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Traffic and Rail Noise and Vibration Assessment

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1 INTRODUCTION

This report presents out assessment of noise and vibration impacts on the proposed development at 1 Villawood Place, Villawood.

In this report we will:

- Conduct an external noise impact assessment (primarily rail and traffic noise) and recommend acoustic treatments to ensure that a reasonable level of amenity is achieved for future occupants.

- Conduct a rail vibration impact assessment and if necessary provide recommendations regarding vibration isolation.

Railway noise and vibration levels at the site have been measured and assessed in accordance with Council requirements, the NSW Department of Planning SEPP Infrastructure 2007 and Australian Standard AS2107:2000.

The assessment is based on the architectural drawings provided to this office from Tony Owen and Partners and dated March 2015.

2 SITE DESCRIPTION

The proposed development is a mixed use building with 1 level of retail and 7 stories of residential use with a basement carpark. To the north of the site lies the rail corridor and within the vicinity of the site to the east is Villawood Road.

Detailed site map and measurement locations are shown in Figure 1.

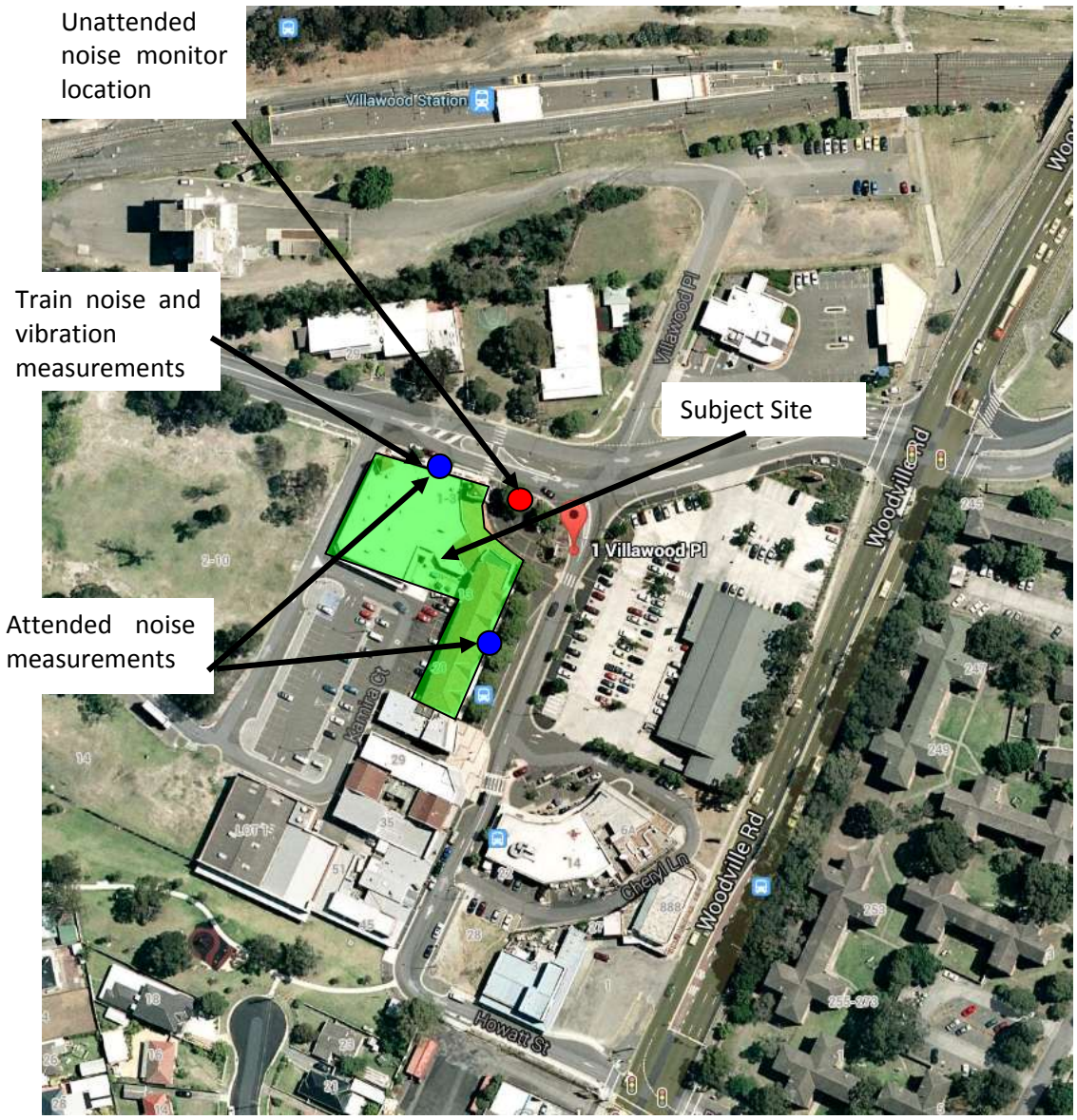


Figure 1: Site Map and Measurements Location

3 NOISE DESCRIPTORS

Traffic noise constantly varies in level, due to fluctuations in traffic speed, vehicle types, road conditions and traffic densities. Accordingly, it is not possible to accurately determine prevailing traffic noise conditions by measuring a single, instantaneous noise level. To accurately determine the effects of traffic noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters. These parameters are used to measure how much annoyance would be caused by a particular noise source.

In the case of environmental noise three principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement interval.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of traffic noise.

Current practice favours the L_{eq} parameter as a means of measuring traffic noise, whereas the L_{10} parameter has been used in the past and is still incorporated in some codes. For the reasons outlined above, the L_{90} parameter is not used to assess traffic noise intrusion.

4 ASSESSMENT CRITERIA

The assessment of traffic and rail noise and vibration is conducted in accordance to the following documents:

- State Environmental Planning Policy (Infrastructure) 2007
- AS2107-2000 Acoustic – Recommended design south levels and reverberation times for building interiors

4.1 STATE ENVIRONMENTAL PLANNING POLICY 2007

The NSW Department of Planning's policy, Development Near Rail Corridors And Busy Roads – Interim Guideline, sets out internal noise level criteria adapted from the State Environmental Planning Policy (Infrastructure) 2007 (the 'Infrastructure SEPP') for developments with the potential to be impacted by traffic or rail noise and vibration.

For rail noise and vibration, the following controls apply:

"87 Impact of rail noise or vibration on non-rail development

(1) This clause applies to development for any of the following purpose that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to adversely affected by rail noise or vibration:

(a) a building for residential use,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or child care centre.

(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purpose of this clause and published in the Gazette.

(3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceed:

(a) in any bedroom in the building – 35 dB(A) at any time between 10.00 pm and 7.00 am,

anywhere else in the building (other than a garage, kitchen, bathroom or hallway) – 40 dB(A) at any time."

