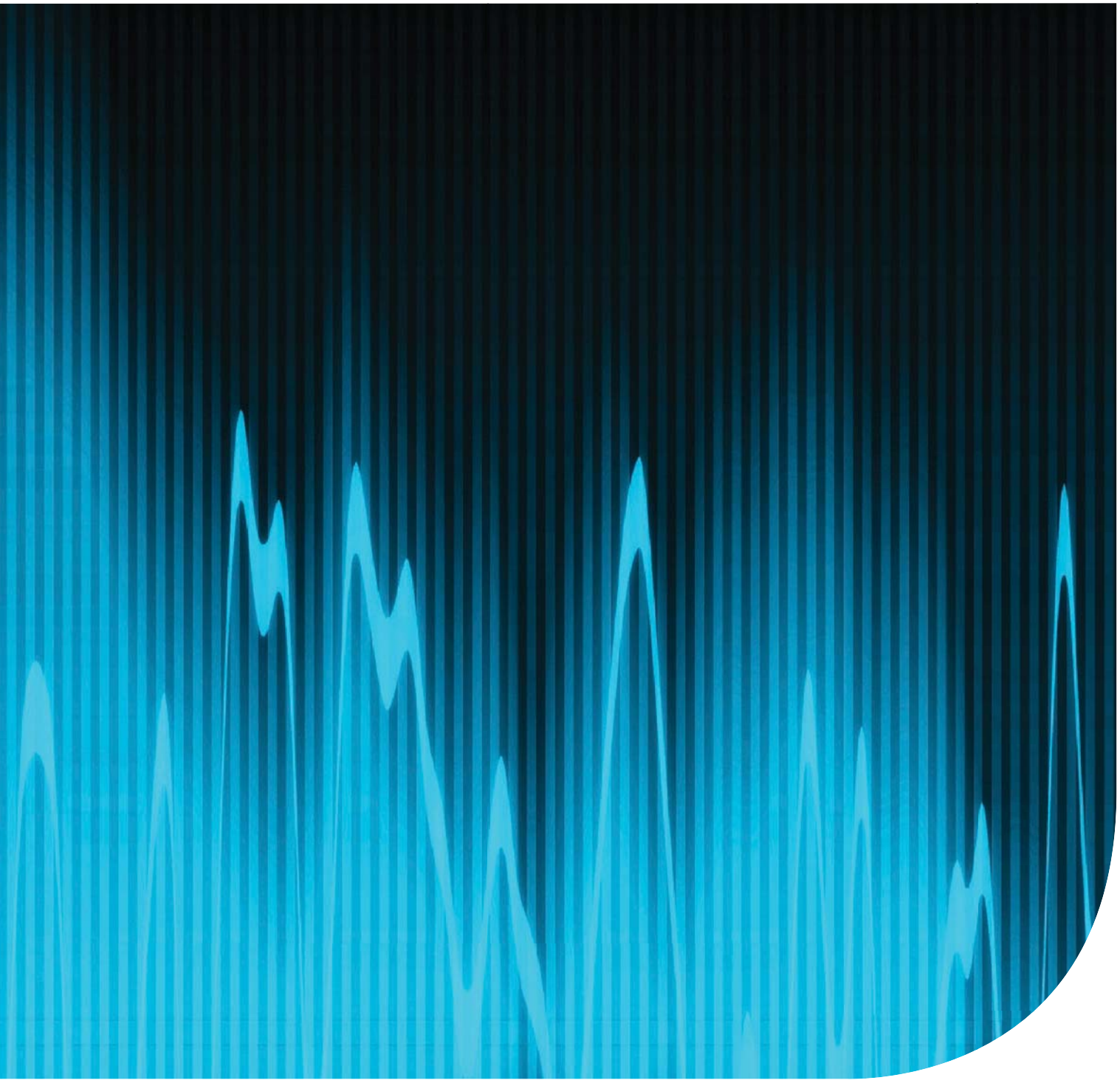
2 Hume Highway, Chullora (SSD 15-7235)

Noise and vibration impact assessment

Prepared for Charter Hall Core Plus Industrial Fund, Bieson Pty Limited as trustee of the CPI Hume Highway Logistics Trust, Commercial & Industrial Property Pty Ltd | 27 October 2015



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2 Hume Highway, Chullora (SSD 15-7235)

Final

Report J15104RP1 | Prepared for Charter Hall Core Plus Industrial Fund, Bieson Pty Limited as trustee of the CPIF Hume Highway Logistics Trust, Commercial & Industrial Property Pty Ltd | 27 October 2015

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1 Introduction

EMGA Mitchell McLennan Pty Ltd (EMM) has been engaged by Commercial & Industrial Property Pty Ltd (CIP) to prepare a noise and vibration impact assessment suitable to accompany an application to Department of Planning & Environment (DP&E) in relation to a development application for a proposed warehouse distribution facility (the Project). The Project is to be located at 2 Hume Highway, Chullora, NSW.

This report presents an assessment of potential noise and vibration impacts from construction and operation of the Project on the surrounding community and provides recommended noise management measures.

The assessment has been developed and guided by the following:

- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline;*
- NSW Environment Protection Authority (EPA) 2000, *NSW Industrial Noise Policy* (INP);
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- Standards Australia – AS 1055.1-1997 *Acoustics - Description and measurement of environmental noise - General procedures*; and
- Australian Standard AS 2436-2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*.

Several technical terms are required for the discussion of noise and vibration. These are explained in Appendix A.

The main potential noise issues with respect to the proposal are broadly as follows:

- noise and vibration associated with construction of the project including earthworks;
- noise associated with the operation, which is expected to be dominated by on-site trucking movements and loading/unloading at the docks;
- noise associated with the increased traffic to/from the site during construction and operation; and
- cumulative noise from all existing and proposed industrial operations in the vicinity of the Project site.

Secretary's Environmental Assessment Requirements (SEARs) were issued by the Department of Planning & Environment (DP&E) for the proposed development on 15 September 2015. The requirements relevant to the assessment of noise and vibration are provided in Table 1.1 together with where they have been addressed within this report.

Table 1.1 Noise and vibration impact assessment requirements

SEAR	Relevant section of this report
An assessment of all construction, operational and transportation noise and vibration impacts, including impacts on nearby receivers;	Entire report, Section 6.
Cumulative impacts of other developments both on the site and in the vicinity of the site; and	Section 6.3
Details of the proposed noise management and monitoring measures.	Section 8

A separate development application (DA 1246/2015) has been lodged with Bankstown City Council for 'early construction works' consisting of demolition of existing structures and bulk earthworks including importation of 45,000m^3 of fill to the site. These proposed works do not form part of this application (SSD 15-7235).

2 Project and site description

2.1 Project description

The Project will consist of a warehouse distribution centre which will operate 24 hours per day, seven days per week. A diagram showing the proposed development is provided in Figure 2.1. Operations will consist of the daily processing of consignment items picked up and delivered across Australia. Items mostly consist of carton parcels, but also include palletised items and other packed goods. The facility will feature a multi-level car park, a main office, a cafe, a warehouse and an operational yard. The warehouse will feature an automated freight sorter system. Freight is unloaded from inbound vehicles manually onto the sorter system for small items, and via forklift for larger items. Small items are automatically sorted to outbound vehicles, and larger items are loaded via forklift into outbound vehicles.

2.2 Site description

The existing site and surrounding area is shown in Figure 2.2.

The northern and western boundaries of the subject site are surrounded by commercial and industrial developments including a heavy rail line to the north of the site. The south-eastern boundary of the site adjoins the Hume Highway.

2.3 Noise-sensitive receivers

As shown in Figure 2.2, the nearest noise-sensitive receivers are residential dwellings located east and south-east of the subject site on the southern side of the Hume Highway. These are considered to be the nearest potentially most affected noise-sensitive receivers to the subject site.

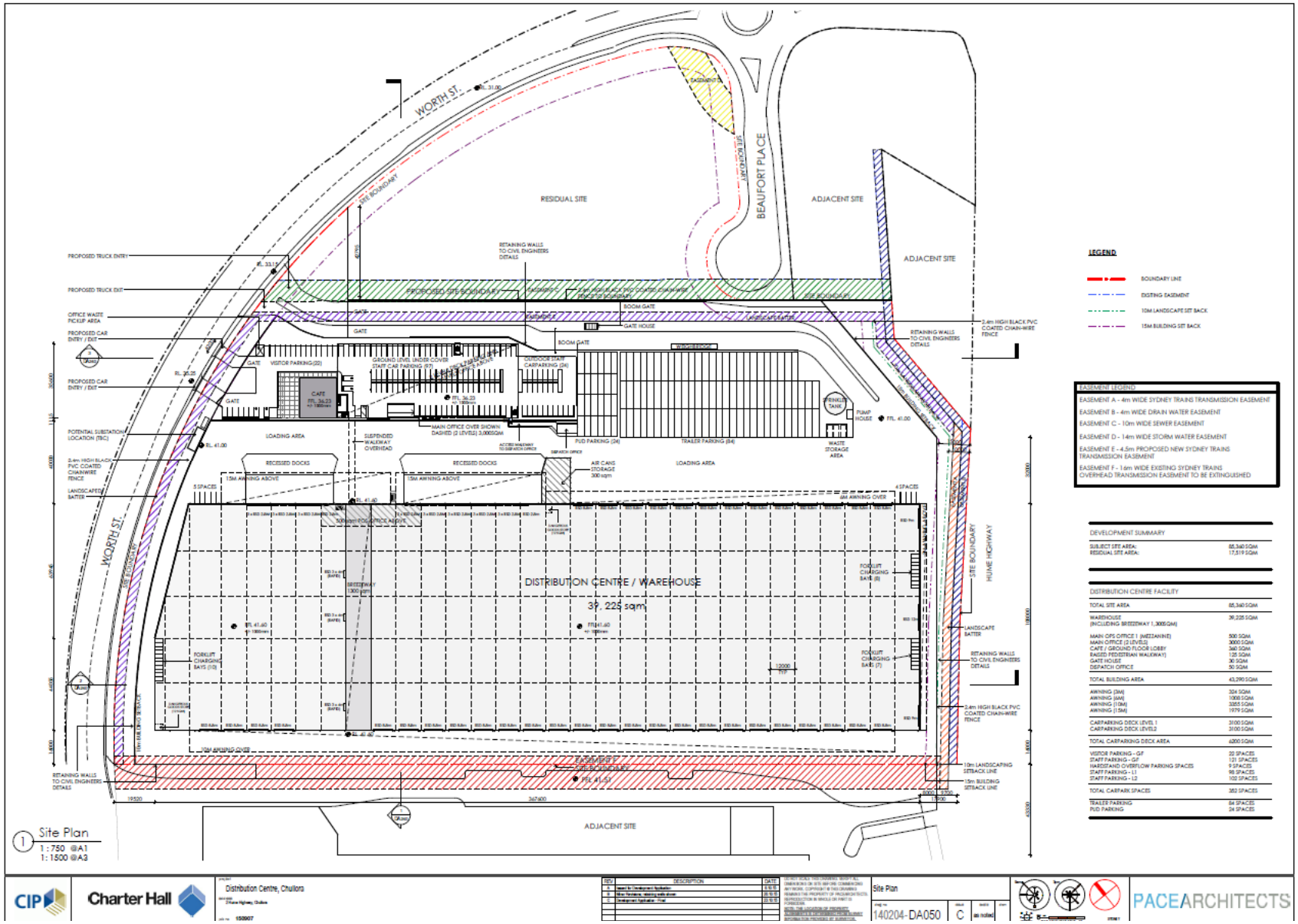


Figure 2.1 Proposed warehouse facility

Figure 2.2 Subject site and surrounds

3 Existing acoustic environment

The existing acoustic environment (ie ambient noise) was quantified by long-term unattended and short-term attended noise monitoring. Operator-attended 15-minute noise measurements were completed at four locations in September 2015, including at the unattended noise monitoring location (Table 3.1).

