B2 M3	Stabling Yard (Down side)	39	38	37	49	44	43	42	55

Notes:
1. Standard construction hours, as defined in Section 4.1.
2. OOH = outside standard construction hours, as defined in Section 4.1
3. In line with the direction in Section 2.3 of the NPfI, as the community generally expects greater control of noise during the more sensitive evening and night-time periods than during the less sensitive daytime period, the project noise management levels for evening are set at no greater than daytime level, and the night-time is set to be no greater than the day or evening levels.

While the two monitoring locations on the Up side of the railway (B2 M1 and B2 M2 in Table 2-2) show similar background noise levels, the monitoring at B2 M2 are marginally lower than at B2 M1. As a conservative measure, NMLs for receivers on the Up side of the railway have been adopted from noise monitor B2 M2.

3.2 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings, and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings.

Construction vibration management levels have been determined in accordance with Section A.3 of the CNVS.

3.2.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the NSW 'Environmental Noise Management Assessing Vibration: A Technical Guideline' (AVTG) [5].

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected, are presented in Table 3-4. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

Table 3-4: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night)[1]	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day[2]	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night[2]	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above
2. Daytime is 7am to 10pm and night-time is 10pm to 7am

3.2.2 Building damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 and German Standard DIN4150-3. There is no Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 times higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

BS 7385 sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration

induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS 7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3-5.

Table 3-5: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

The standard states that the guide values in Table 3-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3-5 may need to be reduced by up to 50%.

The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 3-5 and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless the calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 3-5 should not be reduced for fatigue considerations. It is noteworthy that, extra to the guide values nominated in Table 3-5, the standard states that: *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Regarding heritage buildings, heritage items are to be considered on a case by case basis, and care should be taken as these structures can be difficult to repair in the case of damage. However, it should be noted that BS 7385 Part 2 notes that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive"* (p.39) when compared to other structures.

3.2.3 General vibration (building damage) screening criterion

In accordance with Appendix A.3.4 and A.3.5 of the CNVG, a conservative vibration damage screening level (peak component particle velocity) per receiver type is detailed in the CNVS and outlined below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s
- Heritage structures (structurally unsound): 2.5 mm/s

Where the predicted and/or measured vibration is greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure will be completed to determine the applicable vibration limit. Heritage buildings found to be structurally sound should not be assumed to be more sensitive to vibration and should therefore be assessed to the screening criterion for reinforced or unreinforced structures, depending on the structure. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered.

3.2.4 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

There is no explicit guidance on acceptable vibration levels for such equipment, so recommended vibration levels should be obtained from instrument manufacturers. In the absence of equipment specific data provided by manufacturers, there are generic vibration criteria that can be used to assess the impact of vibration generating activities on buildings housing vibration sensitive equipment. For example, the Vibration Criteria (VC) curves are often referred to as they are generic and apply to all tools/ equipment types within each category. The VC curves are defined over the frequency range 8 to 100 Hz.

Table 3-6 below summarises a range of suitable and conservatively stringent vibration limits that are applicable to buildings housing vibration sensitive equipment which may potentially be affected by construction vibration.

Table 3-6: Acceptable vibration limits for vibration measured on building structure housing sensitive equipment

Equipment Requirements	Vibration Limit[1] mm/s,		Description of Use[3]
	RMS[4]	Peak [5]	
Computer Areas[2]	0.7	1.0	Barely perceptible vibration. Adequate for computer equipment accommodation environments.
Medical[2, 3]	0.1	0.14	Vibration not perceptible. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.
VC-A[3]	0.05	0.07	Vibration not perceptible. Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc

Notes: 1. As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz. Vibration measured on the building structure near vibrating equipment or in areas containing sensitive equipment.

2. Based on AS 2834 Computer Accommodation

3. Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment

4. Root Mean Square value representing the average value of a signal

5. In the absence of Peak limits, RMS limits are converted to Peak by conservatively assuming the vibration signal is sinusoidal and random with a nominal crest factor of 1.414

3.2.5 Damage to buried services

Section 5.3 of DIN 4150-3:2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 3-7 below.

Table 3-7: DIN 4150-3:1999 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For long-term vibration the guideline levels presented in Table 3-7 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific CNVIS addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

3.3 Operational rail noise objectives

The NSW Rail Infrastructure Noise Guideline (RING) provides guidance in relation to the prediction and assessment of railway noise from new and upgraded railway projects.

The purpose of the guideline is to ensure noise and vibration impacts associated with particular rail development are evaluated in a consistent and transparent manner. This is achieved by specifying noise and vibration trigger levels to protect the community from the adverse effects of noise and vibration. If the noise assessment identifies that the trigger levels are likely to be exceeded, the assessment is required to outline feasible and reasonable noise mitigation measures that could be implemented to ameliorate the predicted impacts.

Some rail infrastructure works (refer Section 1.4.1.3 of RING) may increase existing noise levels. These works include crossovers, sidings, turnouts, loops, refuges, relief lines, straightening curves or the installation of track signalling devices.

If a preliminary assessment of the noise impacts associated with the infrastructure proposal indicates that the noise trigger levels are likely to be exceeded, a detailed study must be made to evaluate the predicted noise and vibration levels and determine if feasible and reasonable mitigation measures need to be considered as part of the detailed design. For residential receivers, the redeveloped rail line noise trigger levels are presented in Table 3-8.

Table 3-8: Residential noise trigger levels - Redevelopment of existing rail line (from RING)

Receiver Type	Noise Trigger Levels - dB(A) (External)	
	Day (7am to 10pm)	**Night (10pm to 7am)**
Residential	Development increases existing $L_{Aeq(period)}$ 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 $L_{Aeq(15hour)}$ or 85 L_{AFmax}	60 $L_{Aeq(9hour)}$ or 85 L_{AFmax}

Noise mitigation measures are required to be considered if the "noise increase" and "overall" noise trigger levels are exceeded as a result of the proposed changes to rail infrastructure at Wollongong Stabling Yard and Station.

3.4 NSW Noise Policy for Industry (NPfI)

This assessment aims to quantify the change in operational noise levels associated with the Wollongong Stabling Yard upgrades and the modifications in accordance with the NSW 'Noise Policy for Industry' (NPfI), 2017. The assessment procedure has two components:

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

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

3.4.1 Project intrusive noise levels

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ Intrusiveness noise level = Rating Background Level ('RBL') plus 5dB(A)

For the purposes of assessing operational noise impacts, background noise levels for all nearby residential receivers have been based upon the noise monitoring location B2 M3 at 80 Auburn Street, Wollongong. A single noise monitoring location has been used for assessing operational noise impacts considering the night period is the critical assessment period, the nature of the ambient noise environment (Section 2.3.2), the proposed operating hours of the facility, and for the purposes of a consistent and conservative assessment. The intrusiveness noise levels for residential receivers are reproduced in Table 3-9 below.

Table 3-9: Intrusiveness noise levels

Receiver	Intrusiveness noise level, $L_{Aeq,15min}$		
	Day	Evening	Night
Residences	39 + 5 = 44	38 + 5 = 43	37 + 5 =42

Notes: Day: 7:00 to 18:00 Monday to Saturday and 8:00 to 18:00 Sundays & Public Holidays
Evening: 18:00 to 22:00 Monday to Sunday & Public Holidays
Night: 22:00 to 7:00 Monday to Saturday and 22:00 to 8:00 Sundays & Public Holidays

3.4.2 Amenity noise levels

The project amenity noise levels for different time periods of day are determined in accordance with Section 2.4 of the NPfI. The NPfI recommends amenity noise levels ($L_{Aq,period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for total industrial noise experienced at a receiver location. However, when assessing a single industrial development and its impact on an area, "project amenity noise levels" apply.

The recommended amenity noise levels applicable for the subject area are reproduced in Table 3-10 below.

Table 3-10: Project amenity noise levels

Type of Receiver	Noise Amenity Area	Time of Day	Recommended amenity noise level, L_{Aeq}, dB(A)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom (internal)	All	Noisiest 1-hour period when in use	35[5]
Hospital ward	All		
- Internal		Noisiest 1-hour	35
- External		Noisiest 1-hour	50
Place of worship (internal)	All	When in use	40
Passive recreation (e.g. national park)	All	When in use	50
Active recreation (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	When in use	Add 5 dB(A) to recommended noise amenity area

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated
5. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40 dB LAeq(1hr)

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$L_{Aeq,period}$ Project amenity noise level = $L_{Aeq,period}$ Recommended amenity noise level – 5dB(A)

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15minute}$ level in order to standardise the time periods.

$$L_{Aeq,15minute} = L_{Aeq,period} + 3dB(A)$$

The project amenity noise levels ($L_{Aeq, 15min}$) applied for this project are reproduced in Table 3-11 below, based on an 'Urban' noise amenity area, considering the existing noise environment (refer to noise measurements presented in Section 2.3.2).

Table 3-11: Project amenity noise levels

Type of Receiver	Noise Amenity Area	Time of Day	Recommended Noise Level, dB(A)	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residence	Urban	Day	60 – 5 = 55	55 + 3 = **58**
		Evening	50 – 5 = 45	45 + 3 = **48**
		Night	45 – 5 = 40	40 + 3 = **43**
School classroom (internal)[4]	All	Noisiest 1-hour period when in use	40 – 5 = 35	35 + 3 = **38**
Place of worship (internal)	All	When in use	40 - 5 = 35	35 + 3 = **38**
Hospital ward	All	Noisiest 1-hour	50 – 5 = 45	45 + 3 = **48**
Active recreation area (school playground)	All	When in use	55 – 5 = 50	50 + 3 = **53**
Commercial Premises	All	When in use	65 – 5 = 60	60 + 3 = **63**
Industrial premises	All	When in use	70 – 5 = 65	65 + 3 = **68**

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40 dB LAeq(1hr)

3.4.3 Applying the policy to existing industrial premises

Section 6 of the NPfI acknowledges that many existing industrial facilities were designed for higher noise emission levels than the project trigger levels derived in accordance with the policy, as is the case for Wollongong Stabling Yard. In these cases, the range of mitigation measures available can be limited or costly.

The NPfI notes that applications for extensions to existing premises often provide an opportunity to redress issues that relate to the whole site. Where noise emissions from the site exceed the project noise trigger levels, the regulatory authorities and the noise-source manager will determine achievable noise limits for the site, taking into account matters that must be considered in accordance with the relevant legislation or process, including negotiation with proponents and discussion with stakeholders as required.

The NPfI notes, there is no 'one-size-fits-all' approach to determine the impact from an existing industry. The following governing principles should be applied when determining the project noise trigger levels and/or assessment requirements for existing industry:

- *The project noise trigger levels should not be applied as mandatory noise limits. The project noise trigger level is the level used to assess noise impact and drive the process of assessing all feasible and reasonable control measures.*
- *Where an existing industry has been in operation for more than 10 years and existing site operations exceed the project amenity noise level, the project amenity noise level may be adopted as the project noise trigger level to assess existing, and existing plus proposed site operations, as relevant.*
- *Where a development proposal involves a discrete process, and premises-wide mitigation has or is to be considered outside of the development proposal, a project noise trigger level for noise from new/modified components (not the whole site) of the operation may be set at 10 dB(A) or more below existing site noise levels or requirements. This approach means that the increase in noise from the whole site is minimised and provides scope for existing components to achieve noise reductions over time*.

In accordance with these principles, as the Wollongong Stabling Yard and sidings has been in operation for more than 10 years, and based upon the attended noise measurements presented in Section 2.3, the **project amenity noise level** is to be adopted as **the project noise trigger level** to assess existing, and existing plus proposed site operation.

The project trigger levels have been converted from $L_{Aeq,\ period}$ values to $L_{Aeq\ 15\ minute}$ values in accordance with Section 3.4.2.

Table 3-12: Project noise trigger levels for residential receivers

Receiver Location	$L_{Aeq,\ 15min}$ Project noise trigger levels, dB(A)		
	Day	Evening	Night
Residential receivers	58	48	43

3.4.4 Project noise trigger levels

In accordance with the NPfI the project noise trigger levels, which are the lower (i.e. more stringent) value of the project intrusiveness noise level and project amenity noise level, have been determined as shown in Table 3-13 below.

Table 3-13: Project noise trigger levels

Receiver Location	$L_{Aeq,\ 15min}$ Project noise trigger levels, dB(A)		
	Day	Evening	Night
Residential receivers	58	48	43
School classroom (external)	48	n/a	n/a
Place of worship (external)	48	48	n/a
School playground	53	n/a	n/a
Commercial	63	63	n/a
Industrial	68	68	n/a

Notes: 1. Conversion of trigger levels from internal to external for school classroom and place of worship assumes 10dB(A) loss from outside to inside through open window.

3.4.5 Sleep disturbance noise levels

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed:

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

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- the likely number of events that might occur during the night assessment period
- the extent to which the maximum noise level exceeds the rating background noise level.

The sleep disturbance noise levels for the project are presented in Table 3-14.

Table 3-14: Sleep disturbance assessment levels

Receiver type	Assessment Level $L_{Aeq,15min}$	Assessment Level L_{AFmax}
Residential	37 + 5 = 42	37 + 15 = 52

In relation to maximum noise level events, the NSW RNP identifies in its summary on sleep disturbance research to date that:

- *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
- *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

The above references identify that internal noise levels of 50 to 55 dB(A), are unlikely to cause awakenings. On the assumption that there is a 10 dB(A) outside-to-inside noise loss through an open window (see Section 2.6 of the NPfI, p15), this indicates that external noise levels of L_{Amax} 60 to 65 dB(A) are unlikely to cause awakening reactions. L_{Amax} 65 dB(A) has then been used as the assessment noise level to determine the potential for awakening reactions.

4 Construction noise and vibration assessment

4.1 Construction hours

4.1.1 Standard construction hours

The recommended standard hours for construction are defined in the ICNG and the CNVS. Whilst the standard construction hours are not mandatory, limiting construction works to within standard construction hours as much as practicable assists in managing noise or vibration impact and provides a lengthy respite period whilst people are most likely to be relaxing or sleeping.

4.1.2 Works outside standard construction hours

The ICNG identifies five categories of works that might be undertaken outside the recommended standard hours (OOH):

1. the **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads
2. **emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
3. **maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
4. **public infrastructure works** that shorten the length of the project and are supported by the affected community
5. works where a proponent demonstrates and justifies a **need to operate outside the recommended standard hours**.

All of the above categories may apply to the Wollongong Stabling Yard and Station upgrades at different stages of the works. Mostly the last two categories will apply and for these clear justification of the requirement for working outside standard hours for reasons other than convenience, is required.

Construction hours, including OOH work periods are defined in Table 4-1 below.

Construction work for the Wollongong Stabling Yard and Station upgrades would be completed during standard construction hours wherever reasonable and feasible. As the proposed works are to be undertaken within the rail corridor and on working station platforms, the existing rail traffic would impose major risks to rail users and construction workers due to the extremely close proximity between all parties involved. Safe work areas would be established to ensure the proposed construction activities have minimal impact on the safety of commuters whilst keeping construction workers a safe distance from rail traffic.

Notwithstanding this, some activities due to their location and plant/equipment requirements would need to occur during rail shutdown possessions to minimise the risks of rail traffic, commuter and work site interaction.

4.1.3 Summary of construction hours and work periods

Table 4-1: Construction hours

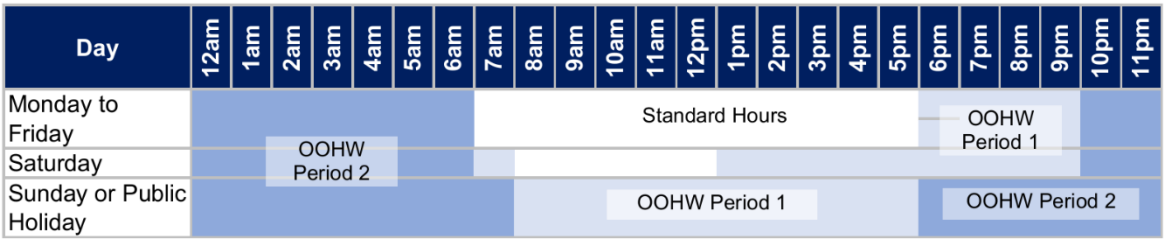
Construction hours	Monday to Friday	Saturday	Sunday/ Public holiday
Recommended standard construction hours			
Standard hours	7:00am to 6:00pm	8:00am to 1:00pm	No work
Activities with special audible characteristics[1]	8:00am to 6:00pm	9:00am to 1:00pm	No work
Outside standard construction hours			
Out of Hours Day (OOHD)	N/A	1:00pm to 6:00pm	8:00am to 6:00pm
Out of Hours Evening (OOHE)	6:00pm to 10:00pm	6:00pm to 10:00pm	6:00pm to 10:00pm
Out of Hours Night (OOHN)	10:00pm to 7:00am	10:00pm to 8:00am	10:00pm to 8:00am

Note: 1. Special audible characteristics includes particularly annoying construction noise sources that may generate high noise impact, impulsive or tonal noise emissions, such as rock hammering. Where applicable, such activities should be limited to continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block, unless otherwise approved by TfNSW.

The CNVS provides a hierarchy of OOH work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the OOHD and OOHE periods. Table 4-2 presents the construction work periods as:

- Standard Hours
- OOHW Period 1
- OOHW Period 2.

Table 4-2: Construction work periods



1. Standard construction hours are defined in the CNVS as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 1:00pm.
2. Work outside of standard construction hours is defined as Out-of-Hours Work (OOHW) and can be divided into 2 periods of sensitivity. **OOHW Period 1** is the least sensitive OOH period and is defined as Monday to Friday 6:00pm to 10:00pm (evenings), Saturday 7:00am to 8:00am and 1:00pm to 10:00pm (day & evening) and Sunday and public holidays 8:00am to 6:00pm (days). **OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (nights) and Sundays and public holidays 6:00pm to 8:00am (nights).

4.2 Construction noise and vibration activities and assumptions

4.2.1 Construction activities

An assessment of the potential level of construction noise and vibration impact has been carried out to determine whether mitigation would be required, and to determine appropriate management controls. Specific construction equipment requirements are not yet known. The type and number of plant and equipment associated with the proposed works was assumed based upon experience with similar noise assessments. A further assessment will be required once final construction detail becomes available with progress of the detailed design.

For each of the Wollongong Stabling Yard and Station upgrades sites the following construction activities have been modelled:

- Site preparation/demobilise site
  - Establish site compound
  - Install environmental and safety controls
  - Commence DSS validation
  - Unload materials for hoardings (OOH)
  - Erect temporary construction hoarding
- Stabling Yard Civil - walkways/ lighting and CCTV/ fences
  - Upgrade of existing walkway and construction of new concrete walkway
  - Upgrade lighting and CCTV
  - Excavate trench for conduits and install conduits
  - Construction new fence footings and erect new fence
- Stabling Yard Electrical
  - Isolate Siding/Down Refuge using existing switches
  - Construction of footings for new OHWS
  - Run new overhead wiring for siding electrification
  - Bond all existing OHWS to rail by spark gap for stabling roads
- Stabling Yard Signals and Communications
  - Service relocation/ protection works (if required)
  - Preparation works for Turnout replacements
  - Construction of cable routes

  - Installation of cables
- Stabling Yard Trackwork
  - Reconditioning stabling tracks as required
  - Re-sleepering and top ballast recondition
- Stabling Yard Civil - Amenities building and car park
  - Construction of amenities building, car park and access paths
  - Commissioning of amenities building, car park and access paths
- Wollongong Station Turnouts
  - Preassemble Turnout and signalling equipment for replacement turnouts off site
  - Remove existing Turnouts and install replacement Turnouts in same location
  - Upgrade to 60 kg concrete sleepers
  - Commission new Turnouts
- Wollongong Station Civil - Platform extensions
  - Preparation works as required for platform extension
  - Excavate for platform extension
  - Construct modifications to existing drainage where affected by platform extension
  - Construct Platform Extension assuming precast panels
  - Pour platform deck
  - Install platform fencing, gate and steps at end of platforms
  - Complete platform extension works i.e. install CCTV, PA, tactile paving, yellow & white lines and repaint car markers where required.

4.2.2 Construction noise sources

Table 4-3 following summarises the likely plant and equipment and the assumed sound power levels for construction activities associated with the Wollongong Stabling Yard and Station upgrades. The sound power levels for the majority of activities presented in Table 4-3 are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', ICNG, information from past projects and information held in the Renzo Tonin & Associates library files.

Table 4-3: Noise modelling assumptions for construction - activities and equipment

Activity	Plant/ Equipment	Operating Weight kg	Assumed No. Units		Sound Power Level (Lw re: 1pW), dB(A)	
			Std Hours	OOHW	L_{Aeq}	L_{A1}
Site Preparation/ Demobilise	Tracked excavator w bucket	20 tonne	1	1	105	108
	Franna crane	20 tonne	1	1	99	
	Small truck	<20 tonne	4 per hour	4 per hour	104	
	Truck (semi-trailer)		4 per hour	4 per hour	108	117
	Mobile crane	100 tonne	1	1	110	
	Hand tools		1	1	107	
	Elevated work platform		1	1	102	
	Power hand tools		1	1	101	116
	Assumed combined activity noise level				**115**	**117**
Civil - walkways/ lighting & CCTV/ fences	Mobile crane	100 tonne	1	1	110	
	Concrete agitator		1	1	108	117
	Pneumatic vibrator		1	1	97	
	Compressor trailer mounted diesel		1	1	102	
	Concrete pump		1	1	103	
	Tracked excavator w bucket	20 tonne	1	1	105	108
	Backhoe/ Front End Loader		1	1	103	108
	Truck (semi trailer)		4 per hour	4 per hour	108	117
	Small dump truck	<20 tonne	1	1	104	115
	Hi-rail Hiab truck		1	1	95	98
	Power hand tools		1	1	101	116
	Assumed combined activity noise level				**116**	**117**
Electrical	Hi rail Hiab truck		1	1	95	98
	Power handtools		1	1	101	
	Truck on-site		1	1	96	93
	Daymaker		1	1	93	
	Mobile crane		1	1	110	120
	Assumed combined activity noise level				**111**	**120**
Signals and communications	Hi rail Hiab truck		1	-	95	98
	Power hand tools		1	1	101	116
	Truck on-site		1	-	96	93
	Daymaker		1	-	93	
	Mobile crane		1	-	110	120
	Backhoe / small excavator		1	-	111	
	Assumed combined activity noise level				**114 (101)**	**116**

Activity	Plant/ Equipment	Operating Weight kg	Assumed No. Units		Sound Power Level (Lw re: 1pW), dB(A)	
			Std Hours	OOHW	L_{Aeq}	L_{A1}
Track work	Hi rail dumper	20 tonne	1	1	108	115
	Daymaker	<20 tonne	1	1	93	
	Dump Truck		1 per hour	1 per hour	108	115
	Backhoe / FEL	100 tonne	1	1	103	108
	Truck		1	1	96	120
	Ballast tamper		1	1	111	
	Regulator		1	1	114	
	Rail saw		1	1	118	118
	Mobile Crane		1	1	110	
	Welding equipment		1	1	105	
	Assumed combined activity noise level				**121**	**121**
Civil - Amenities building and car park	Mobile crane	100 tonne	1	1	110	
	Tracked excavator w bucket	10 tonne	1	1	103	
	Franna Crane		1	1	99	
	Elevated work platform		1	1	102	
	Flat- top truck		1 per hour	1 per hour	106	
	Small Truck	<20 tonne	1	1	104	
	Hi rail Hiab truck		1	-	95	98
	Power hand tools		1	1	101	116
	Assumed combined activity noise level				**114**	**116**
Turnouts	Hi rail dumper	20 tonne	1	1	108	115
	Daymaker	<20 tonne	1	1	93	
	Dump Truck		1 per hour	1 per hour	108	115
	Backhoe / FEL	100 tonne	1	1	103	108
	Truck		1 per hour	1 per hour	96	120
	Ballast tamper		1	1	111	
	Regulator		1	1	114	
	Rail saw		1	1	118	118
	Mobile Crane		1	1	110	
	Welding equipment		1	1	105	
	Assumed combined activity noise level				**121**	**121**
Civil – Platform extensions	Mobile crane	100 tonne	1	1	110	
	Concrete Agitator		1	1	108	117
	Pneumatic vibrator		1	1	97	
	Compressor trailer mounted diesel		1	1	102	
	Concrete pump		1	1	103	

Activity	Plant/ Equipment	Operating Weight kg	Assumed No. Units		Sound Power Level (Lw re: 1pW), dB(A)	
			Std Hours	OOHW	L_{Aeq}	L_{A1}
Civil – Platform extensions *(continued)*	Tracked excavator w bucket	20 tonne	1	1	105	108
	Backhoe/ Front End Loader		1	1	103	108
	Truck (semi-trailer)		4 per hour	4 per hour	108	117
	Small dump truck	<20 tonne	1	1	104	115
	Hi-rail Hiab truck		1	1	95	98
	Power hand tools		1	1	101	116
	Assumed combined activity noise level				**116**	**117**

Notes: 1. $L_{A1(1min)}$ levels only noted for equipment likely to generate instantaneous noise events during the night period

2. Number of units operating at any one time may change on site. Assumptions in table are for modelling purposes, based on a conservative, but realistic estimate of the likely number of units operating concurrently for each activity.