4.2 AUSTRALIAN STANDARD 2107-2000

AS2107-2000 has recommended internal noise level for residential buildings near major road:

Table 1 – Design Sound Level

Type of Occupancy	Space	Recommended Design Sound Level
Residential near major roads	Sleeping Areas (Night time only 10pm – 7am)	35-40 dB(A)$L_{eq(9hr)}$
	Living Areas (24 hrs a day)	40-45 dB(A)$L_{eq(15hr)}$

4.3 PROJECT CRITERIA

The subject site is affected by rail, traffic and aircraft noise, therefore, all the noise criteria listed above will be applied. The governing project criteria are presented in Table 4.

Table 2 – Internal Noise Level Criteria

Location	Criteria
	Average Noise Levels(Environmental Noise)
Bedroom	35 dB(A) $L_{eq(9hour)}$ (10pm – 7am)
Living Area	40 dB(A) $L_{eq(24hour)}$ (All Day)
Bathrooms	45 dB(A) $L_{eq(24hour)}$ (All Day)

4.4 COMMERCIAL

Acoustic treatments for commercial and retail spaces will be designed to achieve internal noise level of 50dB(A)L_{eq} (from rail and traffic noise), which is the recommended noise level for retail spaces in AS2107-2000.

5 TRAIN AND TRAFFIC NOISE MEASUREMENTS

The main environmental noise incidents at the site are those generated by transportation noise. The south façade of the proposed development is mainly affected by traffic along Enmore Road, and the north façade is mainly affected by train noise from the adjacent rail corridor.

Measurements were performed generally in accordance with the Australian Standard AS1055 – "Description and measurement of environmental noise – General Procedures".

5.1 ENVIRONMENTAL NOISE MEASUREMENTS

5.1.1 Measurements Location

Rail noise measurements were conducted at the future façade of the building (the northern façade).

5.1.2 Time of Measurements

Measurements were conducted on the 22nd of August, 2014 between 4pm and 5.30pm at the location detailed in Figure 1 above.

5.1.3 Measurement Equipment

Equipment used consisted of a Norsonic 140 sound level meter, set to A-weighted fast response. The sound level meter was calibrated before and after the measurements, no significant drift was recorded.

5.1.4 Measurement Results

The measured train noise levels are incorporated with passenger trains timetables, in order to calculate the day and night noise levels induced by rail noise, the noise levels are presented in Table 5 below.

Table 3 – External Noise Level (Rail Noise)

Location	Time Period	Train Noise Level
Future northern façade	Day	66dB(A)$L_{Aeq\ (15hour)}$
	Night	62dB(A)$L_{Aeq\ (9hour)}$
Future Eastern façade	Day	67dB(A)$L_{Aeq\ (15hour)}$
	Night	65dB(A)$L_{Aeq\ (9hour)}$

6 EVALUATION OF NOISE INTRUSION

Internal noise levels will primarily be as a result of noise transfer through the windows and doors and roof, as these are relatively light building elements that offer less resistance to the transmission of sound.

The predicted noise levels through the windows, doors and roof are discussed below. The predicted noise levels have been based on the measured level and spectral characteristics of the external noise, the area of building elements exposed to aircraft, traffic and train noise, the absorption characteristics of the rooms and the noise reduction performance of the building elements.

Calculations were performed taking into account the orientation of windows, barrier effects (where applicable), the total area of glazing, facade transmission loss and the likely room sound absorption characteristics. In this way the likely interior noise levels can be predicted.

6.1 GLAZING CONSTRUCTION

The recommended glazing assemblies are indicated in Table 7 and Table 8 below. The glazing thicknesses recommended are those needed to satisfy acoustic requirements and do not take into account other requirements such as structural, safety or other considerations. These additional considerations may require the glazing thickness to be increased beyond the acoustic requirement.

Table 4 – Glazing Requirements (Residential)

Façade Location	Room Type	Glazing Thickness	Acoustic Seals
Northern Façade	Bedroom	10.38mm laminated	Yes
	Living Rooms	6.38mm laminated	
	Wet Areas	6mm float	
Eastern Façade	Bedroom	10.38mm laminated	
	Living Rooms	6.38mm laminated	
	Wet Areas	6mm float	
Southern Façade	Bedroom	6.38mm laminated	
	Living Rooms	6.38mm laminated	
	Wet Areas	6mm float	
Western Façade	Bedroom	6.38mm laminated	
	Living Rooms	6.38mm laminated	
	Wet Areas	6mm float	

Table 5 – Glazing Requirements (Commercial)

Space	Orientation	Glazing Thickness	Acoustic Seals
Commercial/Retail	All	6mm Float/Toughed	Yes

In addition to complying with the minimum scheduled glazing thickness, the STC rating of the glazing fitted into operable frames and fixed into the building opening should not be lower than the values listed in the Table 8 below.

Where nominated, this will require the use of acoustic seals equal to Schlegel Q-lon series *(acoustic bulb seal)* around the full perimeter of operable frames. The frame will need to be sealed into the building opening using a flexible 100% polyurethane sealant equal to Bostik Seal N' Flex. Note that mohair seals and/or mohair/plastic fin combination seals in windows and doors are **not** acceptable where acoustic seals are required.

It is recommended that only window systems have test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended.

Table 6 – Minimum STC/R_w of Glazing Requirements

Glazing Assembly	Acoustic Seals	Minimum STC of Installed Window
6mm Float	Yes	29
6.38mm Laminated	Yes	30
10.38mm Laminated	Yes	35

Noise intrusion through masonry walls will be negligible and will not contribute to internal noise levels. Similarly, noise intrusion through the concrete slab roof construction will not be significant.

7 RAILWAY VIBRATION ASSESSMENT

Trains induce ground borne vibration that is transmitted through the subsoil. These vibrations can be perceptible close to railways, as tactile vibrations and as structure borne noise.

7.1 PROJECT VIBRATION OBJECTIVES

7.1.1 Tactile Vibration

Human comfort is normally assessed with reference to the British Standard BS 7385 Part 2 1993 or Australian Standard AS 2670.2 1990.

The Interim Guideline references the DECCW *Assessing Vibration- A technical guideline* which recommends that habitable rooms should comply with the criteria therein which is in line with the requirements of British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)".

British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" is recommended by the RIC's and SRA's Interim Guidelines for Councils "Consideration of rail noise and vibration in the planning process" as this standard includes guidance for the assessment of human response to building vibration including intermittent vibrations such as that caused by trains.

Human response to vibration has been shown to be biased at particular frequencies, which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the resident is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 "Evaluation of Human Exposure to Vibration and Shock in

Buildings (1 to 80Hz)" which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

This standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the "Daytime" (6am-10pm) and "Night time" (10pm-6am). The overall value is then compared to the levels in Table 9. For this project the aim will be for a low probability of adverse comment.

Table 7 - Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in residential buildings.

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16hr day (Daytime)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8hr night (Night time)	0.13	0.26	0.51

7.1.2 Structure Borne Noise

The Department of Planning 'Development Near rail Corridors and Busy Road – Interim Guideline' only requires structure borne noise assessment to be conducted where buildings or adjacent lands are over railway tunnels. Section 3.6.2 of the standard states the following:

"*Where building are constructed over or adjacent to land over tunnels, ground-born noise may be present without the normal masking effects of air born noise. In such cases, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a ground-born LAmax noise limit of 40 dB(A)(daytime and 35 dB(A) (nigh time)measured using the "slow" response time setting on a sound level meter."*

As the proposed development is not located over or adjacent to railway tunnels, no additional assessment of structure borne vibration is required for the proposed development.

