Appendix F

Noise and vibration assessment

NSW Roads and Maritime

M1 Pacific Motorway, Kariong Ramps and M1 Kariong to Somersby Widening

Noise and Vibration Assessment

5 December 2014

PARSONS BRINCKERHOFF

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Glossary

A-weighted sound pressure

The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic 'A-weighting' frequency filter is applied to the measured sound level dB(A) to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted dB(linear).

Ambient noise

The total noise in a given situation, inclusive of all noise source contributions in the near and far field.

Community annoyance

Includes noise annoyance due to:

- character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content)
- character of the environment (e.g. very quiet suburban, suburban, urban, near industry)
- miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations)
- human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio/TV, recreation).

Compliance

The process of checking that source noise levels meet with the noise limits in a statutory context.

Cumulative noise level

The total level of noise from all sources.

EPA Licence

Environment Protection Authority Licence.

Extraneous noise

Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.

Feasible and reasonable measures

Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:

- Noise mitigation benefits (amount of noise reduction provided, number of people protected).
- Cost of mitigation (cost of mitigation versus benefit provided).
- Community views (aesthetic impacts and community wishes).
- Noise levels for affected land uses (existing and future levels, and changes in noise levels).

Impulsiveness

Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.

Low frequency

Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.

Noise criteria

The general set of non-mandatory noise levels for protecting against intrusive noise (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).

Noise Level (goal)

A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.

Noise Limits

Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.

Non-compliance

A development is deemed to be in non-compliance with its noise consent / licence conditions if the monitored noise levels exceed its statutory noise limit by more than 2 dB.

NSW DECCW

New South Wales Department of Environment, Climate Change and Water.

Performance-based goals

Goals specified in terms of the outcomes/ performance to be achieved, but not in terms of the means of achieving them.

Rating background level (RBL)

The rating background level is the overall single figure background level representing each day, evening and night time period. The rating background level is the median LA90 noise level measured over all day, evening and night time monitoring periods.

Receiver

The noise-sensitive land use at which noise from a development can be heard.

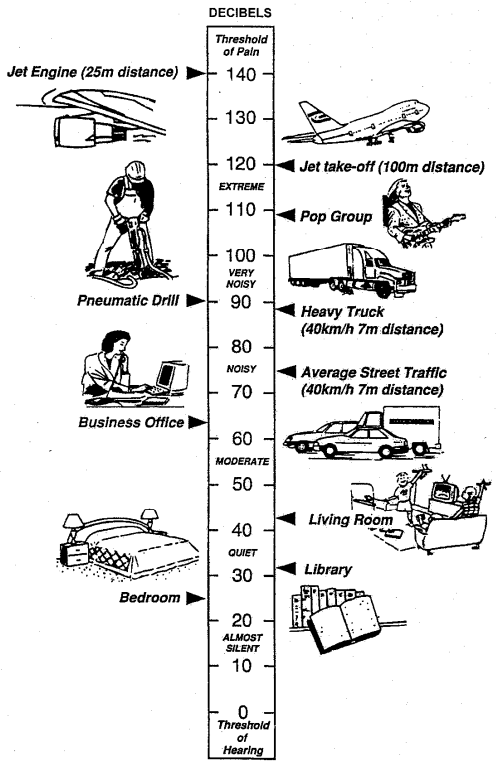
Sleep disturbance

Awakenings and disturbance of sleep stages.

Sound and decibels (dB)

Sound (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which would cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2×10^{-5} Pa.

The picture below indicates typical noise levels from common noise sources



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

Sound power level (SWL)

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

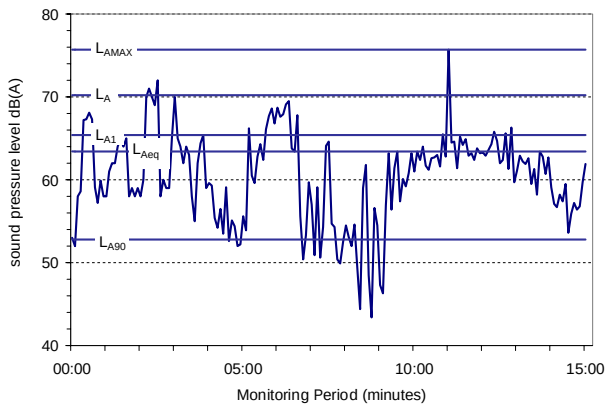
Sound pressure level (SPL)

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

Statistical noise levels

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

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



Key descriptors:

L_{AMax} Maximum recorded noise level.

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

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

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

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

Steady state noise level

The steady state noise level is the operator observed baseline noise level where sources influencing the statistical results are determined.

Threshold

The lowest sound pressure level that produces a detectable response (in an instrument/person).

Tonality

Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 5 dB(A) penalty is typically applied to noise sources with tonal characteristics.

Executive summary

Roads and Maritime engaged Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff) to undertake a noise and vibration impact assessment (NVIA) for the construction and operation of the proposed M1 Pacific Motorway, Kariong Ramps and M1 Kariong to Somersby Widening (the proposal).

This NVIA has been prepared for inclusion in the proposal's Review of Environmental Factors (REF), with consideration to the RTA Environmental Noise Management Manual (RTA ENMM 2001), the Environmental Protection Agency (EPA) Road Noise Policy (RNP, 2011), the NSW Department of Environment and Conservation Assessing Vibration – a technical guideline (DEC 2006) and the NSW Department of Environment, Climate Change (DECC) Interim Construction Noise Guideline (ICNG 2009).

A baseline noise survey was undertaken between Monday 23 June 2014 and Sunday 29 June 2014 at existing nearest residential receivers to the proposal. Adopting measured background noise levels, construction noise goals for residential and noise sensitive receivers were established with consideration to the ICNG.

With consideration to the Environmental Protection Agency (EPA) Road Noise Policy (RNP, 2011), for the management of potential arterial road traffic noise at residential receivers and land uses, project noise goals of 60 dB(A) $L_{Aeq,\ 15hr}$ day time (7 am–10 pm) and 55 dB(A) $L_{Aeq,\ 9hr}$ night time have been adopted.

Construction received noise and vibration levels

A noise assessment was undertaken for the proposed construction works. A worst case scenario of all plant in cumulative operation was assumed for proposed standard day time and outside of standard day time works.

Predictions of worst case construction noise impacts are predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) when:

- site establishment works are within 130 m of residential receivers
- earthworks are within 380 m of residential receivers
- utilities and diversion construction works are within 250 m of residential receivers
- road pavement construction work are within 450 m of residential receivers

Based on the information provided in Figure 5.1 and Table 5.2, in a highly unlikely worst case scenario, construction noise levels have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) when:

- site establishment works are within 750 m of residential receivers
- earthworks are within 2,100 m of residential receivers
- utilities and diversion construction works are within 1,400 m of residential receivers
- road pavement construction works are within 2,500 m of residential receivers
- rehabilitation, landscaping sign installation and line marking works are within 800 m of residential receivers.

Predictions of worst case construction noise impacts from proposed ancillary sites are not predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) at the nearest receivers.

However, predictions of worst case construction noise impacts from proposed ancillary sites have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) at the following receivers:

- Peats Ridge Road (320 m)
- Tallara Road (325 m)
- Dogg Trap Road (325 m)

Predicted construction vibration impacts were found to be compliant with adopted perceptible and structural vibration criteria.

To reduce noise impacts and minimise receiver noise levels, it was recommended that a construction noise and vibration management plan be developed that includes working practises and a consultation process to inform the local community of any anticipated impacts and the proposed works.

Operational road traffic noise assessment

A SoundPLAN model of potential road traffic noise impacts associated with the proposal was developed for future 2019 and 2029 road traffic volumes.

Predicted noise levels at all receivers were below the Roads and Maritime acute noise assessment criteria with the exception of Receiver 2 (41 Reeves St Somersby). Predicted noise at this receiver was less than 1 db (A) in exceedance of the acute noise criteria for both the ‘build’ and ‘no-build’ options in 2019 and 2029. This level of noise is generally regarded as imperceptible to the human ear.

Based on information provided, the results of the assessment suggest traffic noise from the proposal is expected to have a negligible impact on the nearest receivers.

When compared to the ‘no-build’ option, factors including traffic flow, speed and road surface are predicted to remain the same. Furthermore the alignment of the proposal is anticipated to fit wholly within the alignment of the existing Motorway. As such, relative increase noise goals have not been adopted in this assessment as modelling has indicated noise levels will not increase by greater than 2 dB(A).

1. Introduction

Roads and Maritime Services (Roads and Maritime) engaged Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff) to undertake a noise and vibration impact assessment (NVIA) for the construction and operation of the proposed M1 Pacific Motorway, Kariong Ramps and M1 Kariong to Somersby Widening (the proposal).

This NVIA has been prepared for inclusion in the proposal's Review of Environmental Factors (REF), with consideration to the RTA Environmental Noise Management Manual (RTA ENMM 2001), the Environmental Protection Agency (EPA) Road Noise Policy (RNP, 2011) and the NSW Department of Environment, Climate Change (DECC) Interim Construction Noise Guideline (ICNG 2009).

1.1 Objectives

The objectives of this NVIA were to:

- provide assessment of potential noise and vibration levels from the proposed construction and operation of the proposal
- compare potential construction and operational noise and vibration levels with adopted guidelines at nearest receivers
- recommend management and mitigation measures to minimise noise and vibration impacts with consideration to the adopted acoustic guidelines.

1.2 Scope of works

To deliver the objectives of the NVIA the assessment included:

- identification of potentially affected receivers and existing influences to the ambient noise environment
- a baseline noise study incorporating noise monitoring at the nearest potentially affected existing receivers and at a representative traffic noise modelling location
- establishing project specific noise and vibration design goals for construction and operation phases of the proposal
- predictive assessment of construction noise and vibration levels at nearest potentially affected receivers
- assessment of operational noise at the nearest receivers
- based on the results of the assessment, recommend noise and vibration control and mitigation practises where adopted noise and vibration design objectives would possibly be exceeded.

Reference should be made to the limitations accompanying this report (Section 10) and the supporting information in the appendices.

2. Proposal details and site description

2.1 Proposal identification

Roads and Maritime proposes to upgrade the Kariong Interchange Ramps and widen about 8 kilometres (km) of the M1 Pacific Motorway (the Motorway – formerly known as the F3 Freeway) between Kariong and Somersby, to provide three lanes in each direction (the proposal). This route forms part of the Sydney–Brisbane corridor of the National Land Transport Network (NLTN). The proposal aims to improve traffic flow along this route and cater for anticipated increases in traffic movements.

The key features of the proposal include:

- widening on the M1 Motorway between the Kariong and Somersby interchanges to three lanes in each direction. New lanes to be located in the central median.
- upgrading of the Kariong Interchange southbound entry ramp; widening the ramp to two lanes from Piles Creek Bridge and continuing the inner acceleration lane to become the outer left carriageway
- upgrading of the Kariong Interchange northbound exit ramp; extending the deceleration lane and the two lane section
- upgrading of the Kariong Interchange northbound entry ramp; providing an acceleration lane to permit safe acceleration of traffic prior to merge. The acceleration lane continues in the existing left carriageway lane with the third lane replaced on the central median side
- upgrading of the Kariong Interchange northbound entry ramp; providing widening of the existing three lane northbound bridge at Gindurra Road to facilitate the provision of an acceleration lane, therefore adding a fourth lane arrangement to the crest.

2.2 Existing road features

The Motorway (formally the F3 Freeway) is a major transport route running north/south connecting Sydney and Newcastle. It was laid in the mid-1980s with an intended design life of 40 years. It is a 110 km/h motorway consisting of a combination of four to six lanes. The Motorway contains a vegetated median strip dividing the north and south bound lanes. The north bound carriageway currently comprises of an eastern shoulder of about 1.6 m, two to three travel lanes of about 3.7 m each and a western shoulder of about 3 m. The median is about 10 m wide. The south bound carriageway comprises two to three travel lanes of the same widths, with a 1.6 m shoulder on the western side and 3 m shoulder on the western side.

3. Existing ambient noise environment

3.1 Existing noise environment

The proposal is located within both the Gosford Local Government Area (LGA) and the Roads and Maritime's Central Coast Region. Land uses in this locality include road and rail transport, rural residential, commercial and light industrial uses, rural (primary production), and bushland vegetation and reserves and includes part of the suburbs of Gosford, Kariong, Somersby, Niagara Park, Point Clare and Ourimbah. The majority of the area surrounding the proposal is largely bushland and comprises areas of the Brisbane Water National Park, Strickland State Forest, Palm Grove Nature Reserve, Jilliby State Conservation Area, Mooney Mooney Aboriginal Area and the Howe Aboriginal Area.

The nearest residential receivers are located on the eastern and western sides of the Motorway. These receivers include residential properties in Acacia Road, Reeves Road, Debenham Road (North and South), Gindurra Road, Wirrinda Road, Tallara Road, Wisemans Ferry Road, Peats Ridge Road and properties accessed off Strickland Forrest Road. The dominant noise exposure for these receivers is resultant from traffic along the existing Motorway.

No non-residential receivers such as schools, hospitals, places of worship, childcare facilities or open space (active or passive use) could be identified within the study area (600 m from the Motorway centreline).

Baseline noise surveys have been carried out in the study area to develop background noise profiles and identify existing ambient noise profiles.

Nearest noise receivers are also indicated in Figure 3.1.

3.2 Noise monitoring locations

Noise catchment areas are identified to group together areas receiving similar noise levels. Noise catchment areas for this project are outlined in figure 3.1

Operator attended and continuous unattended noise monitoring has been undertaken at locations indicative of nearest existing residential receivers to the proposal to establish ambient and background noise levels, ascertain current traffic noise and set construction noise goals. Each noise logger was set in the free-field at a location selected and agreed upon through consultation with NSW RMS and were deployed with consideration to other noise sources which may influence the measurements, the proximity of receivers, the safety of the equipment and consent of landowners, Monitoring was undertaken at the following locations:

- Location 1: 78 Wirrinda Road, Somersby, noise logger 16-207-023 was established at the fence line of the property to determine road traffic noise.
- Location 2: 41 Reeves Street, Somersby, noise logger 16-707-007 was established within the rear yard of the property to determine road traffic noise.
- Location 3: 21 Goldsmith Road, Somersby, noise logger 16-207-008 was established at the fence line of the property to determine background noise profiles and construction noise goals.

- Location 4: 20 Wirrinda Road, Somersby, noise logger 16-302-485 was established within the rear yard of the property to determine road traffic noise.

These monitoring locations and the proposal area are indicated in Figure 3.1.

3.3 Instrumentation

Operator attended 15 minute noise monitoring was undertaken using a Rion NL-42 Precision Sound Level Meter on Monday 23 June 2014.

Long-term unattended noise monitoring was carried out using Acoustic Research Laboratories statistical environmental noise loggers (type EL-316 or NGARA).

Instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period and comply with Australian Standard AS-1259: *Sound Level Meters.* Copies of the instrument set calibration certificates have been included in Appendix C.

Microphones were positioned 1.5 m above ground level and fitted with windsocks. Each instrument was calibrated before and after the measurement period to ensure the reliability and accuracy of results. No significant variances were observed.

3.4 Meteorological data

Fifteen minute meteorological data was obtained from the nearest Bureau of Meteorology (Gosford, 061425) all-weather station to the noise monitoring location.

Review of meteorological data for the monitoring period indicated unsatisfactory conditions as a result of precipitation and wind speed exceeding five (5) metres/second (m/s) were present approximately 25 per cent of the monitoring period.

Inclement meteorological conditions have been shown as shaded on the compiled daily noise logger graphs (Appendix A) and filtered from derived baseline period noise levels.

3.5 Measured noise levels

3.5.1 Measured short-term ambient noise levels

The results of the attended 15 minute noise surveys undertaken on Monday 23 June 2014 are presented in Table 3.1 and include a description of the noise environment.

Table 3.1 Operator attended noise survey

Location	Date/time	Measured noise level, dB(A)				Comments
		L_{A90}	L_{Aeq}	L_{A10}	L_{A1}	
1	29/6/14 1:53 pm	53	55	56	58	Traffic noise 50–54 dB(A)
2	29/6/14 2:20 pm	63	66	69	71	Traffic noise 68–71 dB(A) Local fauna perceptible
3	29/6/14 2:50 pm	52	56	57	66	Traffic noise 54–56 dB(A) Local fauna perceptible
4	29/6/14 1:13 pm	58	60	62	64	Traffic noise 59–63 dB(A) Local fauna perceptible

LA90 A-weighted sound pressure level exceeded for 90 per cent of the time (background)
LAeq equivalent continuous (energy average) A-weighted sound pressure level
LA10 Noise level present for 10% of the time
LA1 Noise level present for 1% of the time, indicative of a peak noise level
All noise levels in decibels, to nearest dB(A)

3.5.2 Measured long-term ambient noise levels

Observations during logger establishment noted ambient noise environments at the nearest residential receivers to the proposal are primarily influenced by traffic flows along the Motorway.

The median day time (7 am–6 pm), evening (6 pm–10 pm) and night time (10 pm–7 am) period background noise levels determined from the unattended noise survey are presented in Table 3.2.

Table 3.2 Unattended noise monitoring results (period noise levels)

Location	Day (7 am–6 pm)		Evening (6 pm–10 pm)		Night (10 pm–7 am)	
	$L_{Aeq, 11hr}$	$L_{A90, 11hr}$	$L_{Aeq, 4hr}$	$L_{A90, 4hr}$	$L_{Aeq, 9hr}$	$L_{A90, 9hr}$
1	56	52	53	49	53	42
2	67	60	62	55	60	45
3	56	50	52	49	50	40
4	60	55	57	50	56	43

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level
L_{A90} A-weighted sound pressure level exceeded for 90 percent of the time (background)
Values expressed as dB(A); dB(A) = decibels, A-weighted; all values rounded to nearest 1 dB(A)

The median day time (7 am–10 pm) and night time (10 pm–7 am) period background noise levels determined from the unattended noise survey are presented in Table 3.3.

Table 3.3 Unattended noise monitoring results (day/night noise levels)

Location	Day time ambient noise, dB(A)[1]	Night time ambient noise, dB(A)[1]
	$L_{Aeq, 15hr}$	$L_{Aeq, 9hr}$
1	56	53
2	64	60
3	55	50
4	60	56

(1) Values expressed as A weighted dB and rounded to nearest 1 dB(A)
(2) Combined north and south bound traffic volumes are presented
L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level
L_{A10} A-weighted sound pressure level exceeded 10% of the time

Monitoring was undertaken over a seven day period between Monday 23 June 2014 and Sunday 29 June 2014. The Location 3: 21 Goldsmith Road noise logger only collected four days of data before stopping due to a suspected battery problem. Daily noise logger graphs are included as Appendix A.

Review of the noise levels recorded at the residential receivers showed noise characteristics typical of an area in the vicinity of a major road source. Noise profiles followed diurnal patterns with the lowest levels typically occurring in the early hours of the morning. The period noise levels outlined above generally increase with proximity to the Motorway.