3. Assumed activity noise level in brackets () includes all noise sources for that activity that may be used during out of hours works.

4.2.3 Minimum working distances for vibration intensive plant

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Accordingly, based on a database containing vibration measurements from past projects and library information, Table 4-4 below presents the recommended minimum working distances for vibration intensive plant.

Table 4-4: Recommended minimum working distances for vibration intensive plant

Plant item	Rating/ description	Minimum working distance		
		Cosmetic damage		Human response
		Unreinforced or light framed structures	Structurally unsound heritage structures	
Backhoe/ Front End Loader	-	2 m (nominal)	5 m	10 m
Tracked excavator with bucket	20 tonne	2 m (nominal)	5 m	10 m

Notes: Source: TfNSW Construction Noise and Vibration Strategy - April 2018

4.3 Construction noise and vibration assessment

4.3.1 Predicted noise levels

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented in Section 4.2.1. A 5 dB(A) penalty has been factored into the noise modelling levels where applicable to allow for particularly annoying activities, such as saw cutting and jack hammering.

The following sections summarise predicted $L_{Aeq(15min)}$ noise levels (without mitigation) at receivers in each NCA from the construction of the Wollongong Stabling Yard and Station upgrades. The upper end

of the predicted noise level range presented in the summary tables is based on the worst affected receiver/s for that NCA. The lower end of the predicted noise level range is based on the least affected receiver/s. The worst affected receivers for each NCA are typically in the first row of houses and apartments back from the Proposal area, with direct line-of-sight to the construction work area. Receivers in the next row of houses back from the Proposal, or receivers without direct line-of-sight to the construction area would typically be exposed to construction noise levels 5 to 10 dB(A) lower than the levels predicted for the worst affected receivers.

4.3.1.1 Standard construction hours

For construction works during standard construction hours, APPENDIX D presents maps indicating the predicted construction noise level compared with the project NML. These maps are provided to give receivers an indication of the likely noise impact from the different stages of construction. A summary of the predicted construction noise levels is presented in Table 4-5.

Table 4-5: Predicted construction noise levels – standard hours construction activities

Receiver type	NML dB(A)	Predicted $L_{Aeq,\ 15\ minute}$ construction noise levels, dB(A)							
		Stabling Yard						Station	
		Site prep	Civil walkways	Electrical	Signals	Track work	Civil amenities	Turnouts	Platforms
Residential (Up)	50	< 25 - **76**	< 25 - **73**	< 25 - **66**	< 25 - **68**	< 25 - **78**	< 25 - **75**	< 25 - **75**	< 25 - **66**
Residential (Down)	49	< 25 - **64**	< 25 - **66**	< 25 - **57**	< 25 - **69**	< 25 - **73**	< 25 - **63**	< 25 - **73**	< 25 - **68**
Other sensitive	55-75	< 25 - **77**	< 25 - **72**	< 25 - **68**	< 25 - **74**	< 25 - **79**	< 25 - **76**	< 25 - **85**	< 25 - **75**

Notes: **Bold** text indicates predicted noise levels are above the NML, therefore receivers are construction noise affected
Purple bold text indicates predicted noise levels are highly noise affected (i.e. above 75 dB(A)

Table 4-5 above presents the predicted reasonable worst-case construction noise impacts from the Wollongong Stabling Yard and Station upgrades works. The predictions indicate that construction noise would be clearly audible at the receivers closest to the Stabling Yard and station. Receivers set back further from the Proposal site would be less impacted. The construction noise results drawings in APPENDIX D show the spread of noise impact surrounding the Proposal site.

There are no highly noise affected receivers on the Down side of the works during all standard hours construction works. Up to four residential receivers on the Up side are predicted to be highly noise affected (i.e. noise levels > 75dB(A)), one during site establishment works and four during track works. There are no highly noise affected receivers during other construction works.

Civil works relating to the walkway installation, as well as track works along the Stabling Yard, are likely to result in moderately intrusive noise levels at receivers on Gladstone Avenue and Auburn Street. Noise is predicted to be clearly audible as far as Rawlinson Avenue (west), Mackie Street (south), and Atchison Street (east). When works are located towards the south of the Stabling Yard, select receivers on Kenny Street near the cemetery may experience construction noise above the standard hours NML.

The electrical and signals works are likely to have a lower impact compared to activities such as track works and turnout relocation. However, noise from the works may at times be moderately intrusive at some receivers adjacent to the rail corridor.

Station works, such as the turnouts replacement and platform extensions, are likely to affect receivers on Gladstone Avenue, primarily the TAFE Wollongong West campus and neighbouring apartment blocks. Limited receivers on Osborne Street, Auburn Street and Crown Street may perceive construction noise as clearly audible during station works.

4.3.1.2 Outside of standard construction hours

As the works are to be carried out within an active rail corridor, some of the activities would need to be completed outside standard construction hours during rail possession periods or during the midnight to dawn shutdown period.

For works that are to take place outside of standard construction hours APPENDIX D also presents maps indicating the predicted construction noise level compared with the project NML. These maps provide an indication of the likely noise impact from the different stages of construction at receivers around the Proposal site. A summary of the predicted construction noise levels is presented in Table 4-6.

Table 4-6: Predicted construction noise levels at residential receivers – OOH construction activities

Receiver type	NML dB(A)	Predicted $L_{Aeq, 15minute}$ construction noise levels, dB(A)							
		Stabling Yard						Station	
		Site prep	Civil walkways	Electrical	Signals	Track work	Civil amenities	Turnouts	Platforms
OOHW Day									
Residential (Up)	45	< 25 - **76**	< 25 - **73**	< 25 - **66**	< 25 - **55**	< 25 - **78**	< 25 - **75**	< 25 - **75**	< 25 - **66**
Residential (Down)	44	< 25 - **64**	< 25 - **66**	< 25 - **57**	< 25 - **56**	< 25 - **73**	< 25 - **63**	< 25 - **73**	< 25 - **68**
OOHW Evening									
Residential (Up)	44	< 25 - **76**	< 25 - **73**	< 25 - **66**	< 25 - **55**	< 25 - **78**	< 25 - **75**	< 25 - **75**	< 25 - **66**
Residential (Down)	43	< 25 - **64**	< 25 - **66**	< 25 - **57**	< 25 - **56**	< 25 - **73**	< 25 - **63**	< 25 - **73**	< 25 - **68**
OOHW Night									
Residential (Up)	42	< 25 - **76**	< 25 - **73**	< 25 - **66**	< 25 - **55**	< 25 - **78**	< 25 - **75**	< 25 - **75**	< 25 - **66**
Residential (Down)	42	< 25 - **64**	< 25 - **66**	< 25 - **57**	< 25 - **56**	< 25 - **73**	< 25 - **63**	< 25 - **73**	< 25 - **68**

Notes:
1. **Bold** text indicates predicted noise levels are above the NML, therefore receivers are construction noise affected
2. **Yellow bold** text indicates predicted noise levels are more than 5 dB(A) above the NML and may be highly intrusive
3. **Orange bold** text indicates predicted noise levels are more than 15 dB(A) above the NML and may be highly intrusive
4. **Brown bold** text indicates predicted noise levels are more than 25 dB(A) above the NML and may be highly intrusive
5. No typical night works proposed.

Table 4-6 above presents the predicted reasonable worst-case construction noise impacts from the Wollongong Stabling Yard and Station upgrades works assessed against the OOHW NMLs. The predictions indicate that construction noise would be clearly audible at the receivers closest to the stations and may at times be highly intrusive.

Signals and communications works are expected to have the lowest noise impact of the planned out of hours works. While noise is likely to be moderately intrusive, affected receivers are generally within 140 metres of the southern end of the Wollongong station platforms.

The highest noise impacts are expected to occur during track works, primarily due to rail saw usage. Residences adjacent to the rail corridor on Gladstone Avenue, from Rawlinson Street to South Street, may experience highly intrusive construction noise. Receivers as far as Staff Street (north west), McKenzie Avenue (west), Bridge Street (south), Kenny Street (east and south east) and Crown Street (north) are predicted to receive noise above the night NML.

Care would need to be taken during OOHW period to operate equipment behind site hoardings or temporary noise barriers, where practicable which would provide 5 to 10 dB(A) noise reduction, where line-of-sight is broken. In addition, high noise impact plant and equipment should not be used at night, where practicable.

Noise mitigation measures are described in Section 4.4 to reduce noise levels, where reasonable and feasible, or where all reasonable and feasible mitigation measures have been adopted, to manage impacts where they occur.

The potential for sleep disturbance at night has also been considered. Predicted instantaneous noise levels from the operation of plant and equipment have been predicted to the nearest residential receivers. The predicted L_{Amax} noise level results are presented in Table 4-7.

Table 4-7: Predicted construction noise levels at residential receivers – sleep disturbance

Receiver type	Screening level dB(A)	Predicted L_{Amax} construction noise levels, dB(A)							
		Stabling Yard						Station	
		Site prep	Civil walkways	Electrical	Signals	Track work	Civil amenities	Turnouts	Platforms
OOHW Night									
Residential (Up)	52	< 25 – **78**	< 25 – **74**	< 25 - **75**	< 25 - **70**	< 25 - **78**	< 25 - **77**	< 25 - **75**	< 25 - **67**
Residential (Down)	52	< 25 - **66**	< 25 – **67**	< 25 - **66**	< 25 - **71**	< 25 - **73**	< 25 - **65**	< 25 - **73**	< 25 - **69**

Notes: **1. Bold** text indicates predicted noise levels are above the screening level, therefore sleep disturbance may occur

2. No typical night works proposed.

The predicted noise levels indicate that without noise mitigation, predicted instantaneous noise levels exceed the sleep disturbance screening level as well as the awakening reaction level of L_{Amax} 65 dB(A). Therefore, there is potential for sleep disturbance at the receivers closest to the Wollongong Stabling

Yard and Station work sites. The potential sleep disturbance events are likely to be triggered by the use of rail saws, truck air brakes on site or hand tools.

Where these items are not required for OOHW, predicted noise levels from instantaneous noise events are more likely to be within the sleep disturbance NMLs. Construction mitigation and management measures are provided in Section 4.3.2 to assist in reducing OOHW construction noise impacts to receivers. Heavy vehicle movements should be limited as much as practicable in order to limit the potential for sleep disturbance.

4.3.2 Vibration assessment

The numbers of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 4-8.

Table 4-8: Number of buildings within minimum working distances for vibration impact

Worksite	Plant item	Number of buildings[1]		Number of receivers[1]
		Screening criteria for non-heritage structures	Screening criteria for heritage structures[2]	Human response
Wollongong Stabling Yard	Backhoe/ Front End Loader	nil	nil	nil
	Tracked excavator with bucket	nil	nil	nil
Wollongong Station	Backhoe/ Front End Loader	nil	nil	nil
	Tracked excavator with bucket	nil	nil	nil

Note 1: Initial screening test based on Section 3.2.3

2: Excluding Wollongong railway station

Review of the work area and nearby sensitive buildings indicates there is low to negligible risk of vibration impact, depending on the location of the construction works. The station buildings have been conservatively assessed in this report as 'structurally unsound' heritage buildings, however as the nearest works on the station platforms would be more than 20 metres from the station buildings, the risk of impact is assessed as low. This should be confirmed during detailed design.

Measures for managing vibration impacts are described in Section 4.4.2.

4.4 Construction mitigation and management measures

4.4.1 Highly noise affected receivers

A number of the closest residential receivers to the Wollongong Stabling Yard and Station upgrades construction work areas may be 'highly noise affected' [i.e. exposed to noise levels that exceed 75 dB(A)] as a result of high noise impact equipment such as rail saws during general site establishment and civil work activities.

To limit the impact, where feasible and reasonable high noise impact activities would be carried out with respite periods, such that:

- High noise impact activities would only be carried out:
  - between 8:00 am and 6:00 pm on Monday to Friday; and
  - between 8:00 am and 1:00 pm on Saturday
- High noise impact activities would be carried out in continuous blocks of up to 3 hours. Respite from high noise impact activities would be provided between each block for at least 1 hour. No high noise impact activities will be carried out during this 1 hour respite period.

In addition to the above, high noise generating plant and equipment would not be used during the night period (OOHW Period 2).

4.4.2 Vibration sensitive structures

During detailed design the locations where vibration intensive construction activities would be undertaken would be reviewed to confirm plant and equipment are unlikely to operate close to or within the recommended minimum working distances for cosmetic damage (Table 4-4).

Where the review finds that plant and equipment may operate within the recommended minimum working distances, site specific minimum working distances for vibration significant plant items would be measured on site prior to works being undertaken. In addition, condition surveys of all the vibration affected buildings/structures within the minimum working distances would be completed prior to the commencement of construction work. The building condition reports would also confirm the appropriate vibration criteria for the building or structure (i.e. reinforced or unreinforced structures, structurally sound or unsound heritage buildings).

Vibration monitoring would be undertaken where plant is operating close to the site-specific working distances to verify that vibration levels achieve compliance with the structural damage objectives identified for the building or structure. Where monitoring identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels should be considered.

4.4.3 Other noise and vibration control measures

Table 4-9 summarises actions that can be applied to manage the potential for noise and vibration to impact on sensitive receivers near the Wollongong Stabling Yard and Station upgrades works, to be applied where reasonable and feasible.

Table 4-9: Other noise and vibration mitigation and management measures

Action required	Applies to	Details
At-source mitigation measures		
Equipment selection	Airborne noise Vibration	Use quieter and less noise/vibration emittingconstruction methods where feasible and reasonable
Maximum noise levels	Airborne noise	The noise levels of plant and equipment (including rental plant) must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in APPENDIX C of the TfNSW Construction Noise and Vibration Strategy – April 2018.
Use and siting of plant	Airborne noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away fromsensitive receivers.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on allconstruction vehicles and mobile plant regularly used on site and for any out of hours work,including delivery vehicles.
Minimise disturbance arising from delivery of goods	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Delivery vehicles to be fitted with straps ratherthan chains for unloading, wherever possible.
Path mitigation measures		
Construction hoarding as noise barrier	Airborne noise	Any construction hoarding installed on each worksite shall be constructed of material and in a manner so that it acts as a noise barrier. Where feasible and reasonable it would screen the work areas from commuters using the station platforms during construction works, and to provide shielding to the nearest affected receivers. Construction hoarding acting as noise barriers can achieve 5 to 10 dB(A) noise reduction, in the case that it breaks the line-of-sight between the noise source and the receiver and does not include gaps or holes.
Shield stationary noise sources such as pumps, compressors etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materialssuitable for shielding.
Temporary noise barriers	Airborne noise	Where works are to be completed as OOHW outside the construction hoarding area, relocatable noise barriers e.g. acoustic blankets hung from temporary construction fencing would be used, where practicable. Relocatable noise barriers can achieve 5 to 10 dB(A) noise reduction where they break line-of-sight between the noise source and the receiver.
Management measures		
Implement stakeholder consultation measures	Airborne noise	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted to notify the community of upcoming works: • Project Specific Website • Project Infoline • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings.

Action required	Applies to	Details
Register of noise and vibration sensitive receivers	Airborne noise Vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similardocument.
Construction hours and scheduling	Airborne noise	Where feasible and reasonable, constructionshould be carried out during the standarddaytime working hours. Work generating noise with special audible characteristics should be scheduled during less sensitive time periods.
Site inductions	Airborne noise Vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.
Monitoring	Airborne noise	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval conditions.
Attended vibration measurements	Vibration	Attended vibration measurements shall beundertaken at all buildings where vibration intensive plant operates within the minimum working distance specified in Table 4-4. Monitoring must be carried out prior to when theseactivities commence working within the minimum working distance to confirm that vibration levels are within the acceptable range toprevent cosmetic building damage.

4.4.4 Additional mitigation measures

In accordance with the ICNG and the CNVS, all feasible and reasonable mitigation measures outlined in Section 4.4.1, 4.4.2 and 4.4.3 to minimise noise and vibration levels at the nearest receivers will be implemented, where practicable. The implementation of these measures should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work needing to be undertaken outside the standard construction hours, exceedances of construction noise objectives are likely to occur. Where construction noise and vibration levels are still predicted to exceed the noise objectives after the application of the standard mitigation measures the Additional Mitigation

Measures Matrices (AMMM) shall be used to determine the additional measures and implementation where reasonable and feasible, and in consultation with TfNSW communications representatives.

Table 4-10: Additional airborne noise management measures matrix

Construction hours	Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures
	Receiver perception	dB(A) above RBL	dB(A) above NML	
Standard Hours	Noticeable	5 to 10	0	-
	Clearly Audible	10 to 20	≤ 10	-
	Moderately intrusive	20 to 30	10 to 20	LB, V
	Highly intrusive	> 30	> 20	LB, V
	75dBA or greater	N/A	N/A	LB, SN, V
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	0 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	LB, V, SN, AA, RP, DR

Notes:
PN = Project notification RO = Project specific respite offer RP = Project specific respite offer
V = Verification monitoring AA = Alternative accommodation DR = Duration reduction
SN = Specific notifications, individual briefing or phone call
# Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays / Public Holidays 8am-6pm)

Table 4-11: Additional vibration noise management measures matrix

Construction hours	Predicted airborne $L_{Aeq(15min)}$ noise level at receiver		Additional mitigation measures
	Receiver perception	above VML	
Standard Hours	Human disturbance	> HVML	PN, V, RO
	Building damage	> DVML	V, AC
OOHW Period 1	Human disturbance	> HVML	PN, V, SN, RO, RP, DR
	Building damage	> DVML	V, AC
OOHW Period 2	Human disturbance	> HVML	PN, V, SN, RO, RP, DR, AA
	Building damage	> DVML	V, AC

Notes:
PN = Project notification RO = Project specific respite offer RP = Project specific respite offer
V = Verification monitoring AA = Alternative accommodation DR = Duration reduction
SN = Specific notifications, individual briefing or phone call
AC = Alternative construction methodology

Reasonable measures to ameliorate noise and/or vibration impact will need to be considered based on the level of impact and duration of the works, including:

- Short term residual impacts from specific construction activities that generate noise or vibration above the management levels, where these works are not in the highly sensitive night period and occur over a shorter timeframe (e.g. 1 to 2 weeks). Consideration should be given to offering respite in the form of movie tickets, coffee/meal vouchers or similar
- Short term residual impacts where a specific phase of the construction work generates noise or vibration that exceeds the management levels within the highly sensitive night period. Consideration should be given to offering alternative accommodation for the duration of the noise or vibration impact.

5 Operational rail noise assessment

5.1 Changes to rail network

The works in this study includes the following:

- Wollongong Stabling Yard
  - Reconditioning of Up side stabling tracks (No. 1 Up Siding, No. 2 Up Siding and Up Refuge)
  - Remove and replace existing turnouts in the same location (275A & 275B, 259A & 259B, 257A), upgrading to 60 kg concrete sleepers
  - Upgrade existing signalling equipment for replacement turnouts above (same location)
- Wollongong Station
  - Relocate turnout 275B 12 m to the south (Country) and replace crossover keeping Points 275A in existing location
  - Relocate signal WG 463 U 12 m to the south (Country) with Points 275B. Install new trains stops
  - Relocate turnout 270B 13 m to the south (Country) and replace crossover keeping Points 270A in existing location
  - Relocate signal WG 461 D 13 m to the south (Country) with Points 270B. Install new trains stops.

5.2 Rail noise assessment

The potential change in noise emissions from rail operations due to the Proposal have been predicted and summarised in Table 5-1.

Table 5-1: Rail operations noise assessment to nearest residential receivers

Location	Side of Line	Nearest receiver address	Change in dB(A)
Wollongong Stabling Yard	No change	N/A	No change
Wollongong Station	Up	17 Gladstone Avenue, Wollongong	<1
	Down	16 Auburn Street, Wollongong	<1

At Wollongong Stabling Yard, the reconditioning of stabling tracks, replacement of turnouts and signalling equipment would not alter the location of rail operations from existing. There is therefore no change in noise level. This is within the redeveloped rail line noise trigger levels.

The relocation of turnout 275B/ signal WG 463 U and turnout 270B/ signal WG 461 D on the southern side of Wollongong Station would result in a change in the location where locomotives idle waiting for a signal change. The signal would be relocated 12 metres and 13 metres (respectively) further south. The

resultant change in noise level is estimated to be less than 1 dB(A). This is within the redeveloped rail line noise trigger levels.

The risk of potential noise impact as a result of the minor changes to trackwork at Wollongong Stabling Yard and Wollongong Station is considered low and further detailed assessment of noise mitigation measures is not required at this REF stage. Further assessment at the detailed design stage is required to confirm the change in impact.

Note that changes to Stabling Yard operations are assessed separately in Section 6 of this report.

6 Operational noise assessment – Stabling Yard

6.1 Stabling Yard operations

The proposed Wollongong Stabling Yard upgrade includes works are being undertaken in order to allow the re-use of the existing No 1 & No 2 Up Sidings, the Up Refuge Loop, the Down Goods Siding and the No 1 Down Siding to stable eight 10-car NIF trains. As a result, noise emissions from the stabling activities may change due to different noise levels associated with the 10-car NIF trains, and the alternative configuration of the Stabling Yard required to accommodate the 10-car NIF trains.

Presented in Table 6-1 is the existing and future capacity of the Wollongong Stabling Yard.

Table 6-1: Wollongong Stabling Yard capacity

Name of road	Capacity for stabled trains	
	Existing number of trains (typical)	Number of 10-car NIF trains
No. 1 Down Siding	4H x 2 8H	2
Down Refuge / Goods Siding	4H x 2	2
Up Refuge	-	2
No. 1 Up siding	8T 8H 4T	1
No. 2 Up siding	-	1
Perway siding	N/A	-

The future operations of the Stabling Yard are not proposed to substantially change from the existing situation. The only differences that influence the noise emissions from the stabling activities are:

- New trains – 10-car NIF trains
- Trains would now be stabled in the new electrified siding No.2 in the Up yard
- As the NIF trains are 10-car sets, compared with the existing 4-car or 8-car sets, the stabling locations of trains would be reconfigured.

Presented in Figure 2 are the proposed stabling locations for the 10-car NIF trains.

6.2 Operational noise sources

The noise emission requirements for the Wollongong Stabling Yard apply for a reasonable worst case operational scenario during all periods of operation.

The stabled trains at Wollongong Stabling Yard currently stand for periods of time with their auxiliary systems in operation, including static inverters, air-conditioning systems and air compressors. These systems remain on for the trains to be cleaned. Following cleaning they may be turned off by the cleaning staff.

While the majority of these auxiliary system noise sources are constant, the compressors can operate at any time, and operate in a transient manner, with a cycle that involves a compressed air discharge.

6.2.1 Train types

The Wollongong Stabling Yard currently stables 4-car and 8-car Tangara (T-set) and Oscar (H-set) trains.

As part of the introduction of the NIF, the Wollongong Stabling Yard would be reconfigured so that it has the capacity to stable 10-car long NIF trains.

6.2.2 Noise source levels

6.2.2.1 Train stabling and train preparation

In order to prepare a train for departure onto the network following stabling, a number of preparation procedures are required.

The train preparation typically takes up to one hour for a 4-car set and up to 1.5 hours for an 8-car set. During this period all train auxiliary systems are in operation, in addition a number of tests are undertaken which include the testing of brakes and horns. As part of the brake tests the compressed air system is exhausted via a brake pipe on multiple occasions, each resulting in a short high noise event from the air release. These noise sources occur at the bottom of the train below the driver's cab. The drivers also test both the town and country horns at each driver cab.