7.2 RAIL VIBRATION MEASUREMENTS

Rail noise measurements were conducted in line with the future proposed northern façade, which is the potentially worst affected façade.

Attended train vibration measurements were conducted on 22nd of August, 2014 between 4pm and 5.30pm. A Svan 912A Vibration Analyser was used for the vibration measurements. The analyser was fitted with a Dytran triaxial accelerometer.

The measured vibration levels, duration of train passby and the number of rail movements per hour were used to determine the overall vibration dose (VDV) at the proposed development for both daytime and night time periods. The results are presented the table below.

Table 8 - Vibration Dose Values

Time Period	Calculated VDV m/s$^{1.75}$	Criteria VDV m/s$^{1.75}$	Complies
Day (7am – 10pm)	0.1	0.2 to 0.4	Yes
Night (10pm -7am)	0.07	0.13	Yes

In the event the future train use increases, say by 10%, predicted eVDV will not increase significantly (no more than approximately 0.02 more than the levels predicted in the table above) and will not impact recommended vibration isolation treatments.

The calculated levels comply with the tactile vibration requirements listed in table 7 and hence no further acoustic amelioration is required.

8 CONSTRUCTION NOISE AND VIBRATION

This document presents a specification for the processes, which will be followed to manage noise and vibration associated with the proposed construction activities which are required as part of the Project and the potential for noise and vibration impact to receivers within close proximity.

The principal objective of this study is to undertake an evaluation of works to be performed during the operation of the various activities during construction and develop a management plan to ensure noise and vibration is:

1. Minimised to all surrounding receivers.

2. Does not exceed OH&S standards at surrounding receivers.

3. Is monitored when potentially high noise and vibration generating activities are being used.

This assessment will formulate/present the relevant noise and vibration criteria which construction activities are required to comply with. Additionally effective mitigation measures will be recommended where possible to ensure criteria is achieved and impacts are.

The principal issues, which will be addressed in this report, are:

- Identification of the noise and vibration standards which will be applicable to this project.

- Formulation of a strategy for construction activities to comply with the standards identified in the above point.

8.1 PROJECT OBJECTIVES

The objective of this management plan is to set up a protocol to ensure noise and vibration emissions from the construction works associated with the project comply with applicable standards, recommend required management controls and treatments are adopted where required and detail the required monitoring to ensure standards are met.

8.2 PROJECT DESCRIPTION AND POTENTIALLY EFFECTED PROPERTIES

The proposed project includes the excavation of material including infill and soft sand stone and construction of the development. The expected activities can be expected to include:

1. Removal of infill material.
2. Excavation.
3. Building constructions.

8.3 CONSTRUCTION NOISE CRITERIA

It is proposed to utilise Australian Standard AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*, which is the standard commonly applied by Councils for the regulation of construction noise, the New South Wales Construction Noise Guideline developed by The NSW EPA and OH&S requirements are presented in this section of the report.

8.3.1 Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

8.3.2 EPA Construction Noise Guideline

The Department of Environment and Climate Change have developed a specific construction noise guideline in the aid of reducing the impact of construction associated noise.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

8.3.3 EPA Construction Noise Guideline - Qualitative Assessment Method

The guideline refers to a qualitative assessment method in which construction noise is assessed on a case by case basis with regard to various activities to be conducted on site. This assessment method was developed to smaller scale projects.

Essentially this method of assessment requires that the proponent take into consideration and employ all reasonable and feasible measures to ensure that the impact on noise receivers is minimised. This is generally conducted in the following manner:

- The drafting of a noise management plan outlining all reasonable and feasible mitigation methods for the reduction of noise impact;
- The assessment of high impact equipment such as rock-hammers and piling equipment for lower noise producing methods of construction/excavation;
- The implementation of a complaints handling register and community consultation system;
- Employee (builders, contractors etc) education in effective noise reducing techniques and site etiquette; and
- The operation of plant in a quiet and efficient manner (i.e. turning off machinery when not in use).

This qualitative assessment method has been used for the basis of this report and has been used as the basis for the development of acoustic management and treatments of proposed construction activities.

In addition, the guideline specifies goals which can be used in the effort of minimising noise from construction related activities. These noise goals are presented within the table below.

Table 9 – EPA Recommended Construction Noise Goals

Governing Body	Receiver Type	External sound level Goal, $L_{eq\ 15\ min}$ dB(A)
EPA	Residential	Background + 10 dB(A)[1]
		75 dB(A)[2]

1: 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 minimise noise. (DECC CNG, 2008).

2: Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided. (DECC CNG, 2008).

These criteria for resultant noise from construction activities are aimed at maintaining comfort levels within the surrounding residential dwellings. Additionally, noise mitigation techniques as discussed in this report should be used if noise emissions exceed the above criteria. All work is to be carried out in accordance with AS 2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*.

8.3.4 OH&S guidelines

Regulation 49 of the Occupational Health and Safety Regulation specifies maximum levels of noise which a 'worker' may be exposed to. Acoustic treatment to the work environment or hearing

protection is recommended for workers exposed to higher noise levels. These maximum OH&S noise levels are presented in the table below.

Table 10 – OH&S Maximum Noise Level Exposure

	Energy Averaged Over 8 Hour Day	Maximum Noise Level During Day
OH&S maximum noise level exposure	85 dB(A) L_{eq}	140 dB(C)$_{Peak}$

8.4 CONSTRUCTION VIBRATION CRITERIA

Construction vibration criteria associated with works on the project when measured at the potentially affected receivers should not exceed the following sets of vibration criteria to ensure no architectural or structural damage to surrounding buildings and human comfort is maintained. These standards have been selected as they are widely used in the assessment of vibration associated with construction activities within Australia, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"*; and

- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The criteria and the application of these Standards are discussed in separate sections below.

8.4.1 German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the Table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 11 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in 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 (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

8.4.2 British Standard BS 6472:1992

British Standard BS 6472:1992 develops criteria relating to levels of building vibration that may be expected to give rise to *"adverse comment"*, in the frequency range most applicable to impacts associated with construction, which is 1 to 80Hz. These threshold values are used as criteria for assessing the loss of amenity and are presented below in Table 3.

Table 12 – BS 6472:1992 Criteria to Avoid *"Adverse Comment"*

Type of Occupancy	Time of Day	Peak Particle Velocity (mms^{-1}) between 1Hz to 80Hz Likely to Cause *"Adverse Comment"*			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration Excitation with Several Occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.3 to 0.6	0.8 to 0.6	8.4 to 12.6	24 to 36
	Night	0.2	0.6	2.8	8
Offices	Day	0.6	1.6	18	51
	Night	0.6	1.6	18	51
Workshops	Day	1.2	3.2	18	51
	Night	1.2	3.2	18	51

The limits indicate that people in buildings are significantly less susceptible to horizontal vibration than to vertical vibration. Furthermore, Section 4.1 of BS 6472 notes that situations can exist where vibration magnitudes above those generally corresponding to minimal *"adverse comment"* levels can be tolerated, particularly for temporary disturbances and infrequent and intermittent events such as those associated with construction projects.