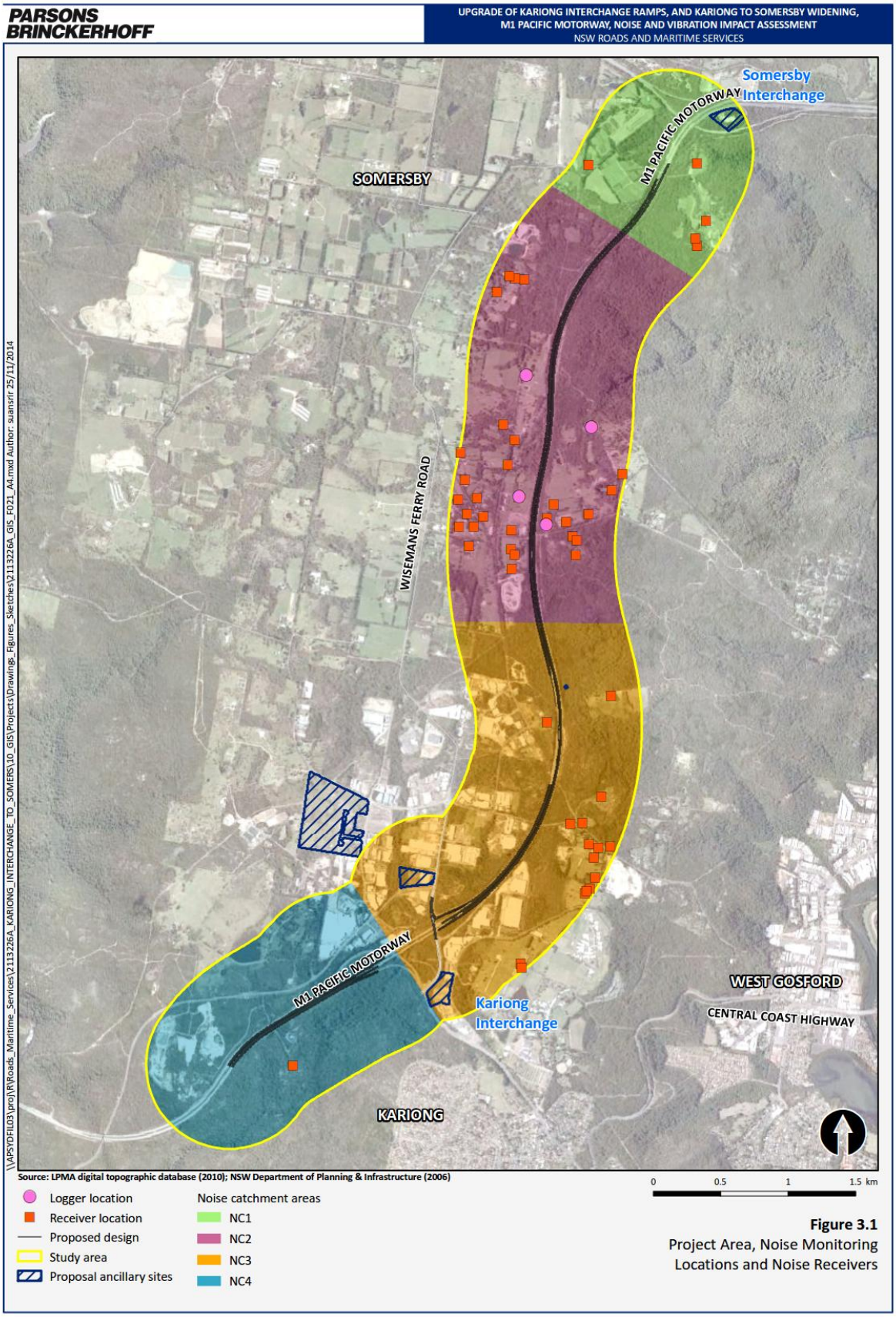


Figure 3.1 Project area, noise monitoring locations and noise receivers

4. Adopted criteria and guidelines

4.1 Overview

The *Protection of the Environment Operations Act, 1997* (POEO Act) regulates noise generation and prohibits the generation of 'offensive noise' as defined under the Act. In addition to regulatory requirements under the POEO Act, the NSW Environment protection authority (EPA) and Roads and Maritime provide guidelines regarding acoustic criteria and noise controls.

4.2 Construction noise criteria

Noise management levels for construction works were established with consideration to the ICNG which provides guidance for the assessment and management of construction noise. Detailed in Table 4.1, noise management levels have been established adopting measured day time, evening and night time background noise level (L_{A90}) from Location 3, 21 Goldsmith Road, Somersby.

Table 4.1 Recommended residential construction noise criteria

Construction period	RBL L_{A90} dB(A)	Management level $L_{Aeq, 15min}$	Application
Standard day time construction hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	50	60	Where measured or predicted noise level > management level: ▪ Proponent is to apply all feasible and reasonable work practises to meet the management level. ▪ Potentially affected residents are to be informed of the works and expected noise levels duration.
Outside of standard day time construction hours	40	45	Strong justification for works is required. Proponent to apply all feasible and reasonable work practices to meet the management level. Where all feasible and reasonable practices have been applied and noise is >5 dB (A) above the management level the Proponent is to negotiate with the community.
Highly noise affected	–	75	Where noise is above this level respite periods for dominant noise generating activity may be required, to consider: ▪ Times identified by the community where they are less sensitive. ▪ If the community is prepared to accept longer periods of construction exchange for restriction on construction hours.

L_{Aeq} equivalent continuous (energy average) A-weighted sound pressure level.

L_{A90} A-weighted sound pressure level exceeded for 90% of the time (background).

It is understood that construction activities may occur on a 24 hour basis. Based on the noise environments at the proposed construction work locations, residential noise management levels for standard day time construction hours of 60 dB(A) $L_{Aeq,15min}$ and outside of standard day time of 45 dB(A) $L_{Aeq,15min}$ have been adopted.

For the assessment of sleep disturbance from construction noise, the ICNG refers to the EPA's Environmental Criteria for Road Traffic Noise (ECRTN). The RNP supersedes the ECRTN however it includes a discussion on sleep disturbance.

Nearest Industrial/commercial receivers are on both the eastern and western sides of the Motorway. Industrial/commercial receivers to the east are located on Wella Way, Kangoo Road and Debenham Road South. Industrial/commercial receivers to the west are located on Gindurra Road, Chives Road and Debenham Road North. The ICNG recommends noise management levels of 75 dB(A) $L_{Aeq,15min}$ for external industrial areas and 70 dB(A) $L_{Aeq,15min}$ for noise levels external of commercial and office receivers.

4.3 Construction vibration criteria

4.3.1 Human exposure to ground vibration

The DEC's *Assessing Vibration: A Technical Guideline* (2006) provides guidance for assessing human exposure to ground vibration. In consideration to British Standard BS6472:1992, the DEC guideline recommends Vibration Dose Value (VDV) levels to achieve a low probability of annoyance or disturbance at affected residential and sensitive land uses during construction.

Table 4.2 details adopted VDV vibration goals for residential receivers. No vibration sensitive receivers such as hospitals, education institutions or places of worship were identified adjacent to the Motorway.

Table 4.2 Adopted residential ground vibration goals

Location	Vibration Dose Value goals, $m/s^{-1.75}$			
	Day time		Night time	
	Preferred	Maximum	Preferred	Maximum
Residences	0.20	0.40	0.13	0.26
Offices, schools, places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

(1) Day time 7 am–10 pm, Night time 10 pm–7 am.

4.3.2 Structural ground vibration

To evaluate the effects of vibration on structures and buildings, the DEC guidance references German Standard DIN 4150: Part 3-1999. Dependent upon the dominant frequency of vibration, assessed in Hertz (Hz), structural vibration limits are established at the foundation of nearest buildings.

Adopted DIN 4150 structural vibration goals in Table 4.3 have been applied to assess potential structural damage during construction activities at residential receivers, industrial premises or sensitive structures.

Table 4.3 Adopted structural ground vibration goals

Structure	Structural vibration goal, PPV mm/s		
	1–10 Hz	10–50 Hz	50–100 Hz
Dwellings and residences or similar occupancy	5	5 to 15	15 to 20
Commercial and industrial premises and buildings of similar design	20	20 to 40	40 to 50
Sensitive structures not classified by either definition above and of great intrinsic value	3	3 to 8	8 to 10

Source: Referenced from German Standard DIN 4150

4.4 Road traffic noise criteria

The RNP has been adopted for the determination of road traffic noise goals for the proposal. The RNP recommends road traffic noise goals for residential land uses for the 15 hour day time (7 am–10 pm) and nine hour night time (10 pm–7 am) periods dependent upon the type of road development being undertaken. The road traffic criteria should be applied immediately after the road opens and to projected road traffic volumes.

4.4.1 Assessment timeframe

Based on the assessment criteria for a redevelopment project outlined in the RNP, noise levels have been evaluated for the following timeframes:

- 2019: within one year of changed traffic conditions following construction of the project.
- 2029: 10 year post project opening scenario.

Assessment is required between the ‘build’ and ‘no-build’ scenario for each timeframe.

4.4.2 Assessment criteria

The proposal is classified as a redevelopment of an existing freeway. Table 4.4 outlines the RNP noise assessment and relative increase criteria for the redevelopment of an existing arterial road at residential receivers and land uses:

Table 4.4 RNP Noise assessment criteria for redevelopment of freeways

Criteria	Assessment criteria dB(A) External	
	Day (7am–10pm)	Night (10pm–7am)
Noise assessment criteria	60 dB(A) $L_{Aeq, 15hr}$	55 dB(A) $L_{Aeq, 9hr}$
Relative increase criteria	Existing traffic noise $L_{Aeq, 15hr}$ + 12dB	Existing traffic noise $L_{Aeq, 9hr}$ + 12dB

Further assessment criteria prescribed by the Roads and Maritime Environmental Direction Number 24 prescribes the need for the application of feasible and reasonable noise mitigation for receivers predicted to be effected by noticeable increase or acute noise levels following the road redevelopment. Table 4.5 outlines the additional Roads and Maritime noise assessment criteria.

Table 4.5 Roads and Maritime Noise assessment criteria for redevelopment of freeways

Criteria	Assessment criteria dB(A) External	
	Day (7am–10pm)	Night (10pm–7am)
Predicted noticeable increase. Based on ten year post project opening scenario	Existing traffic noise $L_{Aeq, 15hr}$ + 2dB	Existing traffic noise $L_{Aeq, 9hr}$ + 2dB
Acute noise assessment criteria. Based on ten year post project opening scenario	65 dB(A) $L_{Aeq, 15hr}$	60 dB(A) $L_{Aeq, 9hr}$

During the night time, road traffic noise can result in awakening reactions and sleep disturbance. To assess potential sleep disturbance impacts the following guidelines outlined in practice note III of the Environmental Noise Management Manual (RTA 2001) have been adopted:

- One or two noise events per night, with maximum internal noise levels of 65 to 70 dB(A) are not likely to affect health or well-being.
- Maximum internal noise levels below 50 to 55 dB(A) are unlikely to result in awakening reactions.

For industrial and commercial receivers the RNP recommends the guidance given in Australian Standard AS2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors.* Based on this, guidance internal noise levels of 45 dB(A) would apply for general office areas and for industrial process areas noise levels of 70 dB(A) and less are desirable. Internal noise levels are assumed at 10 dBA less than external noise.

5. Construction noise and vibration assessment

An assessment of noise and vibration impact potential has been undertaken for the proposed construction activities. Where required, experience and knowledge of construction practises and standard construction techniques have been applied to the modelled scenarios.

5.1 Construction activities

Based on information provided, outlined below is a brief overview of the construction methods and activities proposed for the proposal. It is understood that construction activities may occur on a 24 hour basis. Works associated with the use of ancillary sites are described further in Section 5.4.2.

5.1.1 General site establishment

Site establishment will include the stripping of existing vegetation and installation of erosion and sediment controls. Excess topsoil will be removed and stockpiled for re-use during site rehabilitation. Construction compounds and associated traffic controls will then be installed and implemented. Realignment of infrastructure services shall occur as required including electricity, water and sewer mains and telecommunications.

5.1.2 Works on the motorway

Construction works on the motorway would include the installation of drainage works including culverts and drainage pipes in certain locations to be confirmed. Earthworks including the importation of suitable fill materials are anticipated to reach the required level for road alignment followed by lying of the road base and pavement. The new road construction will require the import of fill, aggregates, concrete and bitumen. Installation of street furniture and line marking will complete the road construction.

5.2 Construction equipment source noise levels

The individual sound power levels (SWL) for the anticipated type of construction plant have been referenced from Parsons Brinckerhoff's database of noise sources (refer to Table 5.1). The SWL will be adopted in the construction noise impact assessment. Based on the information provided, the works are proposed to be undertaken during a 24 month period.

Table 5.1 Construction plant and equipment sound power levels

Construction stage	Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)
Roadway construction	General site establishment	Semi – Trailers	106
		Trucks (8–9 tonnes)	100
		Mobile Crane (30 tonnes)	102
		Excavators	107
	Earthworks	Excavators	107
		Dump Trucks	108
		Front end loaders	113
		Bulldozer	115
		Grader	114
		Compactor	109
		Backhoe	104
	Utilities and Diversion	Excavator	107
		Dump Trucks	108
		Road Trucks	100
		Crane	113
	Road pavement	Asphalt paver	114
		Compactor	109
		Road trucks	100
		Water trucks	107
		Grader	114
		Concrete Truck	108
		Concrete Saw	115
		Road Miller	115
	Rehabilitation, landscaping, signs and line marking	Excavators	107
		Road Trucks	100
		Water truck	107
		Bob cat	104
Ancillary compounds	Batch plant, concrete crushing, stockpiling and	Dump trucks	108
		Excavators	107

Construction stage	Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)
	storage	Batch plant	108
		Concrete Crusher	103
		Front end loaders	113
	Stockpiling and storage	Dump trucks	108
		Excavators	107
		Front end loaders	113

5.3 Construction noise prediction methodology

Due to the mobile nature of the construction works, the potential noise impacts at receivers would be variable, with potential received noise levels dependent on the separation distance between noise generating construction plant and machinery in relation to receivers and the power rating at which the plant and equipment is operating.

The assessment of the potential noise impacts from construction activities has been based on the prediction of noise propagation over increasing separation distance from the construction site. Equation 5.1 has been applied with the construction SWLs to predict noise impacts at nearest receivers. The equation does not account for noise attenuation from receiver buildings and the local terrain. All construction plant and equipment have been treated as point noise source.

Equation 5.1 Calculation of noise propagation

$$SPL\ received = SWL\ source - 20\log(r) - 8$$

Where: SPL received = construction noise level at the receiver
SWL source = sound power level for construction plant

The equation includes a -8 dB(A) correction for the loss of acoustic energy from hemi-spherical radiation from noise sources.

5.4 Construction noise impact assessment

The predicted construction noise levels at increasing separation distance during the various construction work stages of the proposal are detailed in Figure 5.1 below. The predicted noise levels in the figures below represent the worst case scenario of all plant and equipment operating simultaneously during the construction activities. Where the proposed plant and equipment are not in concurrent operation or undertaken at greater separation distances to the assessed locations, further reductions in noise impacts would be expected. It is also noted that the works are unlikely to be continuous for extended periods of time; therefore noise levels are expected to be significantly lower than the predicted construction noise levels.

5.4.1 Assessment of noise impacts for roadway construction

The predicted construction noise levels at increasing separation distance during roadway construction activities are detailed in Figure 5.1 and Table 5.2 below.

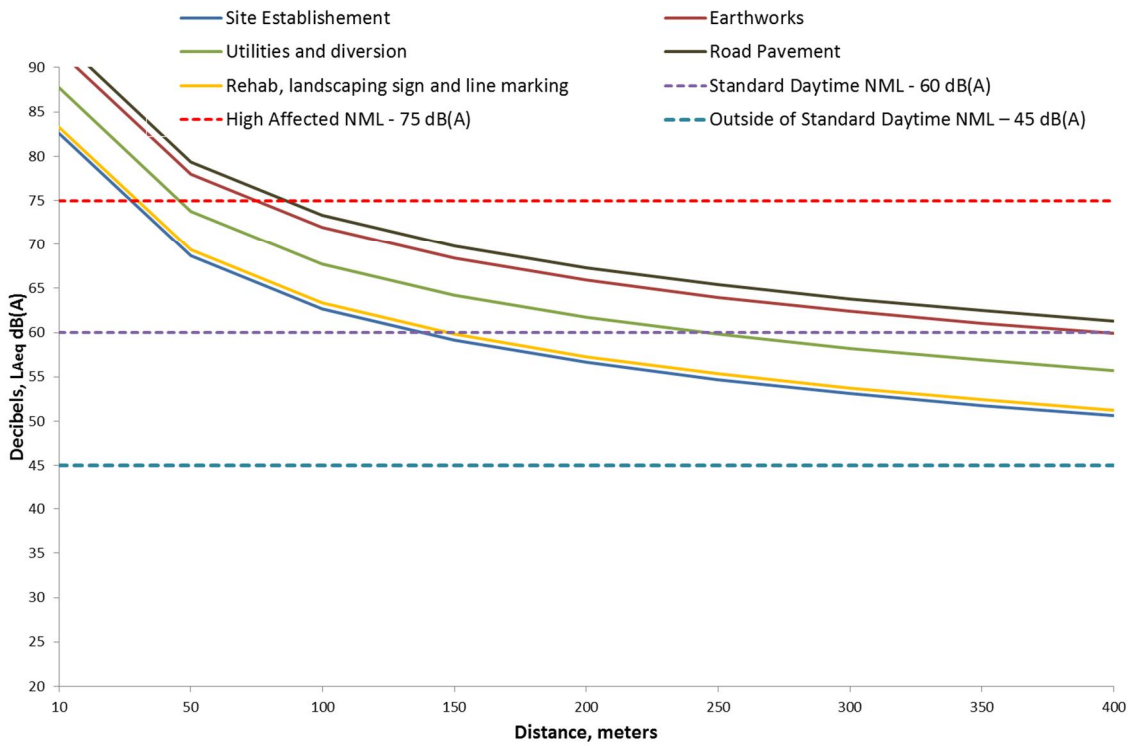


Figure 5.1 Estimated noise levels at increasing separation distance roadway construction

Table 5.2 Predicted construction noise impacts at the nearest residential receivers

Nearest receiver location and distance to alignment	Predicted noise impacts dB(A) $L_{Aeq,15min}$				
	Site establishment	Earthworks	Utilities and diversion	Road pavement	Rehabilitation, landscaping, sign installation and line marking
Standard daytime NML – 60 dB(A) $L_{Aeq,15min}$					
Acacia Road (514 m)	48	58	54	59	49
Debenham Road South (278 m)	54	**63**	59	**64**	54
Gindurra Road (210 m)	56	**65**	**61**	**67**	57
Debenham Road North (114 m)	**61**	**71**	**67**	**72**	**62**
Reeves Road (72 m)	**65**	**75**	**71**	**76**	**66**
Wirranda Road (94 m)	**63**	**72**	**68**	**74**	**64**
Wisemans Ferry Road (336 m)	51	**61**	57	**63**	53
Tallara Road (396 m)	51	60	56	**61**	51
Peats Ridge Road (150 m)	59	**68**	**64**	**70**	60

Nearest receiver location and distance to alignment	Predicted noise impacts dB(A) $L_{Aeq,15min}$				
	Site establishment	Earthworks	Utilities and diversion	Road pavement	Rehabilitation, landscaping, sign installation and line marking
Outside of Standard daytime NML – 45 dB(A) $L_{Aeq,15min}$					
Acacia Road (514 m)	**48**	**58**	**54**	**59**	**49**
Debenham Road South (278 m)	**54**	**63**	**59**	**64**	**54**
Gindurra Road (210 m)	**56**	**65**	**61**	**67**	**57**
Debenham Road North (114 m)	**61**	**71**	**67**	**72**	**62**
Reeves Road (72 m)	**65**	**75**	**71**	**76**	**66**
Wirranda Road (94 m)	**63**	**72**	**68**	**74**	**64**
Wisemans Ferry Road (336 m)	**51**	**61**	**57**	**63**	**53**
Tallara Road (396 m)	**51**	**60**	**56**	**61**	**51**
Peats Ridge Road (150 m)	**59**	**68**	**64**	**70**	**60**

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time varying sound values expressed as dB(A), to the nearest 1 dB(A)

Based on the information provided in Figure 5.1 and Table 5.2, in a worst case scenario, construction noise levels have the potential to exceed the adopted daytime standard construction hours NML of 60 dB(A) when:

- site establishment works are within 130 m of residential receivers
- earthworks are within 380 m of residential receivers
- utilities and diversion construction works are within 250 m of residential receivers
- road pavement construction work are within 450 m of residential receivers
- rehabilitation, landscaping sign installation and line marking works are within 150 m of residential receivers.

Based on the information provided in Figure 5.1 and Table 5.2, in a worst case scenario, construction noise levels have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) when:

- site establishment works are within 750 m of residential receivers
- earthworks are within 2,100 m of residential receivers
- utilities and diversion construction works are within 1,400 m of residential receivers
- road pavement construction works are within 2,500 m of residential receivers
- rehabilitation, landscaping sign installation and line marking works are within 800 m of residential receivers.