During the preparation procedure, the tests are undertaken on each driver cab, which is either end of a Tangara (T-set) train or at each driver cab of an Oscar (H-set) train, which is two locations for a 4-car set and four locations for an 8-car set.

6.2.2.2 Train noise source levels

Noise source sound power levels from trains within the Stabling Yard have been determined based on measurements taken at Wollongong Stabling Yard on 10 July 2019 and are presented in Section 2.3.3. Measurements were taken of both Oscar (H-set) and Tangara (T-set) trains during stationary operation and preparation procedures.

The sound power levels for noise sources included in the model are detailed in Table 6-2. Detailed noise spectra and directivities of noise sources were also included in the model.

Table 6-2: Summary of sound power levels for key rolling stock noise generating items, dB(A)

Train type/ Operating condition	Noise source	Individual source sound power level (SWL), dB(A)		Location of noise source
		L_{Amax}	$L_{Aeq, 15min}$	
Existing trains				
Oscar (H-Set) [Presentation / Cleaning (Idle)] [11]	HVAC	-	84	Top of train (4.4m[1])
	Static Inverter (SIV)	-	84[10]	Top of train (4.4m[1])
	Full compressed air cycle	100	88[7]	Bottom of train (0.5m[1])
Tangara (T-Set) [Presentation / Cleaning (Idle)][11]	HVAC	-	83	Top of train (4.4m[1])
	Static Inverter (SIV)	-	83[10]	Top of train (4.4m[1])
	Full compressed air cycle	111	90[7]	Bottom of train (0.5m[1])
Oscar (H-Set) and Tangara (T-Set)	Town Horn[6,8]	133	103	Front of train (0.5m[1])
	Country Horn[6,8]	136	103	Front of train (0.5m[1])
	Preparation process (excluding horns)	118[5]	96[6]	Bottom of train (0.5m[1])
	Arrival compressor operation	119[6]	90[6]	Bottom of train (0.5m[1])
	Door test cycle[5]	87	66[2]	Side of train (2m[1])
Future trains				
New Intercity Fleet (NIF)	HVAC[3,4]	-	84	Top of train (4.4m[1])
	Static Inverter (SIV) [3,4]	-	83	Top of train (4.4m[1])
	Compressor[3]	-	88	Bottom of train (0.5m[1])
	Door test cycle[5]	87	66	Side of train (2m[1])
	Preparation process (excluding horns)	118	96	Bottom of train (0.5m[1])
	Town Horn[8,9]	133	103	Front of train (0.5m[1])
	Country Horn[8,9]	136	103	Front of train (0.5m[1])

Notes:
1. Above top of rail
2. SWL 83 dB(A) for 20 second test duration
3. NIF design noise levels reference: NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 6, 6 February 2019).
4. The stationary condition 3 (minimum / presentation) operating condition noise levels have been adopted for this assessment for the HVAC and SIV, for consistency with the noise levels measured for existing trains.
5. Based upon H-set
6. Based upon T-set
7. The compressor cycles, and during preparation operates on and off during a 15-minute period during worst-case periods, which have been incorporated into the 15-minute sound power level.
8. Directivity based upon the horn directivity based upon the NIF Prediction Report (2019)
9. Testing horn levels during the preparation procedure are assumed similar to the existing fleet levels, taking into consideration directivity.
10. Estimated level, as the contribution could not be separated from the HVAC during noise measurements.
11. For a conservative assessment and noting train locations could vary, the maximum noise levels between the two sets have been included in the noise modelled.

6.2.2.3 Train movement noise levels

Train speeds within the Stabling Yard are limited to 13 km/h, and as such movements occur at low speed. As such, the $L_{Aeq,\ 15\ minute}$ noise emissions from the trains are controlled by the train auxiliary systems.

Train arrivals and departures includes intermittent noise events from the compressed air system. Their compressed air systems are either released on departure or upon arrival. These noise sources occur during the preparation procedures, and as such are captured in these assessment scenarios.

Track turnouts can result in higher noise levels compared to straight track. However, considering that trains are travelling at low speed, these noise sources would not likely dominate in an $L_{Aeq,\ 15\ minute}$ assessment.

6.2.2.4 Train cleaning activities

Train cleaning takes place following the arrival of a train at the Stabling Yard. It typically does not include any noise sources external of the train, and rubbish and equipment are typically hand carried to and from trains. As such, this activity does not significantly contribute to the overall noise emissions from stabling activities.

6.3 Methodology

6.3.1 Modelling overview

Modelling and assessment of airborne noise impacts from the Proposal were determined by modelling the noise sources, receiver locations and topographical features, and possible noise mitigation measures using SoundPlan Version 8.0. The noise modelling algorithms were used to calculate the contribution of each noise source at each identified sensitive receiver location and to predict the total noise from the site for the various reasonable worst-case scenarios developed for the Proposal.

The noise prediction model considers:

- Location of noise sources and sensitive receiver locations (including multi-storey buildings);
- Height of sources and receivers referenced to digital ground contours with a 2m contour interval, within the site and outside the site area;
- Noise source levels of individual plant and equipment;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (ground absorption value of 0.5);
- Attenuation from buildings and structures (natural terrain and purpose built); and
- Atmospheric losses and meteorological conditions.

As a large number of the nearest noise sensitive receivers are within 100 metres of the Proposal site the noise prediction modelling has been undertaken using the International Standard ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions (i.e. wind and temperature inversions) implemented in accordance with ISO/TR 17534-3 (2015) and is suitable for distances under 100 metres. Due to the surrounding landuse being a mixture of suburban and commercial landuse, an average ground absorption value of G=0.5 has been adopted. The noise model considers the effect of shielding from adjacent trains, in the locations that they would typically be present.

6.3.2 Meteorological conditions

In accordance with the NPfI, the noise assessment considers the effects of adverse meteorological conditions such as wind and temperature inversions.

See Section 2.3.2 for a summary of the prevailing noise-enhancing meteorological conditions, and the required assessment conditions.

As a large number of the nearest noise sensitive receivers are within 100 metres of the Proposal area the noise prediction modelling has been undertaken using the International Standard ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions (i.e. wind and temperature inversions) implemented in accordance with ISO/TR 17534-3 (2015).

Noise modelling taking into consideration prevailing temperature inversions and prevailing winds using the CONCAWE noise modelling algorithm shows that noise levels at receivers further than 300 metres from the facility could potentially increase by 3-5 dB(A) under temperature inversions or source-to-receiver winds of 3 m/s.

6.3.3 Representative receivers

Noise levels have been modelled to all nearby noise sensitive receiver locations, however for the purposes of tabling the results in this report, only the results from 26 representative receivers are presented to provide an indication of predicted noise levels around the Stabling Yard during each of the assessment scenarios: R1 to R14 on the west side of the Stabling Yard and R15 to R26 on the east side of the Stabling Yard.

Table 1-1 presents nearby non-residential receivers in proximity to the Stabling Yard. However, it is noted that the key period of noise emission for the Stabling Yard is over the night-time period (10pm to 7am) when the Stabling Yard is most active. During night-time non-residential receivers are not typically in use. As such, this assessment has not addressed further the noise impacts of the stabling activities on nearby non-residential receivers.

The locations of the representative receivers for the operational noise assessment are presented in Table 6-3, and a map of these locations presented in Appendix B.2.

Table 6-3: Stabling Yard operational noise assessment - representative receivers

Receiver number	Address	Approximate distance to the project, metres
R1	89 Gladstone Avenue Wollongong	10
R2	83 Gladstone Avenue Wollongong	10
R3	69 Gladstone Avenue Wollongong	30
R4	53 Gladstone Avenue Wollongong	20
R5	45 Gladstone Avenue Wollongong	20
R6	37 Gladstone Avenue Wollongong	20
R7	22-32 Gladstone Avenue Wollongong	130
R8	9 Rawlinson Avenue Wollongong	160
R9	56 Gladstone Avenue Wollongong	80
R10	72 Gladstone Avenue Wollongong	80
R11	84 Gladstone Avenue Wollongong	70
R12	28 Strathearn Avenue Wollongong	180
R13	1 Lauder Avenue Wollongong	200
R14	2 Strathearn Avenue Wollongong	140
R15	57 West Street Wollongong	10
R16	82 Auburn Street Wollongong	60
R17	62 Auburn Street Wollongong	60
R18	14-18 Auburn Street Wollongong	180
R19	75 Auburn Street Wollongong	160
R20	47 West Street Wollongong	110
R21	61 Auburn Street Wollongong	110
R22	51 Auburn Street Wollongong	110
R23	35 Auburn Street Wollongong	110
R24	91 Atchison Street Wollongong	230
R25	69 Atchison Street Wollongong	230
R26	55 Atchison Street Wollongong	230

6.4 Noise assessment scenarios

For the assessment of operational noise emissions from the Stabling Yard operations, predicted noise levels for both the existing situation along with the future situation, with the inclusion of the 10-car NIF trains, have been modelled.

To assess operational noise emissions, four assessment scenarios have been developed in order to capture the typical worst-case noise impacts when preparation activities are not being undertaken, along with three scenarios to represent the reasonable worst-case 15-minute noise emission periods from the Stabling Yard during the morning preparation period. The morning preparation activities include brake testing and horn testing. The preparation activities generate the greatest noise emissions from the stabling activities.

These scenarios have been developed based upon analysis of Wollongong Stabling Yard timetables, discussions with site personnel, observations during the Stabling Yard attended noise measurements and inputs from TfNSW.

Presented in Table 6-4 is a summary of the four preparation activities scenarios that have each been assessed for existing and future operations.

Table 6-4: Wollongong Stabling Yard assessment scenarios

Description	Approximate time period	Existing stabling activities	Future 10-car NIF stabling activities
Night-time stabling	2:15am - 2:30am	Scenario 1	Scenario 5
Morning preparation 1	3:45am – 4:00am	Scenario 2	Scenario 6
Morning preparation 2	4:30am – 4:45am	Scenario 3	Scenario 7
Morning preparation 3	5:30am – 5:45am	Scenario 4	Scenario 8

A representation of the typical night at the Wollongong Stabling Yard, along with an indication of the reasonable worst-case assessment time periods which have been selected, are presented in Table 6-5. Based upon this typical night, the locations of trains and the various operating states that they would be in for each of the assessment scenarios is presented in Table 6-6.

For the future 10-car NIF stabling situation, the assessment scenarios have been developed on the basis that the same number of trains will be required onto the network at similar time periods. The 10-car NIF have been located in similar locations within the Stabling Yard to the existing situation, taking into consideration the changed stabling configuration required for the 10-car NIF trains. The locations of the trains for this future assessment scenario are also presented in Table 6-6.

APPENDIX E figures present the train locations and operating states that are assessed in this study.

There is also the potential for sleep disturbance noise impacts when trains arrive, as the compressed air system is exhausted when trains come to a stop at the location that they are to be stabled. However, impacts from these sources are also covered as part of the preparation period assessments.

Each of these scenarios represent the reasonable worst-case operating scenarios that would take place. However, where activities do not occur simultaneously during the same 15-minute period, then noise levels are likely to be lower than those predicted.

Table 6-5: Wollongong Stabling Yard assessment scenarios - concurrent train modelling assumptions

Standard night	Typical stabled trains overnight (No. of cars & train type)	20:00	20:15	20:30	20:45	21:00	21:15	21:30	21:45	22:00	22:15	22:30	22:45	23:00	23:15	23:30	23:45	0:00	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00	4:15	4:30	4:45	5:00	5:15	5:30	5:45	6:00	6:15	6:30	6:45	7:00
Wollongong Down Yard																																															
No. 1 Down Siding South End	4H																																													
No. 1 Down Siding Middle	8T																																													
No. 1 Down Siding North End	4H																																													
Down Refuge South End	-																																													
Down Refuge Middle	8H																																													
Down Refuge North End	4H																																													
Wollongong Up Yard																																														
Up Refuge South End	-																																													
Up Refuge Middle	-																																													
Up Refuge North End	-																																													
No. 1 Up Siding South End	8T																																													
No. 1 Up Siding Middle	8H																																													
No. 1 Up Siding North End	4T																																													
No. 2 Up Siding South End	-																																													
No. 2 Up Siding Middle	-																																													
No. 2 Up Siding North End	-																																													

Legend

- Train arrive and stabled
- Preparation activities taking place
- Train HVAC/compressor left on
- No train present
- Stabled train present (all services switched off)
- Assessment scenario time period

Table 6-6: Wollongong Stabling Yard assessment scenarios - concurrent train modelling assumptions

Operation/ activity modelled	Scenario 1[2]		Scenario 2		Scenario 3		Scenario 4		Scenario 5[2]		Scenario 6		Scenario 7		Scenario 8	
Assessment period	**Night (Stabled) (2:15am - 2:30am)**		**Night (Preparation 1) (3:45 – 4:00am)**		**Night (Preparation 2) (4:30 – 4:45am)**		**Night (Preparation 3) (5:30 – 5:45am)**		**Night (Stabled) (2:15am - 2:30am)**		**Night (Preparation 1) (3:45 – 4:00am)**		**Night (Preparation 2) (4:30 – 4:45am)**		**Night (Preparation 3) (5:30 – 5:45am)**	
Details	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**	**Train**	**Status**
Location																
Down Yard																
No.1 Down Siding (South	4H (arrive 2:16am)	Arrived/Idle	4H	Idle	4H	Idle	4H	Preparation	10-car NIF	Arrived/Idle	10-car NIF (arrive)	Arrived/Idle	10-car NIF	Idle	10-car NIF	Preparation
No.1 Down Siding (Middle)	8T	Idle	8T	Preparation	8T	Preparation	-	-	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*
No.1 Down Siding (North	4H	Idle	-	-	-	-	-	-	10-car NIF	Idle	10-car NIF	Preparation	10-car NIF	Preparation	-	-
Down Refuge South End	-	-	-	-	-	-	-	-	10-car NIF	Idle	10-car NIF	Idle	10-car NIF	Idle	10-car NIF	Idle
Down Refuge Middle	8H	Idle	8H	Idle	8H (leave 5:28am)[1]	Preparation	-	-	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	-	-
Down Refuge North End	-	-	-	-	-	-	-	-	10-car NIF	Idle	10-car NIF	Idle	10-car NIF	Preparation	-	-
Up Yard																
Up Refuge North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Up Refuge South	-	-	-	-	-	-	-	-	10-car NIF	Idle	10-car NIF	Idle	10-car NIF	Idle	10-car NIF	Preparation
No.1 Up Siding (South End)	8T	Idle	8T	Idle	8T	Idle	8T	Preparation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No.1 Up Siding (Middle)	8H	Idle	8H	Preparation	8H (leave 5:04am)[1]	Preparation	-	-	-	-	*(overlap)*	*(overlap)*	-	-	-	-
No.1 Up Siding (North End)	4T	Idle	4T	Preparation	-	-	-	-	10-car NIF	Idle	10-car NIF	Preparation	-	-	-	-
No.2 Up Siding (South End)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No.2 Up Siding (Middle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	*(overlap)*	-	-
No.2 Up Siding (North End)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10-car NIF (arrive)	Idle	10-car NIF	Preparation	10-car NIF	Preparation	-	-

Notes:

1. 4-car train = Preparation is assumed to take 1 hour, 8-car train = Preparation is assumed to take 90 minutes
2. For assessment purposes, the arrival compressor exhausting has not been included, as the scenario it to demonstrate the noise level without these sources.
3. Train description is number of train cars and then train type. Eg. 4H is a 4-car train, while the H represents an Oscar (H-Set). T represents a Tanagra (T-Set).

6.4.1 Stabling Yard operational noise

6.4.1.1 Existing Stabling Yard noise

Predicted noise levels for the existing stabling operations at nearby representative receivers during the night period are presented in Table 6-7. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX F.

Table 6-7: Predicted operational noise levels ($L_{Aeq\ 15\ minute}$) – Existing operations (night)

Representative receiver	PSNL	Night (Stabled) (2:15am - 2:30am)		Night (Preparation 1) (3:45 – 4:00am)		Night (Preparation 2) (4:30 – 4:45am)		Night (Preparation 3) (5:30 – 5:45am)	
		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
		Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance
R1	43	51	8	54	11	57	14	65	22
R2	43	51	8	56	13	59	16	63	20
R3	43	50	7	61	18	62	19	53	10
R4	43	53	10	64	21	64	21	56	13
R5	43	50	7	62	19	60	17	55	12
R6	43	47	4	61	18	60	17	48	5
R7	43	37	-	51	8	49	6	43	-
R8	43	37	-	45	2	44	1	31	-
R9	43	46	3	53	10	55	12	49	6
R10	43	43	-	48	5	48	5	50	7
R11	43	41	-	44	1	45	2	51	8
R12	43	35	-	37	-	38	-	44	1
R13	43	30	-	34	-	35	-	38	-
R14	43	42	-	49	6	49	6	43	-
R15	43	55	12	67	24	69	26	58	15
R16	43	45	2	50	7	52	9	51	8
R17	43	45	2	53	10	55	12	52	9
R18	43	33	-	49	6	47	4	41	-
R19	43	36	-	44	1	45	2	42	-
R20	43	43	-	51	8	52	9	47	4
R21	43	40	-	48	5	49	6	46	3
R22	43	42	-	49	6	51	8	47	4
R23	43	32	-	43	-	44	1	40	-
R24	43	38	-	45	2	46	3	40	-
R25	43	32	-	38	-	39	-	35	-
R26	43	24	-	32	-	33	-	29	-

6.4.1.2 Future stabling operations

Predicted noise level for the existing stabling operations at nearby representative receivers during the night period are presented in Table 6-8. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX F.

Table 6-8: Predicted operational noise levels ($L_{Aeq\ 15\ minute}$) – Future operations (night)

Representative receiver	PSNL	Night (Stabled) (2:15am - 2:30am)		Night (Preparation 1) (3:45 – 4:00am)		Night (Preparation 2) (4:30 – 4:45am)		Night (Preparation 3) (5:30 – 5:45am)	
		Scenario 5		Scenario 6		Scenario 7		Scenario 8	
		Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance	Predicted noise level, $L_{Aeq,\ 15min}$, dB(A)	Exceedance
R1	43	52	9	54	11	54	11	64	21
R2	43	52	9	55	12	55	12	63	20
R3	43	52	9	64	21	63	20	57	14
R4	43	55	12	66	23	65	22	58	15
R5	43	49	6	61	18	61	18	56	13
R6	43	52	9	61	18	61	18	50	7
R7	43	39	-	52	9	52	9	44	1
R8	43	41	-	49	6	49	6	32	-
R9	43	47	4	54	11	53	10	51	8
R10	43	42	-	47	4	46	3	50	7
R11	43	41	-	43	-	44	1	50	7
R12	43	35	-	37	-	37	-	42	-
R13	43	30	-	34	-	34	-	37	-
R14	43	43	-	50	7	51	8	44	1
R15	43	50	7	56	13	56	13	64	21
R16	43	47	4	50	7	51	8	57	14
R17	43	45	2	55	12	55	12	52	9
R18	43	34	-	49	6	48	5	44	-
R19	43	36	-	43	-	43	-	45	2
R20	43	43	-	46	3	47	4	52	9
R21	43	41	-	45	2	48	5	49	6
R22	43	43	-	49	6	49	6	49	6
R23	43	34	-	43	-	42	-	41	-
R24	43	37	-	40	-	40	-	44	1
R25	43	32	-	40	-	39	-	36	-
R26	43	26	-	32	-	32	-	30	-

6.4.2 Sleep disturbance assessment

This section assesses the potential for sleep disturbance impacts, specifically looking at the maximum noise levels (L_{AFmax}). Refer to Section 6.4.1 for the $L_{Aeq15\ minute}$ predicted noise levels to compare against the $L_{Aeq15\ minute}$ sleep disturbance assessment level.

6.4.2.1 Existing Stabling Yard noise

Predicted noise level for the existing stabling operations at nearby representative receivers during the night period are presented in Table 6-9. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX F.

Table 6-9: Sleep disturbance assessment (L_{Amax}) – Existing operations (night)

Representative receiver	Screening level	Awakening reaction	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
			Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance	
				Screening level	Awakening reaction		Screening level	Awakening reaction		Screening level	Awakening reaction		Screening level	Awakening reaction
R1	52	65	70	18	5	78	26	13	84	32	19	93	41	28
R2	52	65	68	16	3	78	26	13	84	32	19	87	35	22
R3	52	65	62	10	-	87	35	22	87	35	22	78	26	13
R4	52	65	70	18	5	89	37	24	89	37	24	84	32	19
R5	52	65	66	14	1	88	36	23	85	33	20	83	31	18
R6	52	65	63	11	-	88	36	23	88	36	23	75	23	10
R7	52	65	51	-	-	78	26	13	74	22	9	70	18	5
R8	52	65	49	-	-	72	20	7	72	20	7	57	5	-
R9	52	65	55	3	-	75	23	10	75	23	10	74	22	9
R10	52	65	57	5	-	71	19	6	71	19	6	76	24	11
R11	52	65	58	6	-	64	12	-	69	17	4	77	25	12
R12	52	65	52	-	-	55	3	-	60	8	-	71	19	6
R13	52	65	43	-	-	55	3	-	56	4	-	65	13	-
R14	52	65	53	1	-	72	20	7	72	20	7	68	16	3
R15	52	65	72	20	7	90	38	25	95	43	30	83	31	18
R16	52	65	58	6	-	75	23	10	75	23	10	78	26	13
R17	52	65	58	6	-	81	29	16	81	29	16	79	27	14
R18	52	65	43	-	-	75	23	10	74	22	9	67	15	2
R19	52	65	44	-	-	70	18	5	70	18	5	68	16	3
R20	52	65	58	6	-	77	25	12	77	25	12	74	22	9
R21	52	65	52	-	-	72	20	7	72	20	7	72	20	7
R22	52	65	51	-	-	74	22	9	74	22	9	74	22	9
R23	52	65	43	-	-	68	16	3	68	16	3	67	15	2
R24	52	65	51	-	-	71	19	6	71	19	6	64	12	-
R25	52	65	43	-	-	63	11	-	63	11	-	60	8	-
R26	52	65	32	-	-	56	4	-	56		-	54	2	-

6.4.2.2 Future Stabling Yard noise

Predicted noise level for the existing stabling operations at nearby representative receivers during the night period are presented in Table 6-10. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX F.

Table 6-10: Sleep disturbance assessment (L_{Amax}) – Future operations (night)

Representative receiver	Screening level	Awakening reaction	Scenario 5			Scenario 6			Scenario 7			Scenario 8		
			Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance		Predicted noise level, L_{AFmax}, dB(A)	Exceedance	
				Screening level	Awakening reaction		Screening level	Awakening reaction		Screening level	Awakening reaction		Screening level	Awakening reaction
R1	52	65	70	18	5	75	23	10	77	25	12	92	40	27
R2	52	65	71	19	6	77	25	12	78	26	13	85	33	20
R3	52	65	67	15	2	90	38	25	90	38	25	81	29	16
R4	52	65	71	19	6	91	39	26	93	41	28	86	34	21
R5	52	65	61	9	-	87	35	22	87	35	22	84	32	19
R6	52	65	70	18	5	81	29	16	81	29	16	77	25	12
R7	52	65	48	-	-	77	25	12	77	25	12	71	19	6
R8	52	65	51	-	-	72	20	7	72	20	7	57	5	-
R9	52	65	59	7	-	76	24	11	73	21	8	74	22	9
R10	52	65	54	2	-	72	20	7	69	17	4	74	22	9
R11	52	65	58	6	-	64	12	-	64	12	-	76	24	11
R12	52	65	52	-	-	57	5	-	55	3	-	66	14	1
R13	52	65	41	-	-	55	3	-	55	3	-	64	12	-
R14	52	65	53	1	-	72	20	7	73	21	8	69	17	4
R15	52	65	70	18	5	79	27	14	81	29	16	90	38	25
R16	52	65	63	11	-	73	21	8	74	22	9	83	31	18
R17	52	65	57	5	-	83	31	18	83	31	18	79	27	14
R18	52	65	41	-	-	74	22	9	74	22	9	69	17	4
R19	52	65	46	-	-	67	15	2	67	15	2	70	18	5
R20	52	65	57	5	-	68	16	3	72	20	7	78	26	13
R21	52	65	55	3	-	66	14	1	72	20	7	74	22	9
R22	52	65	54	2	-	76	24	11	76	24	11	72	20	7
R23	52	65	44	-	-	66	14	1	69	17	4	66	14	1
R24	52	65	49	-	-	62	10	-	62	10	-	67	15	2
R25	52	65	39	-	-	66	14	1	66	14	1	60	8	-
R26	52	65	34	-	-	53	1	-	53	1	-	55	3	-

6.5 Discussion and mitigation and management review

6.5.1 Operational noise impacts

6.5.1.1 Existing

The noise modelling results demonstrate that the existing stabling activities exceed the project specific noise levels at many nearby noise sensitive receivers.