The attended noise surveys were conducted using a Brüel & Kjær Type 2250 one-third octave hand-held sound level meter (s/n 3008201). Field calibration of the instrument was undertaken before and after the survey using a Brüel and Kjær type 4230 calibrator with the variation in calibrated levels not greater than ±0.5dB. Attended measurements were conducted in general accordance with Australian Standard (AS) 1055-1997 *Description and Measurement of Environmental Noise,* Parts 1, 2 and 3. Meteorological conditions throughout the attended surveys period generally consisted of winds at 2 to 4 m/s from the east to north-east with some cloud cover. There were no winds above 5 m/s or rain events during the attended surveys. A summary of the results of the attended measurements is presented in Table 3.1.

Table 3.1 Attended noise monitoring summary

Location	Date	Start time	Measurement result, dB(A)			Comments
			L_{eq}	L_{90}	L_{max}	
57 Lawford St (noise logger location)	8/9/2015	12:00	56	47	83	Bird activity, dominated by Hume Hwy road traffic noise. Distant aircraft 55-60dB. Existing industrial noise inaudible.
Cnr Lawford St / Hume Highway	8/9/2015	12:30	68	60	79	Dominated by Hume Hwy road traffic noise. Existing industrial noise inaudible.
Cnr Como Rd / Hume Highway	21/9/2015	09:45	69	56	82	Dominated by Hume Hwy road traffic noise. Existing industrial noise inaudible.
23 Como Rd	21/9/2015	10:15	59	45	83	Dominated by Hume Hwy road traffic noise. Existing industrial noise inaudible.

The ambient noise environment is dominated by road traffic from the Hume Highway at all monitoring locations. It was noted that noise levels from existing industrial operations were inaudible at all attended monitoring locations during the surveys. It is noted that the measured difference in L_{90} between that measured adjacent the Hume Highway and that measured further from the Highway (approx. 90m) is at least 9dB.

Long-term noise monitoring was completed by EMM at one location from 8 to 21 September 2015 as described in Table 3.2. The long-term monitoring was complete using an ARL Ngara Type 1 environmental noise logger (s/n 878113).

Table 3.2 EMM noise logging details

Location	Description
57 Lawford Street	Free-field in yard of residence, approx. 300 m from the site boundary and approx. 120 m from the Hume Highway.

The Rating Background Levels (RBL) and ambient $L_{eq,period}$ noise levels derived from EMM's long-term noise monitoring are summarised in Table 3.3. The daily noise data and charts from EMM's noise logging are provided in Appendix B. The logging data was analysed in accordance with the INP, whereby data was excluded where rainfall and/or winds of greater than 5 m/s were recorded. This analysis was completed using weather data obtained from a mobile weather station located adjacent to the noise logger.

Table 3.3 Summary of measured ambient noise levels

Location	RBL, dB(A)			Ambient (L_{eq}) noise level, dB(A)		
	Day	Evening	Night	Day	Evening	Night
57 Lawford Street	45	44	41	58	52	52

Note: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.

Several industrial developments currently operate in the area surrounding the Project site. Based on the results of operator-attended noise measurements, ambient noise at the logger location was primarily influenced by road traffic noise and is not expected to have been significantly influenced by existing industrial noise.

4 Noise criteria

4.1 Operational noise

4.1.1 Industrial noise criteria

The NSW Government's INP stipulates guidelines for assessment of noise from the operation of industrial facilities. The main objectives of the policy are to protect the community from excessive intrusive noise; and to preserve the amenity for specific land uses. In order to do so the INP provides two criteria to assess industrial noise sources, namely, the intrusiveness criteria and the amenity criteria.

4.1.2 Intrusive criteria

The intrusiveness criterion requires that the $L_{eq,15min}$ noise levels from the newly-introduced source during each of the day, evening and night time periods do not exceed the existing rating background noise levels (RBL) by more than 5 dB at the most affected noise sensitive location. Table 4.1 shows the derived noise criteria adopting the measured background level as presented in Section 3. It is noted that the representative RBL adopted for residences adjacent to the Hume Highway are considered to be conservative since these residences are considerably more affected by road traffic noise than the long-term noise monitoring location.

Table 4.1 Intrusiveness noise criteria

Location	Period	Noise Level, $L_{eq, 15min}$ dB(A)	
		Representative RBL	Intrusiveness criteria
Nearest residences (Hume Hwy)	*Day*	45	50
	Evening	44	49
	Night	41	46

Notes: Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.

Given the measured difference in L_{90} from the results of operator-attended noise monitoring it is likely that the intrusive noise criteria provided in Table 4.1 is likely to be conservative for the nearest residences in the order of 9 dB.

4.1.3 Amenity criteria

The INP stipulates acceptable and maximum noise levels from all industry consistent with maintaining amenity for specific land uses. The acceptable target noise levels are presented in Table 4.2 for the 'urban' category. The INP defines an 'urban' amenity area as one with an acoustical environment that is dominated by 'urban hum', has through traffic with characteristically heavy and continuous traffic flows during peak periods and is located near commercial or industrial districts.

Table 4.2 Noise amenity targets for specific land uses

Residential land use	Target acceptable amenity industrial noise levels, dB(A) $L_{eq,period}$		
	Day	Evening	Night
Urban	60	50	45

Notes: 1. These target levels apply to the total noise attributable to all industrial sites (as scheduled in the Protection of Environment (Operations) Act).

In this case, given that the existing industrial noise, as observed during a site visit, does not approach the targets in Table 3.3, the recommended amenity levels have been applied. However, consideration to possible future developments has been given as described in the cumulative noise section later. Both the amenity and intrusiveness criteria apply to the project. Table 4.3 summarises the applicable criteria. In all cases, the intrusiveness criteria are the limiting and therefore adopted criteria.

Table 4.3 Project specific noise criteria

Locations	Period	RBL, dB(A)	Intrusiveness, dB(A) $L_{eq,\ 15min}$	Amenity (Urban), dB(A) $L_{eq,period}$	Project specific level, dB(A)
Nearest residences	Day	45	50	60	50 $L_{eq,\ 15min}$
	Evening	44	49	50	49 $L_{eq,\ 15min}$
	Night	41	46	45	46 $L_{eq,\ 15min}$ [1]

Note: 1. *Based on previous experience at similar sites and given the likely intermittent nature of activities, the predicted $L_{eq(period)}$ noise level from the project has been conservatively estimated as 3 dB lower than the predicted $L_{eq(15\ min)}$. Hence, given the amenity criteria is only 1 dB lower than the intrusive criteria for the night-time period, if the intrusive criteria is achieved then the amenity noise goal will also be achieved.*

4.2 Construction noise goals

Proposed construction activities relevant to the project include importation of fill and related earthworks and building construction. It is proposed to stockpile up to 405,000m^3 of excavated natural material as it becomes available (ie 24 hours/day, 7 days/week). The development application seeks consent to stockpile fill on site outside of standard construction hours subject to complying with strict management protocols, including noise monitoring, to ensure the stockpiling works do not result in noise impacts at the nearest noise-sensitive receivers.

The NSW DECC Interim Construction Noise Guidelines (ICNG) provides guidelines for the assessment and management of noise from construction works.

i Noise management level

The ICNG suggests the following time restriction for construction activities where the noise is audible at residential premises:

- Monday to Friday 7.00 am - 6.00 pm;
- Saturday 8.00 am - 1.00 pm; and
- No construction work is to take place on Sundays or public holidays.

Table 4.4 is an extract from the ICNG and provides noise management levels for residential receivers for both recommended standard construction hours and outside of these periods. These time restrictions are the primary management tool of the ICNG.

Table 4.4 ICNG residential criteria

Time of day	Management level $L_{eq, 15min}$	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

In summary, the ICNG noise level goals for activities during the standard hours are 10 dB above the existing background levels. For activities outside of the above hours the noise levels should be no more than 5 dB above the existing background levels.

The ICNG recommends that where noise levels from construction during out of hours periods are above the noise affected level (RBL + 5dB(A)) all feasible and reasonable mitigation should be adopted. Where this has been applied and noise levels remain above the noise affected level, the proponent should negotiate with the community.

Table 4.5 is an extract from the ICNG and provides noise management levels for commercial and industrial land uses for standard and OOH periods.

Table 4.5 ICNG noise management levels at commercial and industrial land uses

Land use	Management level, $L_{eq(15\text{-}min)}$
Industrial premises.	External noise level 75dB(A) (when in use)
Offices, retail outlets.	External noise level 70dB(A) (when in use)

Source: ICNG (DECC, 2009).

The construction noise management levels (NMLs) for this assessment have been developed using the noise monitoring data provided in Section 3 and in accordance with the ICNG. It is noted that the representative RBL adopted for residences adjacent to Hume Highway are considered to be conservative since these residences are considerably more affected by road traffic noise than the long-term noise monitoring location.

Table 4.6 Construction noise management levels

Receiver	Period	Representative RBL, dB(A)	NML, $L_{eq,15min}$
Residences adjacent Hume Highwy (nearest potentially affected)	Day	45	55 (Highly affected, 75 dB)
	Evening	44	49
	Night	41	46
Offices, retail outlets	When in use	N/A	70
Neighbouring industrial premises	When in use	N/A	75

Notes: 1. N/A = not applicable.