5.4.2 Construction Noise – Sleep Disturbance

The ICNG assesses sleep disturbance due to construction noise impacts in accordance with the NSW *Environmental Criteria for Road Traffic Noise* (ECRTN, 1999). However the ECRTN has since been superseded by the Road Noise Policy (RNP, 2011). Therefore, where construction works are required during the night time period, with consideration to RNP guidance, propensity for sleep disturbance or sleep arousal would be reduced where maximum internal noise levels are below 50-55 dB(A).

The RNP research suggests one or two noise events per night of maximum internal noise levels of up to 65-70 dB(A) are not likely to affect health or wellbeing.

Typical noise reduction through a window open for ventilation can be 10dB(A). This would mean an external noise level of 65dB(A) can correspond to an internal noise level of 55dB(A) with windows open and would be unlikely to cause sleep disturbance.

Based on the worst case construction noise assessment outlined above, there is the potential to exceed sleep disturbance noise goals of $L_{A1(1min)}$ 65dB(A). The assessment provides distances from construction activities where noise levels have the potential to be above 65dB(A). Therefore, It is recommended that particularly highly noisy activities are managed during out of hours construction.

5.4.3 Assessment of noise from ancillary sites

Five ancillary sites have been proposed within the study area and are shown on Figure 3.1, and are located at:

- Somersby Interchange
- Southbound Motorway
- Somersby Central Industrial Park
- Wisemans Ferry Road
- Kangoo Road.

At the ancillary sites, the following activities and equipment are proposed:

- Concrete batch plant (excluding Southbound Motorway and Kangoo Road)
- Concrete crushing (excluding Southbound Motorway and Kangoo Road)
- Staff car parking (excluding Southbound Motorway and Somersby Interchange)
- Stockpiling
- Site offices
- Site compounds/equipment storage.

The predicted noise levels at increasing separation distance from the proposed ancillary sites are detailed in Figure 5.2 and Table 5.3 below.

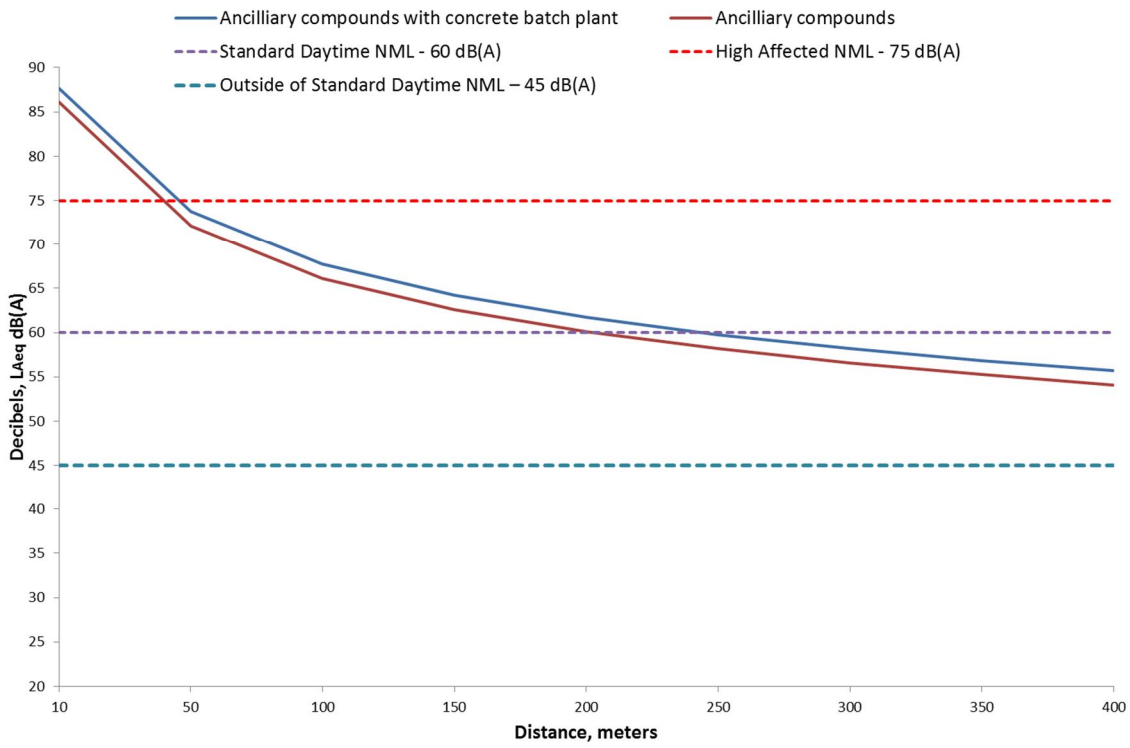


Figure 5.2 Estimated noise levels at increasing separation distance from proposed ancillary sites

Table 5.3 Predicted construction noise impacts at the nearest residential receivers

Anciliary compound	Proposed use	Nearest receivers and distance	Predicted noise impact dB(A) $L_{Aeq,15min}$
Standard daytime NML – 60 dB(A) $L_{Aeq,15min}$			
Somersby Interchange	Batch plant, crushing, stockpiling and storage	Peats Ridge Road (320 m)	57
Southbound Motorway	Stockpiling and storage	Tallara Road (325 m)	56
Somersby Central Industrial Park	Batch plant, crushing, stockpiling and storage	Gindurra Road (1,500 m)	44
Wisemans Ferry Road	Batch plant, crushing, stockpiling and storage	Acacia Road (1,140 m)	46
Kangoo Road	Stockpiling and storage	Kangoo Road (550 m)	51
Outside of Standard daytime NML – 45 dB(A) $L_{Aeq,15min}$			
Somersby Interchange	Batch plant, crushing, stockpiling and storage	Peats Ridge Road (320 m)	**57**
Southbound Motorway	Stockpiling and storage	Tallara Road (325 m)	**56**
Somersby Central Industrial Park	Batch plant, crushing, stockpiling and storage	Gindurra Road (1,500 m)	44
Wisemans Ferry Road	Batch plant, crushing, stockpiling and storage	Acacia Road (1,140 m)	**46**
Kangoo Road	Stockpiling and storage	Kangoo Road (550 m)	**51**

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

Values expressed as dB(A), to the nearest 1 dB(A)

Based on the information provided in Figure 5.2 and Table 5.3, in a worst case scenario, construction noise levels from proposed ancillary sites are not predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) at the nearest receivers.

However in a highly unlikely worst case scenario, construction noise levels from proposed ancillary sites have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) at the following receivers:

- Peats Ridge Road (320 m)
- Tallara Road (325 m)
- Dogg Trap Road (325 m)

It should be noted that this is a worst case scenario with all plant operating simultaneously at their maximum sound power levels, based on the minimum separation distances to the closest residential receivers to the proposed alignment. In reality, mobile machinery would move about, continuously altering the directivity of the noise sources. With respect to individual receivers, during any given period, the machinery may produce lower sound power levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of construction machinery would be present on site for only brief periods during the proposed construction works.

5.4.4 Summary of noise impacts from construction works

Tables 5.4 and 5.5 provide a summary of the residential receivers where predicted worst case scenario, construction noise levels exceed the adopted daytime and outside of standard daytime standard hours construction NMLs.

Table 5.4 Summary of residential receivers impacted from predicted worst-case scenario construction noise

Potentially impacted residential receiver
Standard daytime construction hours
10 Acacia Road
30-32 Bimbil
49, 59, 107, 227, 242, 244, 252 Debenham Road
56 Gindurra Road
20 Goldsmith Road
1 Peats Ridge Road
22, 41, 59, Lot 432 Reeves Street
Lot 9 Ridge Road
45 Tallara Road
65 Ulinga Road
596, 600 Wisemans Ferry Road
20, 56, 78, 85-87, 108 Wirrinda Road

Potentially impacted residential receiver
Outside of Standard daytime construction hours
10, 16-32, 25 Acacia Road
23, 30-32, 35-37 Bimbil Road
15, 17, 19, 21, 23, 25, 27, 29, 31, 33 Cebalo Place
1, 27, 49, 59, 60, 107, 184, 198, 223, 227, 242, 244, 252 Debenham Road
Lot 1, Lot 2, 32, 280, 332 Dogg Trap Road
56 Gindurra Road
8, 12, 16, 20 Goldsmith Road
Lot 602 Kangoo Road
Lot 2, 65, 90 Lackersteens Road
1, 30, 50 Lutana Road
10 Nyah Road
1, 38 Peats Ridge Road
22, 41, 59, Lot 432 Reeves Street
Lot 9 Ridge Road
45 Tallara Road
65 Ulinga Road
360, 376, 440, 578, 580, 596, 600, 829, 830 Wisemans Ferry Road
20, 56, 78, 85-87, 108 Wirrinda Road
21 Ulinga Road
Lot 602 Kangoo Road
Lot 601 The Avenue
Cebalo Place
181 – 253 Langford Drive
Lotter St
Casey Crescent
Casenmore Close
Reed Close
Sampson Street
Pullock Avenue
Garafelo Road
Thurling Ave
65-95 Mitchell Drive

Potentially impacted residential receiver
Lotter Street
Marshal Close
Samson St
Pollock Ave
Smith Close
Graham Place
Bowe Road
Fox Close
Gurringa Road
Taranna Road
Lowry Close
Robert Ave
Carmel Crescent
Karoom Steet
Old Mt Penang Road
Rafa Place
Festival Drive
5, 41, 51, 56, 59 Kowara Road
30 Tallara road
2, 33 Elwins Road

Where house numbers are absent all houses with the street are considered potentially noise affected.

Table 5.5 Summary of residential receivers impacted from predicted worst-case scenario construction noise from ancillary sites

Ancillary site	Potentially impacted residential receiver
Standard daytime construction hours	
Somersby Interchange	Predicted noise levels below NML of 60 dB(A) LAeq,15min at all nearest residential receivers
Southbound Motorway	
Somersby Central Industrial Park	
Wisemans Ferry Road	
Kangoo Road	

Ancillary site	Potentially impacted residential receiver
Outside of Standard daytime construction hours	
Somersby Interchange	280, 332 Dog Trap Road
	1, Lot 9 Peats Ridge Road
Southbound Motorway	56 Gundurra Road
	184, 223, 242, 252 Debenham Road
	45 Tallara Road
	65 Ulinga Road
Somersby Central Industrial Park	29, 63 Ghilkes Road
	79 Howes Road
	Lot 206 Myoora Road
	191,249 Somersby Falls Road
Wisemans Ferry Road	Predicted noise levels below NML of 45 dB(A) LAeq,15min at all nearest residential receivers
Kangoo Road	Lot 602 Kangoo Road
	Lot 601 The Avenue
	Cebalo Place (all)
	181 – 253 Langford Drive
	Lotter St (all)
	Casey Crescent (all)
	Casenmore Close (all)
	Reed Close (all)
	Sampson Street (all)
	Pullock Avenue (all)
	Garafelo Road (all)
	Thurling Ave (all)
	65-95 Mitchell Drive
	Lotter Street (all)
	Marshal Close (all)
	Samson St (all)
	Pollock Ave (all)
	Smith Close (all)

5.5 Construction vibration assessment

This section provides an assessment of potential ground vibration impacts from the proposed construction works.

5.5.1 Construction vibration prediction methodology

The assessment of potential ground vibration impacts has referenced measured peak particle velocity (PPV) levels for key vibration generating plant and machinery from Parsons Brinckerhoff's database of vibration levels.

In the assessment scenarios the referenced PPV levels have been applied in Equation 5.2 to estimate received ground vibration levels. The dominant frequency of vibration has been assumed to be between 1 Hertz (Hz) and 10Hz; the most conservative range for assessing potential impacts.

Equation 5.2 Calculation for the estimation of ground vibration propagation

$$PPV\ at\ receptor = PPV\ source\ x\ \left({}^{25m}/_{dist.\,to\ receiver,\,m}\right)^{1.5}$$

Equation 5.3 has been referenced to estimate vibration dose value (VDV) from the PPV levels for the assessment of potential disturbance impacts at nearest receivers.

Equation 5.3 Calculation for the estimation of VDV

$$eVDV = 1.4\ x\ \frac{2\pi 8}{1000}\ V_{rms} x\ t^{0.25}$$

Where *t* is time in seconds and Vrms is the vibration velocity (root mean squared).

5.5.2 Construction vibration assessment

Measured ground vibration levels from the operations of construction plant have been applied to recommend safe work distances between key vibration generating construction plant and nearest sensitive receivers.

Table 5.6 Recommended vibration safe working distances for construction plant

Construction Plant	Predicted PPV at 25m (mm/s)	Recommended safe working distance, metre (m)	
		Human annoyance	Structural damage
Excavator	0.6	>15	>7
Truck pass-by at 50 km/h	0.3	>10	>5
Rock breaker	1.1	>40	>13
Compactor	1.3–1.8	>40	>18

PPV Peak Particle Velocity at the recommended safe working distances in Table 5.6, compliance with the most conservative structural damage vibration management levels is predicted to be achieved at greater than 20 m from the individual assessed sources of vibration. Compliance with the most conservative human annoyance management levels is predicted to be achieved at greater than 40 m from the individual assessed sources of vibration. All nearest sensitive receivers are located more than 15 m from the proposal.

All ground vibration levels are expected to be contained within the proposal area, and any receiver ground vibration would comply with the maximum allowable eVDV of 0.4 $m/s^{1.75}$ (human annoyance) and 5 mm/s (structural damage) vibration goals.

The majority of construction road traffic would be at least 15 m from the nearest receivers on the local roads; referencing a road truck vibration level of 0.1 mm/s at 25 m, potential vibration levels would be within the human annoyance and structural damage vibration goals. No vibration impacts are expected from construction road traffic for the proposal.

6. Road traffic noise assessment

This section details the assessment of road traffic noise impacts undertaken for the proposal. As the proposal fits wholly within the alignment of the existing Motorway, this assessment has been undertaken through a noise model with a visual representation of traffic noise impacts via contour plots.

For the purpose of this assessment the 'build' option is no closer to any residential receiver than the 'no-build' option. As such significant increases in predicted noise levels between these two scenarios are not anticipated.

6.1 Road traffic count survey

Traffic count data was supplied by Roads and Maritime for the period of the baseline noise assessment between Monday 23 June 2014 and Sunday 29 June 2014. This data was obtained from in-situ traffic counting stations located along the Motorway. Traffic data included vehicle counts, classification and speed. From this data the heavy vehicle percentage was calculated.

The traffic data has been used to determine the influence of road traffic on the measured noise levels and assist in the calibration of the road traffic noise prediction model.

6.2 Measured ambient noise levels

The ambient noise levels measured during the road traffic survey are detailed in Table 6.1. The table shows the measured daily noise levels and the total (north bound and south bound) road traffic volumes for the Motorway.

The measured L_{Aeq} and L_{A10} noise levels are representative of the influence of the 15 hour day time and nine hour night time road traffic noise at the nearest residential noise receivers.

The measured noise levels in Table 6.1 have been applied for the verification of the road traffic noise model.

Table 6.1 Measured ambient noise levels during road traffic survey

Location	Day time ambient noise, dB(A)[1]	Night time ambient noise, dB(A)[1]	Total daily road traffic count light/ heavy vehicles[2]	
	L_{Aeq},15hr	L_{Aeq},9hr	Day 15 hr	Night 9 hr
1	56	53	38,564 / 9,641	7,040 / 1,760
2	64	60		
3	55	50		
4	60	56		

(1) Values expressed as A weighted dB and rounded to nearest 1 dB(A)
(2) Combined north and south bound traffic volumes are presented
L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level
L_{A10} A-weighted sound pressure level exceeded 10% of the time

6.3 Road traffic noise model

A traffic noise model was developed utilising the SoundPLAN (Version 7.1) noise propagation modelling software. The noise model has been developed from the following datasets and modelling approaches:

- Topography was included based on NSW Land and Property Information data.
- AUSTROADS 1994 vehicle classification applied; Class 1 and 2 light vehicles and Class 3 to 13 heavy vehicles.
- Vehicle noise was modelled at an average height of 0.5 m for cars, 1.5 m for heavy vehicles engines and 3.6 m for heavy vehicle exhausts based on the standard Road Traffic Noise (CoRTN) algorithms.
- Receiver height was modelled at 1.5 m for logger validation and 2 m for residential receivers.
- Heavy vehicle exhausts were modelled at 8dB less than engine noise.
- A ground absorption co-efficient of 0.75 has been modelled.
- The noise model was verified to the existing road traffic conditions and concrete road surface. A positive 2.5 dB(A) correction factor for a concrete surfaces was applied in the model.
- Road traffic speeds modelled at 110 km/h for cars and 100 km/h for heavy vehicles.
- A free field correction of -0.7 dB(A) for monitoring locations and for road traffic noise, refer Saunders, Samuels, Leach & Hall, 1983.
- A 2.5 dB(A) correction for the prediction of operational noise to residence was applied.
- A -1.7 dB(A) correction was applied to façade predictions, refer April 1983 Australian Road Research Board Report – Research Report ARR No.122.
- Received noise levels were calculated applying Calculation of Road Traffic Noise (CoRTN) algorithms for LA10 and a -3 dB(A) correction applied for LAeq.

Road traffic volumes are interpolated from Roads and Maritime forecast traffic flows and data obtained from the M1 Pacific Motorway, Kariong Ramps and M1 Kariong to Somersby Widening Traffic and Transport Assessment (Parsons Brinckerhoff, 2014). Future scenario road traffic volumes are predicted assuming a 1.5per cent (up until 2019) and 1.1per cent (2019 onwards) annual growth rate.

Based on a forecast 60,000 (2019) and 66,600 (2029) vehicles per day, Table 6.2 outlines the traffic volumes used in this assessment.

Table 6.2 Road traffic volumes for the project

Year of operation	Day time 15-hour		Night time 9-hour	
	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
2019 from Roads and Maritime commissioned traffic counts				
Combined North and South Bound	40,590	10,147 (20%)	7,410	1,853 (20%)
2029 (assuming 1.5 per cent per annum growth rate from 2012)				
Combined North and South Bound	45,054	11,264 (20%)	8,226	2,056 (20%)

Heavy vehicle traffic was modelled at 20 per cent based on traffic data supplied by Roads and Maritime.

6.3.1 Model verification

The noise prediction model was verified to the measured free field road traffic noise levels as detailed in Table 6.3. All predicted noise levels exclude façade corrections to be representative of the measured noise levels. The validation sample points are considered within an acceptable ±2 dB(A) margin of accuracy.

Table 6.3 Noise model calibration

Location	Measured noise level, L_{Aeq} dB(A)		Predicted noise level, L_{Aeq} dB(A)		Difference dB(A)	
	Day 15 hr	Night 9 hr	Day 15 hr	Night 9 hr	Day	Night
1	56.0	52.9	56.4	51.2	-0.4	1.7
2	64.2	59.8	63.5	58.7	0.7	1.1
3	55.9	50.0	54.4	49.3	1.5	0.7
4	59.6	55.8	61.6	56.2	-2.0	-0.4

L_{Aeq} Equivalent continuous (energy average) A-Weighted sound pressure level.
Values expressed as A-weighted dB and rounded to nearest 0.1 dB(A).

6.4 Road traffic noise levels

Factors including traffic flow, speed and road surface are predicted to remain the same between the 'no-build' and 'build' options. This represents a worst scenario, as any pavement treatments would reduce noise generated by vehicle's tyres. The alignment of the proposal is anticipated to fit wholly within the alignment of the existing Motorway. As such, relative increase noise goals have not been adopted in this assessment as modelling has indicated noise levels will not increase by greater than 2 dB(A).

Table 6.4 outlines the difference between the 'build' and 'no-build' predicted noise levels at the nearest receivers.