8.5 CONSTRUCTION HOURS

Woking hours are subject to planning approval conditions. Typically the hours of work at sites will be:

- 7:00am to 5:00pm Monday to Friday
- 8:00am to 5:00pm on Saturdays
- No work on Sundays, Public Holidays or Saturdays adjacent to a Public Holiday.

Works which are proposed to be conducted outside of these hours will be subject to special approval.

8.6 CONTROL OF CONSTRUCTION NOISE AND VIBRATION

As a part of the noise management of noise and vibration on each site the following process should be conducted when investigating the impact and construction activities.

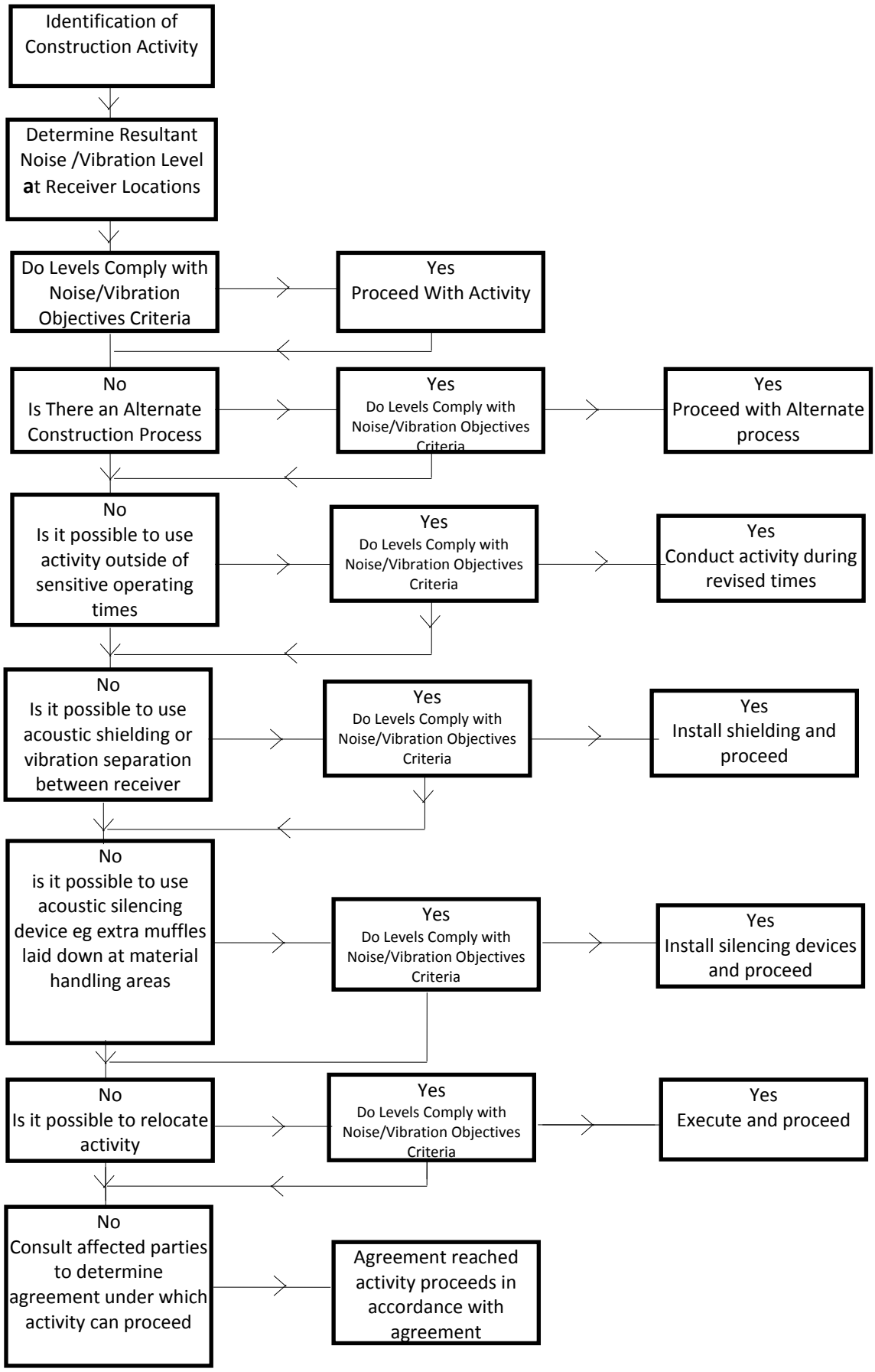


Figure 1 – Process Flowchart

8.7 NOISE AND VIBRATION CONTROL METHODS

The determination of appropriate noise control measures will be dependant on the particular activities and construction appliances. This section provides an outline of available methods.

8.7.1 Selection of alternate appliance or process

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

8.7.2 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependant on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

8.7.3 Silencing devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

8.7.4 Material handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

8.7.5 Treatment of specific equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

8.7.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. A noise plan will be developed for this project outlining work procedures and methods for minimising noise.

8.7.7 Regular noise checks of equipment

To determine the requirement for silencing devices on machinery it is proposed to undertake fortnightly noise check. Noise levels of all machines on site will be measured and if they are found to be higher than nominated for that equipment type, items such as mufflers and engine shrouds will be examined to ensure they are in good working order.

A record of these measurements will be kept on a form similar to that shown in Appendix 1. This measure is expected to maintain noise at constant levels, and prevent any increases.

8.7.8 TREATMENT of EXISTING EQUIPMENT

An effective method of mitigating vibration on existing equipment would be to vibration isolated mounts to existing equipment and installations. Vibration isolation would be required to be investigated on a case by case basis and consist of neoprene mounts as specified (such as waffle pads, supershear flex or the like).

Based on investigations conducted at the site the areas which may be suitable for treatment include tables with sensitive equipment such as microscopes and the like.

8.7.9 Noise and vibration Monitoring

Noise and vibration monitoring will be undertaken to determine the effectiveness of measures which are been implemented. The results of monitoring can be used to devise further control measures.

8.7.10 Combination of methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise.

8.7.11 Saw cutting

Introduction of a saw cut to manage vibration impacting on surrounding receivers from construction activities.

9 CONCLUSION

This report provides the results of an Environmental Noise and Rail Vibration Study for the proposed mixed-use development 1 Villawood Place, Villawood. Noise and vibration at the site have been measured and noise goals have been set in accordance with the requirements of the local council and relevant statutory/regulatory authorities.