2. Based on measured RBL at long-term noise monitoring location approximately 120 m from Hume Highway.

4.3 Sleep disturbance

The INP criteria are appropriate for assessing noise from continuous and intermittent sources, such as engine noise from vehicles. However, transient noise sources also require assessment. The most important effect of these transient noises would be the possibility of disturbing the sleep of nearby residents. The EPA's INP Application Notes indicates that to prevent sleep disturbance, the $L_{1,1min}$ noise level from an intrusive source should not exceed the background noise level by more than 15 dB. More recent advice from the EPA has confirmed that the L_{max} and $L_{1,1min}$ descriptor can be considered interchangeable for such assessments. On this basis, the maximum noise level from any operational event should not exceed the levels shown in Table 4.7 for the night time assessment period.

Table 4.7 Sleep disturbance noise criteria

Location	Representative RBL, dB(A)	Sleep disturbance criteria, L_{max} dB(A)
Nearest residences	41	56

Notes *1. Sleep disturbance criteria apply during the night assessment period only.*

2. Criteria are assessable at the façade of the most affected sleeping area.

However, this criterion does not take account of more recent research on the effects on sleep of road traffic noise. The EPA's Road Noise Policy (RNP) indicates that maximum noise levels below 50 to 55 dB(A) inside residences from road traffic sources are unlikely to cause awakening reactions. If bedroom windows are partly open, this corresponds to an external maximum noise level of approximately 60 to 65 dB(A) outside a residence.

In our experience, adopting the former more stringent criterion would be desirable in the first instance, and if exceedances are predicted, consideration should be given to the potential number of such events and the more recent research above.

4.4 Road traffic noise criteria

The principle guidance for assessing the impact of road traffic noise on receivers is in the NSW EPA's *Road Noise Policy* (RNP 2011).

It is understood that trucks will access the site via Worth Street directly from the Hume Highway. The nearest residences potentially affected by an increase in road traffic noise are located approximately 8 m from the Hume Highway. This road has been classified as an arterial road. Table 4.8 presents the road noise assessment criteria reproduced from Table 3 of the RNP.

Table 4.8 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq(15\text{-}hr)}$ 60 (external)	$L_{eq(9\text{-}hr)}$ 55 (external)

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

5 Effects of meteorology on noise levels

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources. As per the INP, wind effects need to be considered when wind is a feature of the area under consideration. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any period (day, evening, night) of any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

The INP provides two methods to assess wind effects; analysis of relevant weather data to determine if wind is a feature based on the frequency of occurrence and wind speed (detailed approach) or simply assume that wind is a feature of the area (simple approach).

The simple approach has been adopted here and provides a potentially conservative approach. Noise modelling has been undertaken for the following scenarios:

- calm conditions (20^{o}C, 70% relative humidity);
- worst-case wind from source to receiver at 3m/s (20^{o}C, 70% relative humidity); and
- temperature inversion during the night-time period (10^{o}C, 90% relative humidity and F-class stability).

6 Construction vibration criteria

6.1 Human comfort – Assessing vibration a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC, 2006) is based on guidelines contained in *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz).*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 6.1.

Table 6.1 Examples of types of vibration (from Table 2.1 of the guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

6.1.1 Continuous vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to continuous vibration (1-80Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 6.2 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 6.2 Criteria for exposure to continuous vibration

Place	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Notes: 1. RMS velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).

2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

6.1.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer *section 2.4.1* of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for Intermittent Vibration are reproduced in Table 6.3.

Table 6.3 Acceptable vibration dose values (VDV) for intermittent vibration (m/s $^{1.75}$)

Location	Daytime		Night-time	
	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The Guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

6.2 Structural vibration criteria – DIN4150

Structural vibration should be assessed at the foundation of a building structure. In the absence of a relevant Australian Standard, the German Standard *DIN 4150 - Part 3: 1999* provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 6.4 and shown graphically in Figure 6.1 in the case of foundation levels. For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 Hz to 30 Hz, and hence according to DIN4150, the safe vibration criteria range for dwellings is 5 to 15 mm/s. For reinforced commercial type buildings the limit is as low as 20 mm/s.

Table 6.4 Structural damage guideline values of vibration velocity – DIN4150

Line*	Type of Structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1Hz to 10Hz	10Hz to 50 Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Notes: *1. " Line* " refers to curves in Figure 1 of DIN4150.*

2. For frequencies above 100Hz the higher values in the 50Hz to 100Hz column should be used.

These levels are "safe limits", for which damage due to vibration effects is unlikely to occur. "Damage" is defined in DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the "safe limits" then it is likely to be attributable to other causes. DIN 4150 also states that when vibration levels higher than the "safe limits" are present, it does not necessarily follow that damage will occur.

As indicated by the criteria in Table 6.4, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the "point source" nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

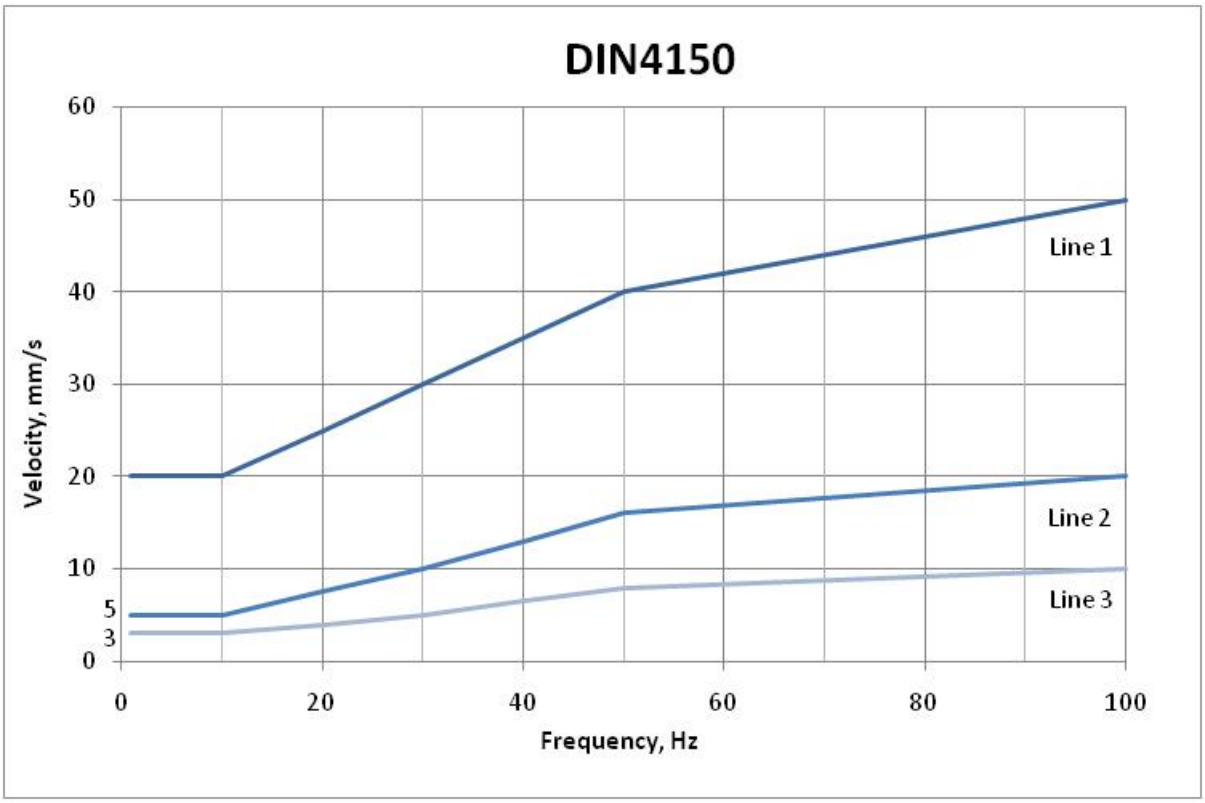


Figure 6.1 DIN4150 Structural vibration safe limits for buildings

6.3 Ground-borne noise

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. The ICNG provides guidance on the assessment of ground-borne noise and relevant internal noise levels for the evening and night-time periods above which management actions should be implemented.

It is understood that vibration-generating events, such as vibratory rolling and compacting, would occur during the daytime only. As such, ground-borne noise impacts are not expected at the nearest residences.

7 Noise predictions and assessment

The key noise issues associated with the proposed development include operational noise (related to transportation), road traffic noise and construction noise. These issues have been addressed based on worst case scenario predictions and past experience with similar developments.

7.1 Operational noise

The following assessment is based on the DA plans provided by Pace Architects. An overview of the proposal is provided in Figure 2.1. It is understood that the proposed site will be used 24 hours a day, seven days a week. Site traffic access will be via Worth Street directly from the Hume Highway.

General noise producing operations on site would include pallet handling and truck and other delivery vehicle movements. In particular, on-site trucking activities will be the dominant noise source. Based on information provided by CIP regarding proposed operations the following assumptions have been incorporated into the noise model:

- a maximum of 26 trucks arrive at the site within a 30-minute period and would be travelling less than 20 km/h around the site;
- up to 15 forklifts would operate across the site, primarily inside the warehouse;
- Up to 230 delivery vans could arrive at the site within a half hour period.

The assumed representative on-site sound power levels associated with a truck is 102 dB(A) $L_{eq,15min}$, 95 dB(A) $L_{eq,15min}$.for a forklift and 90 dB(A) $L_{eq,15min}$.for a typical delivery van pass-by. Noise emission predictions at the nearest potentially affected residence are provided in Table 7.1 for the meteorological scenarios described in Section 5.

Table 7.1 Operational noise predictions

Receptor	Period	Predicted noise level, $L_{eq, 15min}$ dB(A)			Criteria, $L_{eq, 15min}$ dB(A)
		Calm	3 m/s wind	Temp Inv.	
Nearest residences (Hume Highway)	Day	43	43	n/a	50
	Evening	43	43	n/a	49
	Night	43	43	43	46

Noise modelling predicts that the relevant noise criteria will be met at the nearest residential locations for calm and prevailing conditions during all proposed operational periods.

7.2 Sleep disturbance

The loading of trucks during the night time period has been assessed. Typical maximum noise level event activities are likely to include reversing alarms. A typical L_{max} sound power level of 110 dB(A) (ie 105 dB(A) L_w for the reverse alarms plus a 5 dB tonality correction as per the INP) has been used in the noise model. The predicted external maximum noise level (L_{Amax}) at the nearest potentially affected residential receivers from reversing alarms at the nearest truck parking bay during the night-time period (10pm to 7am) is 66 dB. As provided in Section 4.3, external maximum noise levels in the order of 60-65 dB are unlikely to cause awakening reactions.

It is noted, with reference to operator-attended noise monitoring results, that existing maximum noise levels are in the order of 80 dB adjacent Hume Highway which is significantly higher than those predicted from the proposed works.

Notwithstanding the above, the proponent will manage and minimise the potential for L_{max} events from site, discussed further in Section 7.