Table 6.4 Difference between 'build' and 'no-build' predicted road traffic noise levels

Receiver	Predicted noise 'no-build' scenario L_{Aeq} dB(A)		Predicted noise 'build' scenario L_{Aeq} dB(A)		Compliance with Roads and Martime Predicated Noticeable Increase	
	Day 15 hr	Night 9 hr	Day 15 hr	Night 9 hr	Existing traffic noise LAeq, 15 hr + 2 dB	Existing traffic noise LAeq, 9 hr + 2 dB
2019						
Receiver 1	58.2	52.3	58.2	52.3	Yes	Yes
Receiver 2	65.4	59.4	65.5	59.5	Yes	Yes
Receiver 3	56.2	50.3	56.3	50.4	Yes	Yes
Receiver 4	63.5	57.5	63.6	57.6	Yes	Yes

Receiver	Predicted noise 'no-build' scenario L_{Aeq} dB(A)		Predicted noise 'build' scenario L_{Aeq} dB(A)		Compliance with Roads and Martime Predicated Noticeable Increase	
	Day 15 hr	Night 9 hr	Day 15 hr	Night 9 hr	Existing traffic noise LAeq, 15 hr + 2 dB	Existing traffic noise LAeq, 9 hr + 2 dB
2029						
Receiver 1	58.7	52.4	58.7	52.4	Yes	Yes
Receiver 2	65.8	59.5	65.9	59.6	Yes	Yes
Receiver 3	56.7	50.4	56.8	50.5	Yes	Yes
Receiver 4	63.9	57.6	64.0	57.7	Yes	Yes

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level.
Values expressed as A-weighted dB and rounded to nearest 0.1 dB(A).

The predicted 'build' option 2019 and 2029 scenarios for day time and night time road traffic noise levels are detailed in Table 6.5. Results are limited to the four nearest residential receivers to the Motorway.

Table 6.5 Predicted road traffic noise levels at the nearest receivers

Receiver	Predicted noise L_{Aeq} dB(A)		Noise goal compliance			
	Day 15 hr	Night 9 hr	Day 60 dB(A) L_{Aeq},15hr	Night 55 dB(A) L_{Aeq},9hr	Acute day 65 dB(A) L_{Aeq},15hr	Acute night 60 dB(A) L_{Aeq},9hr
2019 'build' option						
Receiver 1	58	52	Yes	Yes	Yes	Yes
Receiver 2	66	60	**No +6**	**No +5**	**No**	**No**
Receiver 3	56	50	Yes	Yes	Yes	Yes
Receiver 4	64	58	**No +4**	**No +3**	Yes	Yes
2029 'build' option						
Receiver 1	59	52	Yes	Yes	Yes	Yes
Receiver 2	66	60	**No +6**	**No +5**	**No**	**No**
Receiver 3	57	51	Yes	Yes	Yes	Yes
Receiver 4	64	58	**No +4**	**No +3**	Yes	Yes

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level.
Values expressed as A-weighted dB and rounded to nearest 1 dB(A).

6.4.1 Assessment of sleep disturbance

To assess the potential for sleep disturbance a 10 dB(A) reduction to external road traffic noise levels, achieved by the building façade, has been applied to estimate internal noise levels.

Referencing a predicted worst case night time noise level of 60 dB(A) L_{Aeq} (Receiver 2) potential internal noise levels of 50 dB(A) L_{Aeq} comply with the noise level guideline of maximum internal noise levels of 50 to 55 dB(A) and one or two noise events per night, with maximum internal noise levels of 65 to 70 dB(A).

6.4.2 Maximum noise level assessment

The RNP offers guidance for the assessment of maximum noise levels where noise impacts at night are expected to occur. These criteria include:

- Individual LA_{max} noise levels should not exceed 65 dB(A)
- LA_{max} noise levels should not exceed the predicted $LA_{eq,1hr}$ by more than 15 dB(A).

Based on this guidance, a maximum noise level assessment was undertaken at each of the four nearest residential receivers. For the purpose of this assessment, the difference between the predicted maximum noise levels between the 'build' and 'no build' option are insignificant. This assessment has instead focused on the differences between the 2019 and 2029 scenarios. Table 6.6 outlines the night time maximum level noise events at the nearest receivers based on heavy vehicle movements.

Table 6.6 Maximum noise level events – 2019 and 2029 'build' and 'no build' options

Receiver	Maximum noise L_{Amax} dB(A)	Predicted noise $L_{Aeq, 1hr}$ dB(A)	Noise goal compliance	
			65 dB(A) L_{Amax}	$L_{Aeq, 1hr}$ dB(A) + 15 dB(A)
2019 'build' and 'no build' option				
Receiver 1	64	53	Yes	No
Receiver 2	72	60	**No**	No
Receiver 3	61	51	Yes	No
Receiver 4	67	58	**No**	No

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level.
Values expressed as A-weighted dB and rounded to nearest 1 dB(A).
[1] – based on traffic data supplied by Roads and Maritime.

Based on the data presented in Table 6.6 predicted noise levels at the nearest 4 receivers do not trigger both the criteria for 'maximum noise events' and are therefore considered to comply with sleep disturbance noise goals..

6.4.3 Noise contour figures

To assist in the interpretation of potential road traffic noise levels the predicted 2019 'build' scenario day time and night time road traffic noise levels are presented in Figure 6.1 (day time) and Figure 6.2 (night time). Future predicted 2029 'build' scenario road traffic noise levels are presented in Figure 6.3 (day time) and Figure 6.4 (night time).

The noise contours are based on an interpolation of predicted road traffic noise, the maps are for visual interpretation of noise levels only. No façade corrections have been applied to the noise contour lines in the figures below.

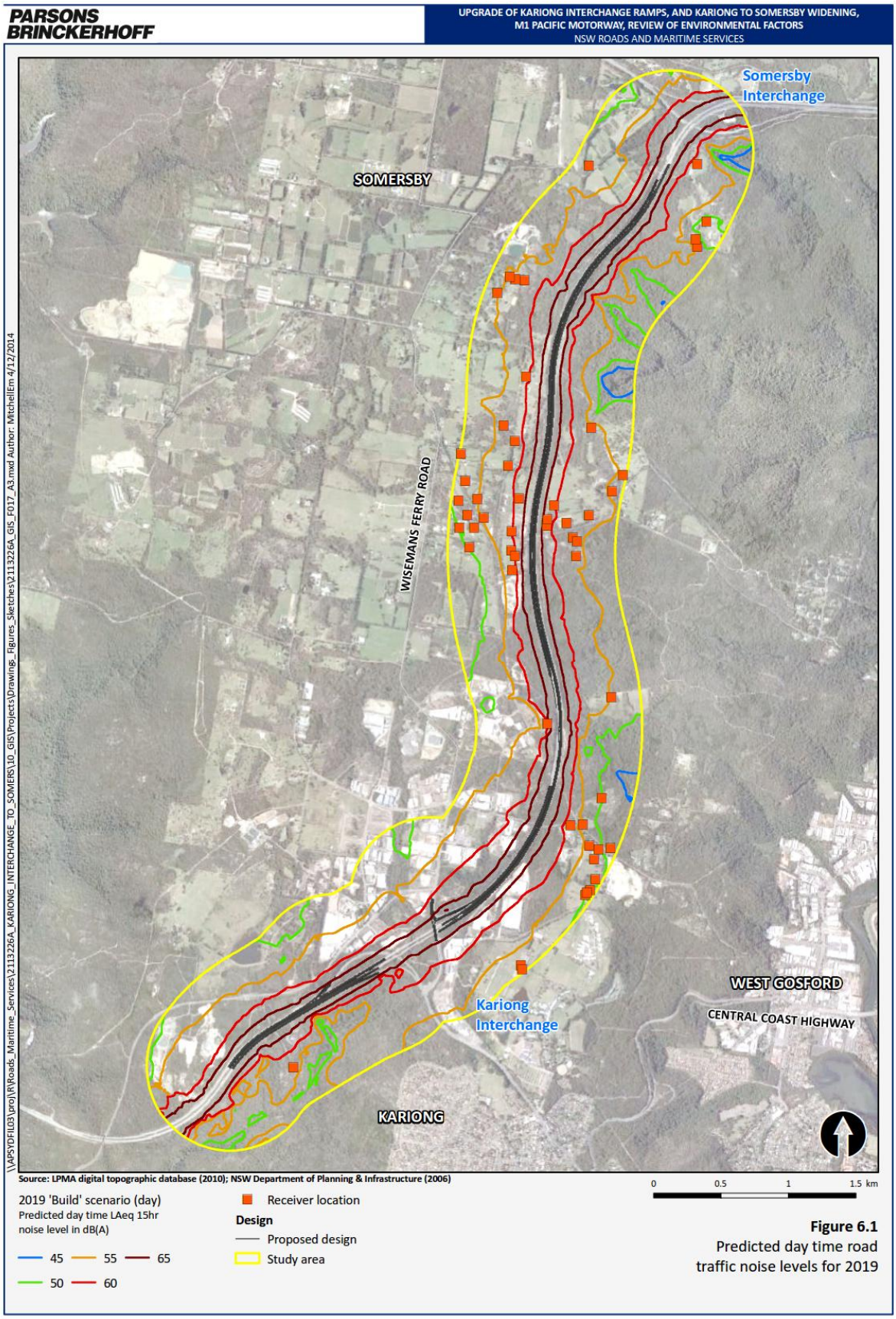


Figure 6.1 Predicted day time road traffic noise levels for the 2019 'build' scenario

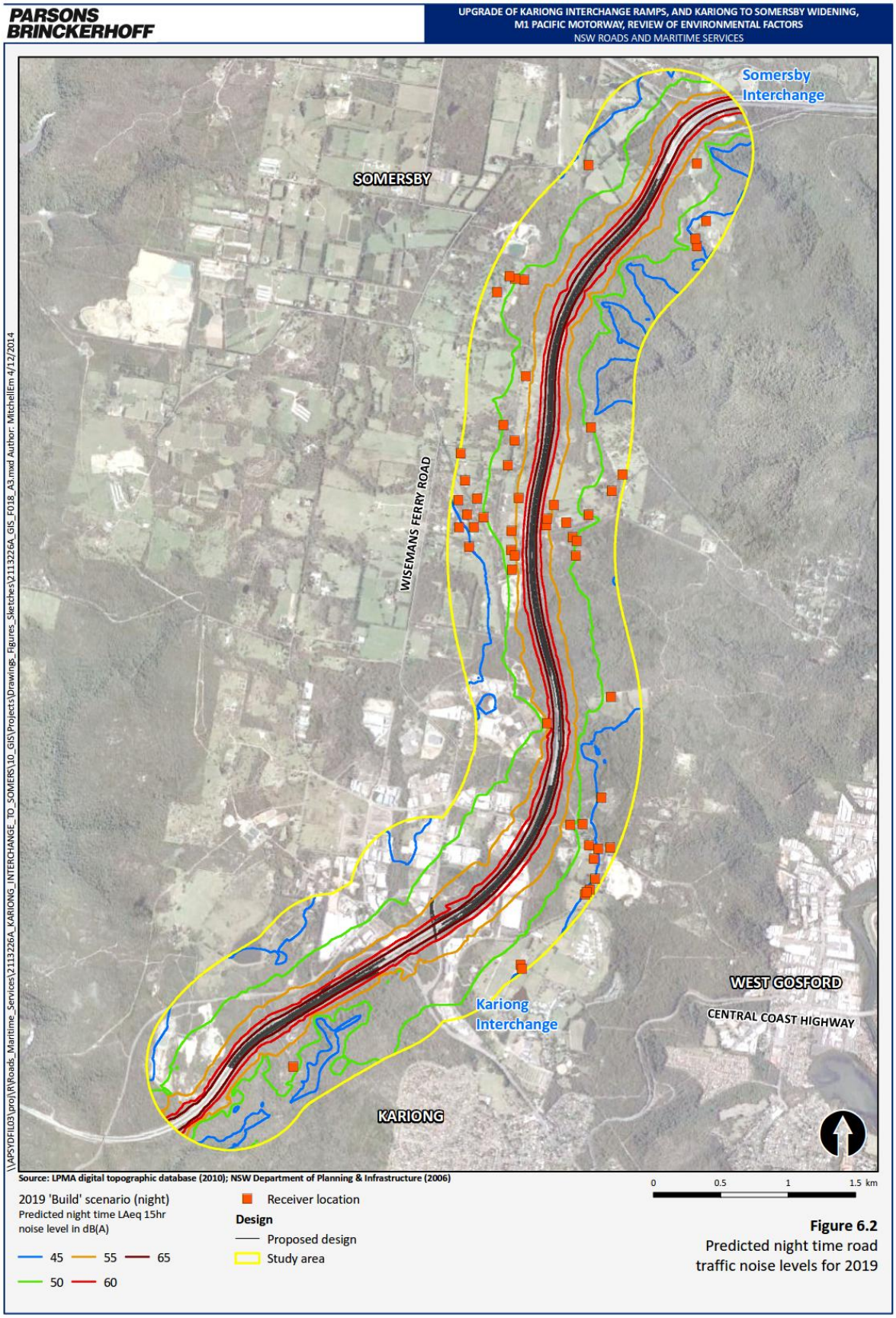


Figure 6.2 Predicted night time road traffic noise levels for the 2019 'build' scenario.

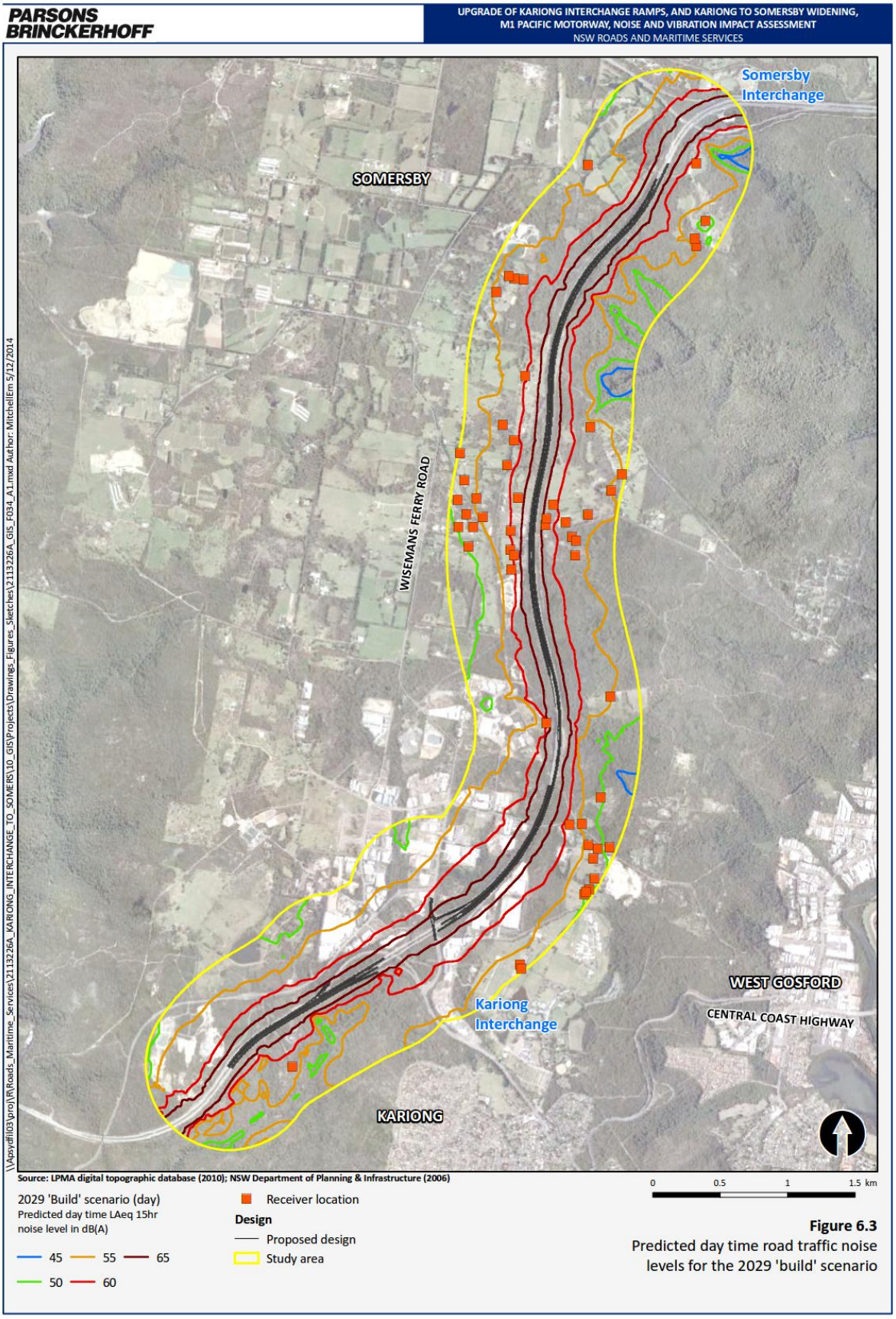


Figure 6.3 Predicted day time road traffic noise levels for the 2029 'build' scenario.

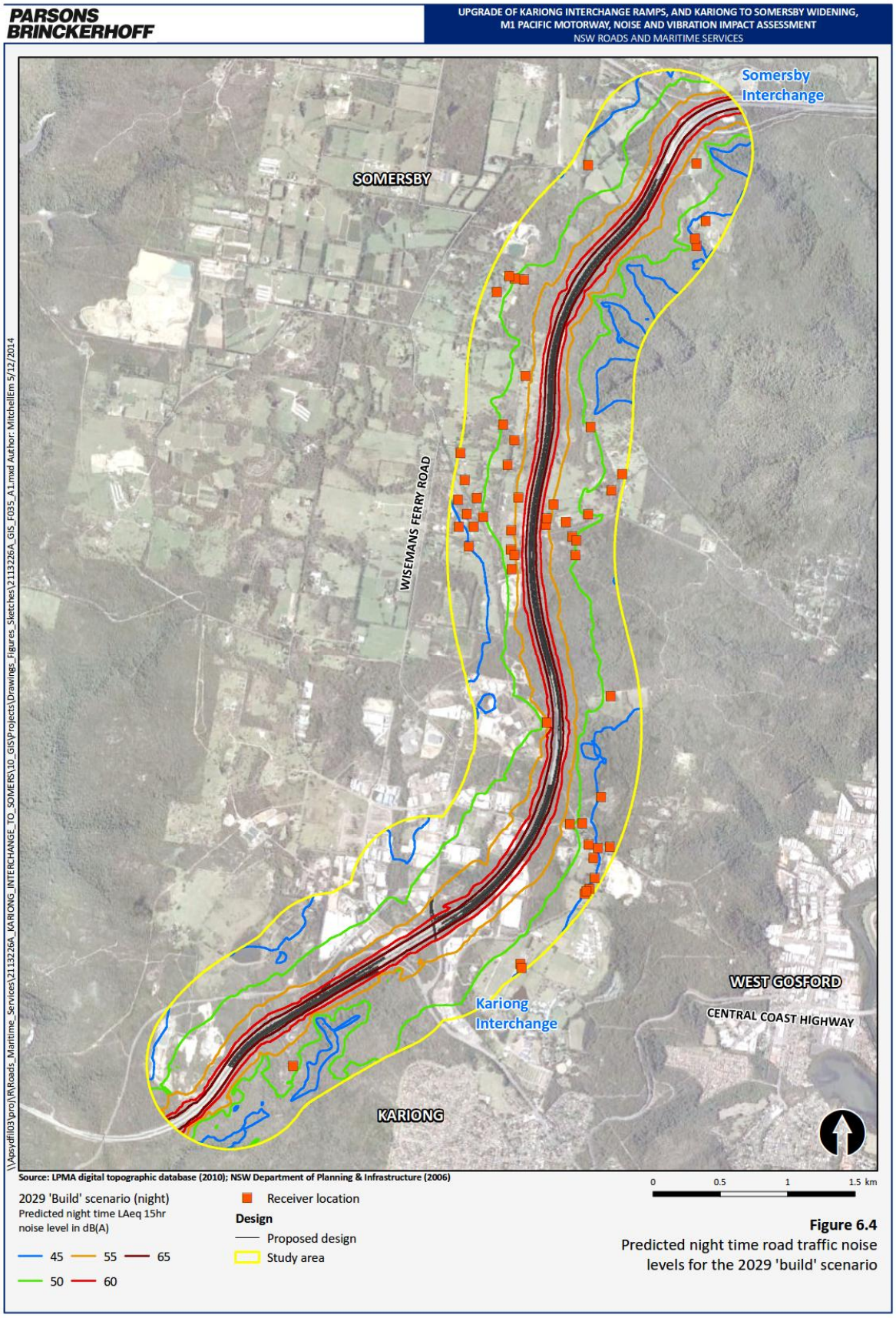


Figure 6.4 Predicted night time road traffic noise levels for the 2029 build scenario

6.5 Discussion of the results

Assessment of road traffic noise indicated existing noise levels exceed RNP noise goals for the redevelopment of freeways by up to 6 dB(A) during the day and 5 dB(A) during the night at the nearest receivers. Similar exceedances are predicted for future scenarios under both the 'build' and 'no-build' options.