The existing stabling activities are modelled as exceeding the PSNL by greater than 20 dB(A) at some representative receivers. The maximum modelled exceedance level for representative receivers west of the Stabling Yard on Gladstone Avenue being 22 dB(A), and east of the Stabling Yard on West Street being 26 dB(A). However, when horn testing and preparation procedure testing noise events are not taking place, the maximum exceedances are 12 dB(A) when the trains are standing idle.

Predicted L_{AFmax} noise levels that could disturb sleep could exceed the sleep disturbance screening level of RBL +15 dB(A) by greater than 40 dB(A), and the awakening reaction by up to 30 dB(A). These noise impacts are as a result of horn testing during train preparation. However, when horn testing and preparation procedure testing events are not taking place, the maximum exceedances of the awakening reaction level is 5 dB(A) to the west of the Stabling Yard, and 7 dB(A) to the east of the Stabling Yard as a result of air releases forming part of the compressor cycle.

The key noise sources that generate the exceedances during the preparation process are:

- horn testing, and
- train compressed air system testing/releases.

6.5.1.2 Future

The noise modelling results demonstrate that the future stabling activities exceed the project specific noise levels at many nearby noise sensitive receivers. However, it is noted that even though the new 10-car NIF trains are longer than the existing, the number of train noise sources required during the night preparation periods is likely to be similar to the present situation. This can be seen in the predicted noise levels presented in Section 6.4, which shows similar noise levels are generally predicted for both the existing and future operational scenarios.

The key differences in noise impacts as a result of the new 10-car NIF's being stabled at the Wollongong Stabling Yard are likely to be as a result of the different locations of driver train cars where the major preparation related noise sources are located.

The future scenario is predicted to exceed the PSNL by greater than 20 dB(A) at some representative receivers. The maximum predicted exceedance level for representative receivers west of the Stabling Yard on Gladstone Avenue being 23 dB(A), and east of the Stabling Yard on West Street being 21 dB(A). However, when horn testing and preparation procedure testing events are not taking place, the maximum exceedances are 12 dB(A) when the trains are standing idle.

Predicted L_{AFmax} noise levels that could disturb sleep could exceed the sleep disturbance screening level of RBL +15dB(A) by up to 41 dB(A), and the awakening reaction by up to 28 dB(A). These noise impacts are a result of horn testing during train preparation. However, when horn testing and preparation procedure testing events are not taking place, the maximum exceedances of the awakening reaction level is 6 dB(A) to the west of the Stabling Yard, and 5 dB(A) to the east of the Stabling Yard as a result of air releases forming part of the compressor cycle.

The differences in the noise impacts for the future operational situation compared with the existing are mainly around the changing location of the driver cabs, which are the location of the key noise sources during preparation activities.

6.5.2 Recommended noise mitigation and management

The NPfI identifies that the range of noise reduction strategies for existing situations is generally more limited than those available for a new development at the planning stage. As such, the NPfI notes that the project noise trigger levels outlined in Section 3.4.4 are not to be used as mandatory noise limits when assessing noise emissions from the site but instead are to be used as noise levels to aid in determining what are feasible and reasonable noise control measures. The project noise trigger level is a level that would indicate a potential noise impact on the community if exceeded. This would 'trigger' a management response to identify feasible and reasonable mitigation and management controls.

Mitigation and management measures should be considered in a hierarchical approach as follows:

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

Furthermore, mitigation and management measures should be considered in parallel with effective community engagement, so that community preferences and expectations can be considered when assessing if mitigation and management measures are feasible and reasonable.

Below are details of some specific mitigation and management measures that should be considered when determining what would be reasonable and feasible to mitigate noise from the Stabling Yard. These options have been presented using the same hierarchical approach identified in the NPfI.

6.5.2.1 Controlling noise at the source

The following at-source mitigation and management controls should be reviewed to determine if they would be feasible and reasonable:

- Management practices so that trains are turned completely off once fully stabled and not in use.
- For existing and future rolling stock, investigate modifications to equipment and procedures for key noise generating sources (eg. compressors) during noise intensive activities (eg. testing and preparation procedures).
- For future rolling stock, review actual operational noise sources once the trains are being used within the Stabling Yard. Determine actual operational noise levels so that feasible and reasonable mitigation and management measures that provide the greatest benefits to residents at least cost can be identified.

6.5.2.1.1 Horn testing and usage

Drivers are required to test the horns as part of the preparation procedure. It is also a requirement of Sydney Trains operating procedures to sound the train horn to warn persons that the train is about to move. However, alternative approaches to horn testing and warning of train movements have been investigated and adopted at other Sydney Train facilities.

This noise assessment identifies that horn testing is one of the dominant noise sources at the Wollongong Stabling Yard. As part of the noise reduction program recommended in Section 6.5.2.4, alternative methods to testing or using horns within the Stabling Yard should be considered.

Potential options for horn testing would include testing of horns elsewhere on the network or developing an alternative testing methodology.

Similarly, alternative methodologies to sounding the horn prior to train movements should be investigated. Alternative methodologies to sounding the horn prior to train movements have been adopted at other Sydney Train facilities. Similar approaches to these should be considered to determine if they would be feasible and reasonable at the Wollongong Stabling Yard.

6.5.2.2 Controlling the transmission of noise (eg. noise barriers)

6.5.2.2.1 Noise barriers

When considering noise controls in the noise transmissions path, consideration should be given to the site specific limitations, such as the effectiveness of noise barriers to control noise impacts at receivers in addition to any negative impacts from the installation of noise barriers, such as unappealing visual impacts to the local community (eg. graffiti) or loss of view.

Limitations at the Wollongong Stabling Yard such as residential receivers being directly adjacent to the facility and located on-top of an approximately 3 metre retaining wall, significantly reduces the effectiveness of on-site noise mitigation measures to reduce noise levels at adjacent residential receivers. This is especially so for multi-storey residences which directly overlook the Stabling Yard.

Noise barriers only become effective when they break the line-of-sight between the source and receiver, which would mean that noise barriers in excess of five metres height would be required along the boundary of receivers in Gladstone Avenue. Five metre high barriers (or higher) would likely impede residential views to the east and natural breeze. As such, noise barriers in excess of 5 metres are likely not considered feasible or reasonable.

6.5.2.2.2 Stabling locations and shielding from adjacent trains

Prioritisation of stabling trains that will prepare and depart the stabling facility during periods when nearby receivers are most noise sensitive (eg. 2:00am to 5:00am) should be considered. This is so that the stabling location of these trains would maximise both the distance to the receiver and the local acoustic shielding (eg. from adjacent trains) of key train noise sources (eg. compressors or horns) for nearby noise sensitive receivers.

6.5.2.3 Mitigation measures at noise sensitive receivers

Due to the limited possibilities for on-site mitigation or noise barriers, it is recommended that noise controls at noise sensitive receivers be considered following the implementation of all other feasible and reasonable mitigation measures. The NPfI aims to protect the external amenity, which is why noise controls at source or along the noise propagation path are preferred over noise treatments at a receiver property. However, once all source and transmission path mitigation and management measures have been considered and implemented where feasible and reasonable, at-receiver treatments should be considered. The overall goal of building treatments is to provide similar acoustic amenity and internal noise levels to those experienced within a receiver building where the external noise criteria have been met. These would likely take the form of building treatments, and where suitable, may comprise some of the following elements:

- Fresh air ventilation systems that allow existing windows and doors to remain closed
- Sealing of wall vents
- Upgrading window and door seals, and/or
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only. Upgrading of windows and doors typically provides negligible acoustic benefit for light-weight framed structures.

6.5.2.4 Noise reduction program

Based upon the outcomes of this assessment, it is recommended that a noise reduction program, as outlined in Section 6.2 of the NPfI, be developed in order to provide a formal and structured approach

to reduce noise from the Stabling Yard to acceptable levels over time, by applying reasonable and feasible control measures.

A noise reduction program would review the site-specific activities and investigate and identify feasible and reasonable noise mitigation and management measures. This process will take into consideration community preferences and expectations in order to provide noise reduction benefits for nearby noise sensitive receivers.

The NPfI notes that for existing sites the initial focus should be on operational procedures and prioritising noise-control measures that provide the greatest benefits to residents at least cost. The applicability, effectiveness and cost of particular mitigation measures often depend strongly onsite variables. A number of potential mitigation and management measures have been identified in Section 6.5.2.1, Section 6.5.2.2 and Section 6.5.2.3, which should be considered as part of this review

As part of this review, high noise level activities such as horns or compressed air releases should be reviewed for their potential extent of impacts under prevailing noise-enhancing meteorological conditions. As identified in Section 6.3.2, there is potential for noise levels to increase at distant receiver locations when temperature inversions or source-to-receiver winds of 3 m/s are present.

As outlined in the NPfI, a program would review the specific activities that occur as part of the stabling operations and take into consideration the site-specific requirements of the nearby noise sensitive receivers. The program would include the following elements:

- The aim and scope of the program.
- Identification of noise levels and targets for the site.
- Time frame for implementation of measures.
- An upper limit for new equipment.
- An upper limit for partial upgrades of the site.
- Plans to eliminate problematic characteristics that have been identified, such as tonal, low-frequency noise and intermittent noise (eg. horn testing).
- Noise level targets for relevant sections of the site.
- Operating practices to reduce noise emissions.
- Training and awareness initiatives.
- A noise monitoring procedure and timeframe to verify the effectiveness of noise mitigation and management measures. Verification of new rolling stock noise levels should be undertaken within 6 months of the commencement of their use within the Stabling Yard.
- An ongoing monitoring program to evaluate noise-emission levels over time.
- Communicating with the affected community using tools such as a complaint handling process, liaison group or newsletters.

As identified in Section 6.5.2.3, due to the limited possibilities for on-site mitigation or noise barriers, it is recommended that noise controls at noise sensitive receivers be considered as part of the noise reduction program following the implementation of all other feasible and reasonable mitigation measures.

7 Conclusion

This noise and vibration impact assessment has been prepared as part of the REF to describe and assess the noise and vibration impacts associated with the Wollongong Stabling Yard upgrade and Wollongong Station platform extension works. The proposed works are part of the MTMS program of work packages required to support the introduction of the 10-car NIF trains on the South Coast Line.

The noise and vibration assessment has investigated potential impacts from:

- Construction of the Wollongong Stabling Yard upgrade and Wollongong Station Long 10-car NIF enabling works.
- Railway noise impacts from removing and replacing existing turnouts and upgrading signalling equipment:
  - in the same location at Wollongong Stabling Yard
  - in a new location 12-13 metres south of the existing locations
- Operational noise impact from changes to the Stabling Yard to accommodate the stabling of eight 10-car NIF trains.

7.1 Construction noise and vibration assessment

An assessment of construction noise impact from the proposed Wollongong Stabling Yard upgrade and Wollongong Station platform extension works has been undertaken. Noise emissions from the construction works at the Stabling Yard and Station has been predicted and assessed against the relevant noise criteria set by the Interim Construction Noise Guideline (NSW EPA 2009) during the recommended standard hours for construction. Potential impact from out-of-hours construction works during rail possession periods has also been assessed.

Receivers further away from the works may be noise affected during high noise impact works, however construction noise levels are likely to comply with the NMLs for other activities. The receivers that are located near to the Station and Stabling Yard would be more noise affected by the construction works, with some potentially highly affected receivers as a result of noisier construction activities.

Potential vibration impacts at vibration sensitive structures and buildings, including heritage receivers has been assessed against the relevant guidelines for structural damage from vibration and for human disturbance. The risk of structural damage to property is assessed as very low to negligible for most receivers, including heritage structures on the station platforms. A review of vibration impacts would be undertaken at the detailed design phase to confirm the risk of impact is low to negligible, in particular in relation to heritage structures and to ensure impacts are managed and mitigated where feasible.

Recommendations are provided in Section 4.4 to manage and/or minimise noise and vibration impacts where they occur.

7.2 Railway noise assessment

The potential noise impact from the Wollongong Stabling Yard upgrade and 10-car NIF enabling works at Wollongong Station have been reviewed against the Rail Infrastructure Noise Guideline (EPA 2013).

At Wollongong Stabling Yards these works represent a reconditioning and replacement of the existing rail infrastructure, and no change in noise level is predicted. Changes to Stabling Yard operations are assessed separately.

At Wollongong Station, the changes to the trackwork and signalling as a result of the 10-car NIF enabling works results in negligible change in noise level at the nearest residential receivers. The risk of potential noise impact is considered low and further detailed assessment of noise mitigation measures is not required.

7.3 Operational noise assessment – Stabling Yard

Noise impacts from both the existing and future Wollongong Stabling Yard operations have been assessed. Noise measurements were undertaken of the existing Stabling Yard activities in or to quantify the existing noise levels from the key noise generating activities are part of Stabling Yard operations.

The Wollongong Stabling Yard is an existing Stabling Yard which has been operating for more than 10 years. The future operations of the Stabling Yard are not proposed to substantially change from the existing situation. The only differences that influence the noise emissions from the stabling activities are:

- New trains – 10-car NIF trains
- Trains will now be stabled in the new electrified siding No.2 in the Up yard
- As the NIF trains are 10-car sets, compared with the existing 4-car or 8-car sets, the stabling locations of trains will be reconfigured.

Noise goals were established in accordance with the NPfI. Section 6 of the NPfI acknowledges that many existing industrial sources and facilities were designed for higher noise emission levels than the project trigger levels derived in accordance with the policy, as is the case for Wollongong Stabling Yard.

The key source of noise emissions during stabling operations is the preparation activities such as brake testing and horn testing that are required prior to trains departing the facility. The preparation activities generate the greatest noise emissions from the stabling activities, and also are required to occur between the period starting from around 3 am, which is the most sensitive period for nearby noise sensitive receivers.

The outcomes of the assessment have identified that even though the noise emissions are unlikely to significantly change, they significantly exceed the project trigger noise level for the project.

Based upon the outcomes of this assessment, it is recommended that a noise reduction program, as outlined in Section 6.2 of the NPfI, be developed in order to provide a formal and structured approach

to reduce noise from the Stabling Yard to acceptable levels over time, by applying reasonable and feasible control measures.

The noise reduction program would review site-specific activities and investigate and identify feasible and reasonable noise mitigation and management measures that can be adopted at the Stabling Yard. The review would take into consideration the community preferences and expectations in order to provide noise reduction benefits for nearby noise sensitive receivers. A number of potential mitigation and management measures to control noise at the source, along the transmission path, and at the receivers have been identified in Section 6.5. These measures should be considered when determining feasible and reasonable mitigation and management measures as part of this program.

References

1. Environment Protection Authority 2013 NSW Rail Infrastructure Noise Guideline (RING)
2. Environment Protection Authority 2016 NSW Noise Policy for Industry (NPfI)
3. Transport for NSW 2018 Construction Noise and Vibration Strategy (CNVS)
4. Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline (ICNG),
5. Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline (AVTG)
6. British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)
7. British Standard BS 7385: Part 2-2009 Evaluation and Measurement for Vibration in Buildings
8. German Standard DIN 4150-3: 1999-02, Structural vibration - Effects of vibration on structures, February 1999
9. ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
10. BS5228.2 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration
11. Australian Standard AS/NZS 2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors*

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our daytime environment:

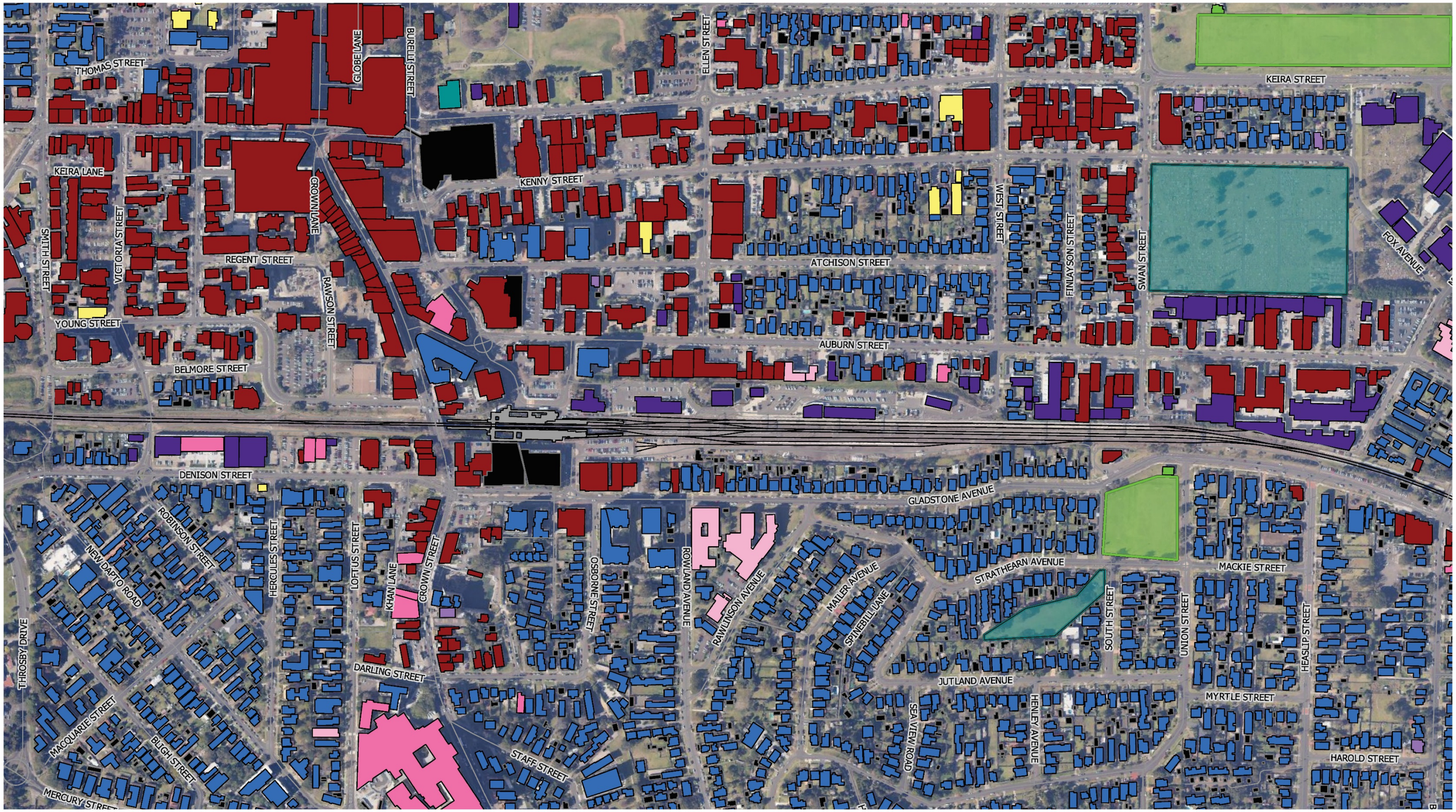
threshold of hearing	0 dB	The faintest sound we can hear
	10 dB	Human breathing
almost silent	20 dB	
	30 dB	Quiet bedroom or in a quiet national park location
generally quiet	40 dB	Library
	50 dB	Typical office space or ambience in the city at night
moderately loud	60 dB	CBD mall at lunch time
	70 dB	The sound of a car passing on the street
loud	80 dB	Loud music played at home
	90 dB	The sound of a truck passing on the street
very loud	100 dB	Indoor rock band concert
	110 dB	Operating a chainsaw or jackhammer
extremely loud	120 dB	Jet plane take-off at 100m away
threshold of pain	130 dB	
	140 dB	Military jet take-off at 25m away

dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.

Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Locality Map and Land Use Survey

B.1 Locality Map and Land Use Survey



Legend

- Residential
- Chilcare centre
- Education
- Medical
- Mixed use
- Place of worship
- Other sensitive receiver
- Outdoor active recreation
- Outdoor active recreation (open space)
- Outdoor passive recreation
- Outdoor passive recreation (open space)
- Commercial
- Industrial
- Non-sensitive
- Railway station
- Railway

80 0 80 160 240 m

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:
Jacobs Group (Australia) Pty Ltd

Project:
More Trains More Services
Package B PAC
B2 Wollongong

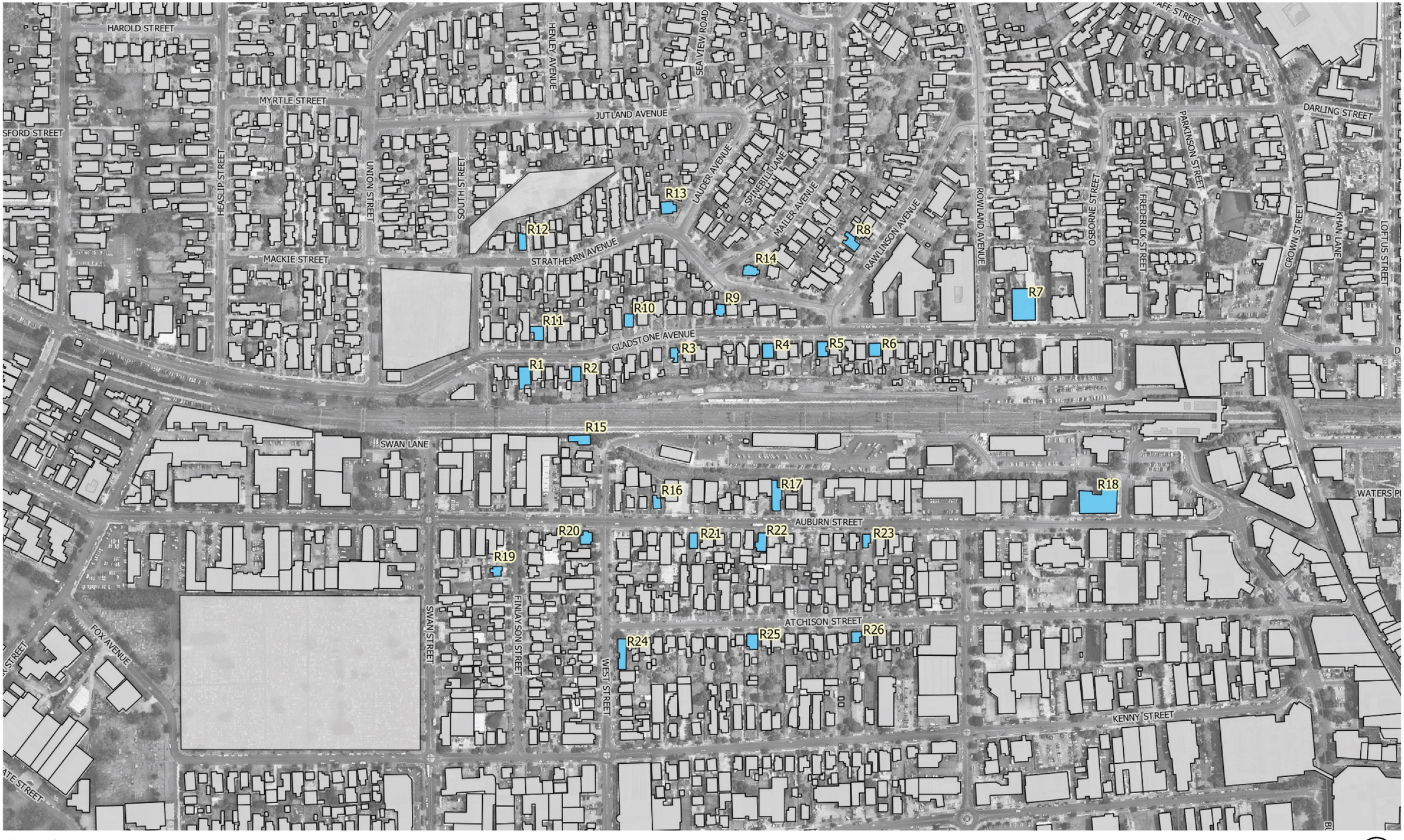
Description:
Receiver types

Figure No: TK877-01-B2-LU (r1)
Date: 25.07.2019
Created by: AMo

Rev: R1
Sheet: A3
Scale: 1:5000

B.2 Operational assessment representative receivers locations

50 0 50 100 150 200 m



Legend

Representative receiver building

Client:
Jacobs

Project:
MTMS
Wollongong Stabling Yard

Notes:
1. For information only and not for construction.
2. This information is protected by copyright.