7.3 Cumulative noise assessment

The proposed development site is situated within a developed industrial area. Potential cumulative noise impacts from existing and successive developments are embraced by the INP procedures by ensuring that the appropriate noise emission criteria (and consent limits) are established with a view to maintaining acceptable noise amenity levels for residences. Therefore, the cumulative impact of the Project with existing industrial noise sources has been assessed in the determination of the amenity levels (refer Table 4.3) at surrounding potentially noise sensitive areas.

7.4 Construction noise modelling and results

7.4.1 Earthworks and building construction

Noise from proposed construction activity on site was predicted for the nearest residential locations. It is noted that this assessment excludes the demolition of existing structures and initial bulk earthworks (45,000m^3).

Simultaneous operation of 4 dump trucks, 4 concrete trucks, 2 cranes, 2 scrapers and 2 excavators (30T) were used to represent typical construction activities and are considered to represent an acoustically worst-case 15-minute period during standard construction hours.

Representative sound power levels associated with these equipment used in noise modelling are summarised in Table 7.2.

Table 7.2 Representative equipment sound power levels

Equipment	$L_{eq(15\text{-}min)}$ Sound Power Level, dB(A)
Dump Trucks	100
Concrete trucks	111
Scraper	103
Excavator	109
Crane	105

A worst case scenario assuming the simultaneous operation of all aforementioned construction equipment was used for the analysis. It has been assumed that construction activity would generally take place during standard construction hours other than stockpiling fill on site. Activities outside standard construction hours may be permitted where there is a safety requirement or emergency work needs to be undertaken or where it can be demonstrated that construction activity will not cause noise impact at nearby residences.

Construction noise levels have been predicted to the nearest representative receivers assuming attenuation due to distance only. Hence, construction noise level predictions are considered conservative. The topography in the area is generally flat.

Construction equipment has been modelled at locations nearest to and furthest away from receivers within the subject site to represent the range of noise levels that may be experienced over the relevant periods. Indicative noise predictions are provided in Table 7.3.

Table 7.3 Construction noise predictions

Representative receiver	Distance	Indicative construction noise level $L_{Aeq\ (15\ min)}$, dB	Construction noise management level $L_{Aeq\ (15\ min)}$, dB
		Standard construction hours	Standard construction hours
Residence (adj Hume Hwy)	60-450m	58-75	55 (Highly affected 75 dB)

Predictions presented in Table 7.3 indicate that construction noise levels are likely to be above the recommended noise management levels at times during all periods of proposed activity but below the highly noise affected level during the daytime period. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings, it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, the proponent will actively manage construction noise from the site. Further advice and discussion is provided in Section 7 in this regard.

7.5 Road traffic

Traffic generated by the Project will consist of construction vehicles, staff vehicles and truck deliveries to and from the site. Total daily traffic generated by the site is estimated to be up to 1,691 (3,382 vehicle movements in and out including up to 72 heavy vehicle movements).

Access to the subject site will be from the driveway off Worth Street which is accessed directly from the Hume Highway. The existing average annual daily traffic volume on the Hume Highway in the vicinity of the site (east of Worth Street) is in excess of 58,000. Hence, traffic generated by the Project represents less than 6% of total existing traffic.

Traffic generated by the Project is not expected to generate any noticeable increase in road traffic noise levels at the nearest residential locations. This finding is based on a 6% increase in traffic volume which would translate to less than 0.5 dB increase in average road traffic noise levels.

7.6 Vibration

The major vibration generating activities associated with the proposed works are the use of vibratory rollers (up to 20T) and compactor. The nearest distance that such equipment is likely to operate near residences or the adjacent industrial building is 100m and 40m, respectively.

Based on typical vibration levels generated by such activities it is predicted that the use of such equipment will be below the relevant human comfort criteria at distances of 100m or greater and below the relevant criteria for cosmetic damage to buildings at distances of 25m or greater. Hence, construction vibration is not likely to cause disturbance or damage to the nearest vibration-sensitive receivers.

8 Recommendations and noise management

8.1 Construction

While there is the potential for construction noise to exceed the recommended criteria (without mitigation) at the potentially closest residences to the south, there are several mitigation measures that may be employed to reduce noise impacts. These include:

- scheduling construction activities such that the concurrent operation of plant is limited;
- preparation of a construction noise management plan (CNMP) (to be included in the project Environmental Management Plan) prior to construction to ensure that all employees understand and take responsibility for noise control at site. The CNMP should include, as a minimum, the following components:
    - identification of nearby residences and sensitive land uses;
    - description of proposed hours of work and what work will be undertaken;
    - description of what work practices will be applied to minimise noise in particular for out of standard construction hours works;
    - description of complaints handling process;
    - description of noise and/or vibration monitoring that is required; and
    - notification process for nearby properties;
- properly maintaining plant to ensure rated noise emission levels are not exceeded;
- undertaking construction activities guided by AS2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*; and
- providing a contact telephone number via which the public may seek information or make a complaint. A log of complaints should be maintained and actioned by the site superintendent in a responsive manner.

It is recommended that noise monitoring be adopted as a noise management strategy throughout the construction works. The purpose of monitoring would be to validate background noise levels, the construction noise predictions and to confirm that the noise levels from individual items of equipment are not excessive. Ideally, noise monitoring would be undertaken at the commencement of works and during (or soon after) any significant change in acoustically significant activity.

8.2 Operations

Operational noise predictions indicate that sensitive receivers will not be exposed to noise above relevant criteria. There are mitigation measures that may be employed to further reduce noise impacts. These include:

- scheduling truck movements and loading dock operations such that concurrent operation of vehicles is minimised. This would include limiting onsite vehicle idling while loading;
- design traffic management to minimise the need for reversing especially during the night-time period; and
- preparation of an operational noise management plan (to be included in the project Environmental Management Plan) within 12 months of commencement of operation to ensure that all employees understand and take responsibility for noise control at site.

9 Conclusion

EMM has prepared a noise and vibration impact assessment suitable to accompany a development application for a proposed warehousing facility to be located at 2 Hume Highway, Chullora, NSW.

The existing ambient noise environment was quantified by undertaking long-term unattended and short-term attended noise monitoring in the vicinity of the subject site. Relevant noise criteria were conservatively established for operation, construction and road traffic associated with the development. The findings and recommendations of the noise and vibration impact assessment are summarised as follows:

- Results of computer noise modelling indicate that the relevant noise criteria will be met at the nearest residential locations for calm and worst case meteorological conditions during all proposed periods of operation.

- Results of noise modelling indicate that construction noise levels may be above the recommended noise management levels at times for the proposed construction activities but below the highly noise affected level during the daytime period. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, the proponent will actively manage construction noise from the site. This will include the preparation of a construction management plan which will incorporate noise mitigation and management measures to ameliorate construction noise impacts.

- Vibration associated with construction activity is shown to not likely generate impacts at the nearest vibration-sensitive receptors; residences on Hume Highway or the adjacent industrial buildings.

- Traffic generated by the Project is not expected to generate any noticeable increase in road traffic noise levels at the nearest residential locations.

Appendix A

Glossary of acoustic terms

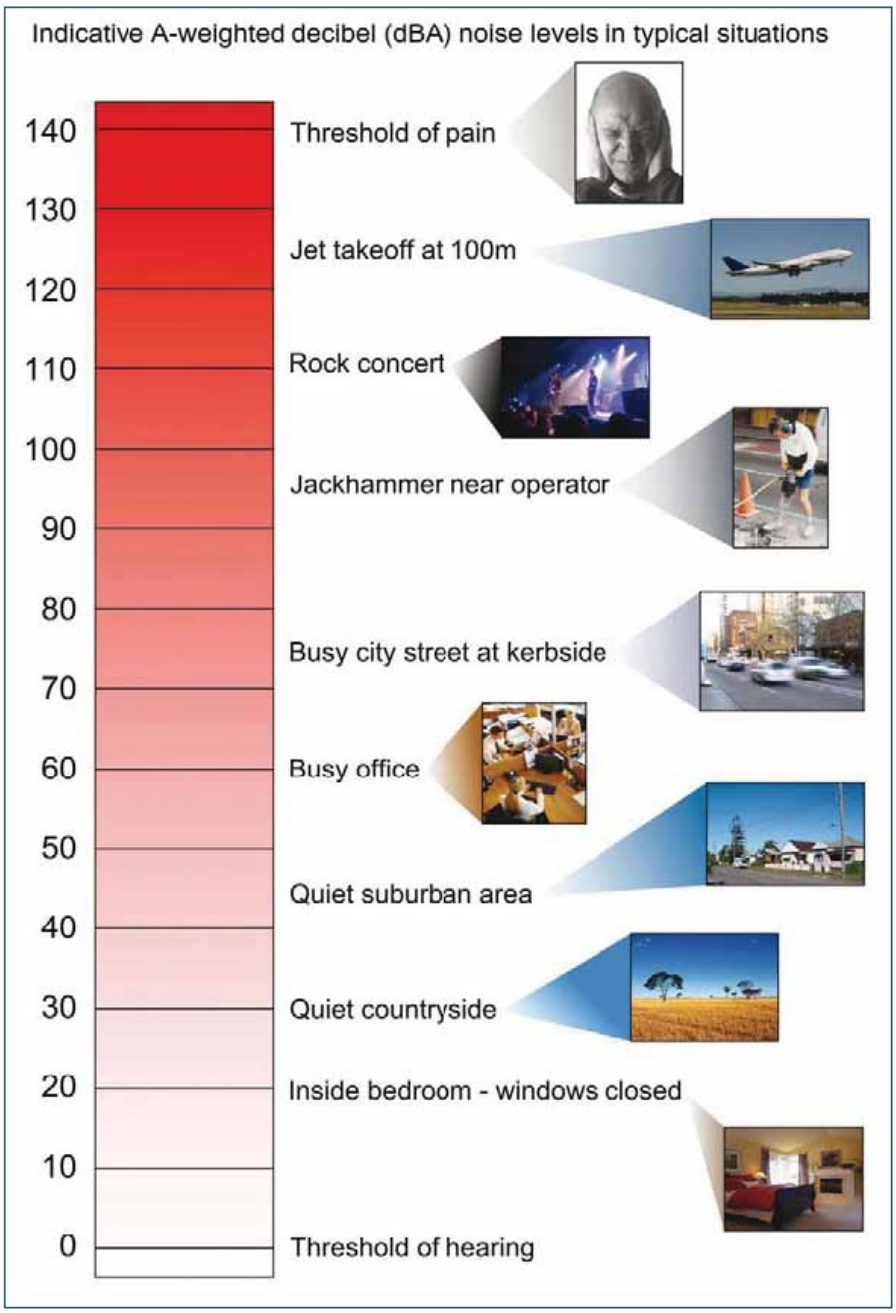
Table A1 Glossary of acoustic terms

Term	Description
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
DECC	The NSW Department of Environment, Climate Change
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
L_1	The noise level exceeded for 1% of the time.
L_{10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{eq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{eq(15min)}$ descriptor refers to an L_{eq} noise level measured over a 15-minute period.
L_{max}	The maximum root mean squared sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (Lw)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

It is useful also to have some appreciation of the scale of decibels, the unit of noise measurement. The following gives some practical indication as to what an average person perceives about changes in noise levels:

- differences of less than approximately 2dB are imperceptible in general, ie, most people would find it difficult to discern which is the louder of two noise sources having levels within 2dB of each other; and
- a difference in noise levels of around 10dB appears as either doubling or halving of loudness.