Comparison of predicted noise levels between the 'build' and 'no-build' scenarios indicated an increase of less than 2 dB(A) at the nearest receivers. The proposal therefore does not exceed the Roads and Maritime criteria for predicted noticeable increase (existing traffic noise L_{Aeq} + 2 dB).

Predicted noise levels at all receivers were below the Roads and Maritime acute noise assessment criteria with the exception of Receiver 2 (41 Reeves St Somersby). Predicted noise at this receiver was less than 1 db(A) in exceedance of the acute noise criteria which would be imperceptible to the human ear. It should be noted that this predicted exceedance occurs under both the 'build' and 'no build' scenarios.

Based on information provided, the results of the assessment suggest traffic noise from the proposal in itself is expected to have a negligible impact on the nearest receivers.

7. Recommended noise management and mitigation measures

Worst case potential construction noise along the Motorway is predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) at a minimum distance of 130 m. Worst case potential construction noise along the Motorway is predicted to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) at a minimum distance of 250 m.

Potential construction noise from the proposed ancillary sites is expected to comply with the adopted daytime standard construction hours NML of 60 dB(A) at nearest residential receivers. However, worst case scenario, construction noise levels from proposed ancillary sites have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) at:

- Peats Ridge Road (320 m)
- Tallara Road (325 m)
- Dogg Trap Road (325 m)

Potential construction road traffic noise and construction vibration impacts at nearest receivers are anticipated to be within adopted ICNG criteria during standard construction hours.

A series of construction measures and management practices designed to mitigate and ensure satisfactory noise levels are detailed in Section 7.1. The recommended management approaches have been made considering the predicted noise impacts and the proposed construction schedules.

Operational noise increases from the proposal are expected to be less than 2 dB(A). Exceedance of the Roads and Maritime acute operational noise criteria was predicted at one residence under both the 'build' and 'no-build' scenarios. This exceedance was within 1dBA of the day-time criteria for both 2019 and 2029.

7.1 Construction noise management and mitigation measures

During the planning and scheduling of construction works the predicted noise levels should be considered in establishing work site locations, construction techniques and on site practices.

While worst case impacts from construction are not expected, the following principles and proactive noise management measures should be considered for implementation:

- A Construction Noise and Vibration Management Plan (CNVMP) should be formulated to provide a framework for addressing noise levels associated with construction works. Specifically any out of hours works undertaken near sensitive receivers.
- Construction works should adopt Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA) practices as addressed in the ICNG. BMP includes factors discussed within this report and encouragement of a project objective to reduce noise emissions.

- Construction plant source noise levels should be confirmed prior to the commencement of works to verify construction noise impacts and confirm the requirement for noise management and mitigation measures.
- The construction program would be scheduled where feasible to:
  - maximise the offset distance between construction plant and adjacent receivers
  - orientate construction and auxiliary equipment away from sensitive receivers
  - minimise reversing alarm noise emissions from mobile plant and vehicles and where practicable, site entry and exit points will be managed to limit the need for reversing
  - minimise concurrent operation of dominant noise generating equipment such as: bulldozer, rock breaker, mobile crane and asphalt paver construction plant. Where dominant noise generating plant are not in concurrent operation reductions to received noise impacts of up to 6 dB(A) are anticipated.
- Adjacent residents should be notified of potential night time construction works at least two weeks prior to the commencement of construction works.
- A one page summary of required construction noise and vibration management practices would be provided to construction staff and contractors and be discussed during site inductions. The summary should include, as a minimum, the permitted hours of construction work, work site locations, locations of sensitive receivers and site ingress/egress.
- A complaints management procedure would be established and implemented in the environmental management plan for the proposal. This would include the implementation of a phone hotline and a procedure for recording and responding to any issues relating to noise that may arise during fieldwork associated with the proposal.
- Noise impacts would be minimised in accordance with Practice Note 7 in the RTA's *Environmental Noise Management Manual* and RTA's *Environmental fact sheet No. 2 – Noise management and Night Works*.
- Noise monitoring should be considered if complaints are received regarding excessive noise and this would be assessed against relevant guidelines.
- Machinery and equipment should be well maintained to assist with minimising noise levels.
- Idling equipment should be turned off where appropriate.

7.2 Road traffic noise management and mitigation measures

During the detailed design phase, Roads and Maritime would investigate suitable measures to mitigate road noise at Receiver 2, in consultation with this property owner.

8. Conclusion

The following section provides an overview of the noise and vibration impact assessment for the project.

8.1 Construction noise and vibration

The construction noise assessment was undertaken for the construction works for the proposal. A worst case scenario of all plant in cumulative operation was assumed for proposed day time (core hours) works.

Predictions of worst case construction noise impacts are predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) when:

- site establishment works are within 130 m of residential receivers
- earthworks are within 380 m of residential receivers
- utilities and diversion construction works are within 250 m of residential receivers
- road pavement construction work are within 450 m of residential receivers

Predictions of worst case construction noise impacts are predicted to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) when:

- site establishment works are within 750 m of residential receivers
- earthworks are within 2,100 m of residential receivers
- utilities and diversion construction works are within 1,400 m of residential receivers
- road pavement construction works are within 2,500 m of residential receivers
- rehabilitation, landscaping sign installation and line marking works are within 800 m of residential receivers.

Predictions of worst case construction noise impacts from proposed ancillary sites are not predicted to exceed the adopted daytime standard construction hours NML of 60 dB(A) at the nearest receivers.

However, predictions of worst case construction noise impacts from proposed ancillary sites have the potential to exceed the adopted outside of standard daytime standard construction hours NML of 45 dB(A) at the following receivers:

- Peats Ridge Road (320 m)
- Tallara Road (325 m)
- Dogg Trap Road (325 m)

Measures to mitigate these impacts were recommended in Section 7.

Construction road traffic is not expected to result in a significant increase in existing road traffic noise. No perceptible or structural construction vibration impacts are expected.

Recommended noise management and mitigation measures include the implementation of a construction noise and vibration management plan, responsible working practises and a consultation process to inform the local community of the proposed works and any anticipated impacts.

8.2 Operational road traffic noise assessment

Operational noise is expected to comply with RNP guidance, with the exception of Receiver 2. Predicted noise at this receiver were less than 1 db(A) in exceedance of the acute noise criteria under both the 'build' and 'no build' scenarios.

Roads and Maritime would investigate suitable measures to mitigate road noise in consultation with this property owner.

9. References

- AUSTROADS 1994, AUSTROADS Vehicle Classification System, AUSTROADS Sydney.
- Department of Transport, Welsh Office (1988) Calculation of Road Traffic Noise (CoRTN), HMSO, London.
- Department of Environment Climate Change and Water (2011), NSW Road Noise Policy (RNP), Sydney NSW.
- Kean S, 2008, Is CorTN an Leq or L10 Procedure, Australian Acoustical Society, Acoustics 2008 Geelong Victoria.
- Parsons Brinkerhoff 2014, M1 Pacific Motorway, Kariong Ramps and M1 Kariong to Somersby Widening.
- Roads and Maritime 2008, Environmental Direction 24 – Noise assessment for acute levels of noise – redevelopment of existing roads.
- Roads and Traffic Authority 2001, RTA Environmental Noise Management Manual.
- Saunders RE, Samuels SE, Leach R and Hall A, 1983, An evaluation of the UK DoE traffic noise prediction method. Australian Road Research Board Research Report 122, Vermont South Victoria.

10. Limitations

Scope of services and reliance of data

This noise and vibration assessment ('the study') has been prepared in accordance with the scope of work/services set out in the contract, or as otherwise agreed, between Parsons Brinckerhoff and the Client. In preparing this study, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in this study ('the data'). Except as otherwise stated in the noise and vibration assessment, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the study ('conclusions') are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

Study for benefit of client

The study has been prepared for the exclusive benefit of the Client and no other party. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with in this study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this study (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this study). Other parties should not rely upon the study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

Other limitations

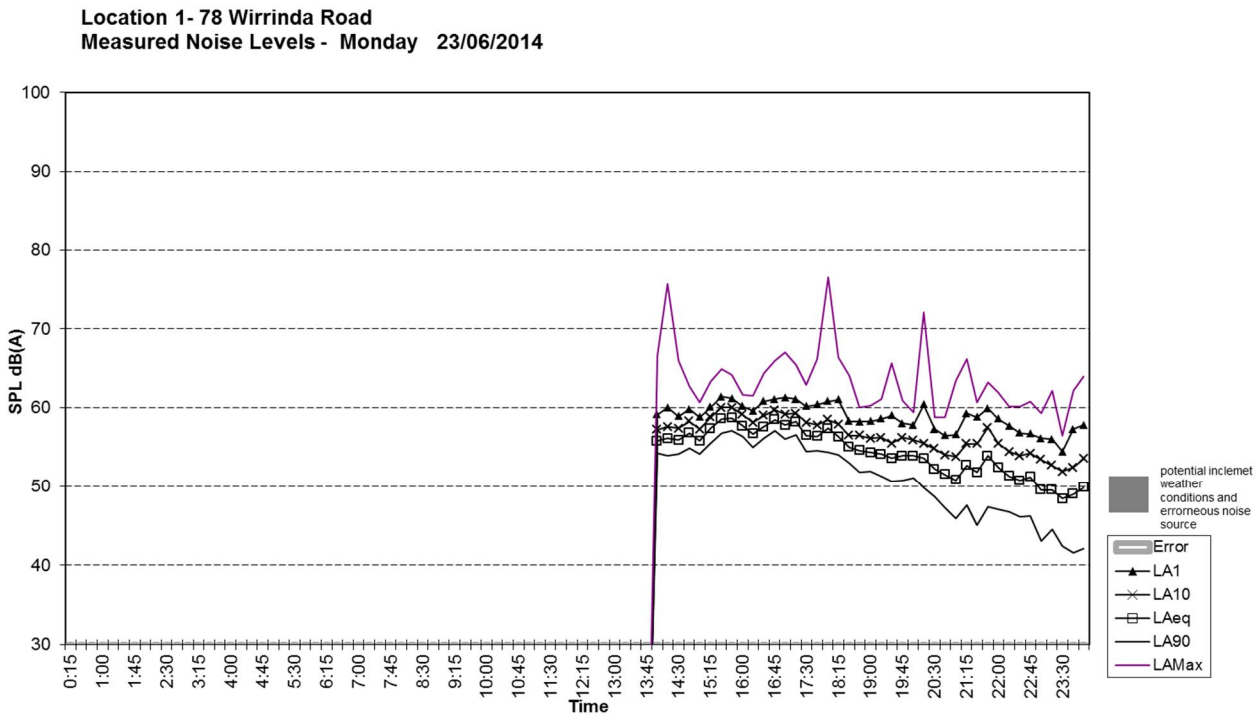
To the best of Parsons Brinckerhoff's knowledge, the project presented and the facts and matters described in this noise impact study reasonably represent the Client's intentions at the time of printing of the noise impact study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the project and of its possible noise and vibration impacts.

Parsons Brinckerhoff will not be liable to update or revise the study to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the study.

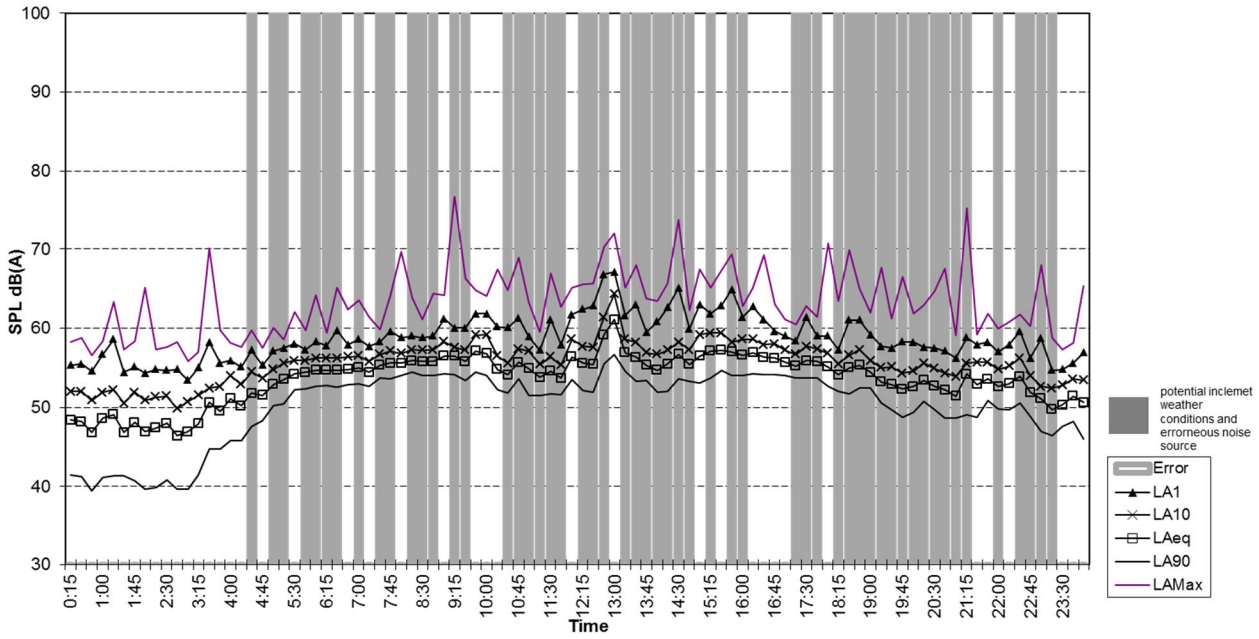
Appendix A

Measured ambient noise levels

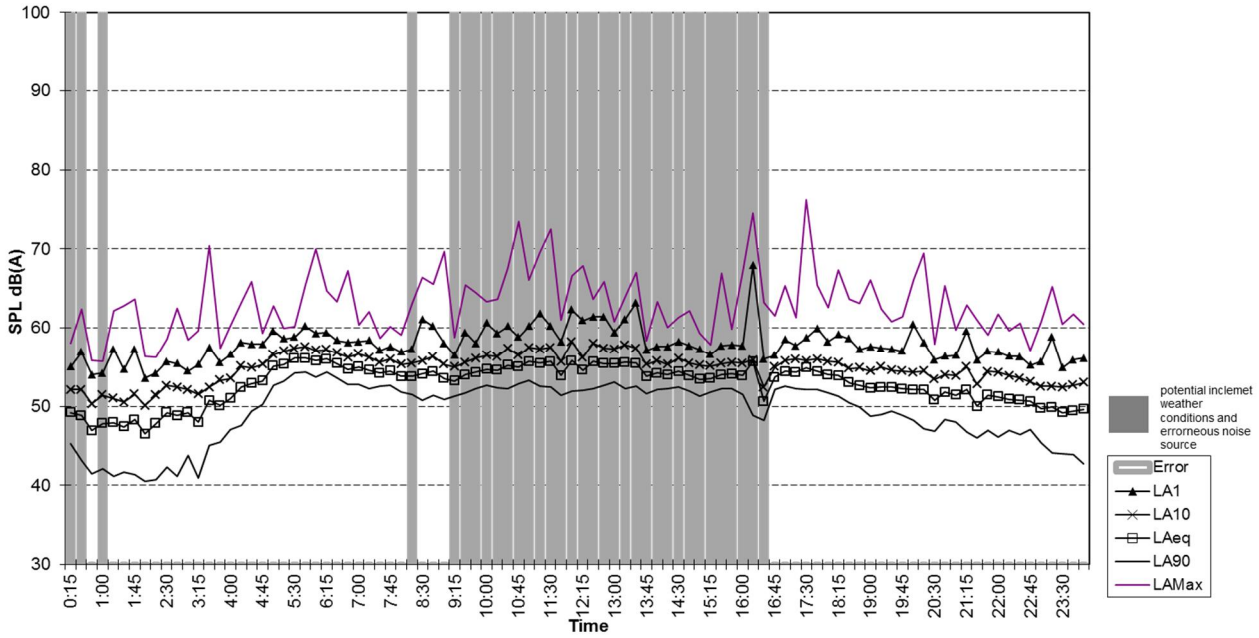
Monitoring location 1 – 78 Wirrinda Road, Somersby NSW; 33.388577 South, 151.295636 East



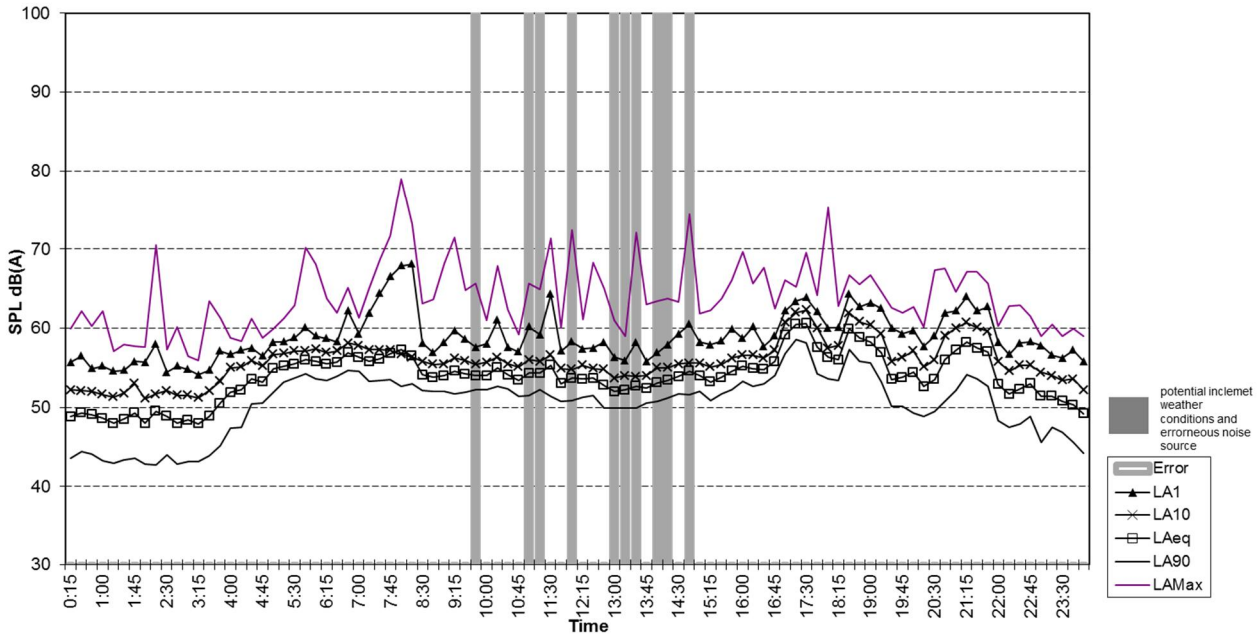
Location 1- 78 Wirrinda Road
Measured Noise Levels - Tuesday 24/06/2014