Description:
Operational noise assessment - Representative receiver locations

RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Created by: ALE
Figure No: TK877-01 6 1 2 B2-006 (r0)
Date: 25-07-2019
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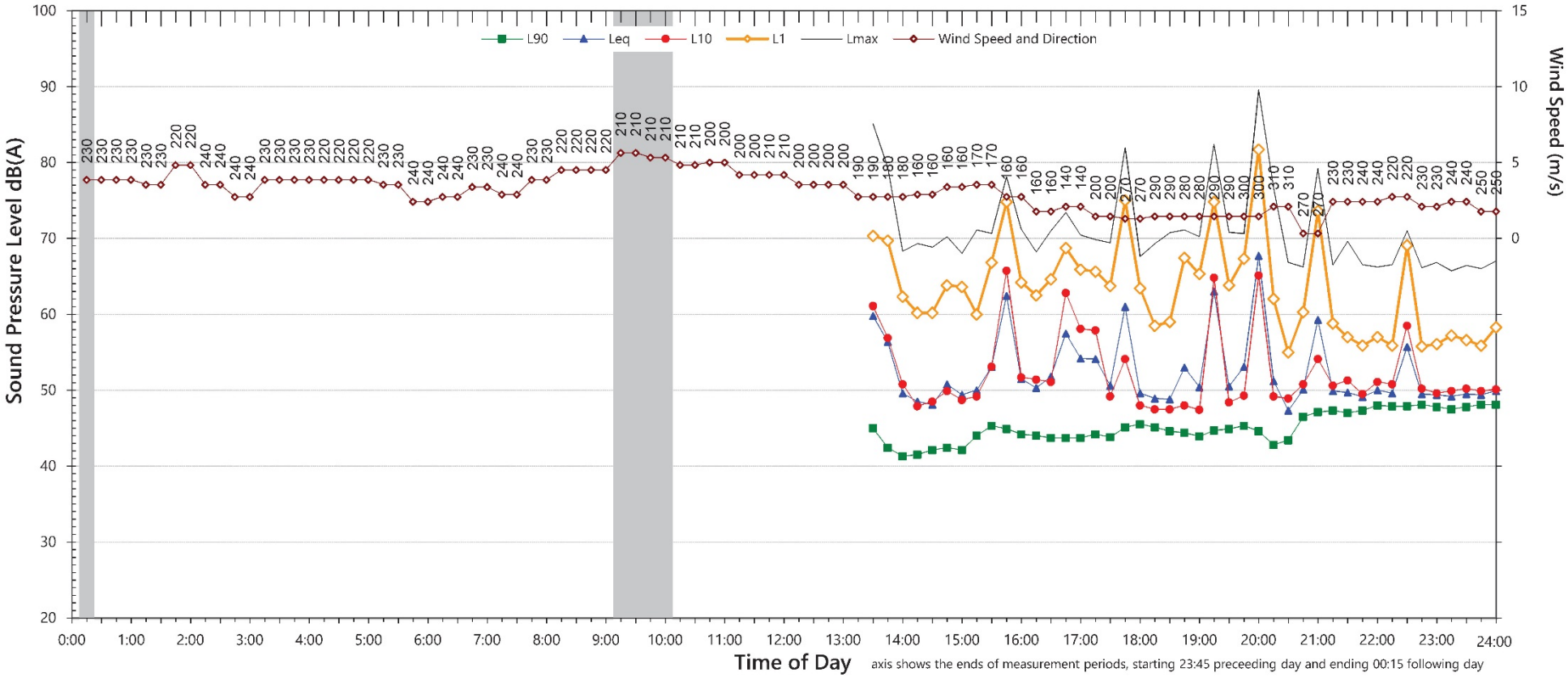
APPENDIX C Existing acoustic environment

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Monday, 6 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	44	47
LAeq	-	58	52

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	67	to	85
L_{Max} - L_{eq} (Range)	17	to	31

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59	55
$L_{eq\ 1hr}$ upper 10 percentile	61	56
$L_{eq\ 1hr}$ lower 10 percentile	52	52

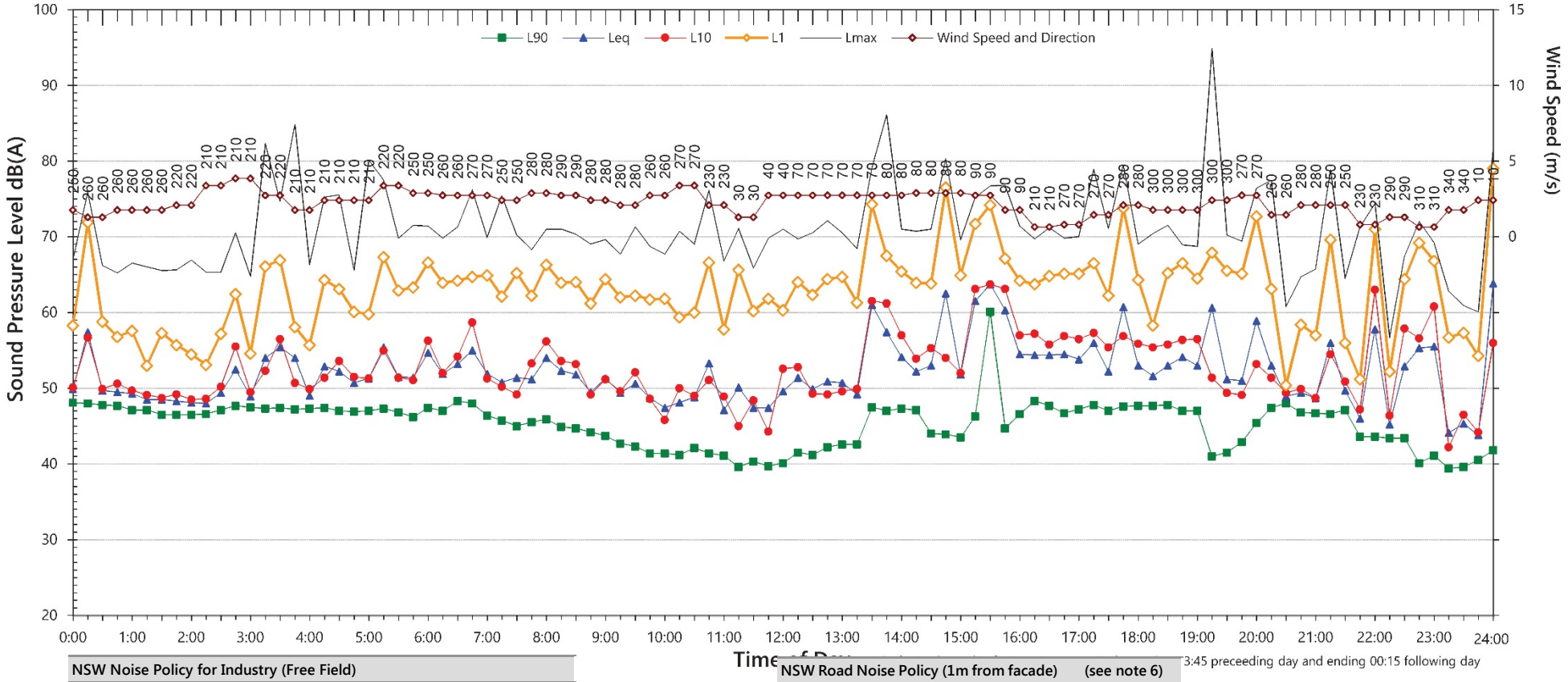
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Tuesday, 7 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	41	42	39
LAeq	55	55	55

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	96
L_{Max} - L_{eq} (Range)	18	to	37

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58	57
$L_{eq\ 1hr}$ upper 10 percentile	60	61
$L_{eq\ 1hr}$ lower 10 percentile	52	50

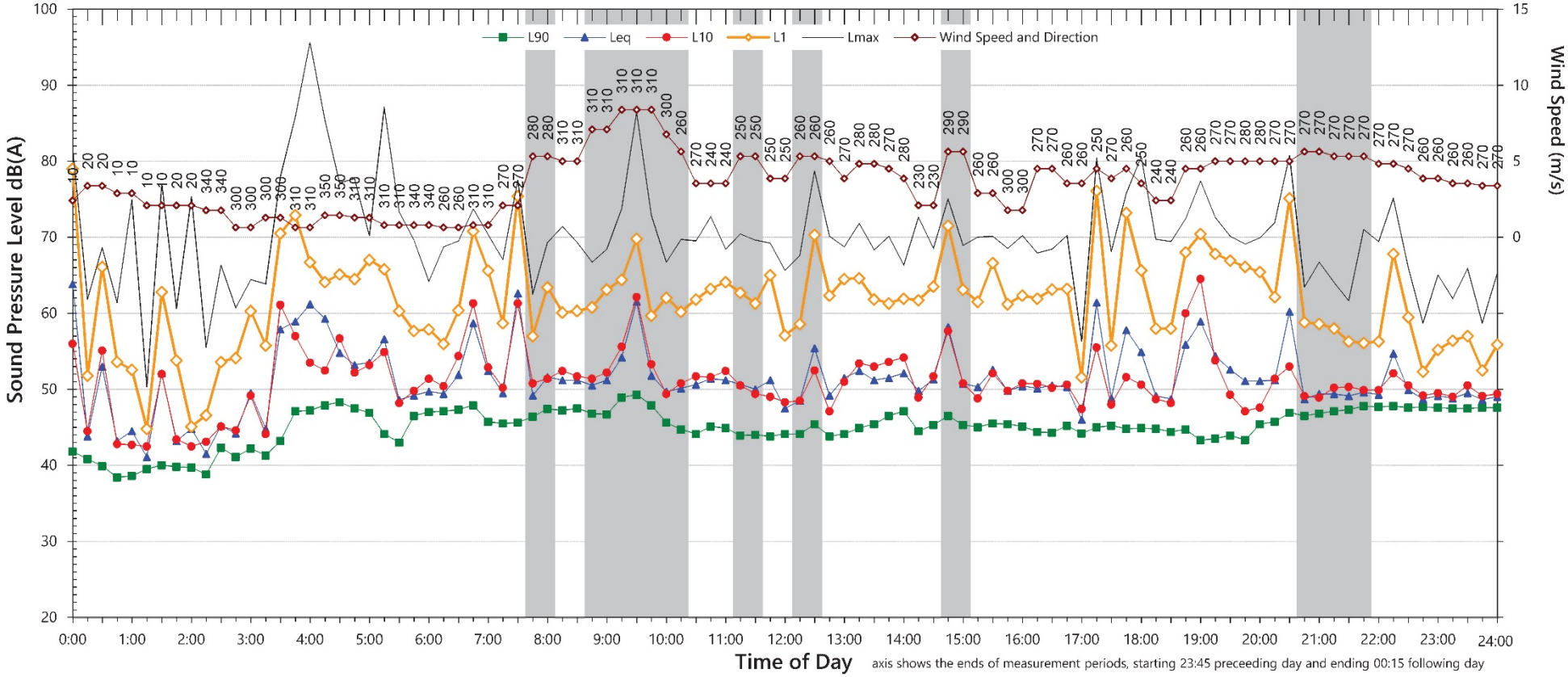
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Wednesday, 8 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	46
LAeq	-	-	55

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57	57
$L_{eq\ 1hr}$ upper 10 percentile	60	61
$L_{eq\ 1hr}$ lower 10 percentile	52	52

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	99
L_{Max} - L_{eq} (Range)	17	to	40

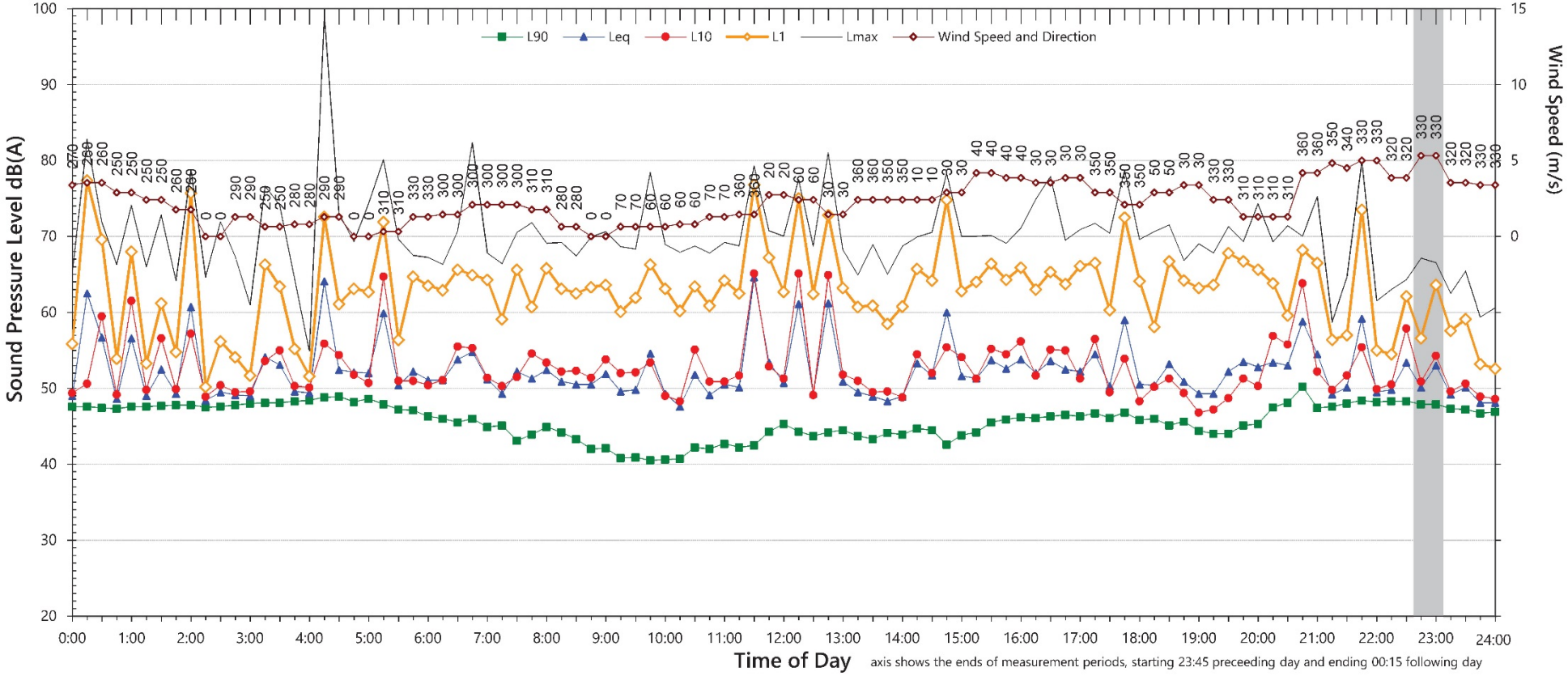
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Thursday, 9 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	41	44	47
LAeq	55	54	54

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	96
L_{Max} - L_{eq} (Range)	16	to	37

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57	57
$L_{eq\ 1hr}$ upper 10 percentile	60	58
$L_{eq\ 1hr}$ lower 10 percentile	53	51

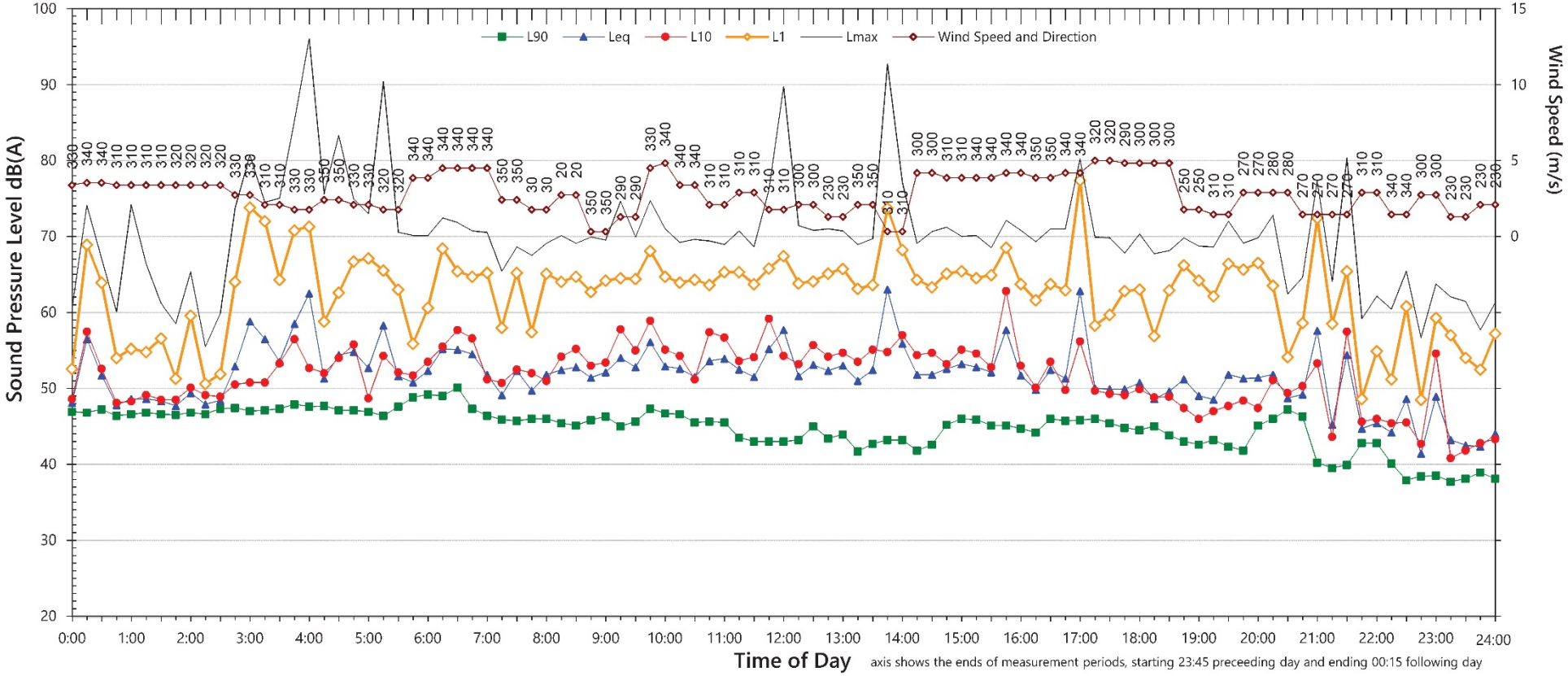
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Friday, 10 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	43	40	38
LAeq	54	51	46

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56	49
$L_{eq\ 1hr}$ upper 10 percentile	59	51
$L_{eq\ 1hr}$ lower 10 percentile	52	46

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	75
L_{Max} - L_{eq} (Range)	19	to	29

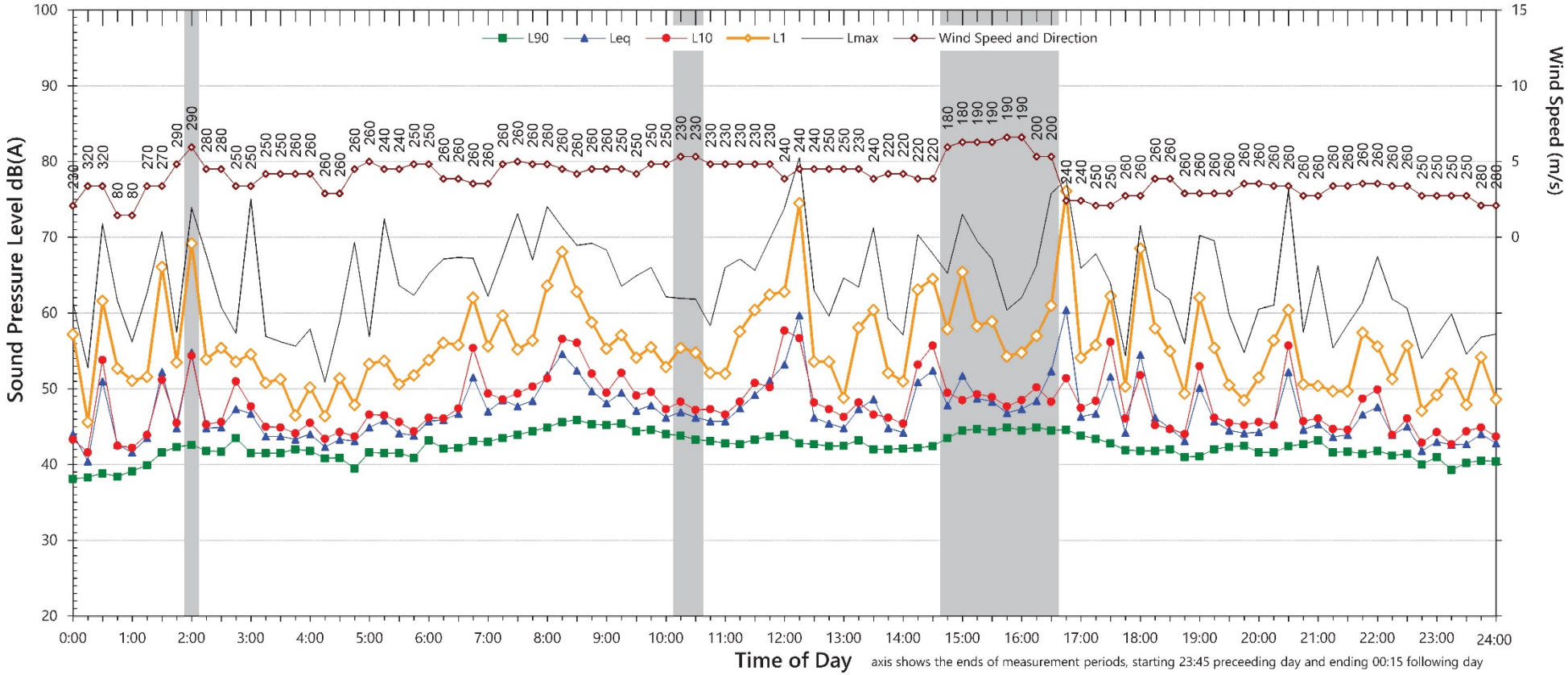
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Saturday, 11 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	41	40
LAeq	-	47	48

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53	50
$L_{eq\ 1hr}$ upper 10 percentile	56	53
$L_{eq\ 1hr}$ lower 10 percentile	48	46

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	67	to	74
L_{Max} - L_{eq} (Range)	17	to	28