Examples of common noise levels that may be encountered on a daily basis are provided in Figure 1.2.

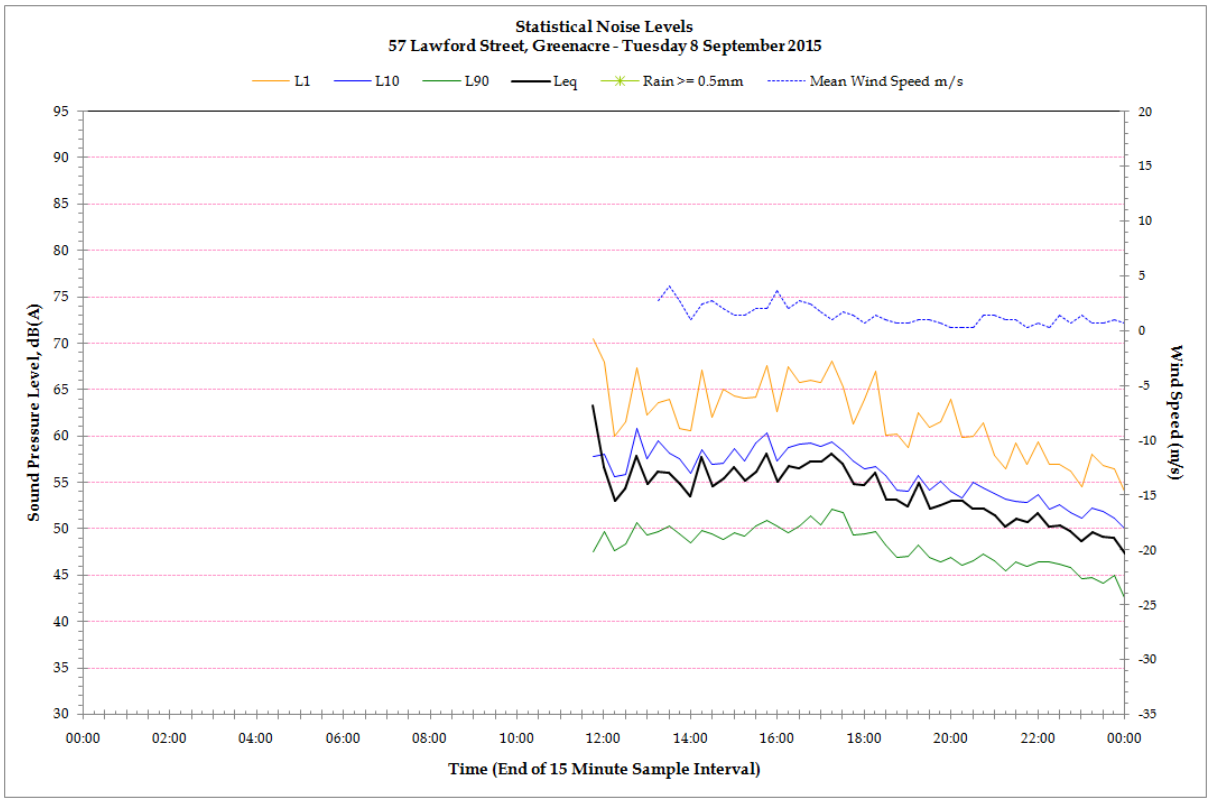


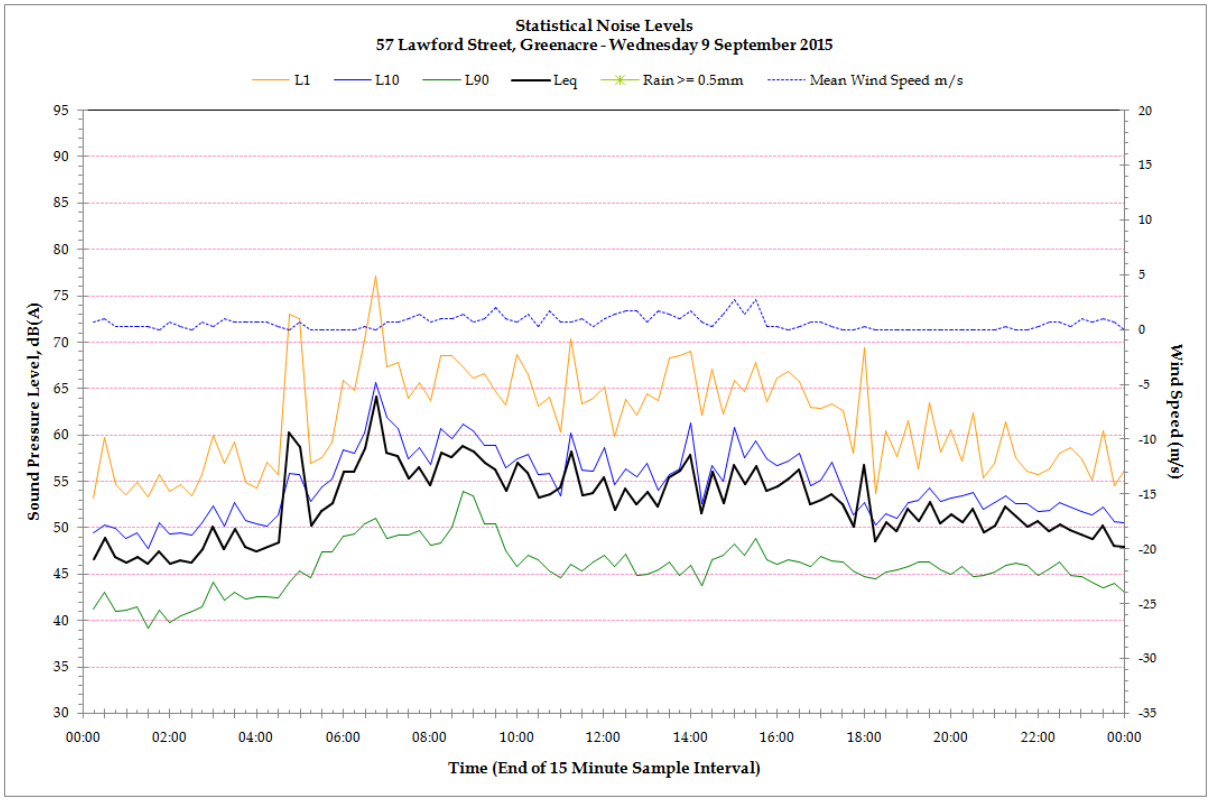
Source: *NSW Road Noise Policy (DECCW 2011).*

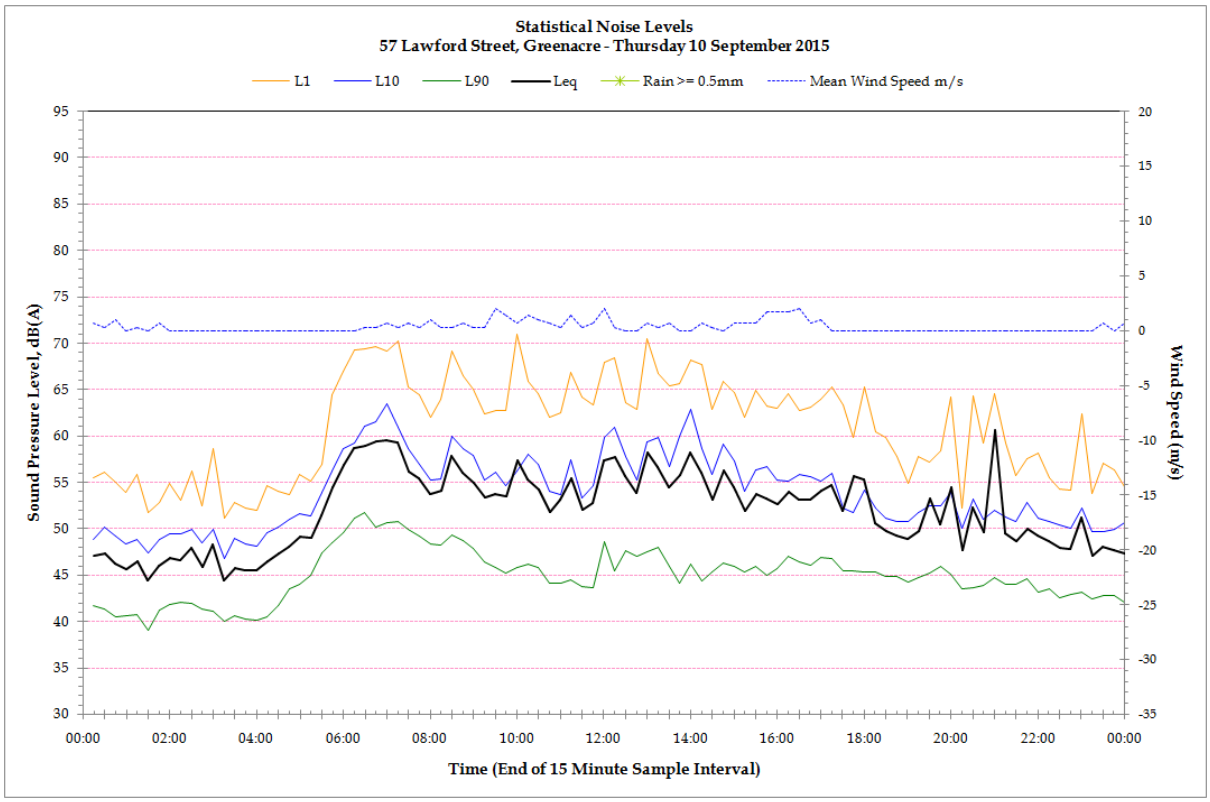
Figure A.1 Common sources of noise with levels