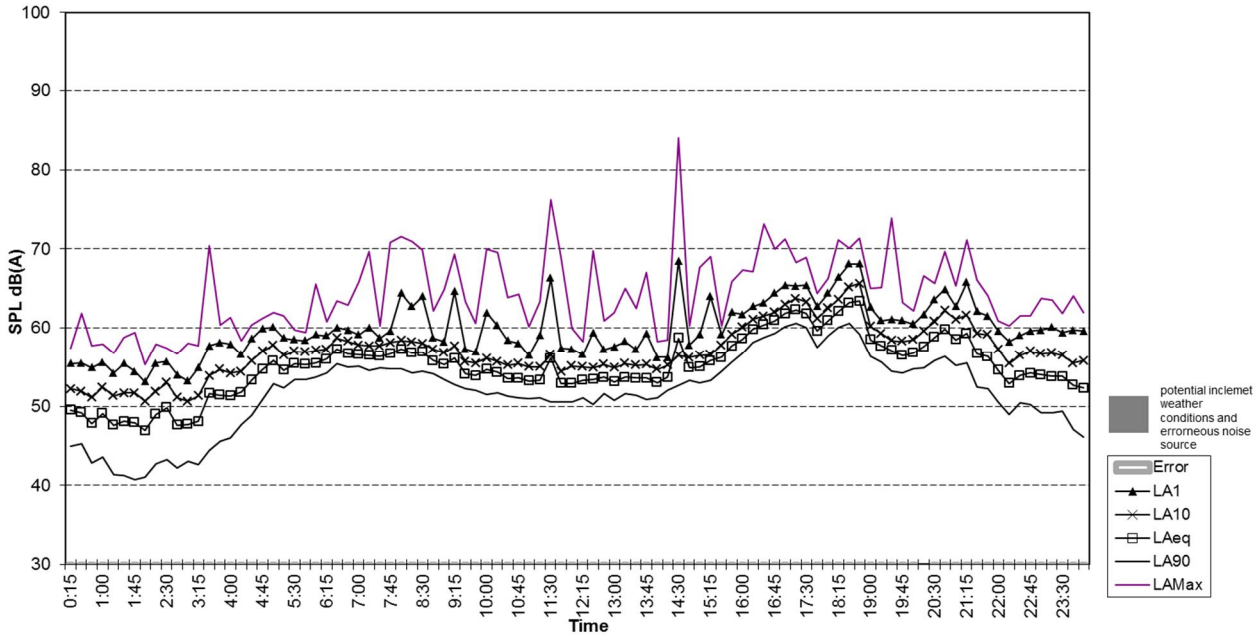
Location 1- 78 Wirrinda Road
Measured Noise Levels - Wednesday 25/06/2014



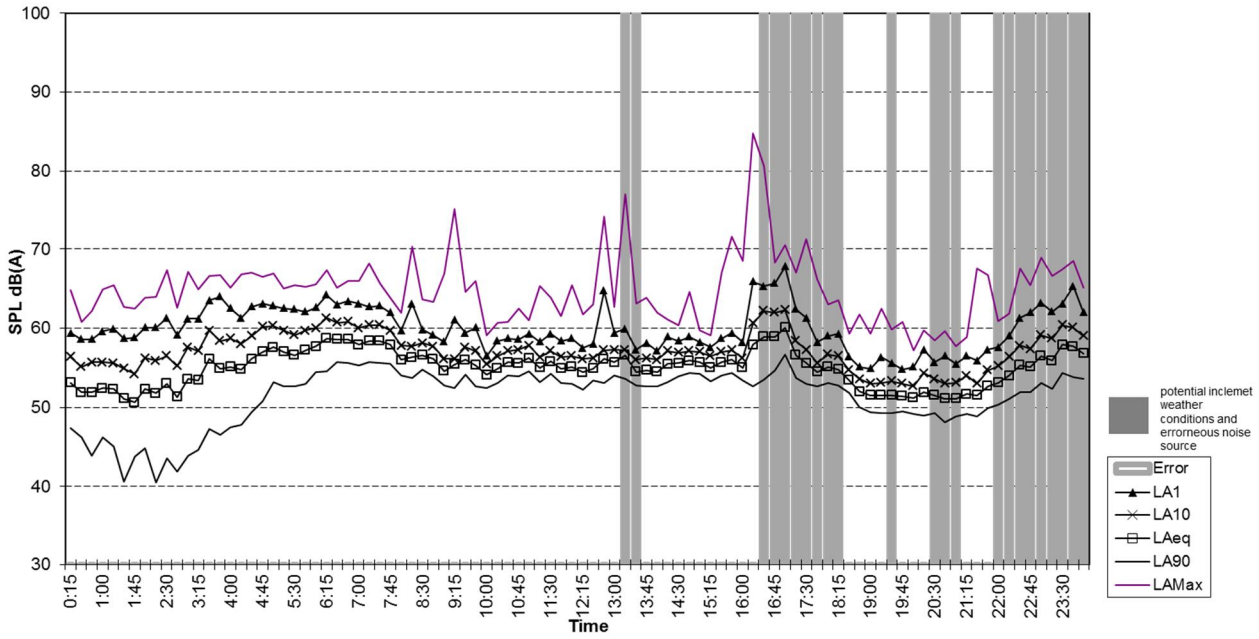
Location 1- 78 Wirrinda Road
Measured Noise Levels - Thursday 26/06/2014



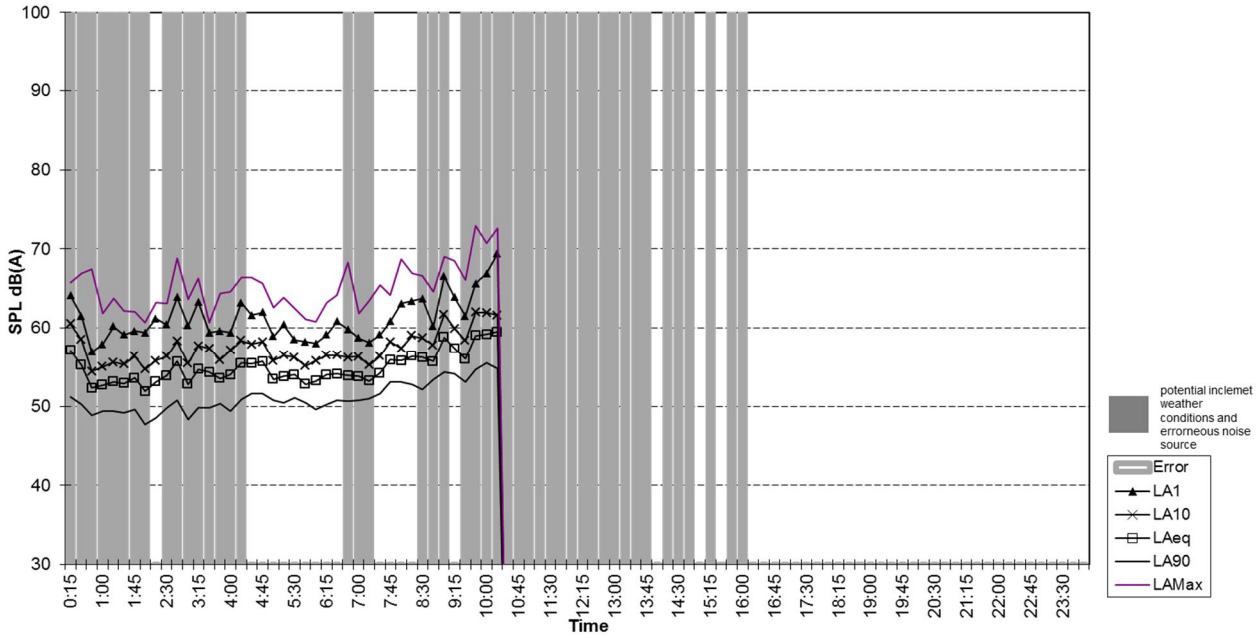
Location 1- 78 Wirrinda Road
Measured Noise Levels - Friday 27/06/2014



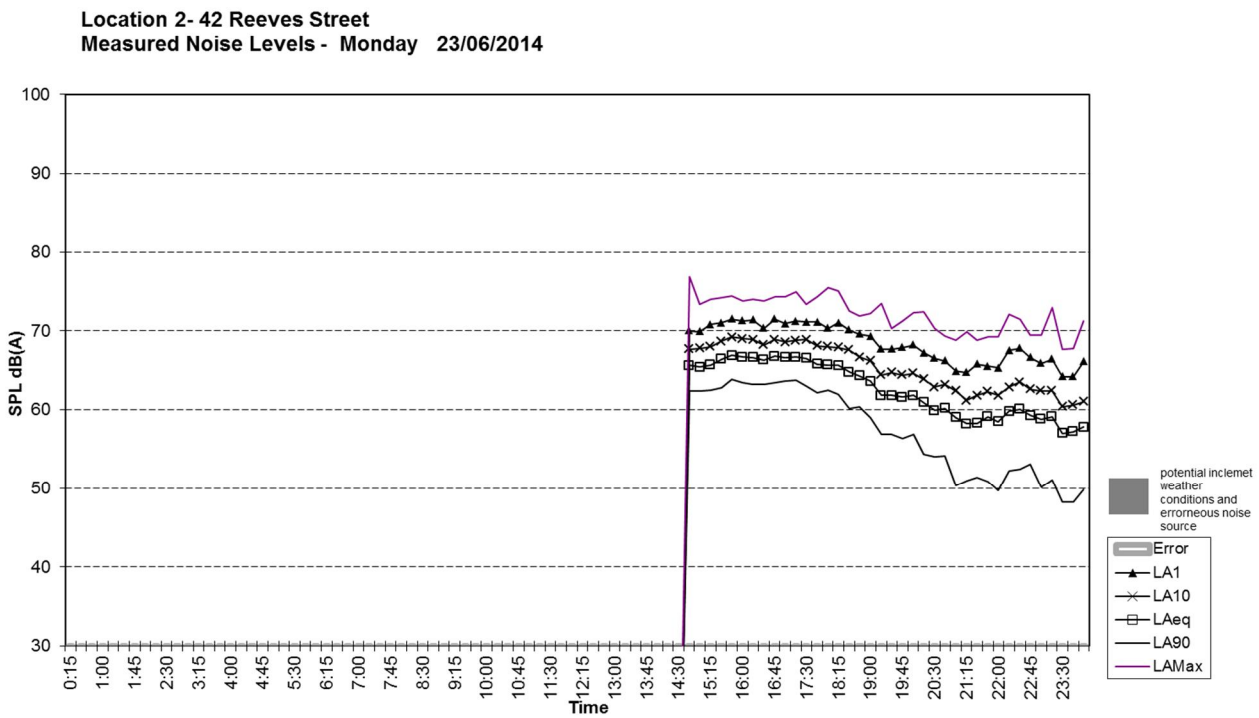
Location 1- 78 Wirrinda Road
Measured Noise Levels - Saturday 28/06/2014



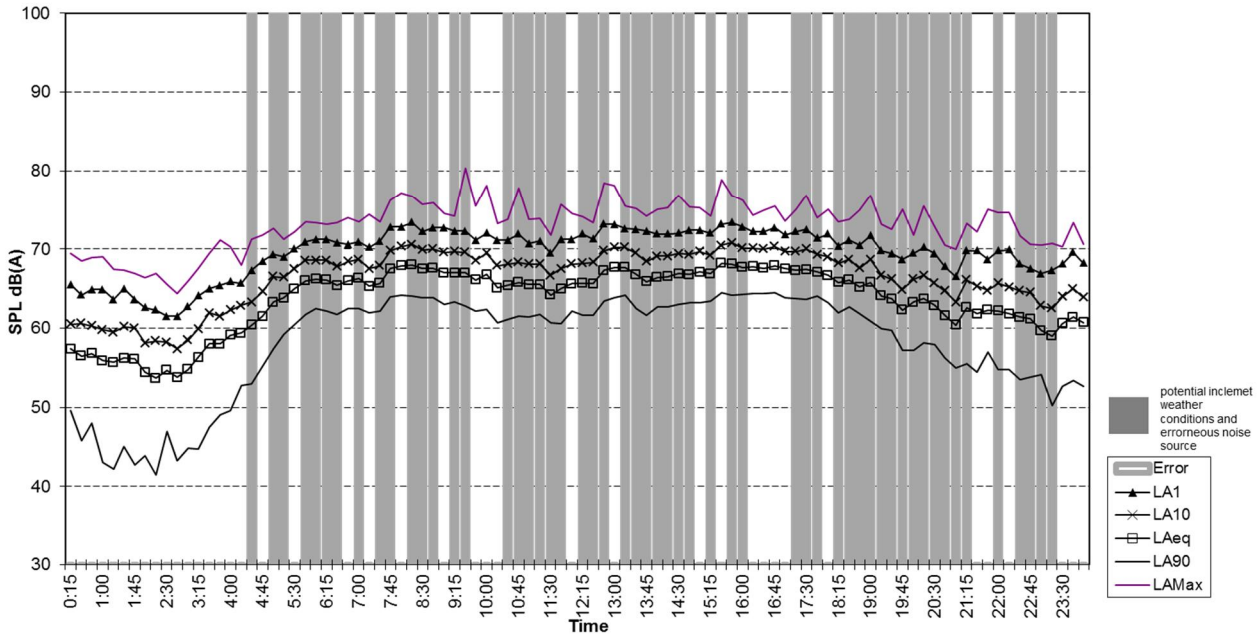
Location 1- 78 Wirrinda Road
Measured Noise Levels - Sunday 29/06/2014



Monitoring Location 2 - 41 Reeves Street, Somersby NSW; 32.394489 South, 151.297942 East



Location 2- 42 Reeves Street
Measured Noise Levels - Tuesday 24/06/2014



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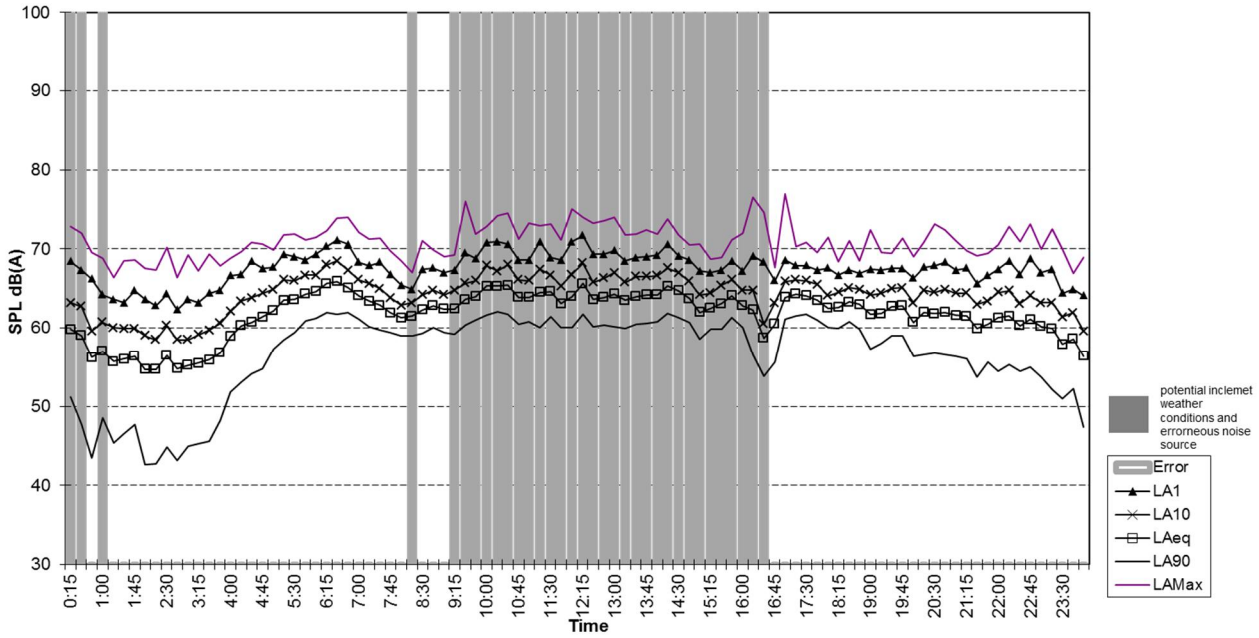

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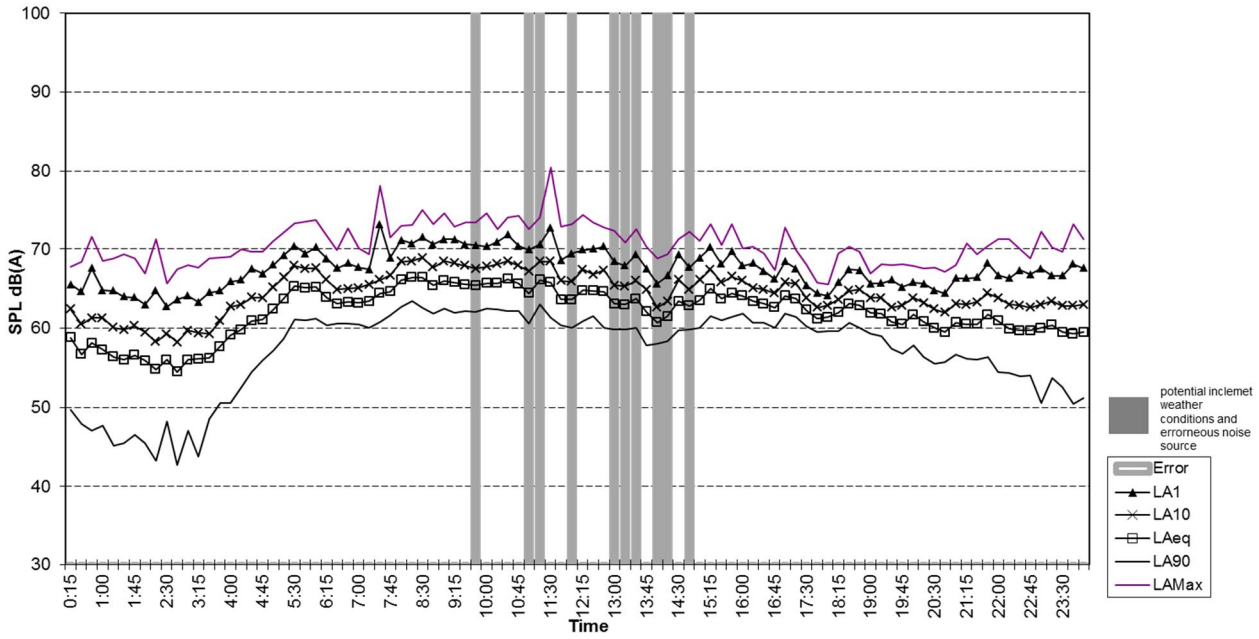
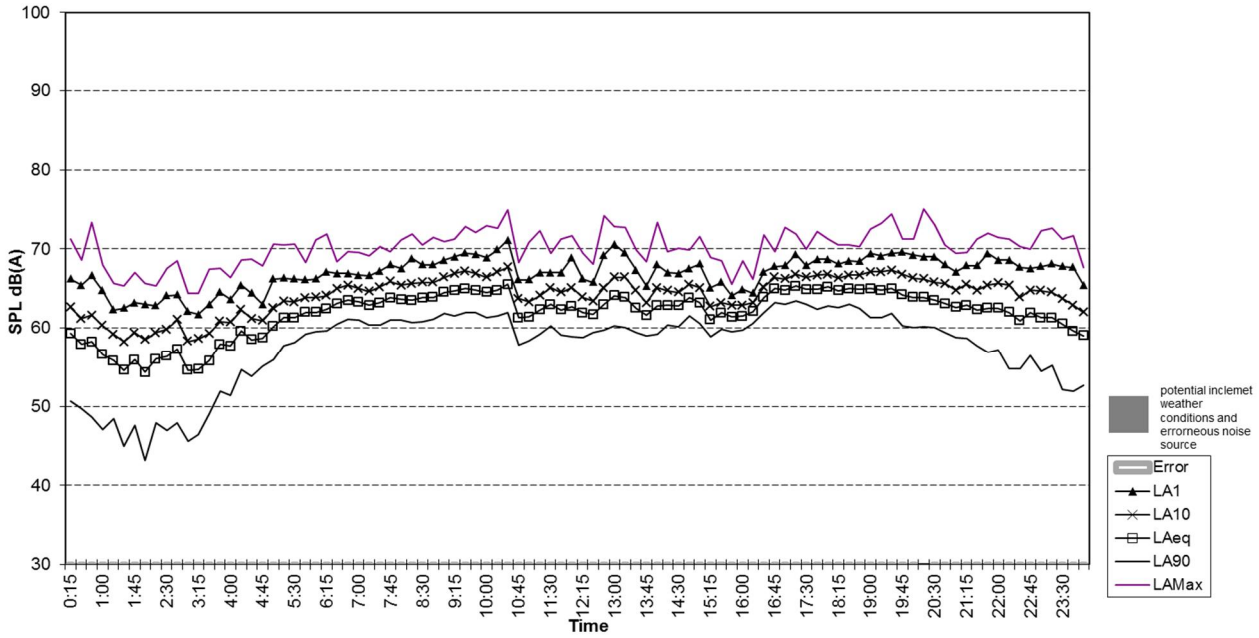
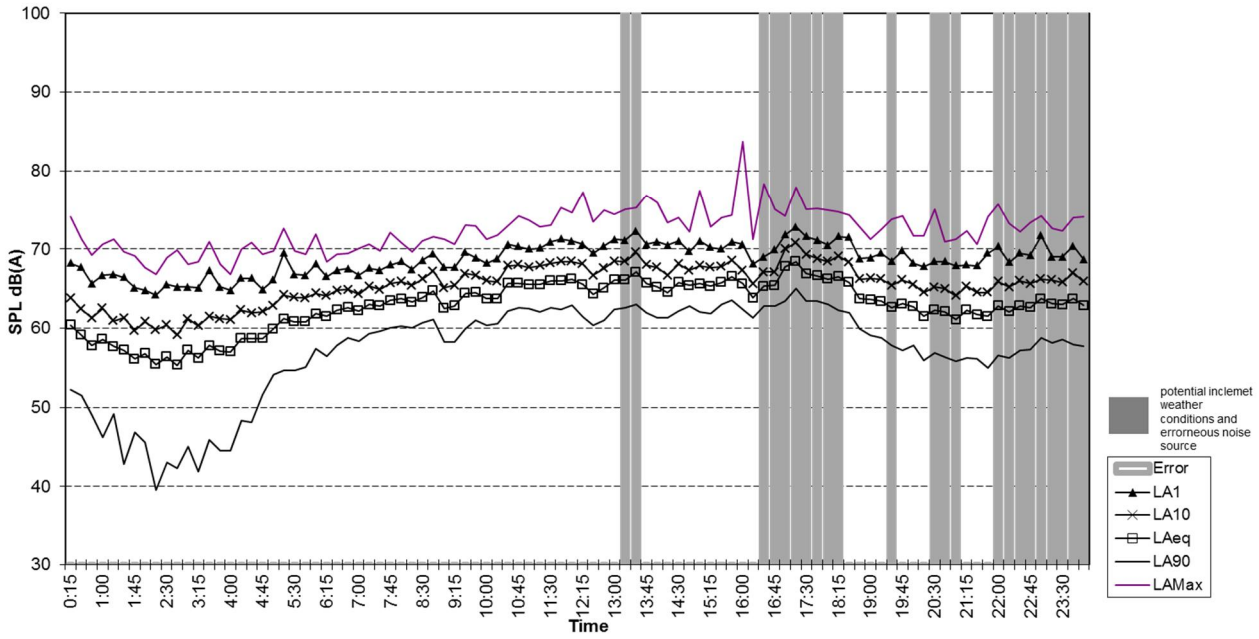