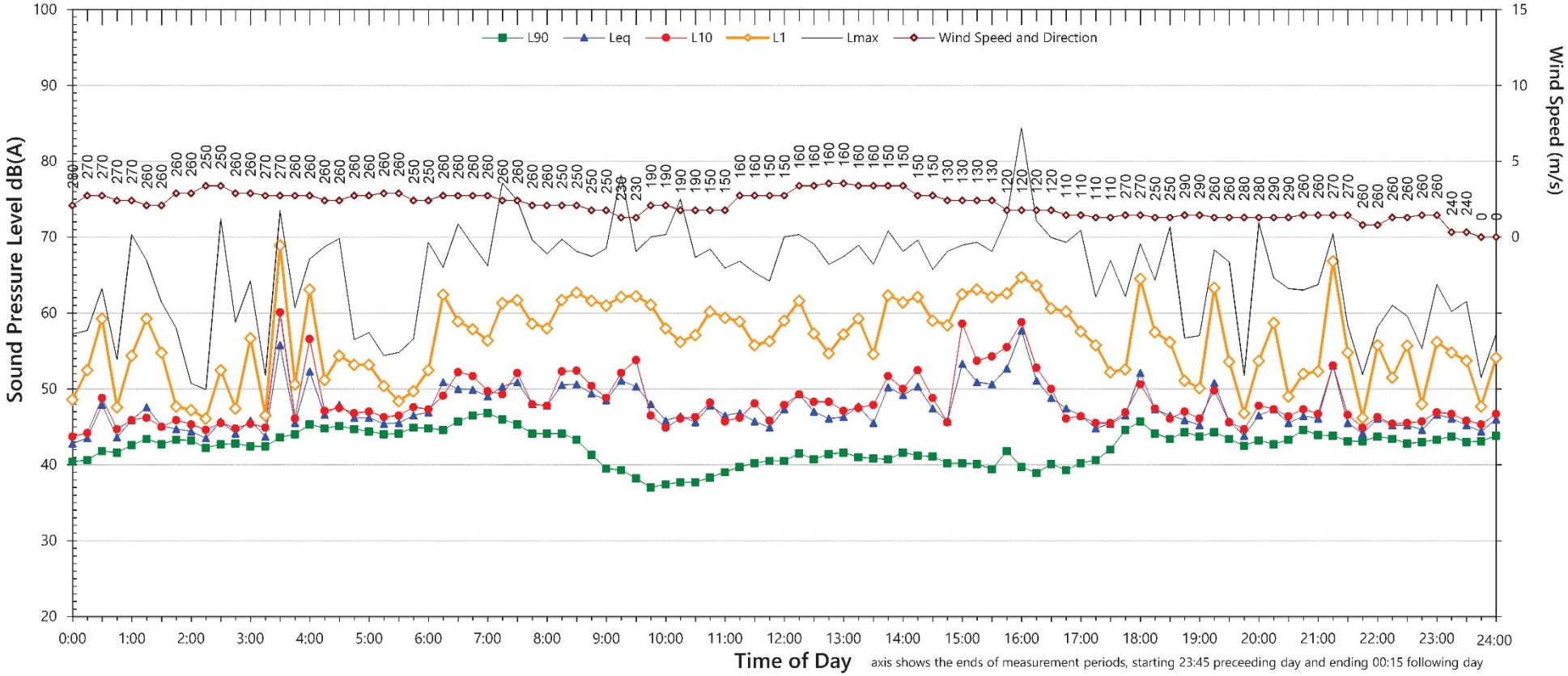
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Sunday, 12 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	38	43	42
LAeq	50	47	52

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	95
L_{Max} - L_{eq} (Range)	16	to	39

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	55
$L_{eq\ 1hr}$ upper 10 percentile	53	59
$L_{eq\ 1hr}$ lower 10 percentile	49	48

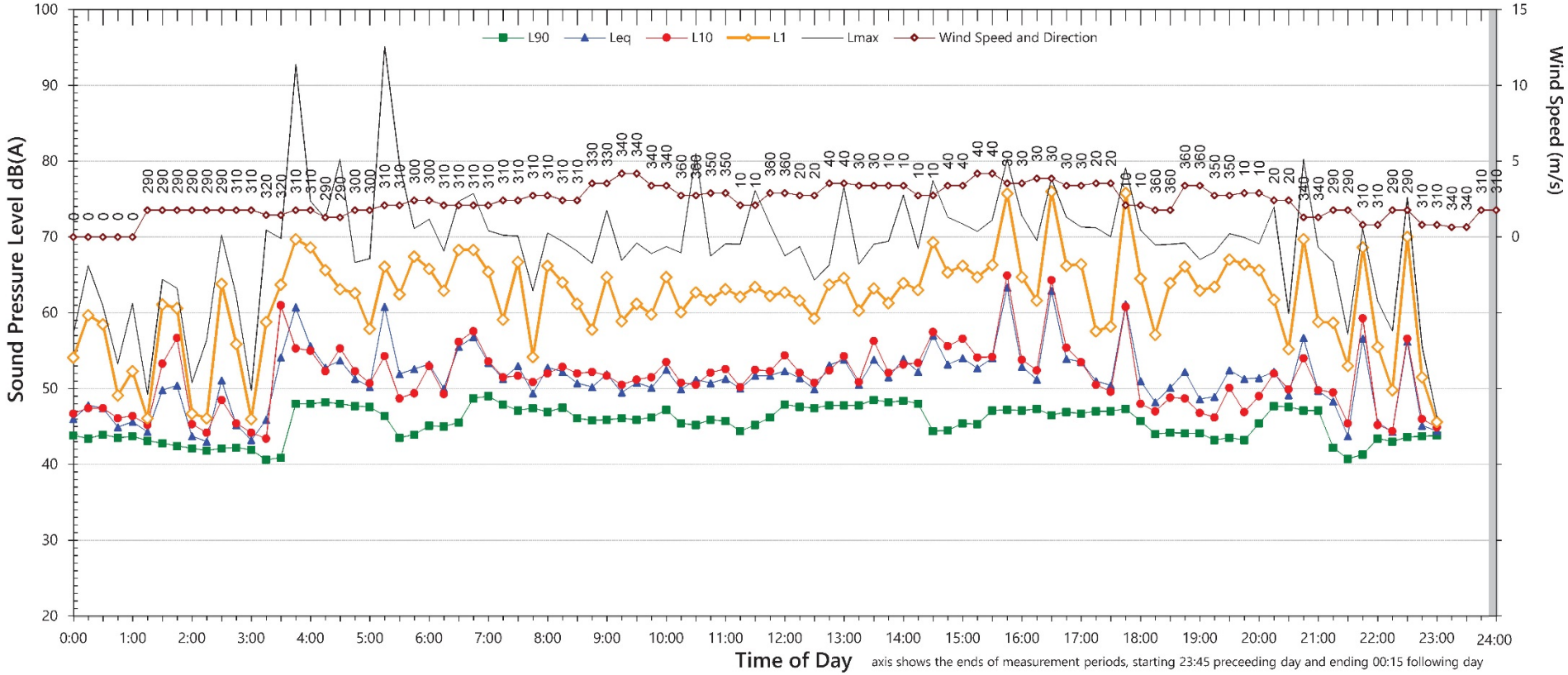
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

39 Gladstone Avenue Wollongong

Monday, 13 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	45	42	-
LAeq	54	52	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	75	to	75
L_{Max} - L_{eq} (Range)	24	to	24

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56	54
$L_{eq\ 1hr}$ upper 10 percentile	60	54
$L_{eq\ 1hr}$ lower 10 percentile	53	54

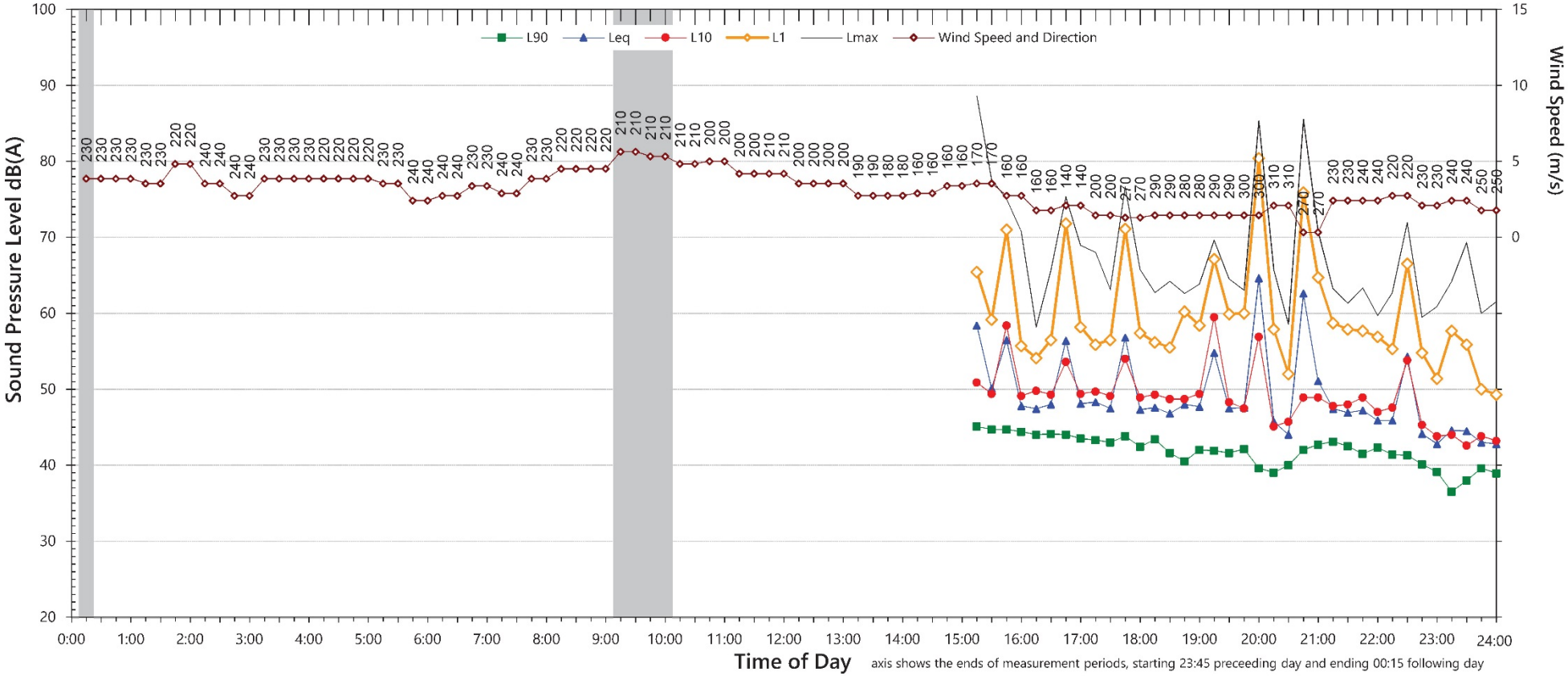
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone AveWollongong

Monday, 6 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	40	38
LAeq	-	56	50

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	85
L_{Max} - L_{eq} (Range)	18	to	29

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57	52
$L_{eq\ 1hr}$ upper 10 percentile	60	53
$L_{eq\ 1hr}$ lower 10 percentile	50	47

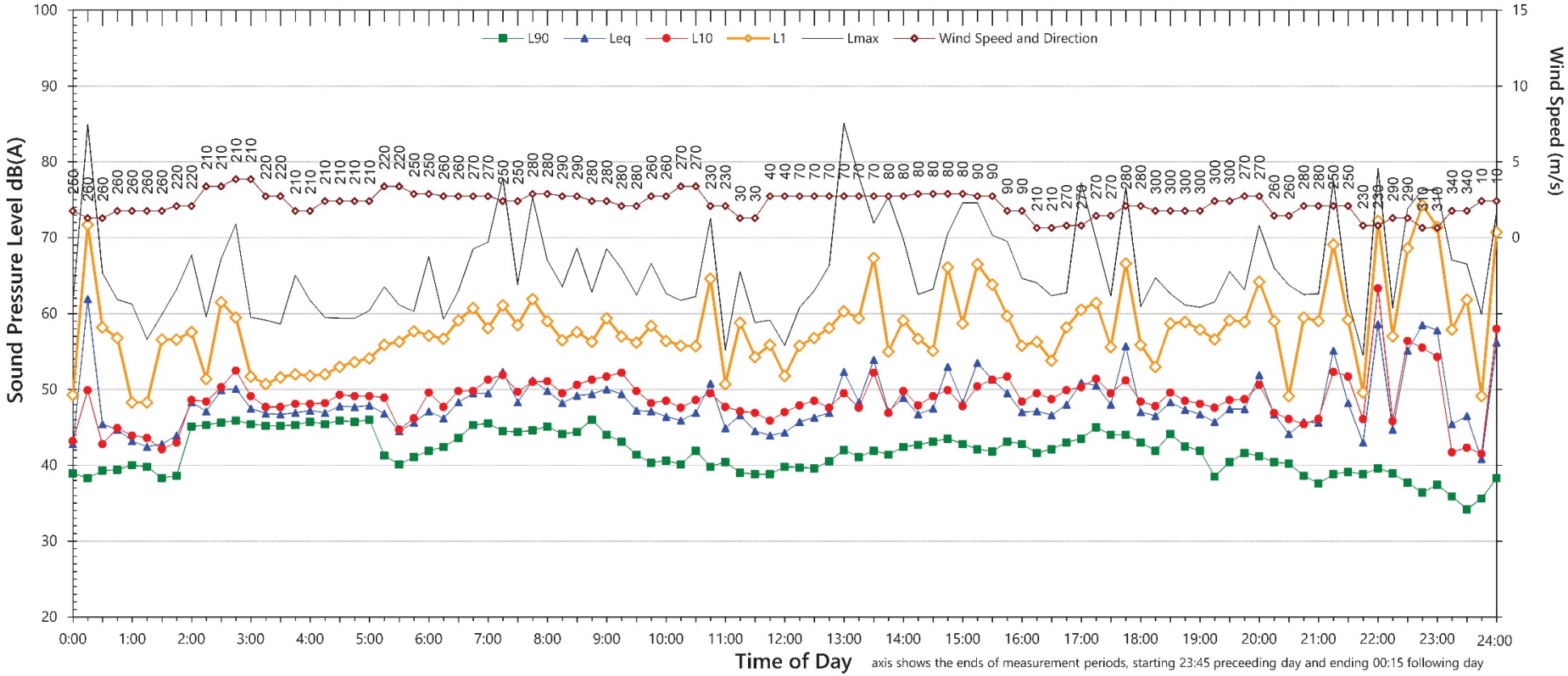
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone AveWollongong

Tuesday, 7 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	40	39	34
LAeq	49	50	51

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	53
$L_{eq\ 1hr}$ upper 10 percentile	54	55
$L_{eq\ 1hr}$ lower 10 percentile	49	49

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	71	to	80
L_{Max} - L_{eq} (Range)	18	to	29

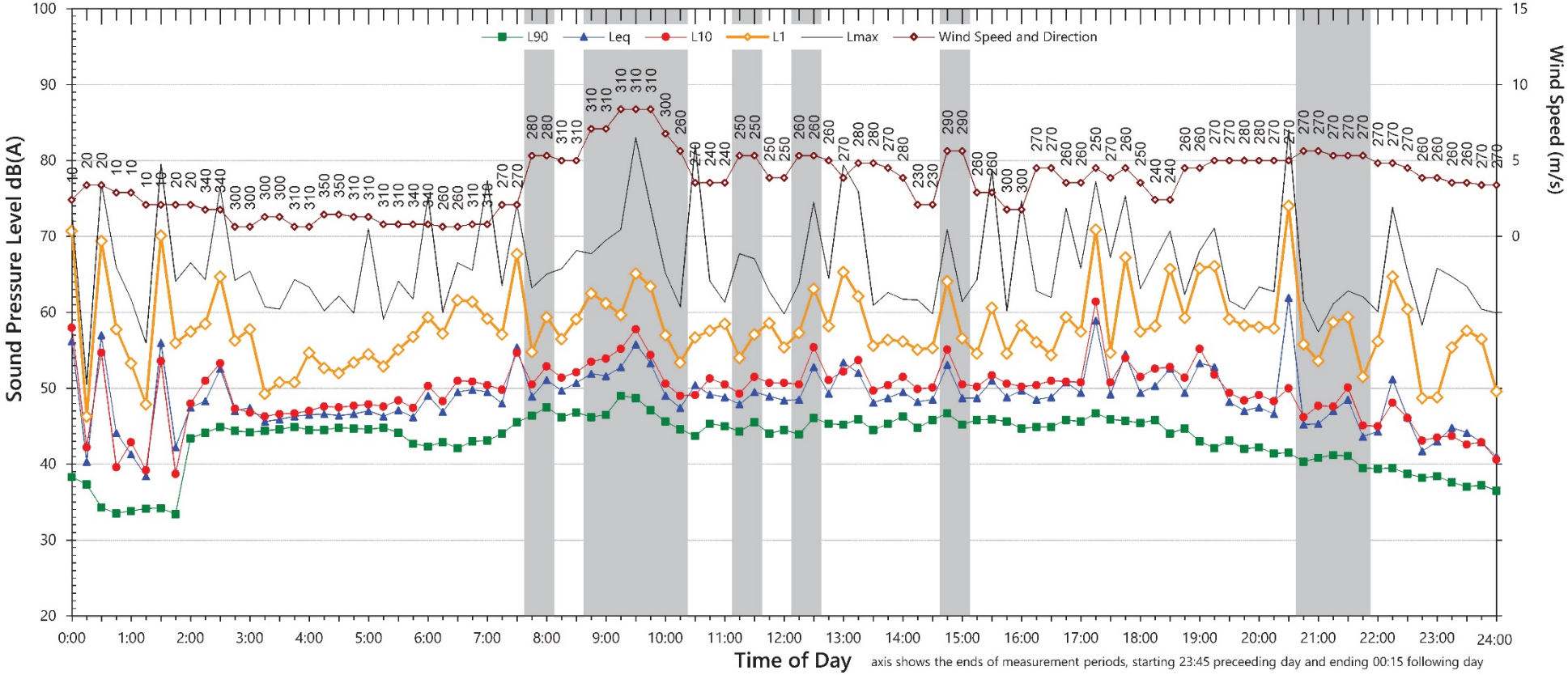
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Wednesday, 8 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	37
LAeq	-	-	51

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55	53
$L_{eq\ 1hr}$ upper 10 percentile	57	55
$L_{eq\ 1hr}$ lower 10 percentile	51	48

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	82
L_{Max} - L_{eq} (Range)	16	to	28

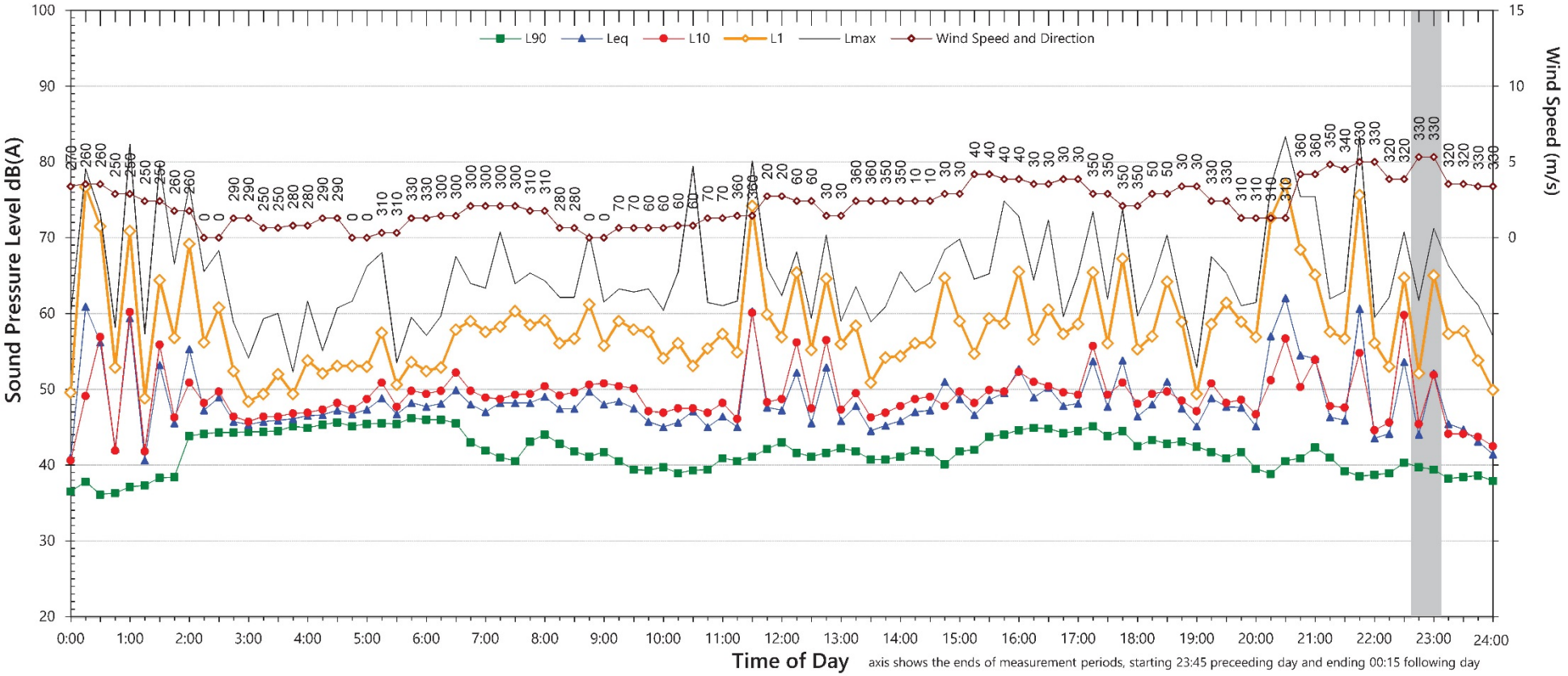
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Thursday, 9 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	39	39	37
LAeq	50	54	51

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	86
L_{Max} - L_{eq} (Range)	20	to	35

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	54	53
$L_{eq\ 1hr}$ upper 10 percentile	57	55
$L_{eq\ 1hr}$ lower 10 percentile	49	49

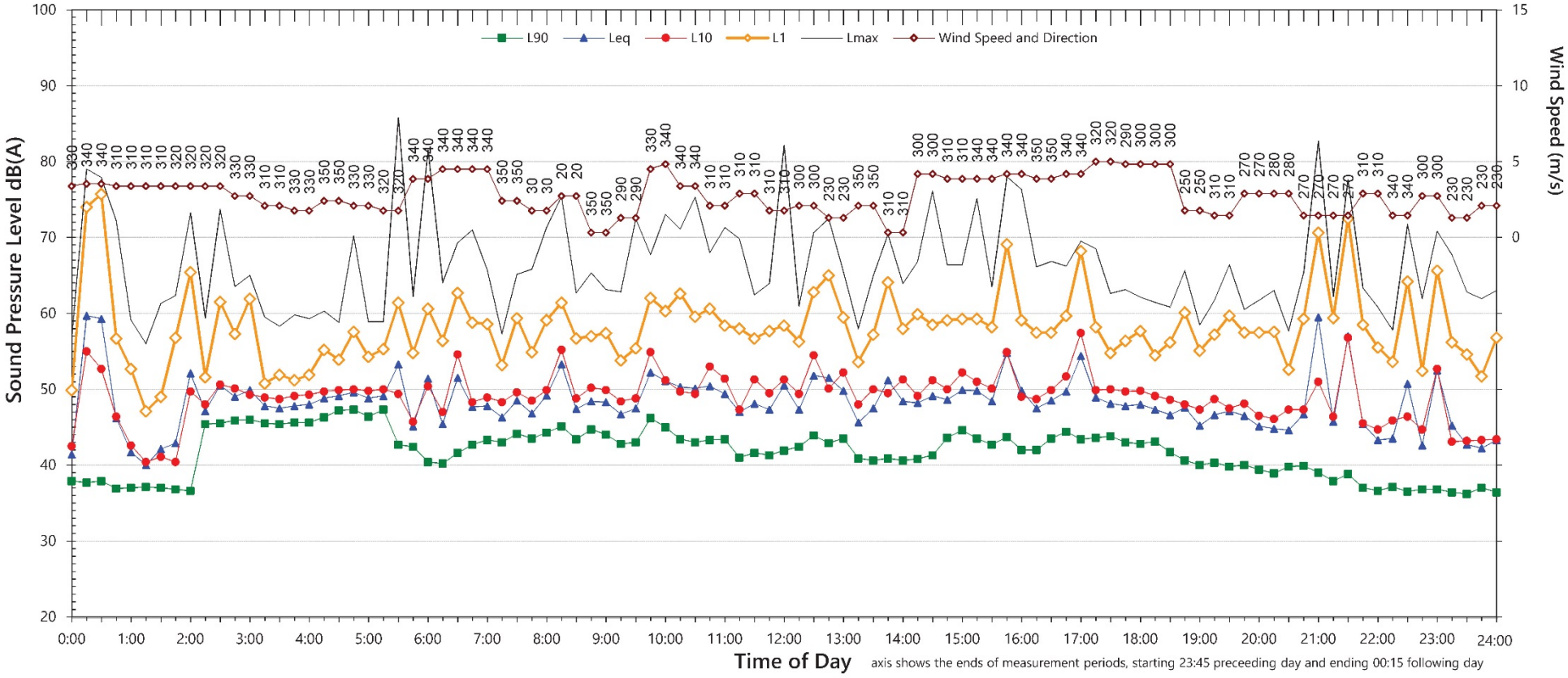
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Friday, 10 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	41	37	36
LAeq	50	51	47