Appendix B

Ambient noise levels


Statistical Noise Levels
57 Lawford Street, Greenacre - Tuesday 8 September 2015
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
57 Lawford Street, Greenacre - Wednesday 9 September 2015
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
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L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
95
90
85
80
75
70
65
60
55
50
45
40
35
30
20
15
10
5
0
-5
-10
-15
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-25
-30
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18:00
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22:00
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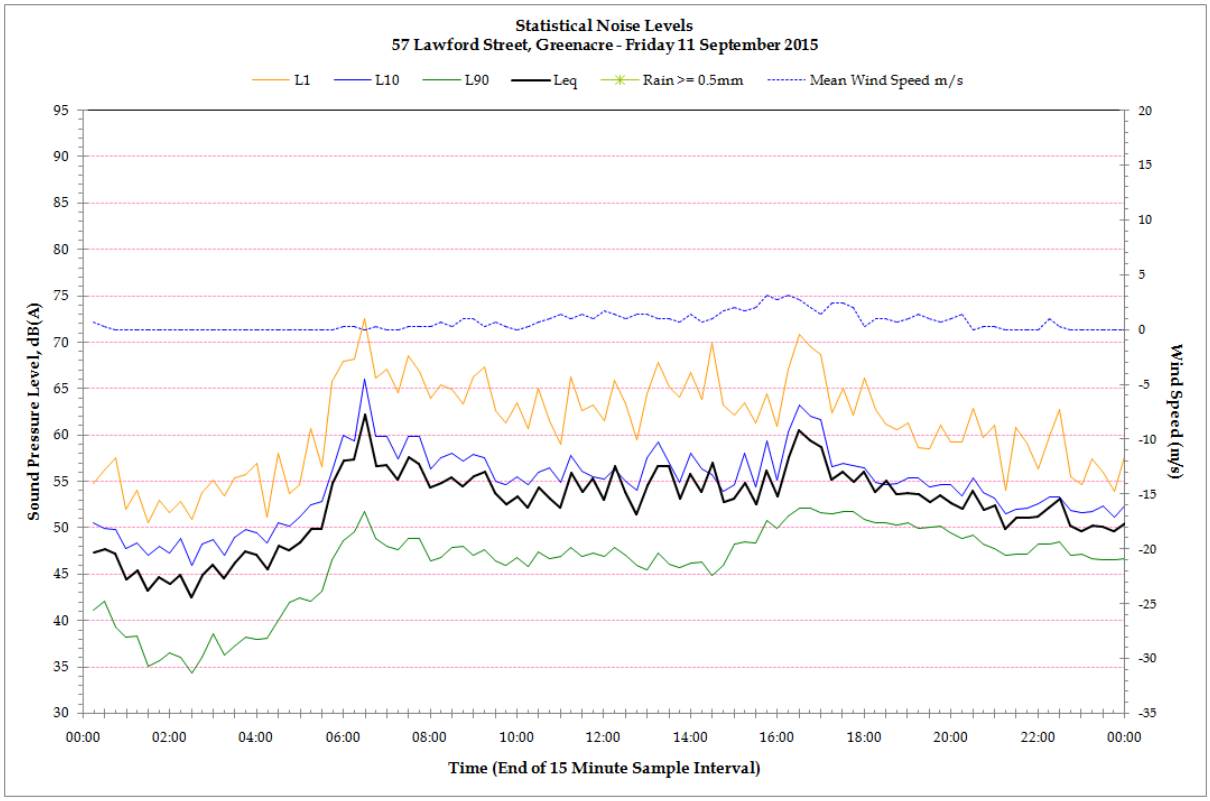
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
57 Lawford Street, Greenacre - Friday 11 September 2015
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