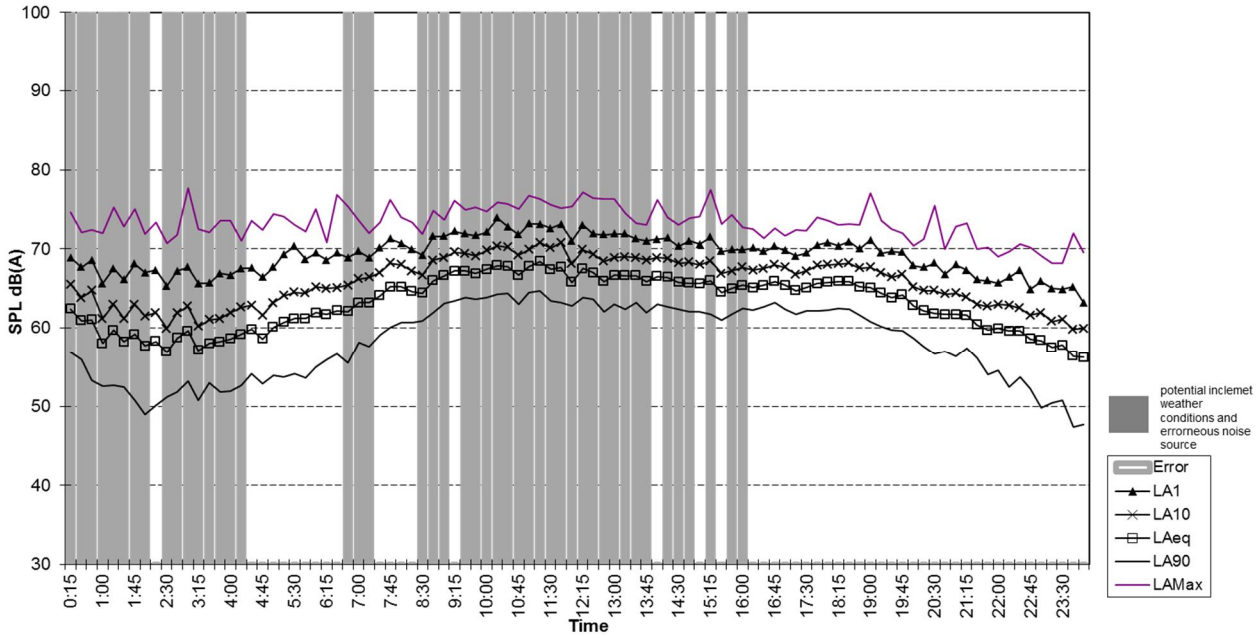
Location 2- 42 Reeves Street
Measured Noise Levels - Friday 27/06/2014



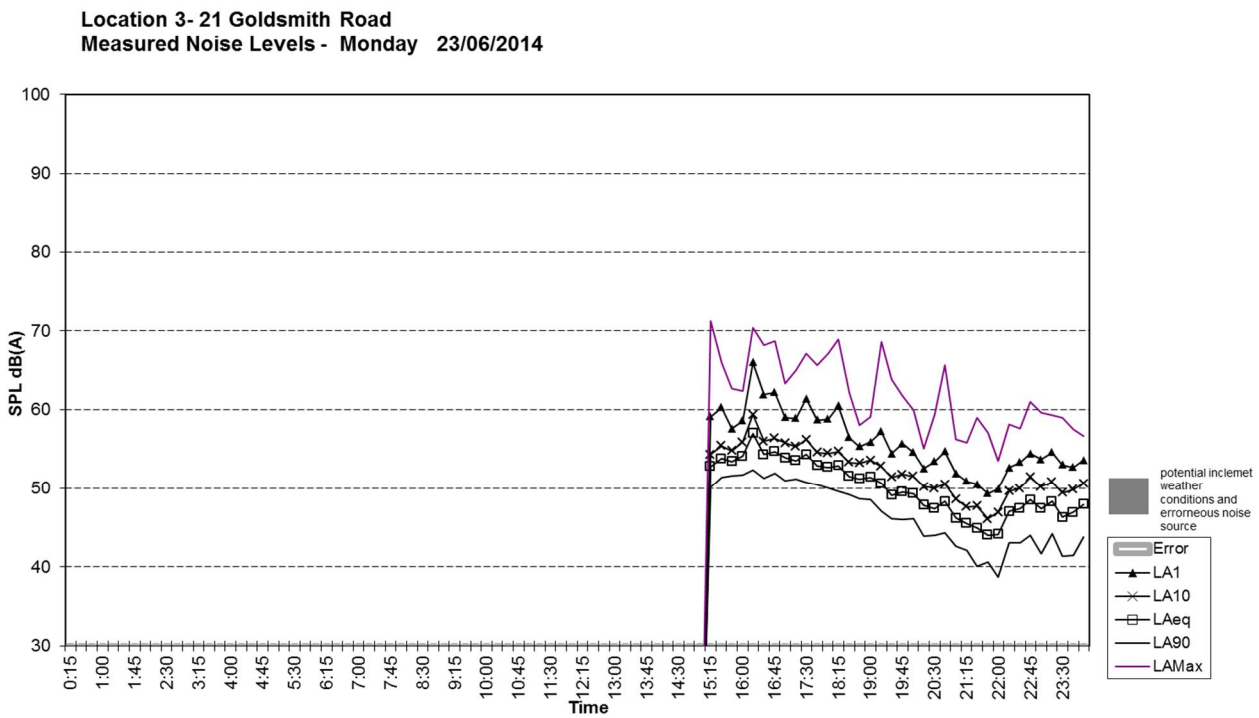
Location 2- 42 Reeves Street
Measured Noise Levels - Saturday 28/06/2014



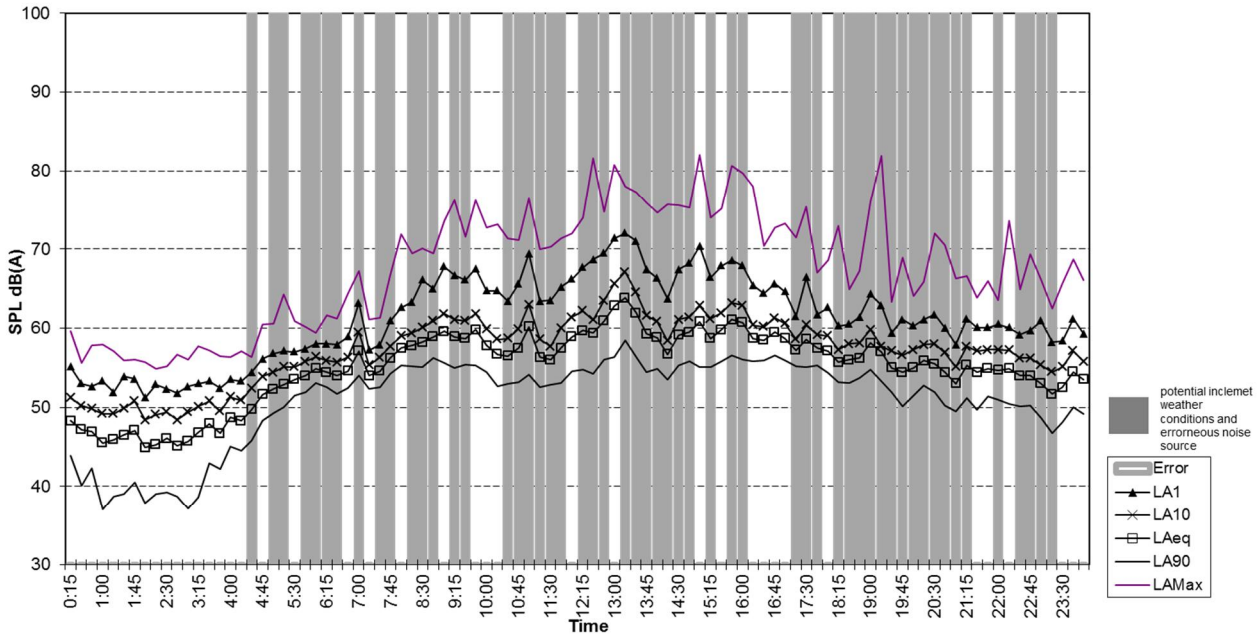
Location 2- 42 Reeves Street
Measured Noise Levels - Sunday 29/06/2014



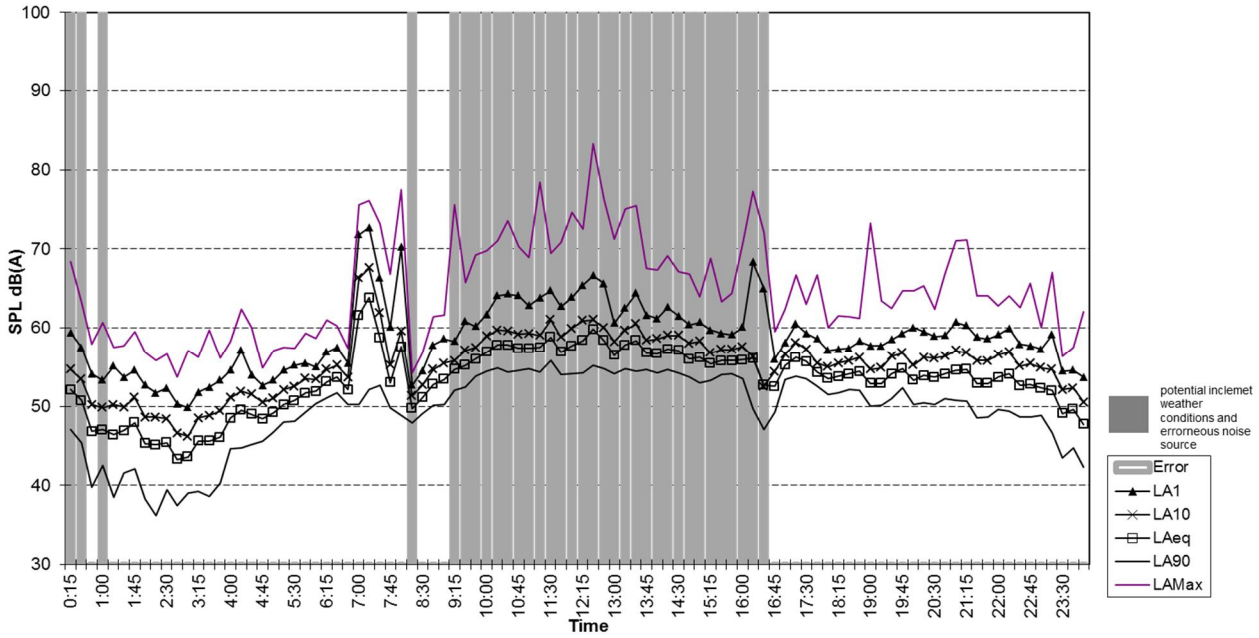
Monitoring Location 3 – 21 Goldsmith Road, Somersby NSW; 33.388742 South, 151.302744 East

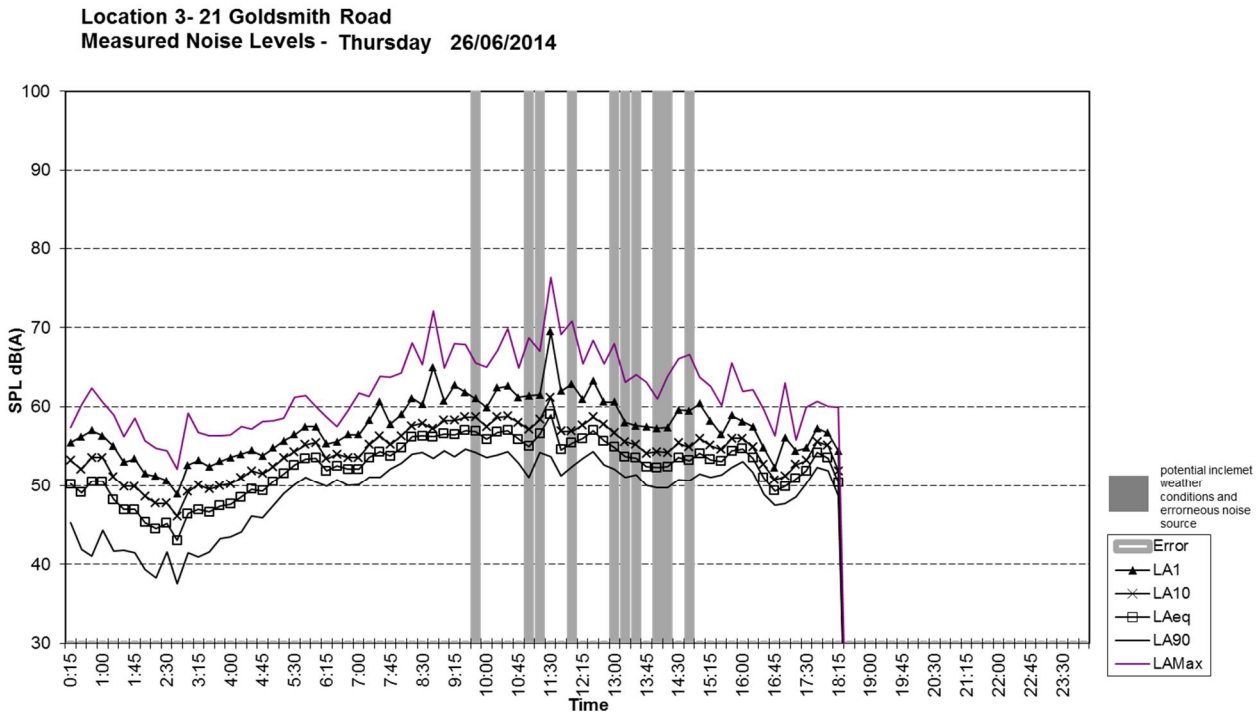


Location 3- 21 Goldsmith Road
Measured Noise Levels - Tuesday 24/06/2014

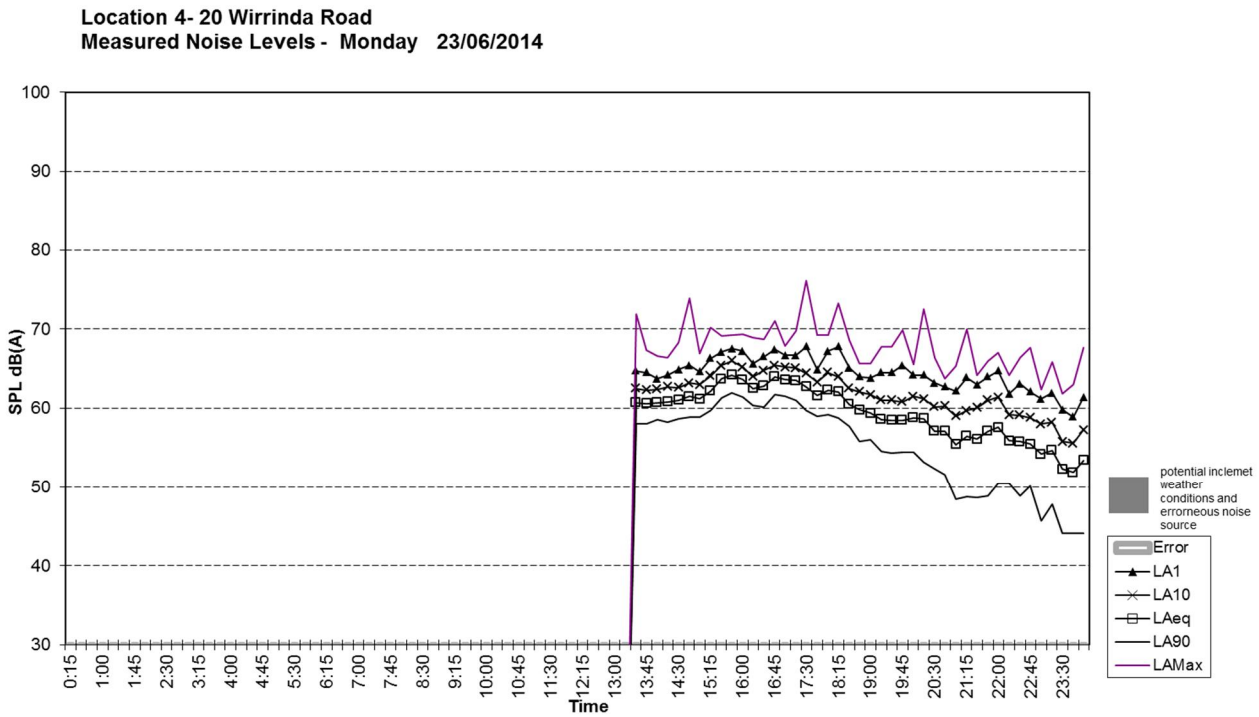


Location 3- 21 Goldsmith Road
Measured Noise Levels - Wednesday 25/06/2014




Location 3- 21 Goldsmith Road
Measured Noise Levels - Thursday 26/06/2014
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