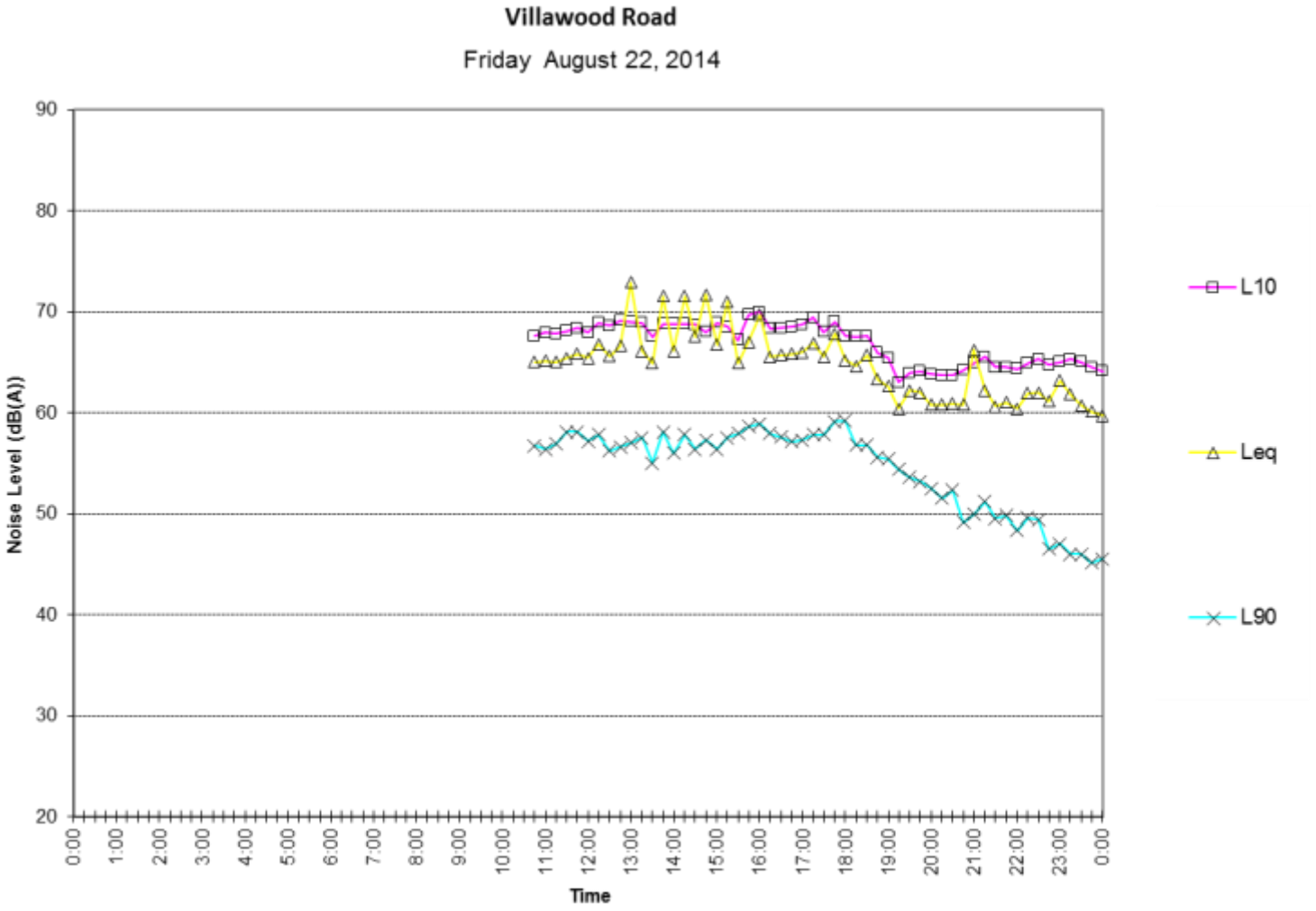
Treatments for control noise impacts to meet the nominated criteria in Sections 5 and 6 are presented in Section 7.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Ben White