95
90
85
80
75
70
65
60
55
50
45
40
35
30
20
15
10
5
0
-5
-10
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-25
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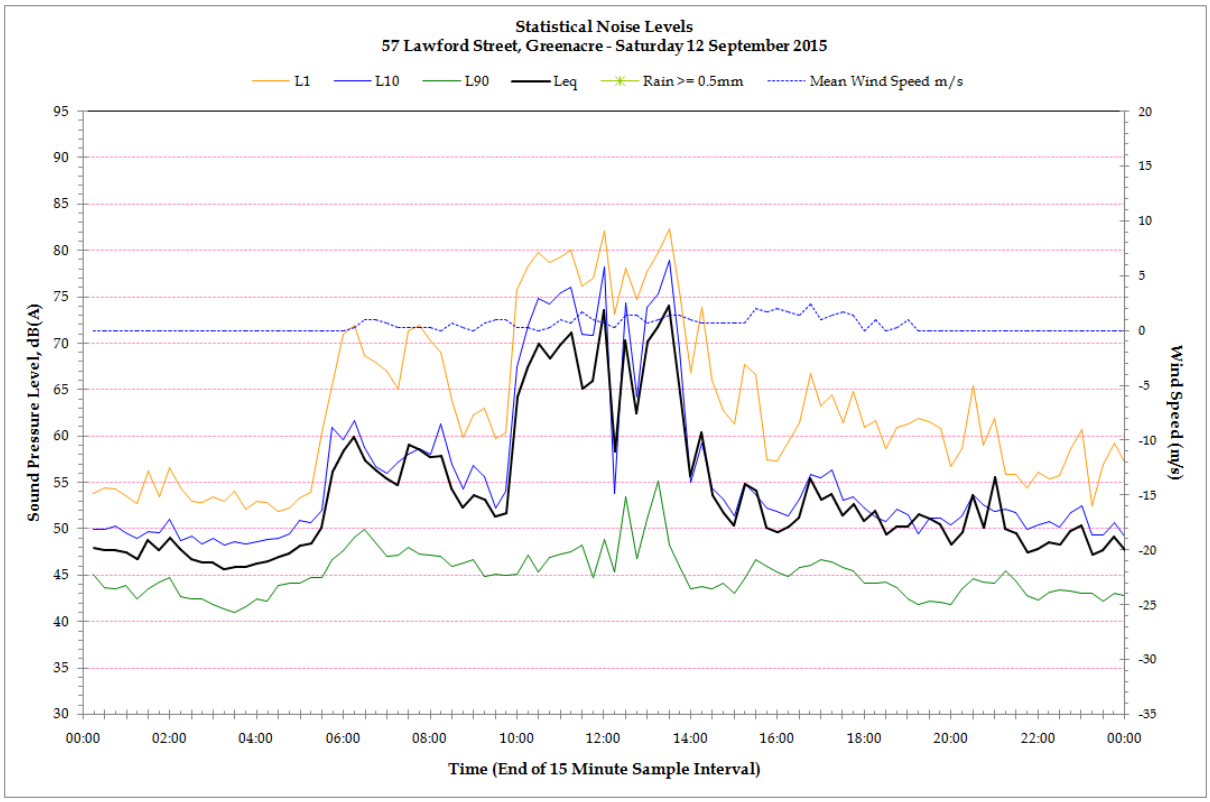
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
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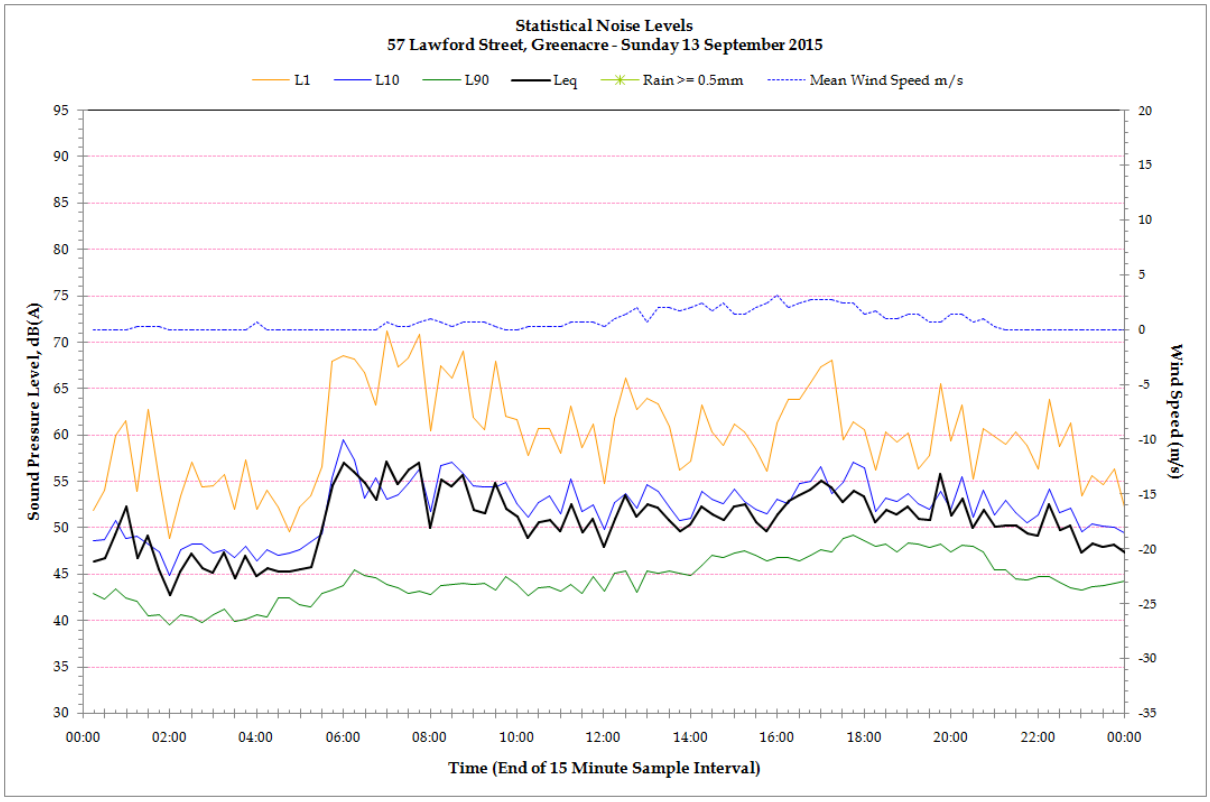
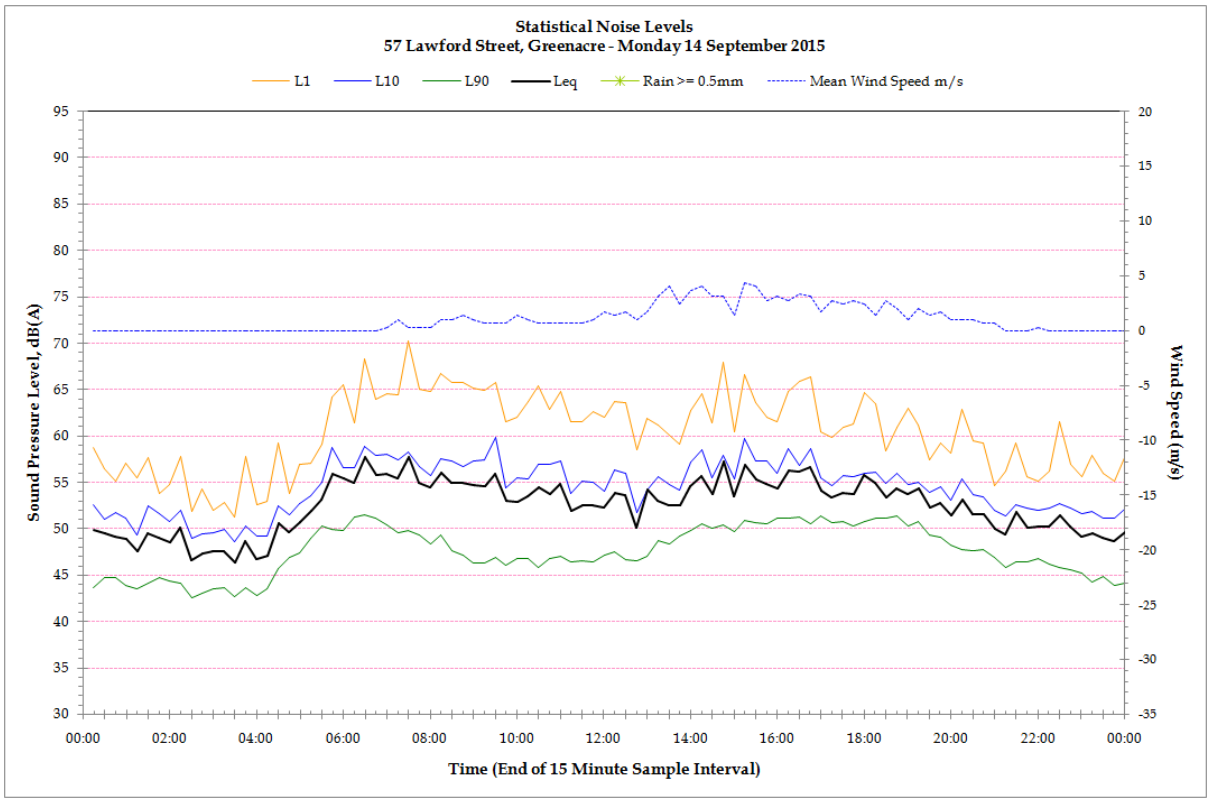
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
57 Lawford Street, Greenacre - Sunday 13 September 2015
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)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57 Lawford Street, Greenacre - Monday 14 September 2015
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
95
90
85
80
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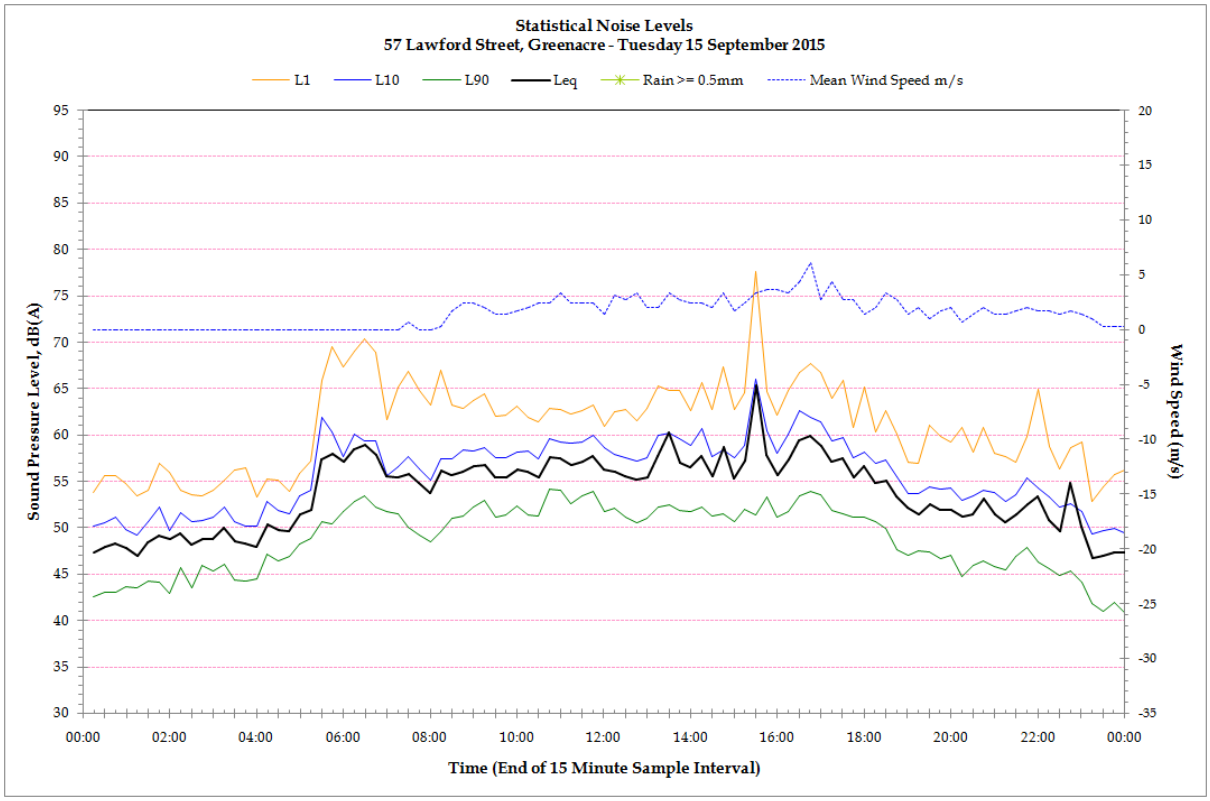
Time (End of 15 Minute Sample Interval)