Monitoring Location 4 – 20 Wirrinda Road, Somersby NSW; 33.391952 South, 151.296510 East



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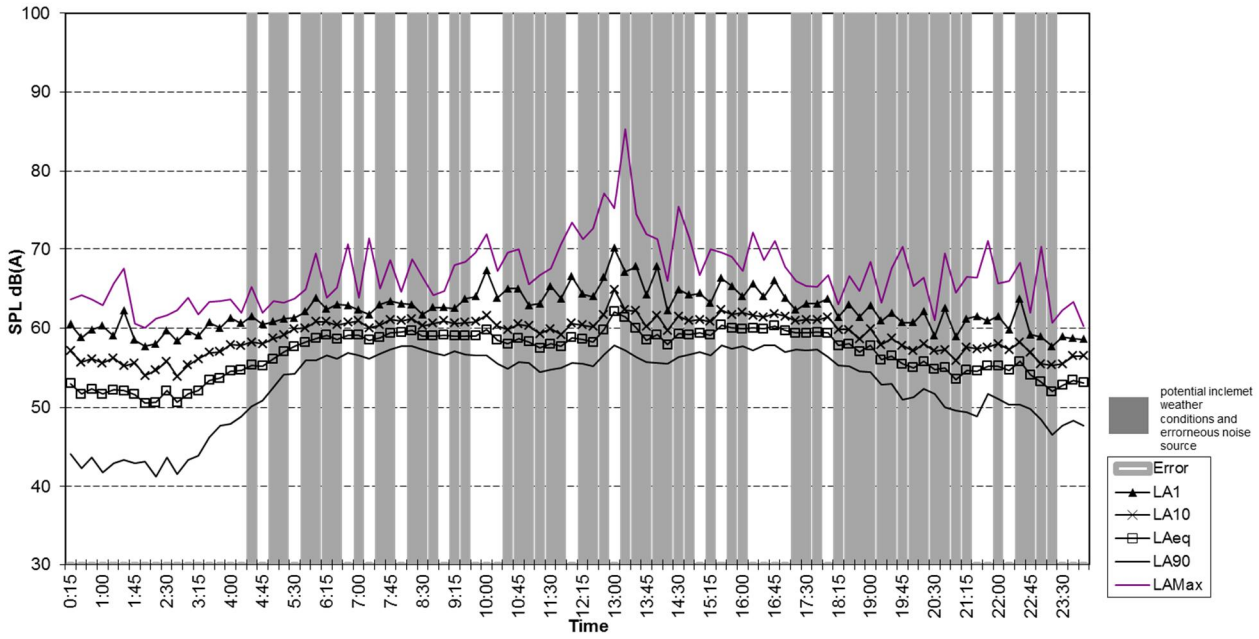
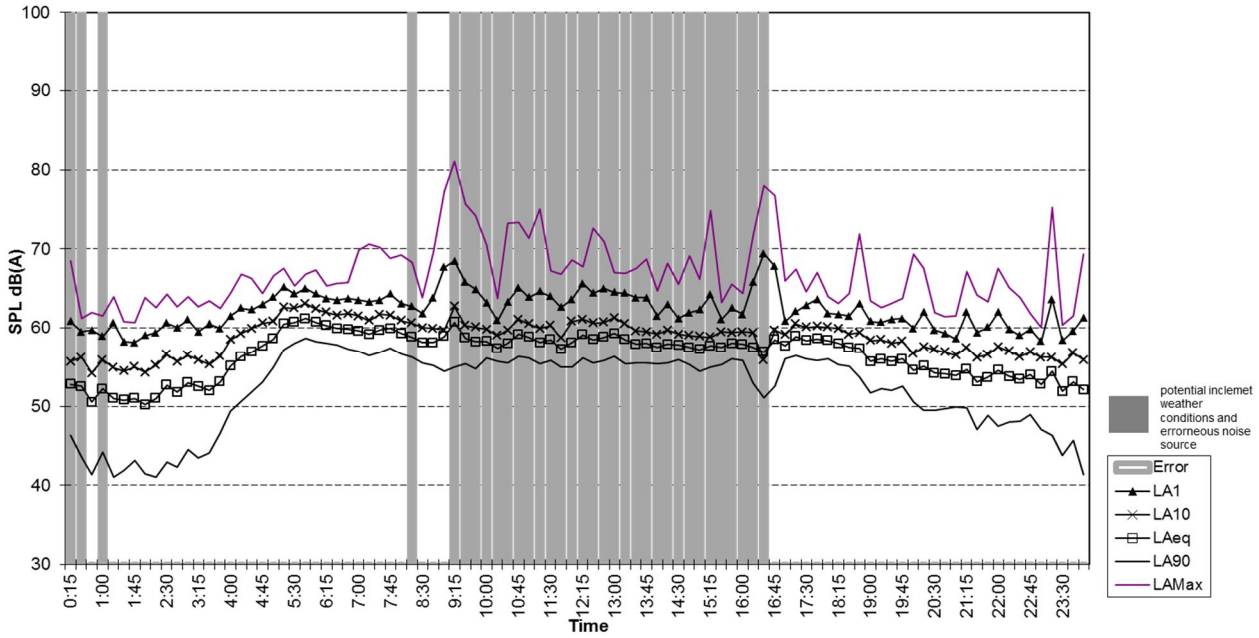


Location 4- 20 Wirrinda Road
Measured Noise Levels - Wednesday 25/06/2014



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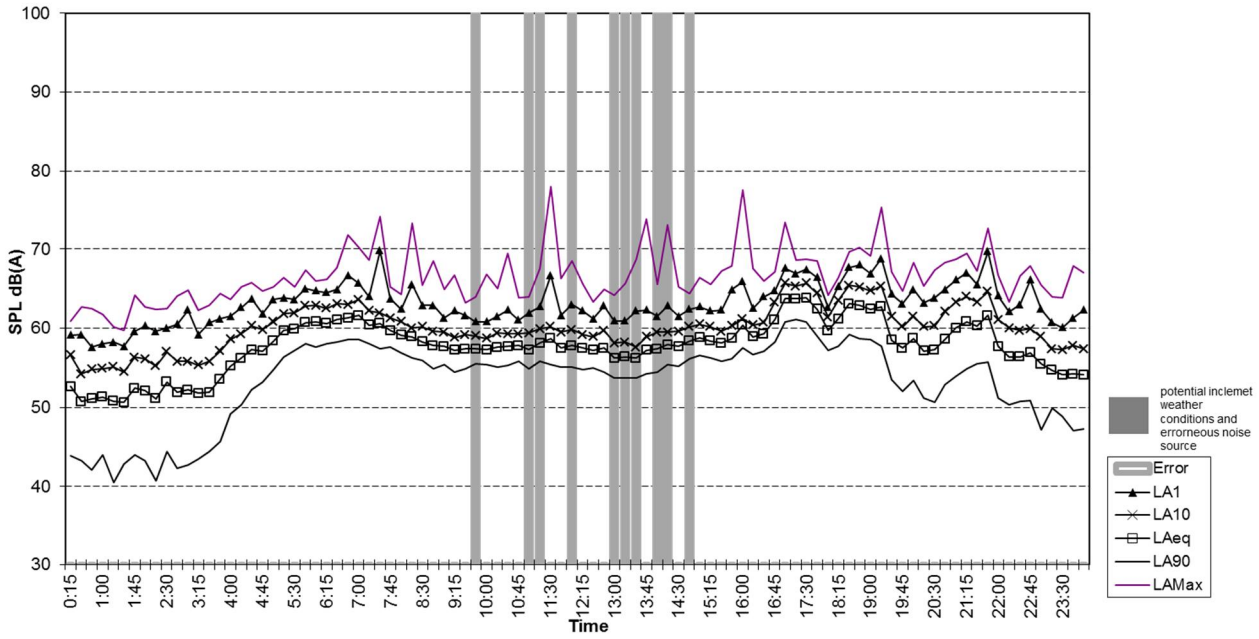
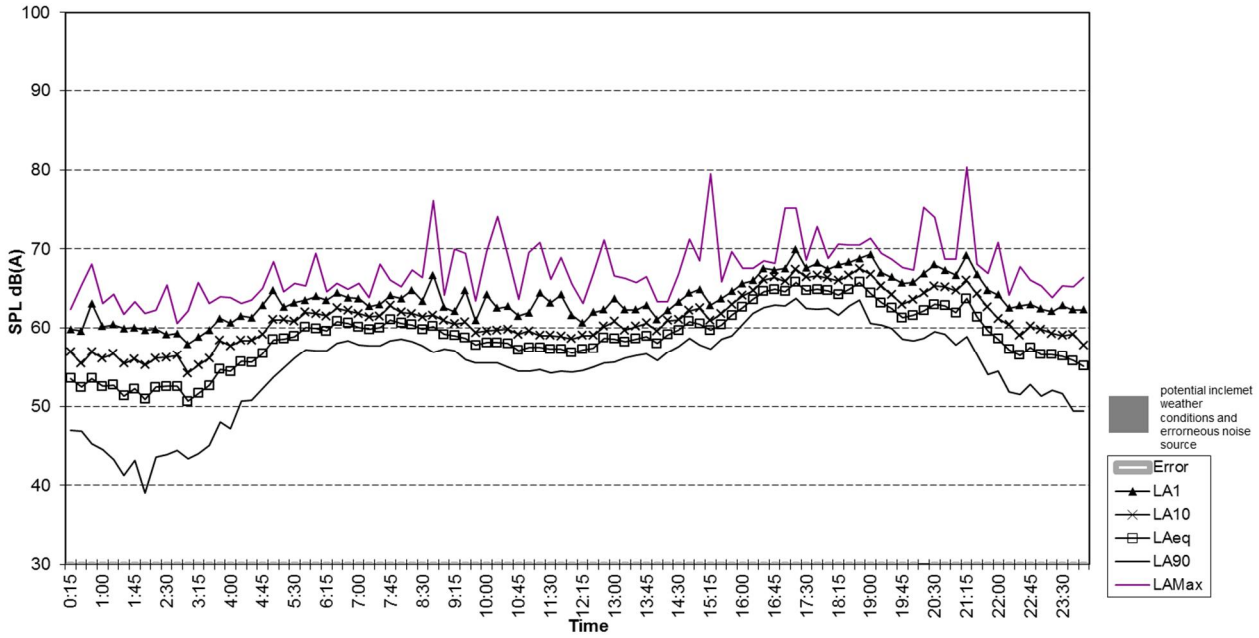
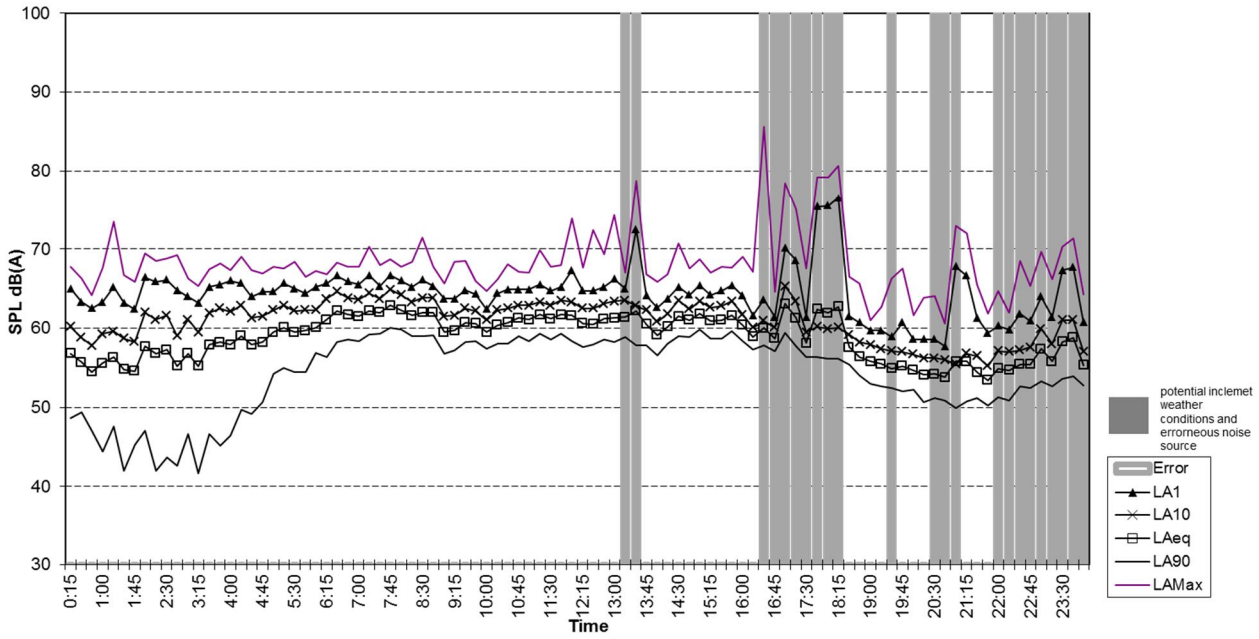


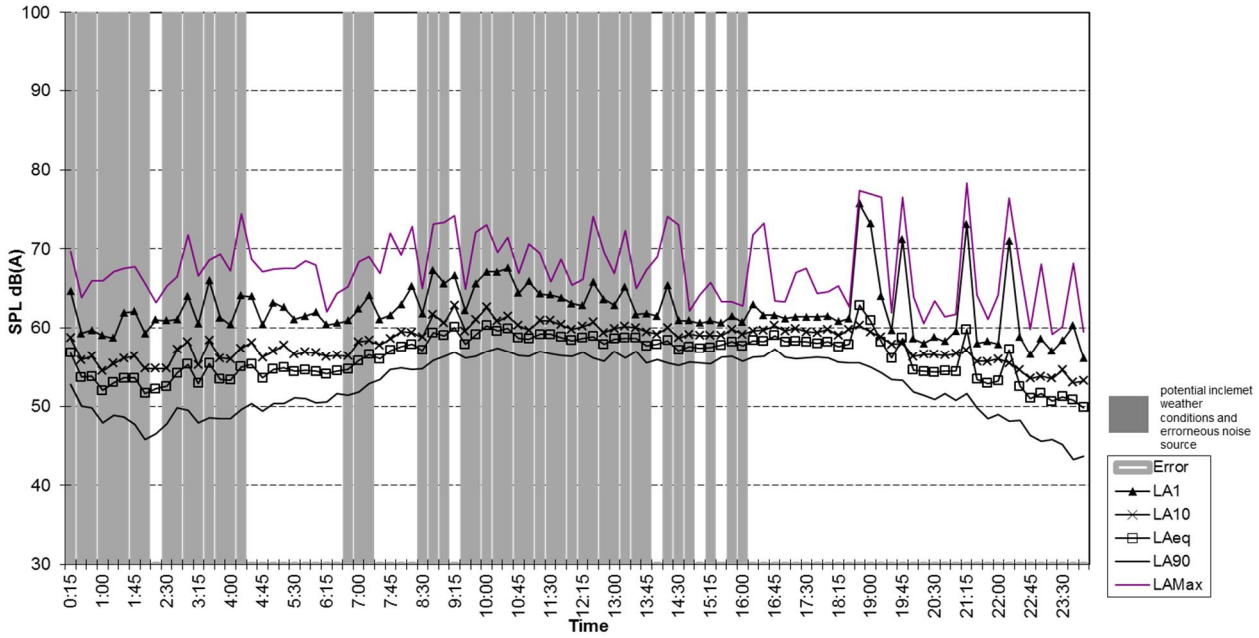
Location 4- 20 Wirrinda Road
Measured Noise Levels - Friday 27/06/2014



Location 4- 20 Wirrinda Road
Measured Noise Levels - Saturday 28/06/2014



Location 4- 20 Wirrinda Road
Measured Noise Levels - Sunday 29/06/2014



Appendix B

Calibration certification

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Calibration Certificate

Number : C13003

Client Details : Parsons Brinckerhoff
Level 27, Ernst & Young Centre, 680 George St
Sydney NSW 2000

Equipment Tested/ Model Number : ARL EL-316

Instrument Serial Number : 16-207-023

Microphone Serial Number : 317328

Preamplifier Serial Number : 27521

Ambient Temperature : 22°C

Relative Humidity : 53%

Barometric Pressure : 100.57 kPa

Calibration Technician : Alan Rutherford

Calibration Date : 08-January-2013

Secondary Check by : Sandra Minto

Report Issue Date : 10-January-2013

Approved Signatory :

Tested To : AS1259.1:1990
AS1259.2:1990

Comments : All tests passed for type 1

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.4.5: R.M.S performance	Pass
10.2.3: Frequency weighting	Pass	9.3.2: Time averaging	Pass
10.3.2: Overload indications	Pass	9.3.5: Overload indication	Pass
8.9: Detector-indicator linearity	Pass		
8.10: Differential level linearity	Pass		
10.3.4: Inherent weighted system noise level	Pass		
10.4.2: Time weighting characteristics F and S	Pass		

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www.acousticresearch.com.au

Calibration Certificate

Number : C13133

Client Details : Parsons Brinckerhoff (Sydney)
Level 27, Ernst & Young Centre, 680 George
Sydney NSW 2000

Equipment Tested/ Model Number : **ARL EL-316**
Instrument Serial Number : 16-207-008
Microphone Serial Number : 312579
Preamplifier Serial Number : 27471

Ambient Temperature : 24°C
Relative Humidity : 52%
Barometric Pressure : 101.4 kPa

Calibration Technician : Adrian Walker
Calibration Date : 22-March-2013
Secondary Check by : Kirsten Gillies
Report Issue Date : 27-March-2013
Approved Signatory :

Tested To : AS1259.1:1990
AS1259.2:1990

Comments : All tests passed for type 1

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.4.5: R.M.S performance	Pass
10.2.3: Frequency weighting	Pass	9.3.2: Time averaging	Pass
10.3.2: Overload indications	Pass	9.3.5: Overload indication	Pass
8.9: Detector-indicator linearity	Pass		
8.10: Differential level linearity	Pass		
10.3.4: Inherent weighted system noise level	Pass		
10.4.2: Time weighting characteristics F and S	Pass		

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Calibration Certificate

Number : C12706

Client Details : ARL Hire

Equipment Tested/ Model Number : ARL EL-316

Instrument Serial Number : 16-707-007

Microphone Serial Number : 317525

Preamplifier Serial Number : 27604

Ambient Temperature : 22°C

Relative Humidity : 59%

Barometric Pressure : 101.6 kPa

Calibration Technician : Adrian Walker

Calibration Date : 28-November-2012

Secondary Check by : Sandra Minto

Report Issue Date : 29-November-2012

Approved Signatory :

Tested To : AS1259.1:1990
AS1259.2:1990

Comments : All tests passed for type 1

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.4.5: R.M.S performance	Pass
10.2.3: Frequency weighting	Pass	9.3.2: Time averaging	Pass
10.3.2: Overload indications	Pass	9.3.5: Overload indication	Pass
8.9: Detector-indicator linearity	Pass		
8.10: Differential level linearity	Pass		
10.3.4: Inherent weighted system noise level	Pass		
10.4.2: Time weighting characteristics F and S	Pass		

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Calibration Certificate

Number : C13352

Client Details : ARL Hire
423 Pennant Hills Rd
Pennant Hills NSW 2120

Equipment Tested/ Model Number : ARL EL-316

Instrument Serial Number : 16-302-485

Microphone Serial Number : 314397

Preamplifier Serial Number : 2676

Ambient Temperature : 24°C

Relative Humidity : 52%

Barometric Pressure : 100.9 kPa

Calibration Technician : Adrian Walker

Calibration Date : 13-December-2013

Secondary Check by : Tim Williams

Report Issue Date : 13-December-2013

Approved Signatory :

Tested To : AS1259.1:1990
AS1259.2:1990

Comments : All tests passed for type 1

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.4.5: R.M.S performance	Pass
10.2.3: Frequency weighting	Pass	9.3.2: Time averaging	Pass
10.3.2: Overload indications	Pass	9.3.5: Overload indication	Pass
8.9: Detector-indicator linearity	Pass		
8.10: Differential level linearity	Pass		
10.3.4: Inherent weighted system noise level	Pass		
10.4.2: Time weighting characteristics F and S	Pass		

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