Appendix A – Noise Logging Data


Villawood Road
Friday August 22, 2014
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
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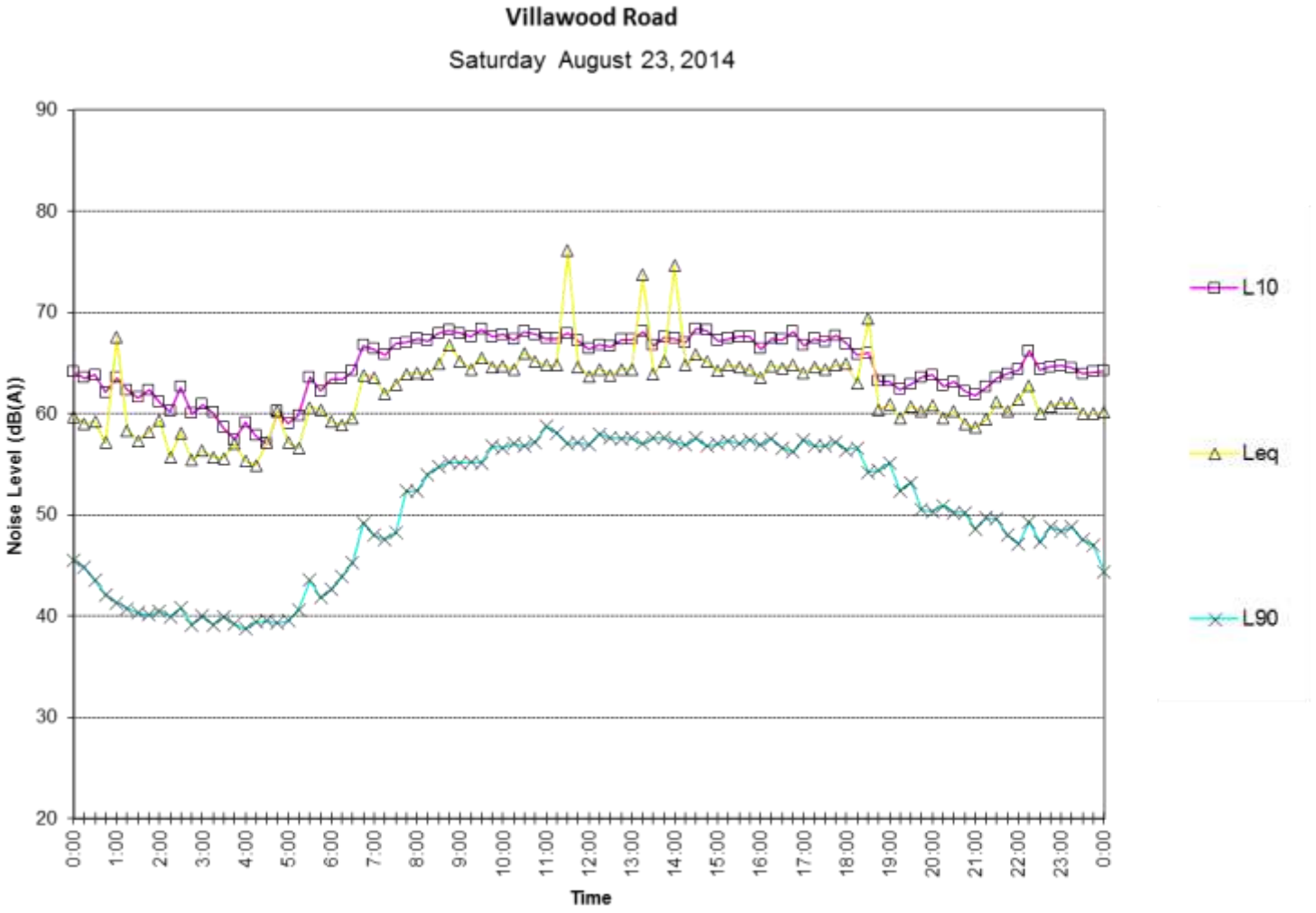
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Villawood Road
Saturday August 23, 2014
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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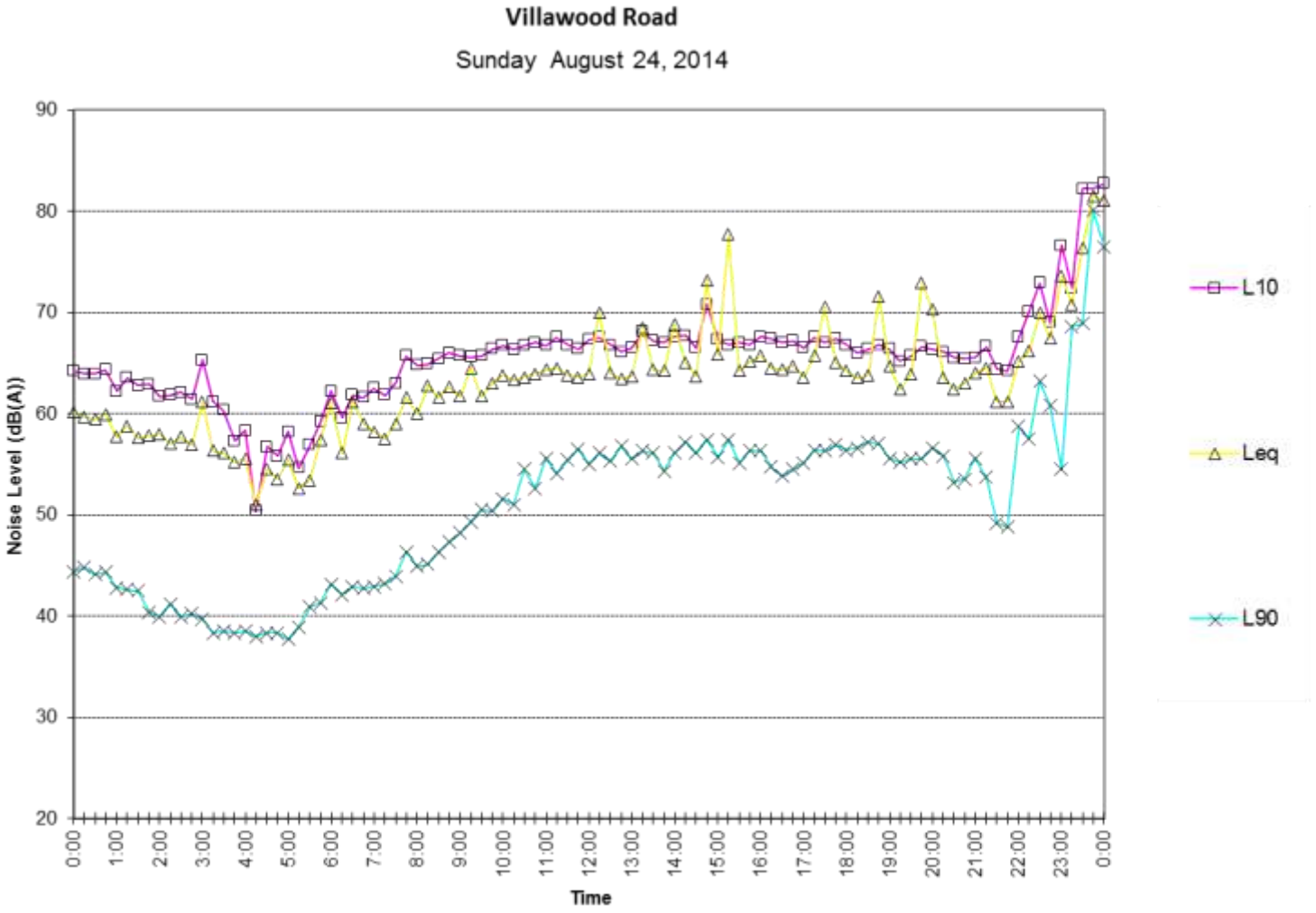
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Villawood Road
Sunday August 24, 2014
Noise Level (dB(A))
90
80
70
60
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40
30
20
0:00
1:00
2:00
3:00
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6:00