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	75
L_{Max} - L_{eq} (Range)	16	to	26

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53	49
$L_{eq\ 1hr}$ upper 10 percentile	54	52
$L_{eq\ 1hr}$ lower 10 percentile	50	45

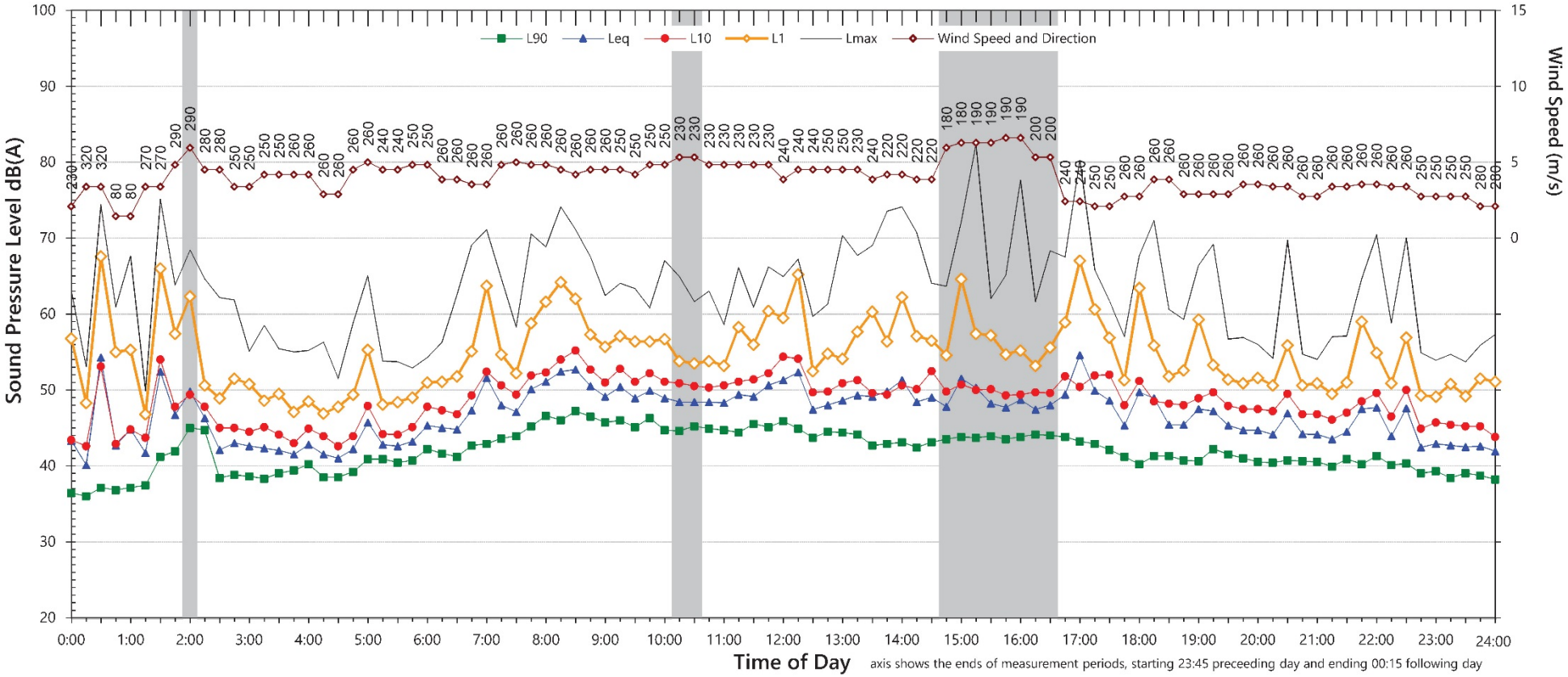
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Saturday, 11 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	40	38
LAeq	-	46	45

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	71
L_{Max} - L_{eq} (Range)	15	to	25

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	47
$L_{eq\ 1hr}$ upper 10 percentile	54	49
$L_{eq\ 1hr}$ lower 10 percentile	48	45

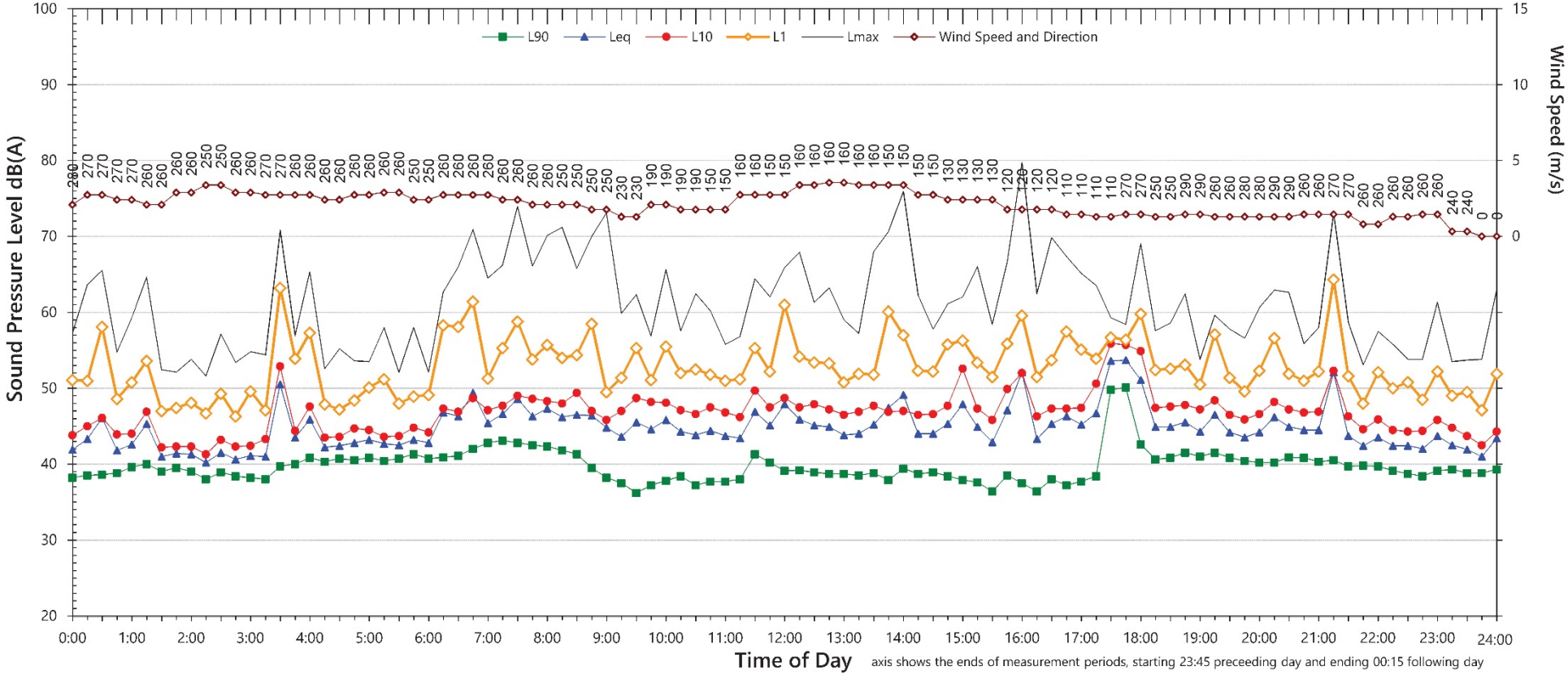
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Sunday, 12 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	37	40	38
LAeq	47	46	46

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	72	to	86
L_{Max} - L_{eq} (Range)	17	to	35

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	49	49
$L_{eq\ 1hr}$ upper 10 percentile	50	53
$L_{eq\ 1hr}$ lower 10 percentile	47	45

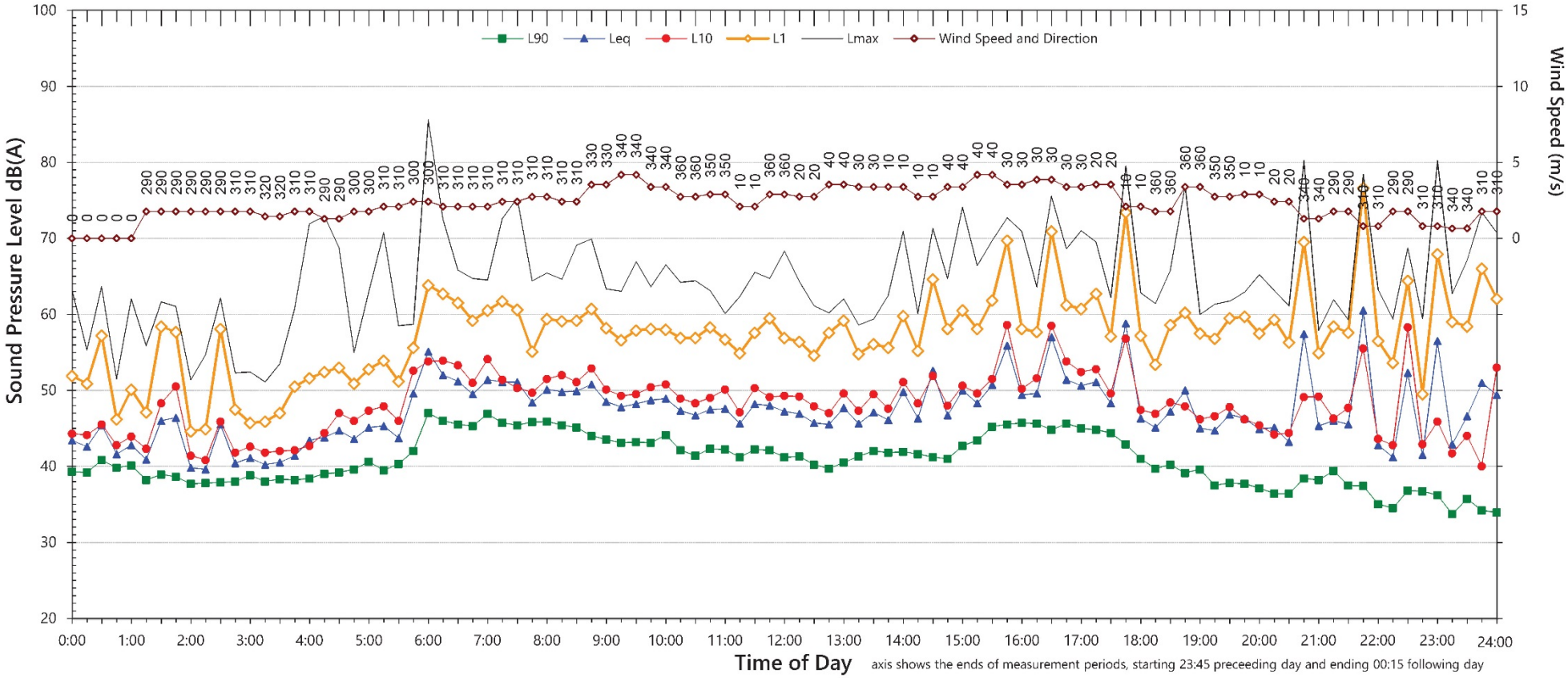
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone Ave Wollongong

Monday, 13 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	41	36	34
LAeq	50	51	50

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	82
L_{Max} - L_{eq} (Range)	18	to	30

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53	52
$L_{eq\ 1hr}$ upper 10 percentile	56	55
$L_{eq\ 1hr}$ lower 10 percentile	49	48

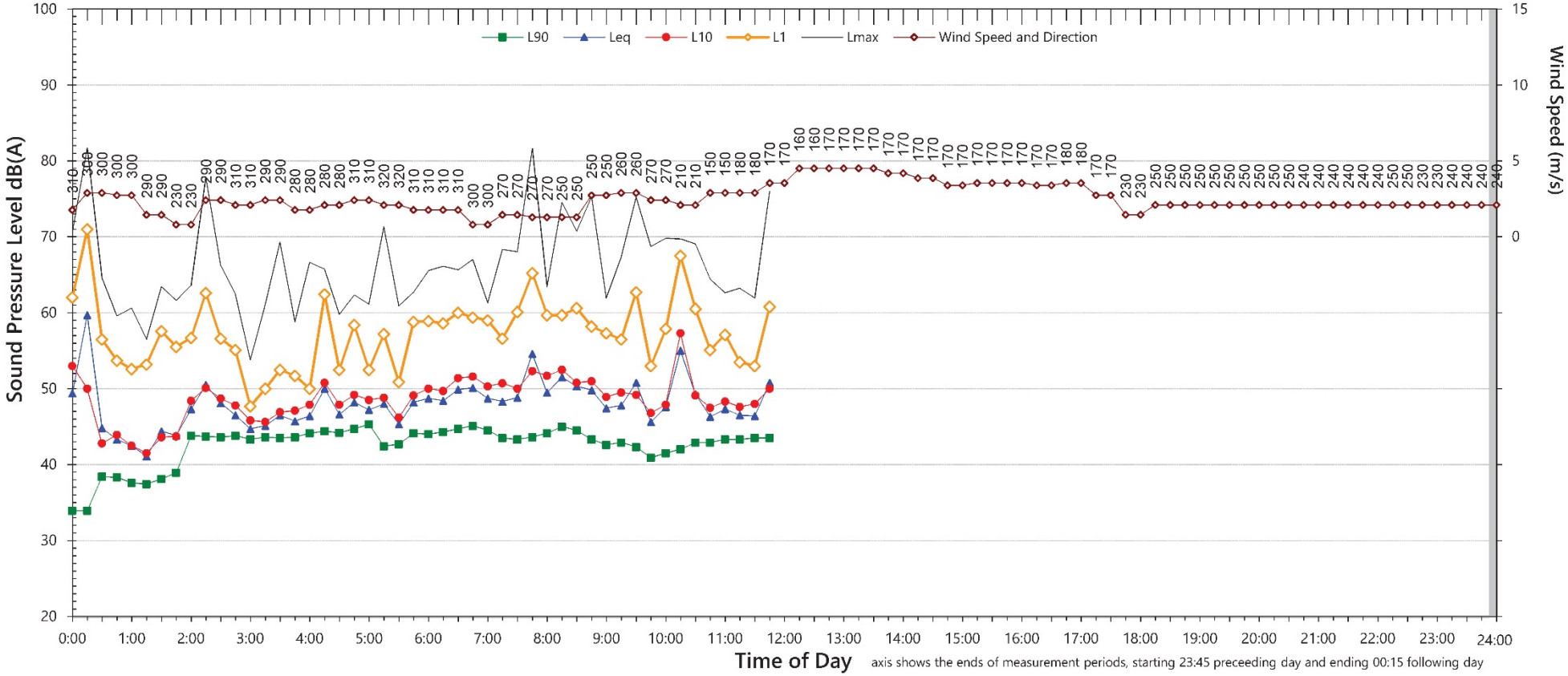
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

81 Gladstone AveWollongong

Tuesday, 14 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	-
LAeq	-	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53	-
$L_{eq\ 1hr}$ upper 10 percentile	54	-
$L_{eq\ 1hr}$ lower 10 percentile	51	-

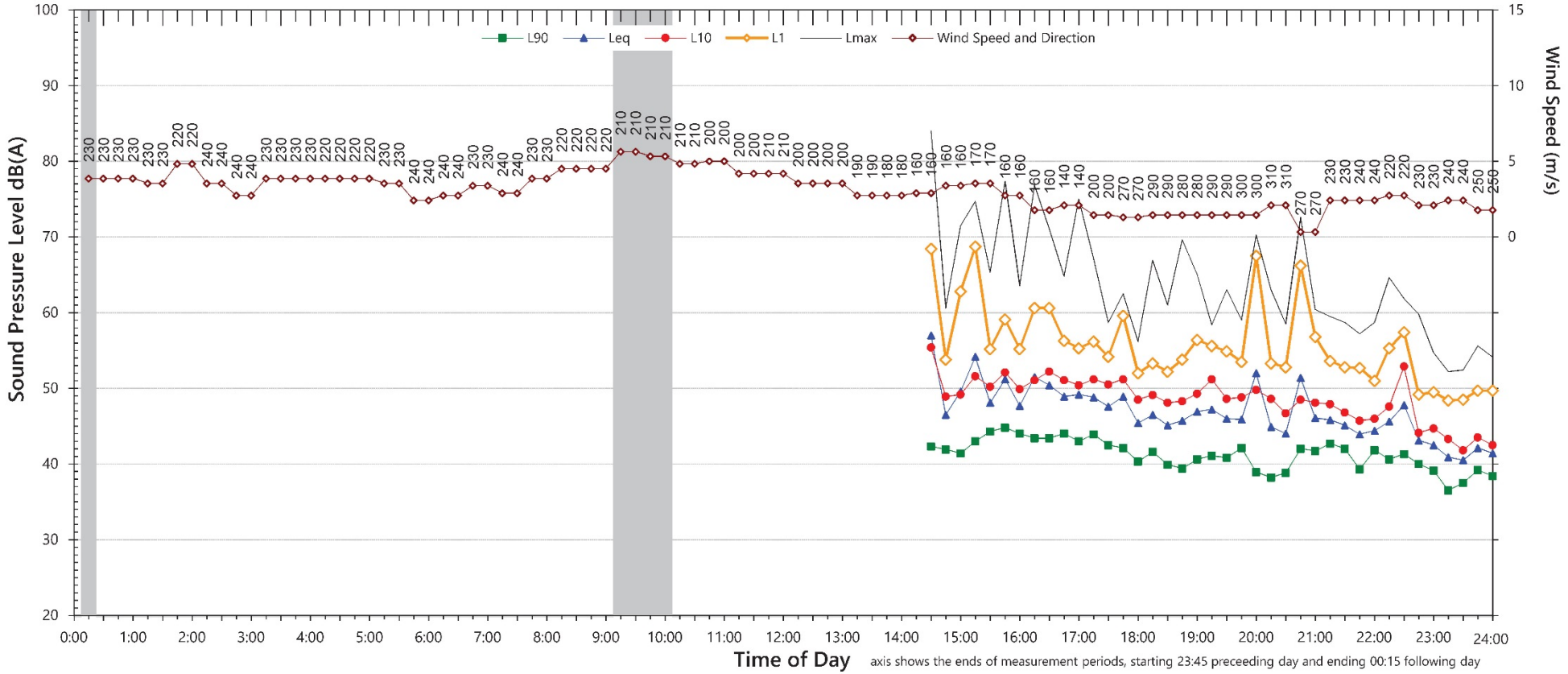
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Monday, 6 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	39	38
LAeq	-	47	45

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	68	to	73
L_{Max} - L_{eq} (Range)	17	to	27

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	47
$L_{eq\ 1hr}$ upper 10 percentile	54	50
$L_{eq\ 1hr}$ lower 10 percentile	48	45

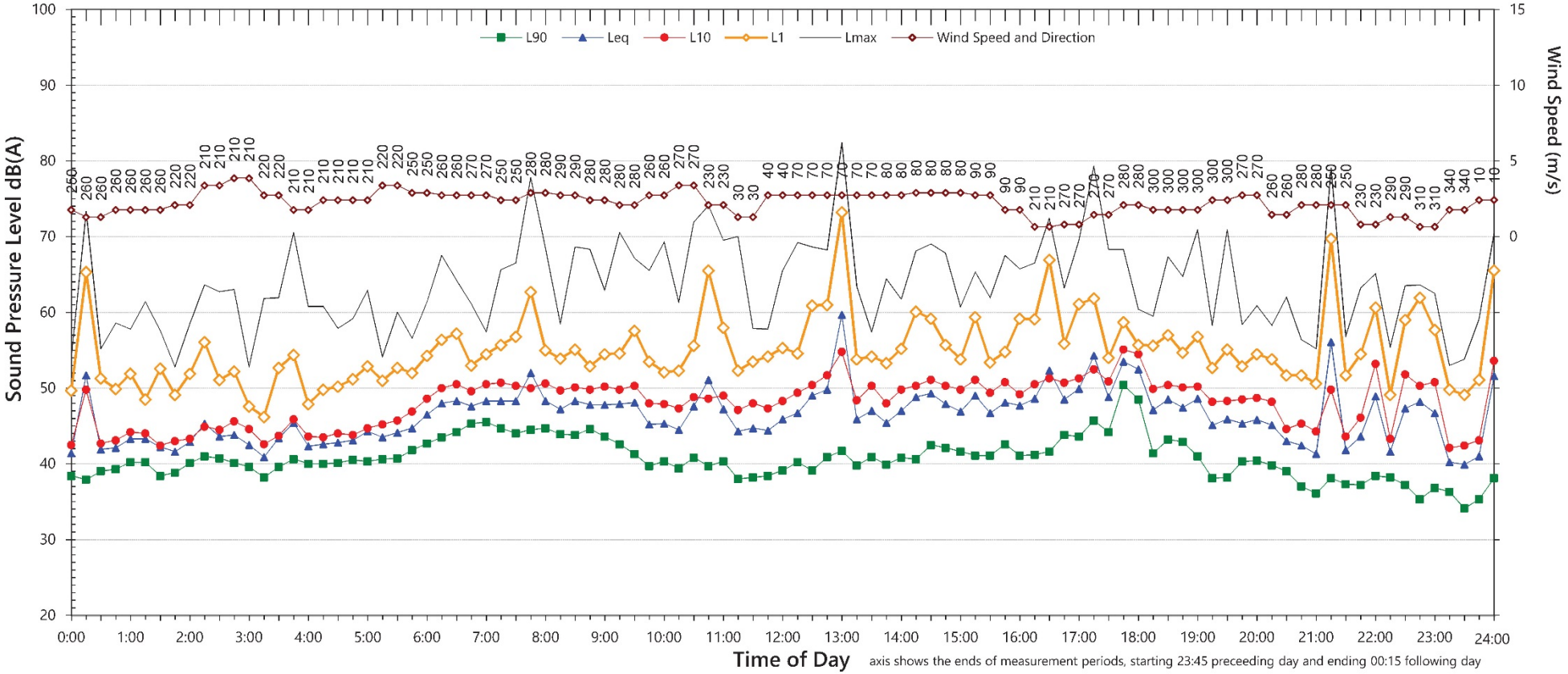
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Tuesday, 7 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	39	37	33
LAeq	50	48	63

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	65
$L_{eq\ 1hr}$ upper 10 percentile	55	56
$L_{eq\ 1hr}$ lower 10 percentile	48	44

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	99
L_{Max} - L_{eq} (Range)	17	to	28