Statistical Noise Levels
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L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
95
90
85
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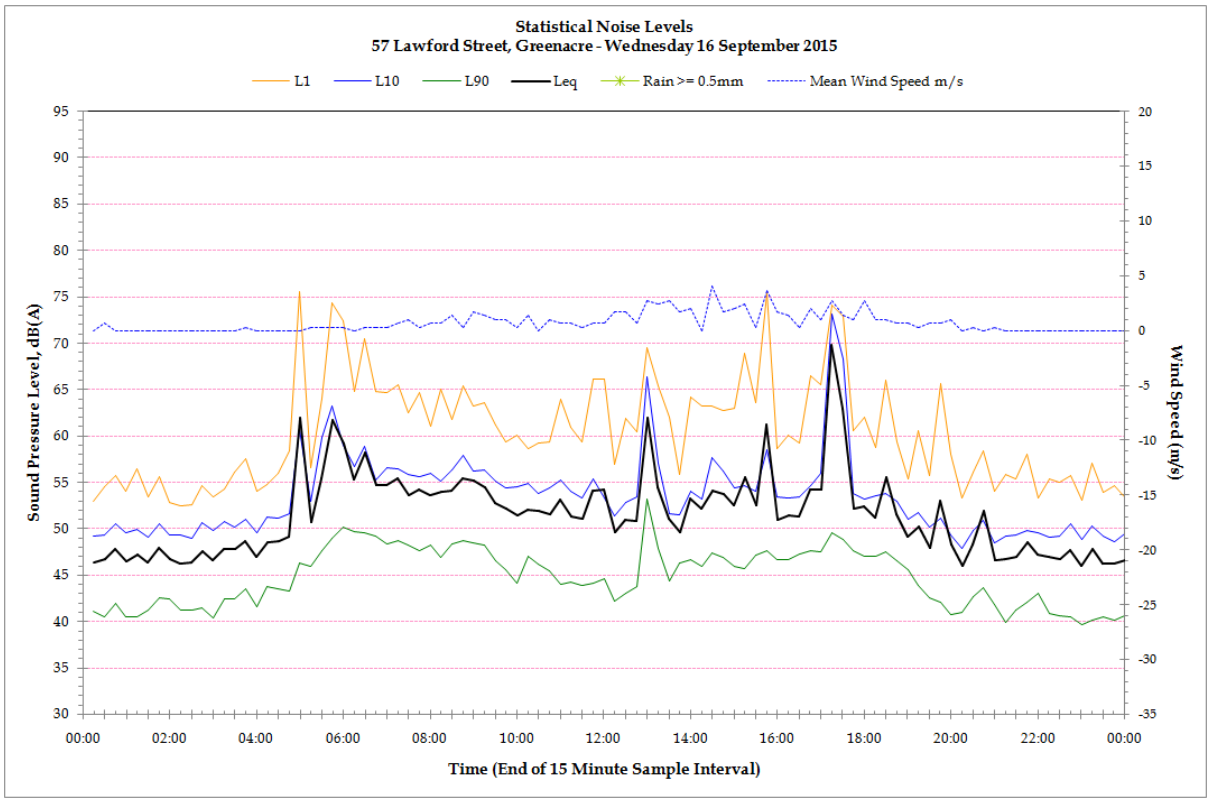
Time (End of 15 Minute Sample Interval)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L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
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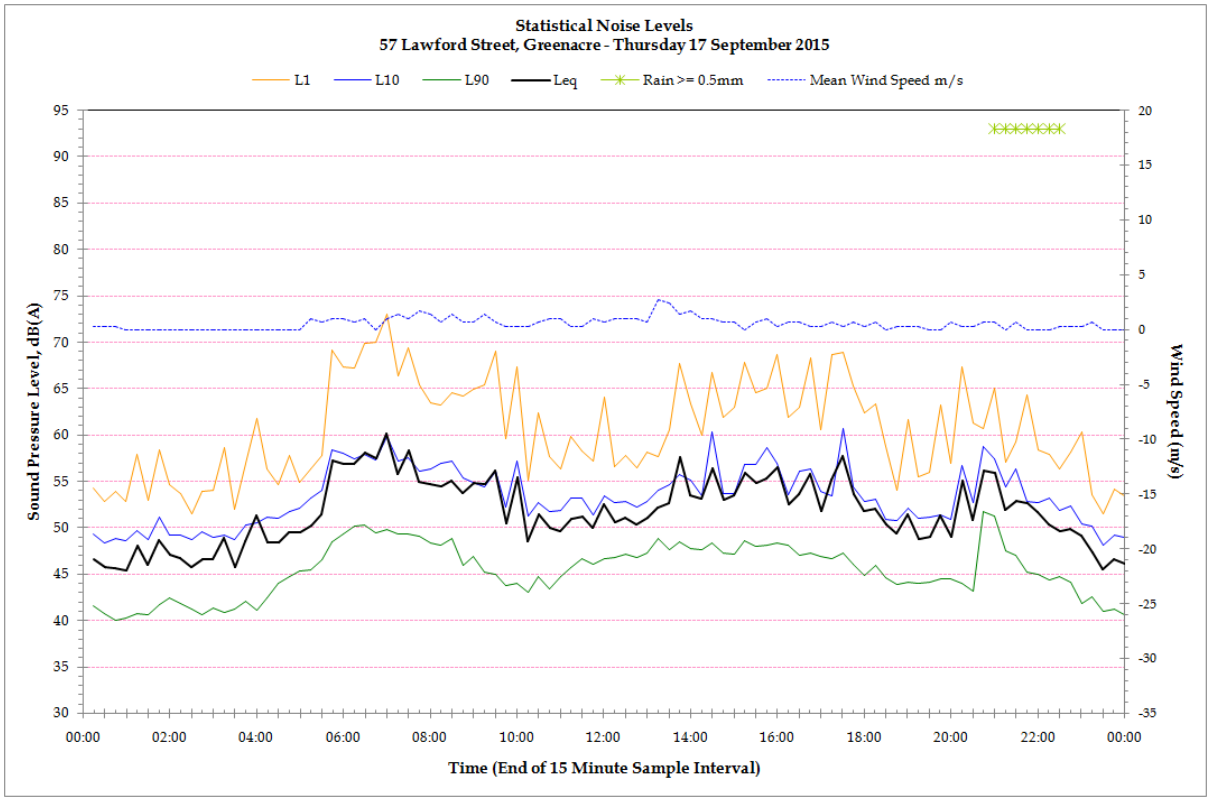
Time (End of 15 Minute Sample Interval)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L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
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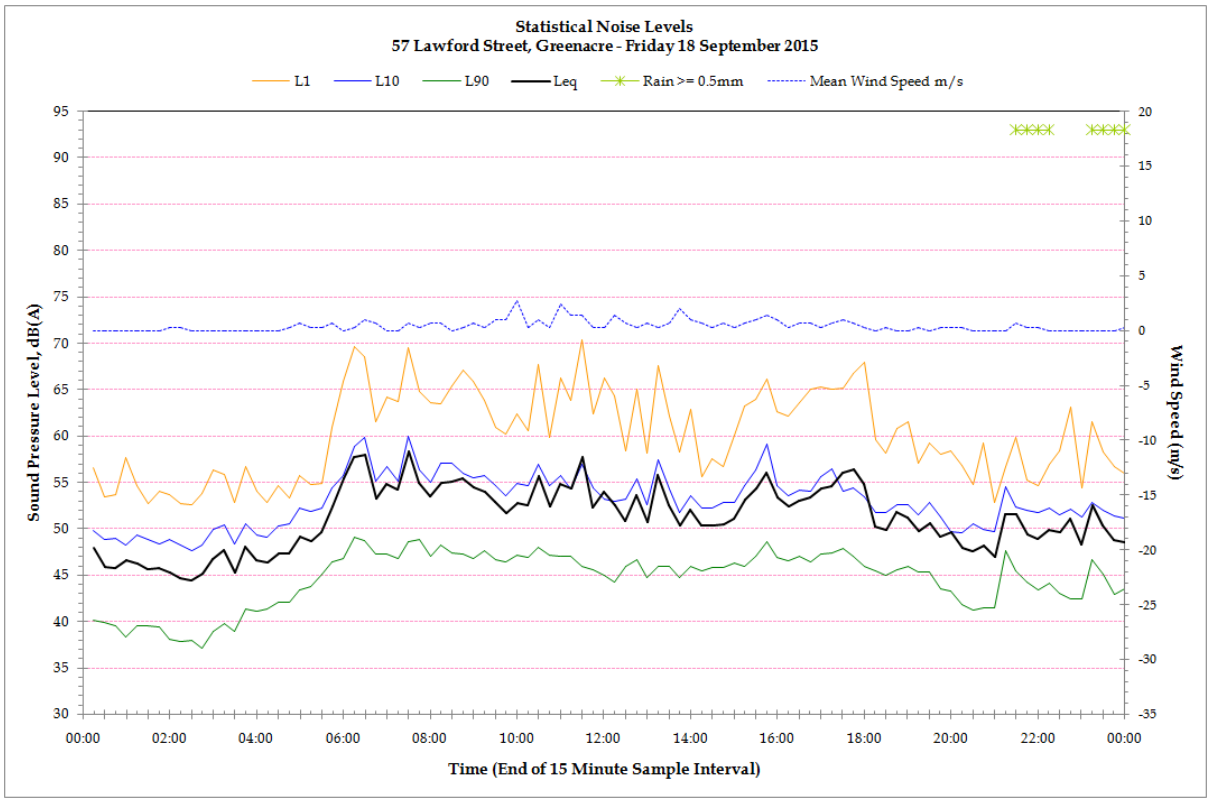
Time (End of 15 Minute Sample Interval)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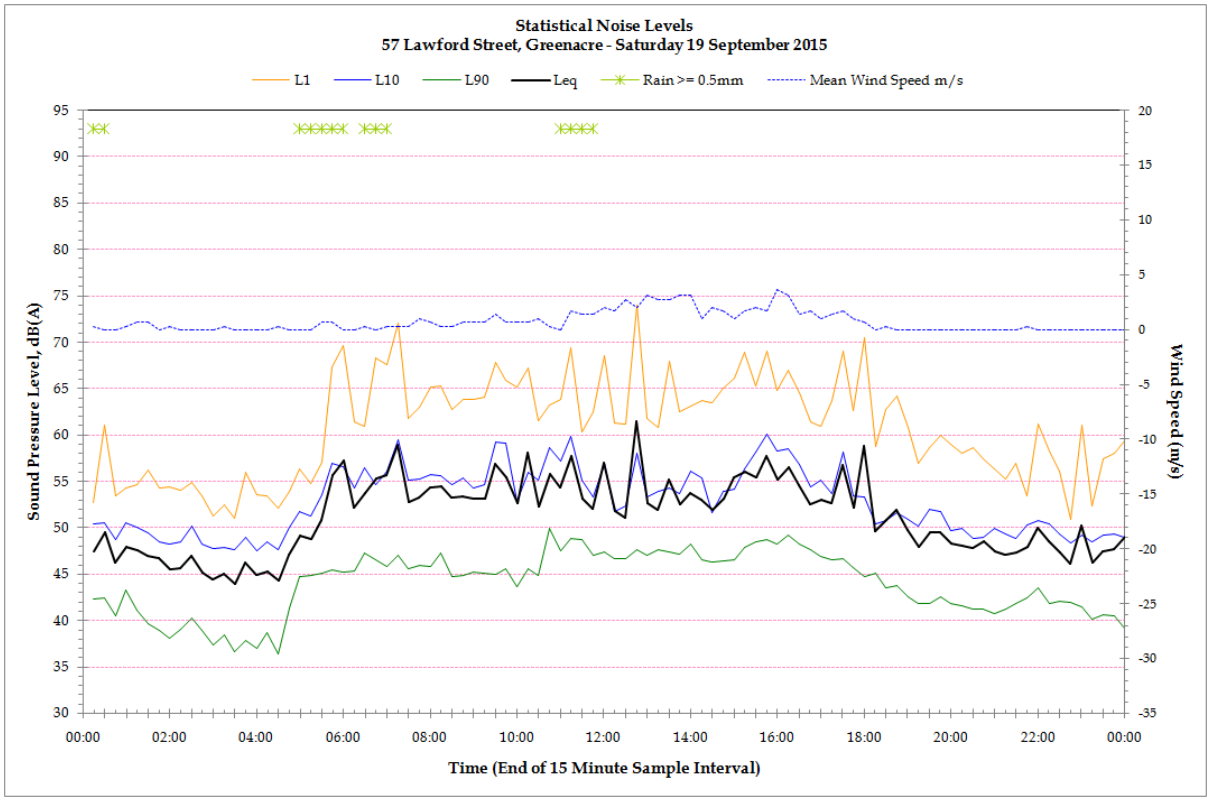
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)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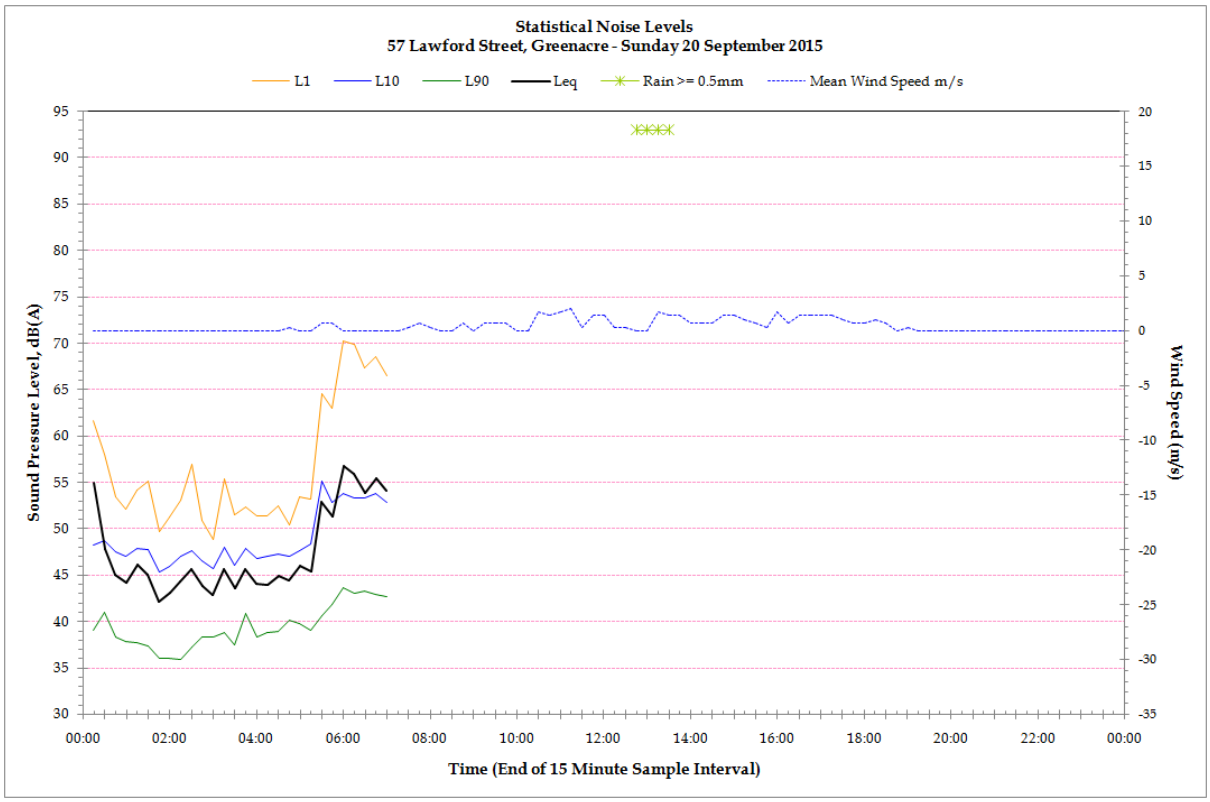
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
Time (End of 15 Minute Sample Interval)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L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed m/s
Sound Pressure Level, dB(A)
Wind Speed (m/s)
95
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00:00
Time (End of 15 Minute Sample Interval)

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