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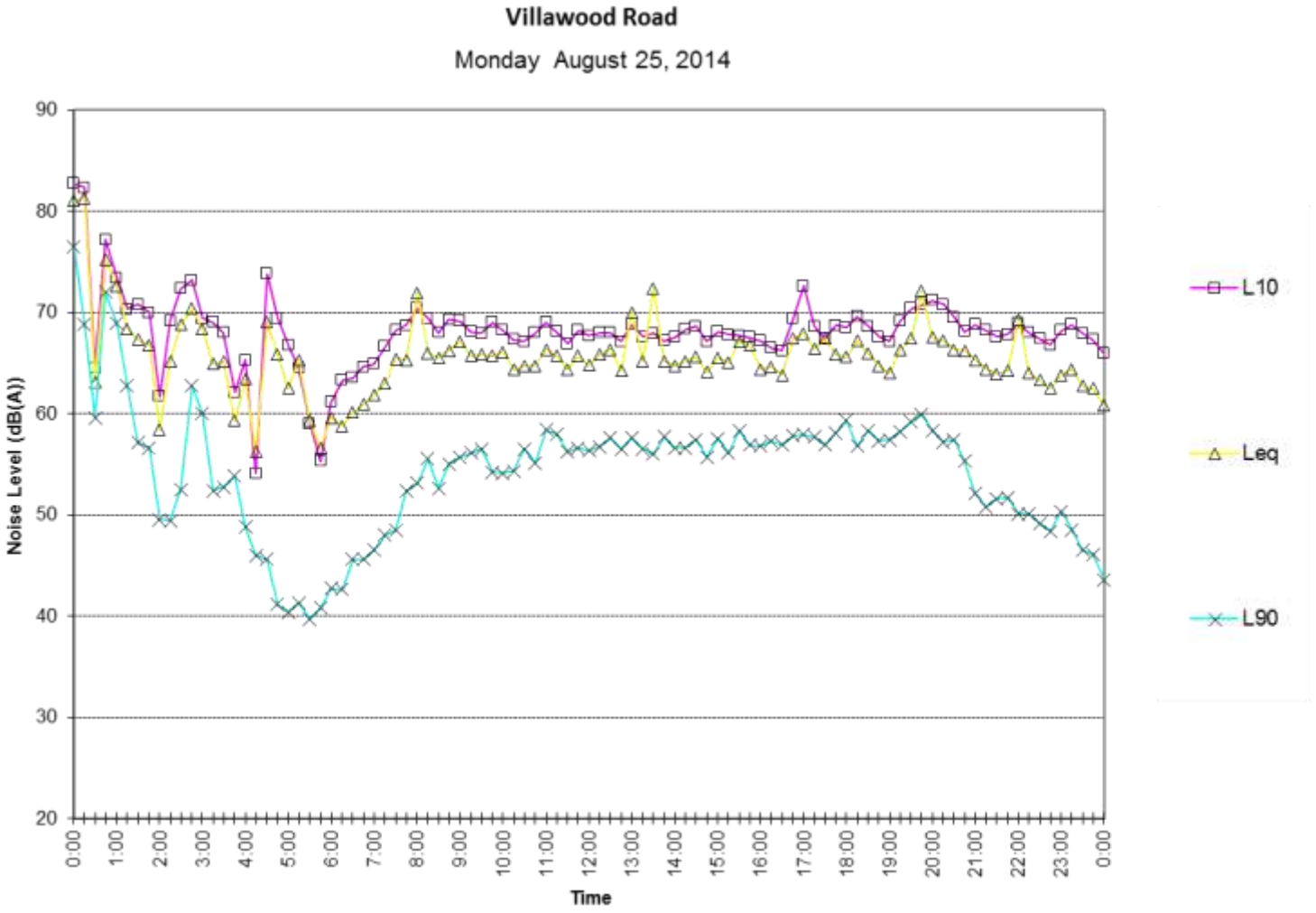
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Villawood Road
Monday August 25, 2014
Noise Level (dB(A))
90
80
70
60
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30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
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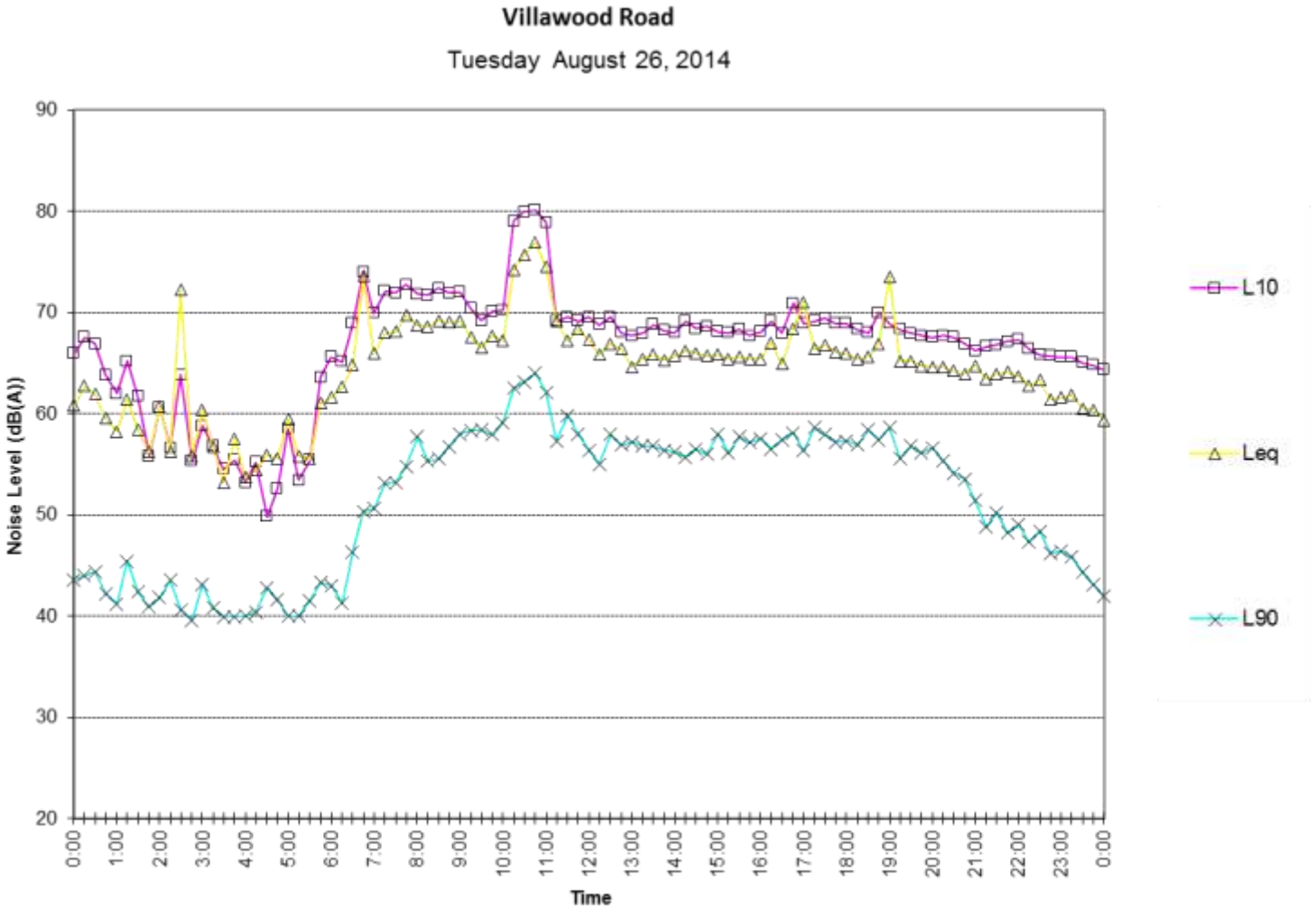
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Villawood Road
Tuesday August 26, 2014
Noise Level (dB(A))
90
80
70
60
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20
0:00
1:00
2:00
3:00
4:00
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6:00
7:00