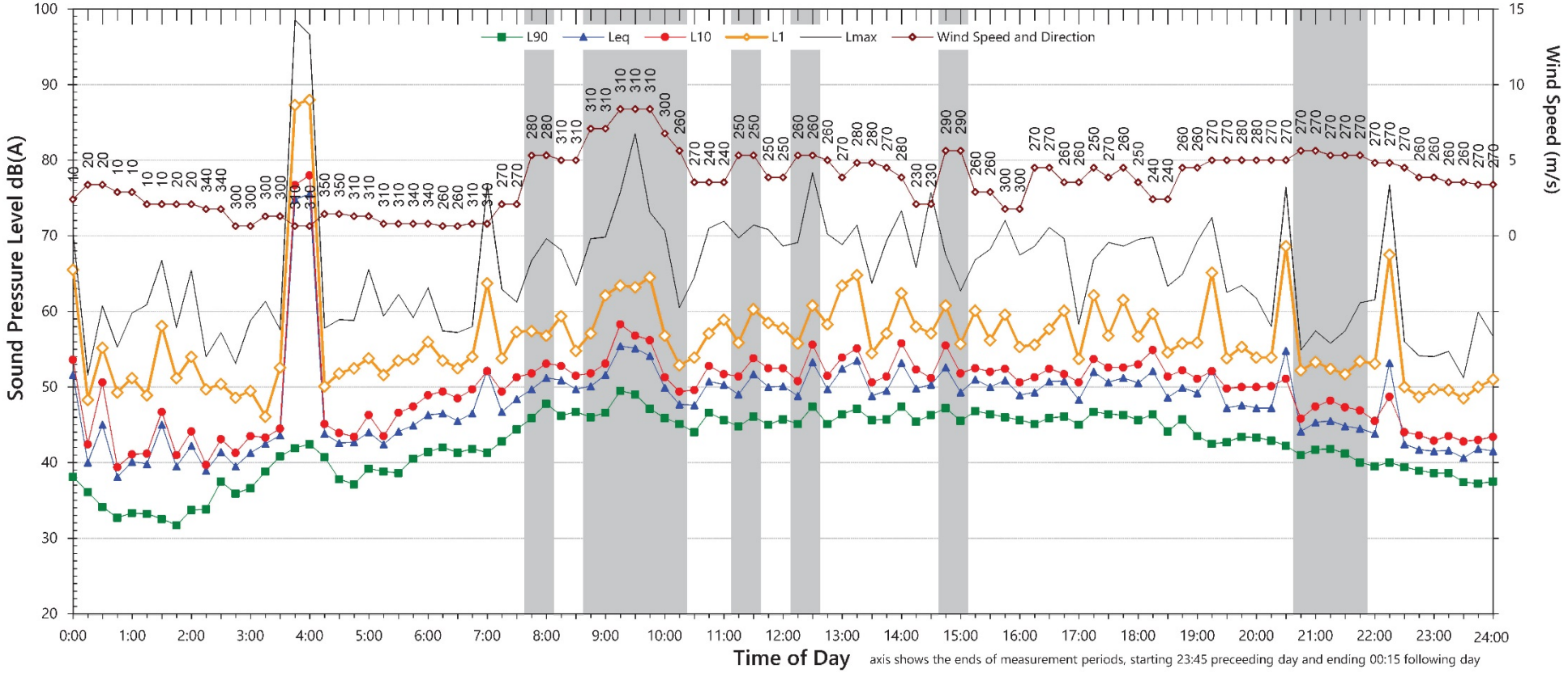
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Wednesday, 8 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	38
LAeq	-	-	57

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	68	to	99
L_{Max} - L_{eq} (Range)	17	to	33

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53	59
$L_{eq\ 1hr}$ upper 10 percentile	54	55
$L_{eq\ 1hr}$ lower 10 percentile	51	44

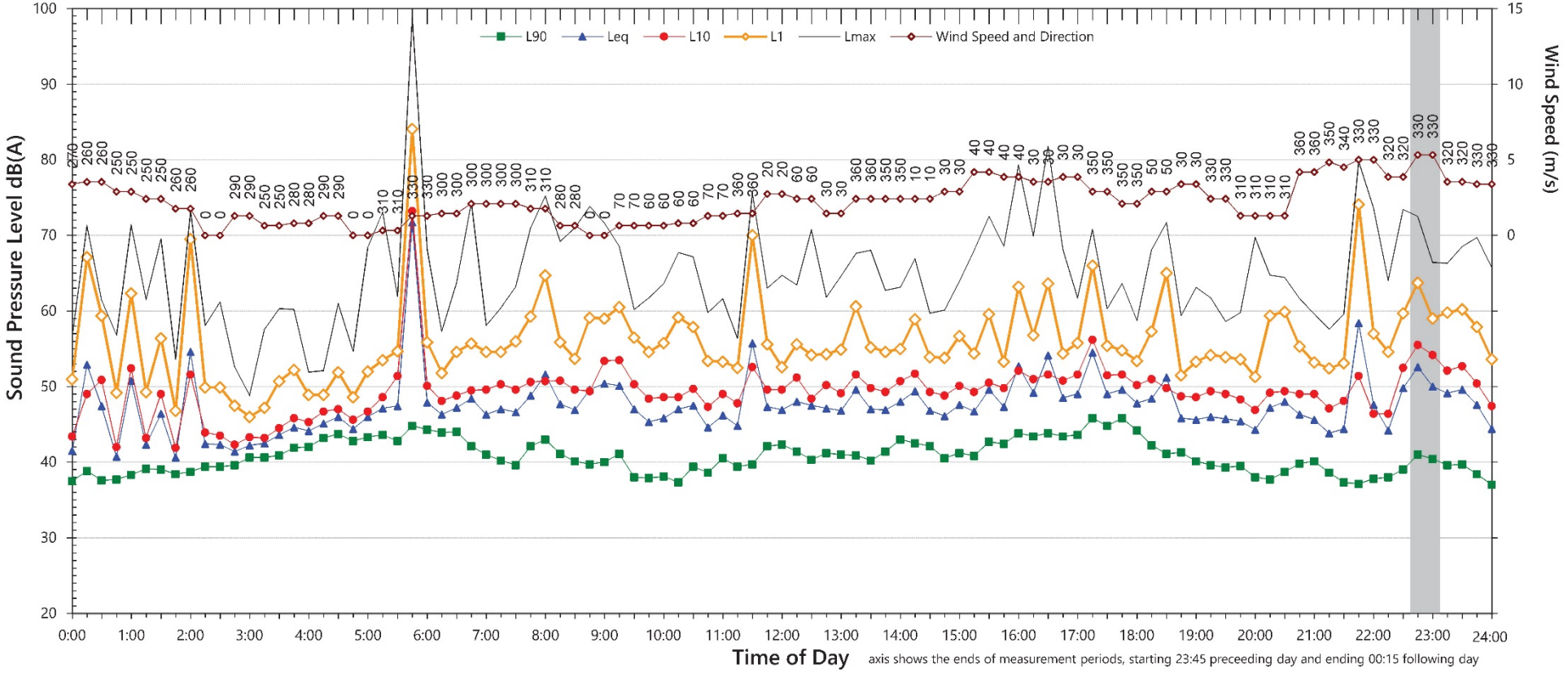
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Thursday, 9 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	39	38	34
LAeq	49	49	46

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	74
L_{Max} - L_{eq} (Range)	17	to	27

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	48
$L_{eq\ 1hr}$ upper 10 percentile	54	51
$L_{eq\ 1hr}$ lower 10 percentile	49	44

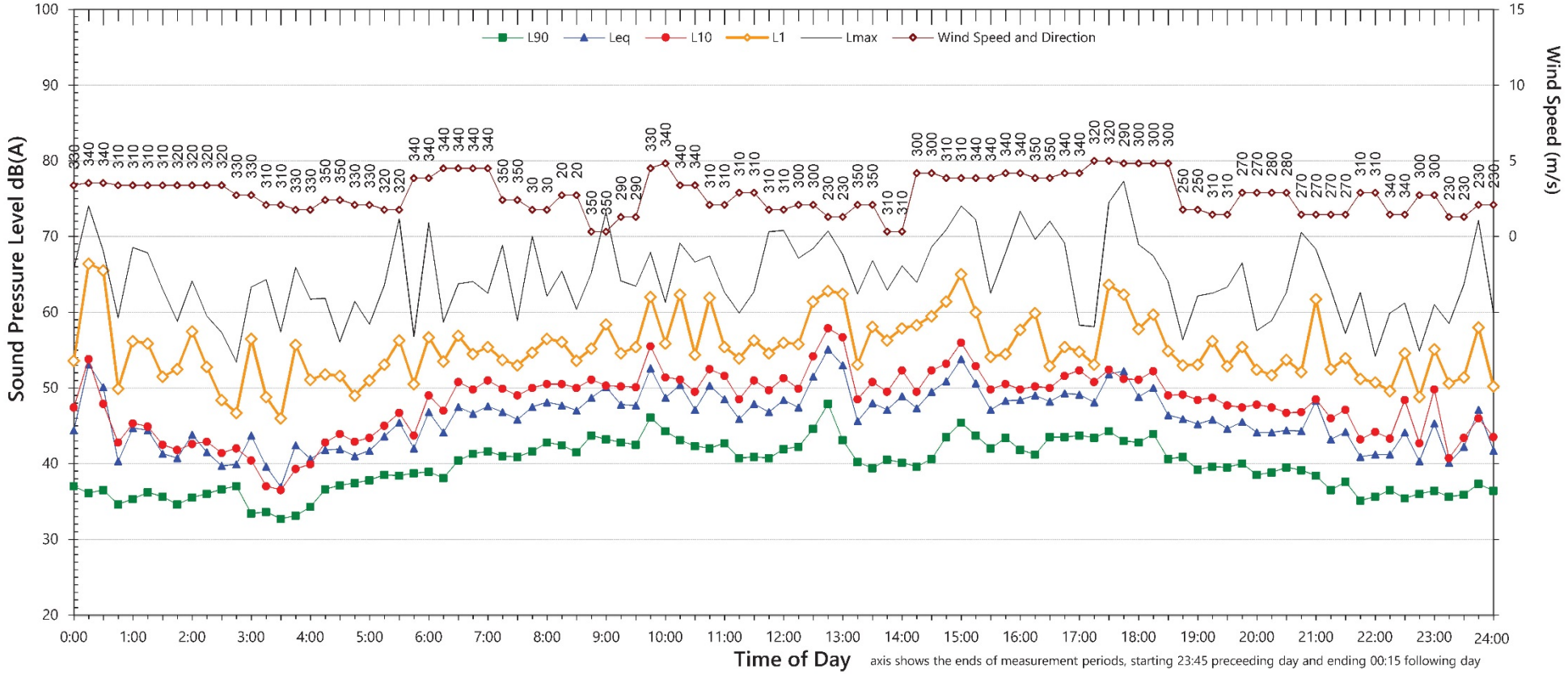
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Friday, 10 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	41	36	36
LAeq	50	45	48

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66	to	78
L_{Max} - L_{eq} (Range)	18	to	30

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51	51
$L_{eq\ 1hr}$ upper 10 percentile	53	53
$L_{eq\ 1hr}$ lower 10 percentile	48	46

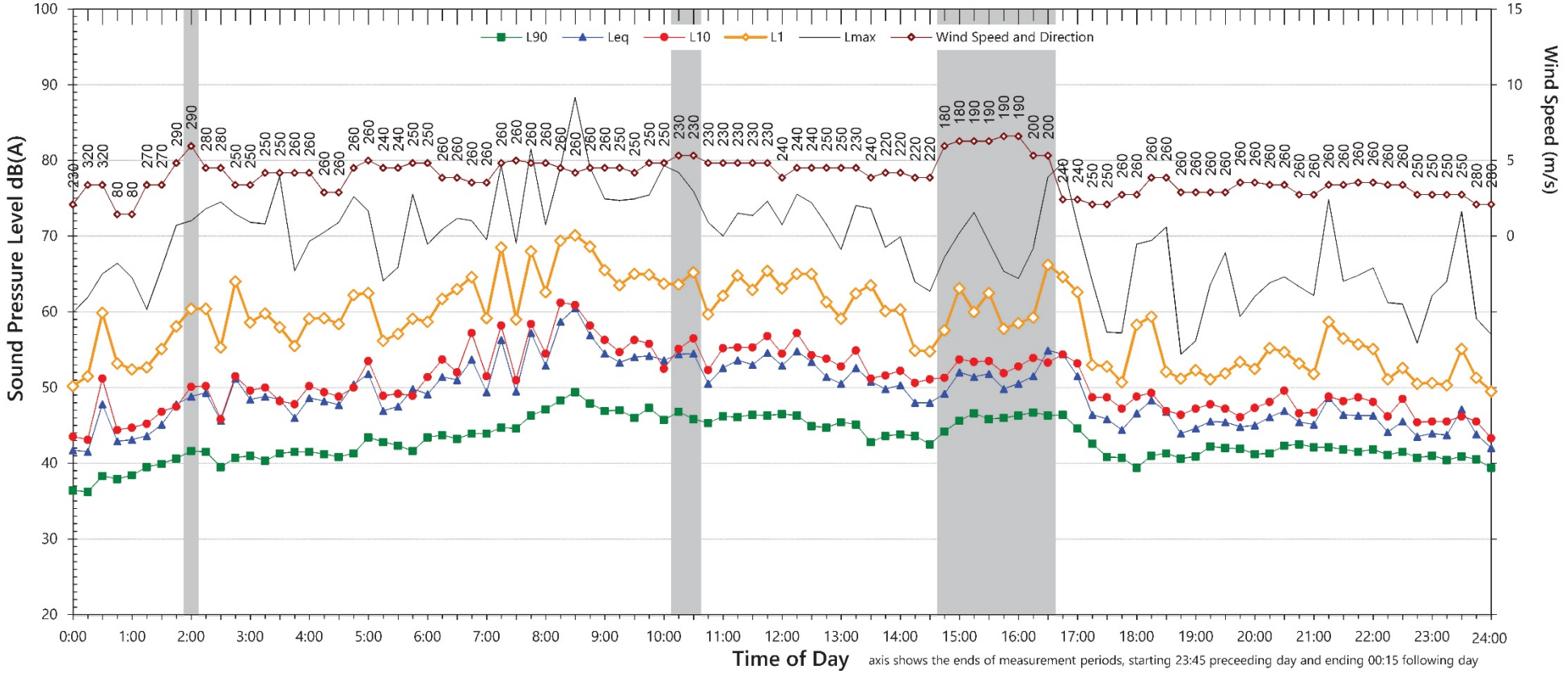
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Saturday, 11 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	-	41	40
LAeq	-	46	45

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	68	to	73
L_{Max} - L_{eq} (Range)	15	to	29

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55	47
$L_{eq\ 1hr}$ upper 10 percentile	57	48
$L_{eq\ 1hr}$ lower 10 percentile	48	46

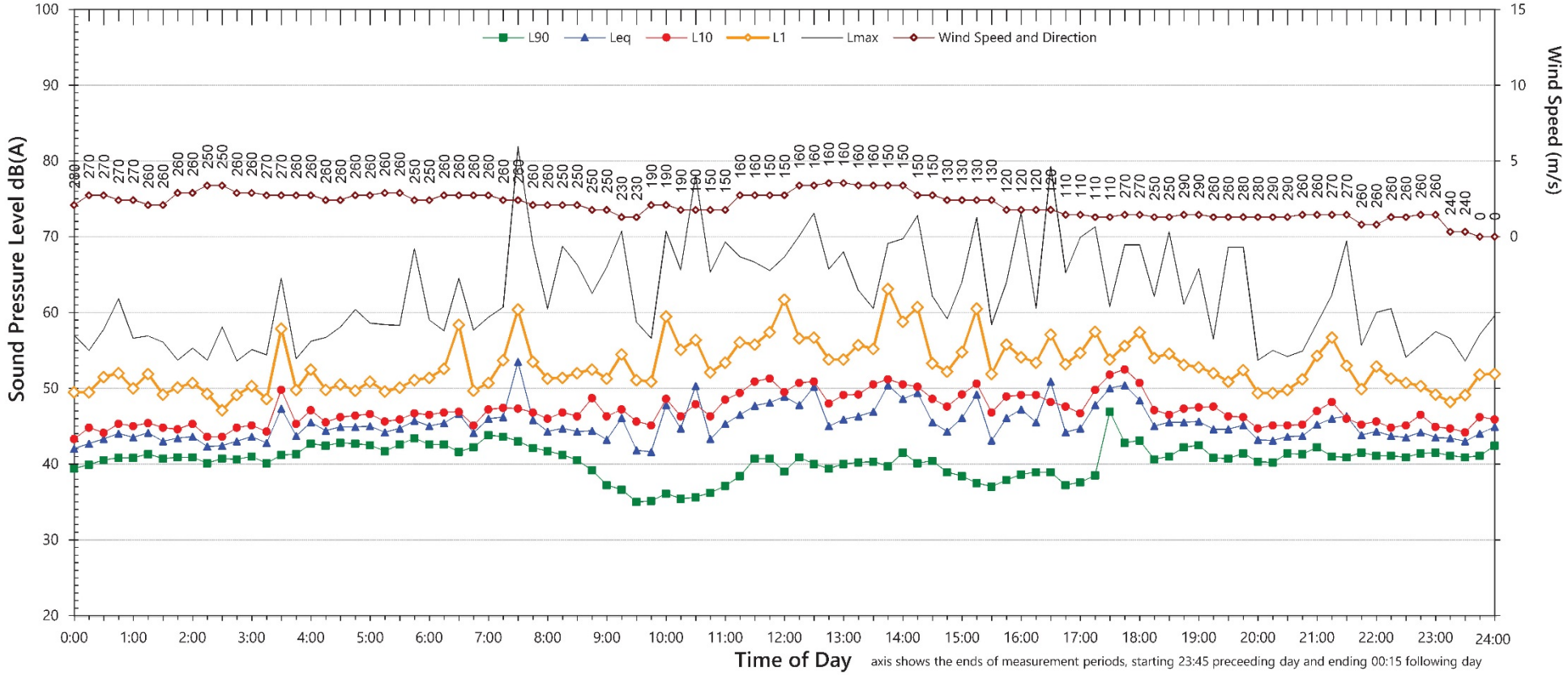
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Sunday, 12 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	36	40	37
LAeq	47	45	45

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	71
L_{Max} - L_{eq} (Range)	16	to	23

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	49	47
$L_{eq\ 1hr}$ upper 10 percentile	51	48
$L_{eq\ 1hr}$ lower 10 percentile	47	45

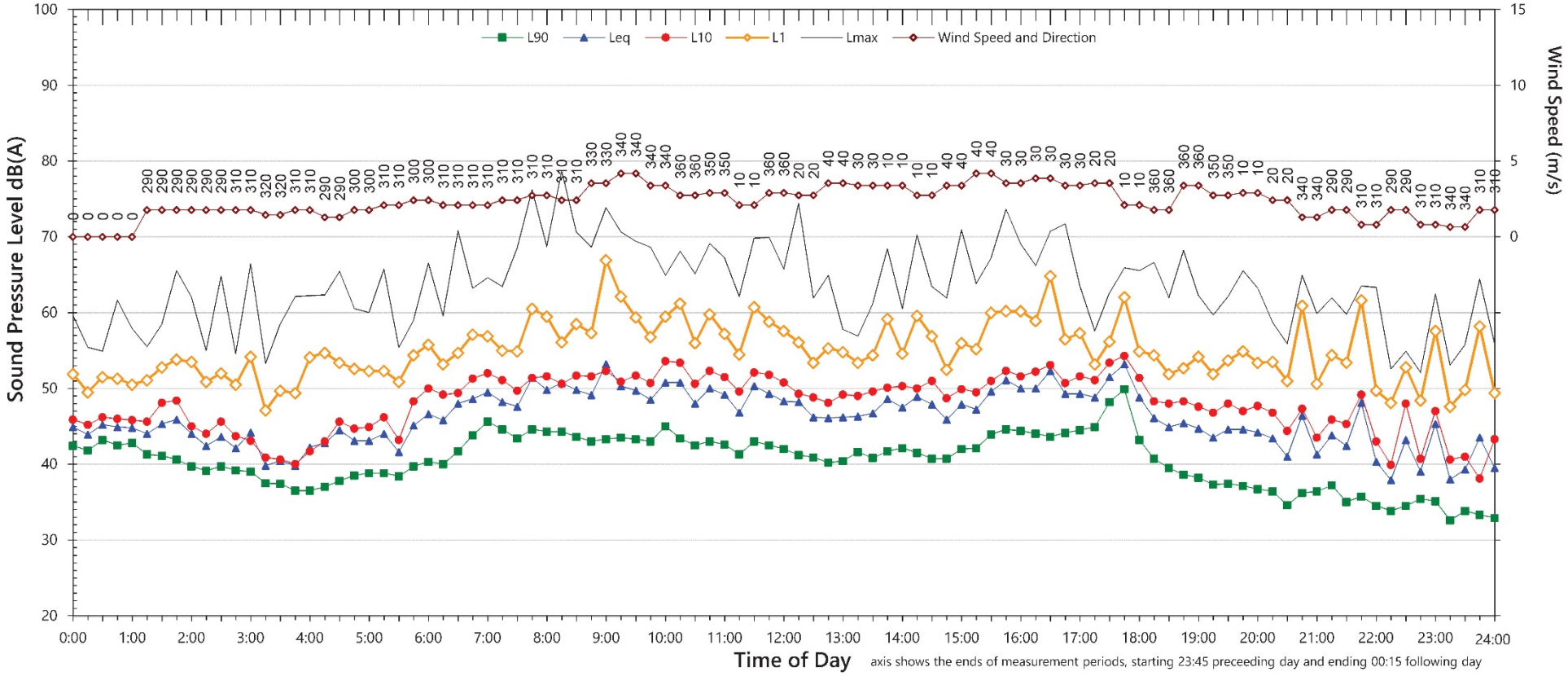
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Monday, 13 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	41	35	33
LAeq	49	44	44

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65	to	68
L_{Max} - L_{eq} (Range)	19	to	24

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51	46
$L_{eq\ 1hr}$ upper 10 percentile	53	49
$L_{eq\ 1hr}$ lower 10 percentile	47	42

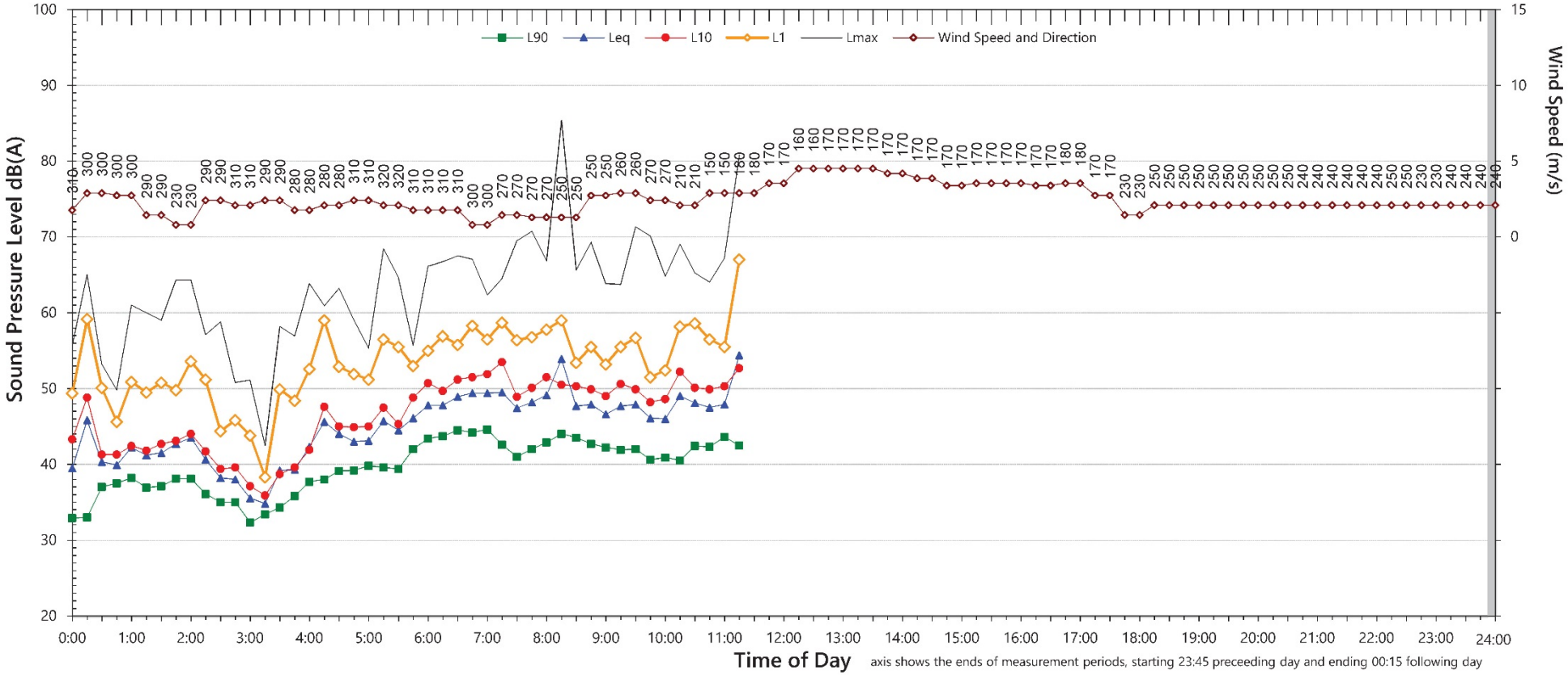
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

80 Auburn Street Wollongong

Tuesday, 14 May 2019



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	-	-
LAeq	-	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52	-
$L_{eq\ 1hr}$ upper 10 percentile	55	-
$L_{eq\ 1hr}$ lower 10 percentile	50	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)