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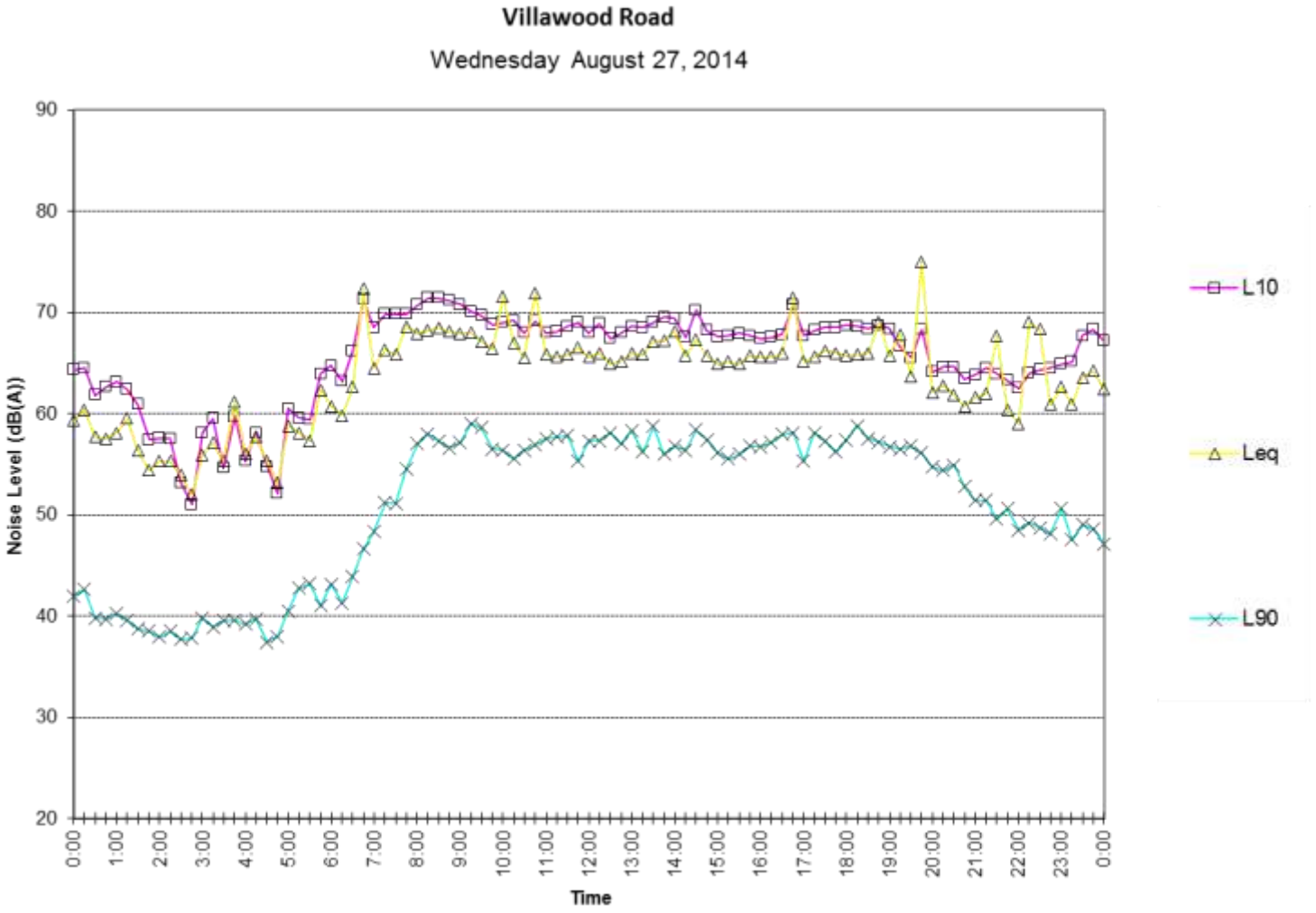
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Villawood Road
Wednesday August 27, 2014
Noise Level (dB(A))
90
80
70
60
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0:00
1:00
2:00
3:00
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6:00
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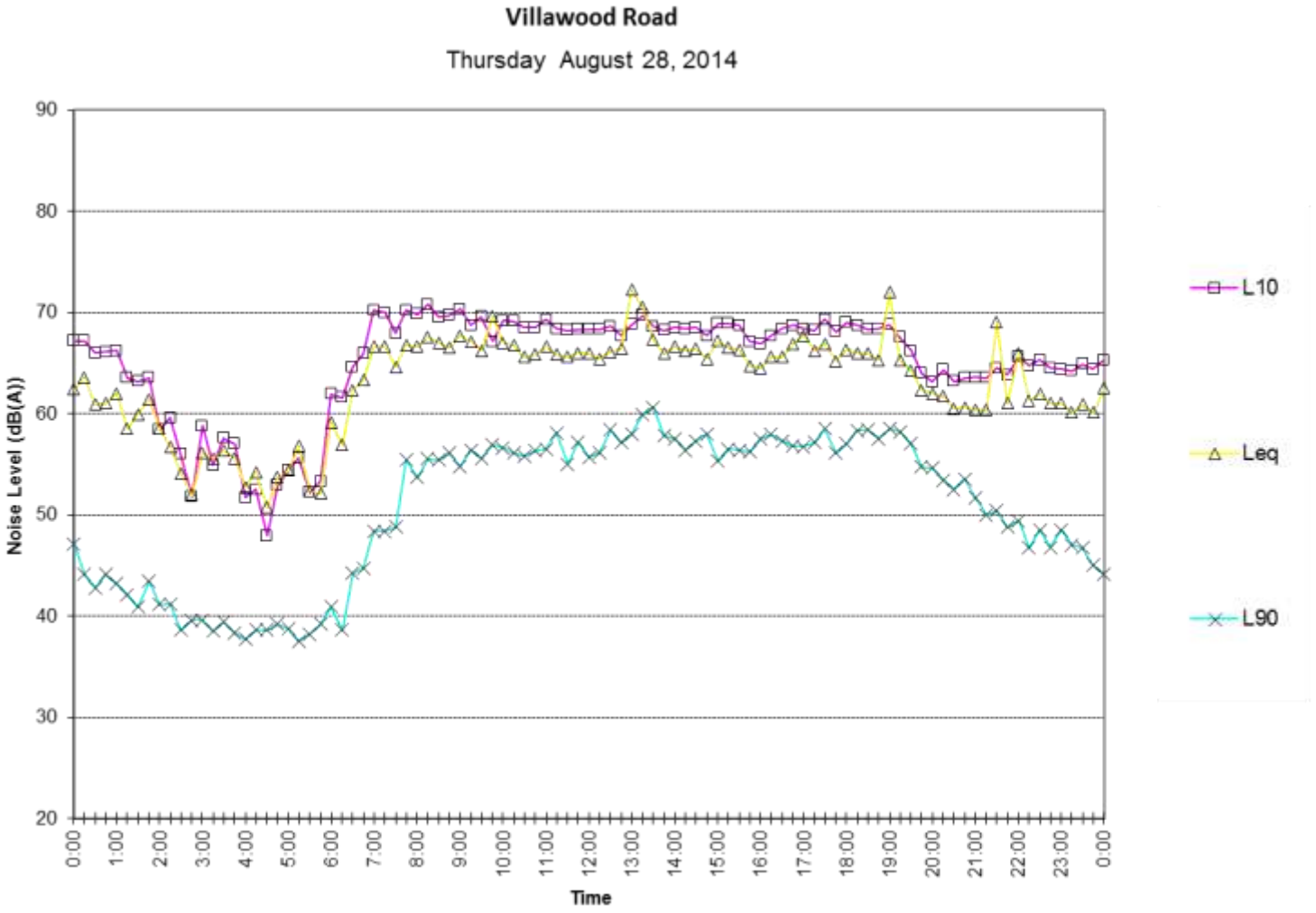
Time
L10
Leq
L90


Villawood Road
Thursday August 28, 2014
Noise Level (dB(A))
90
80
70
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0:00
1:00
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3:00
4:00
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6:00
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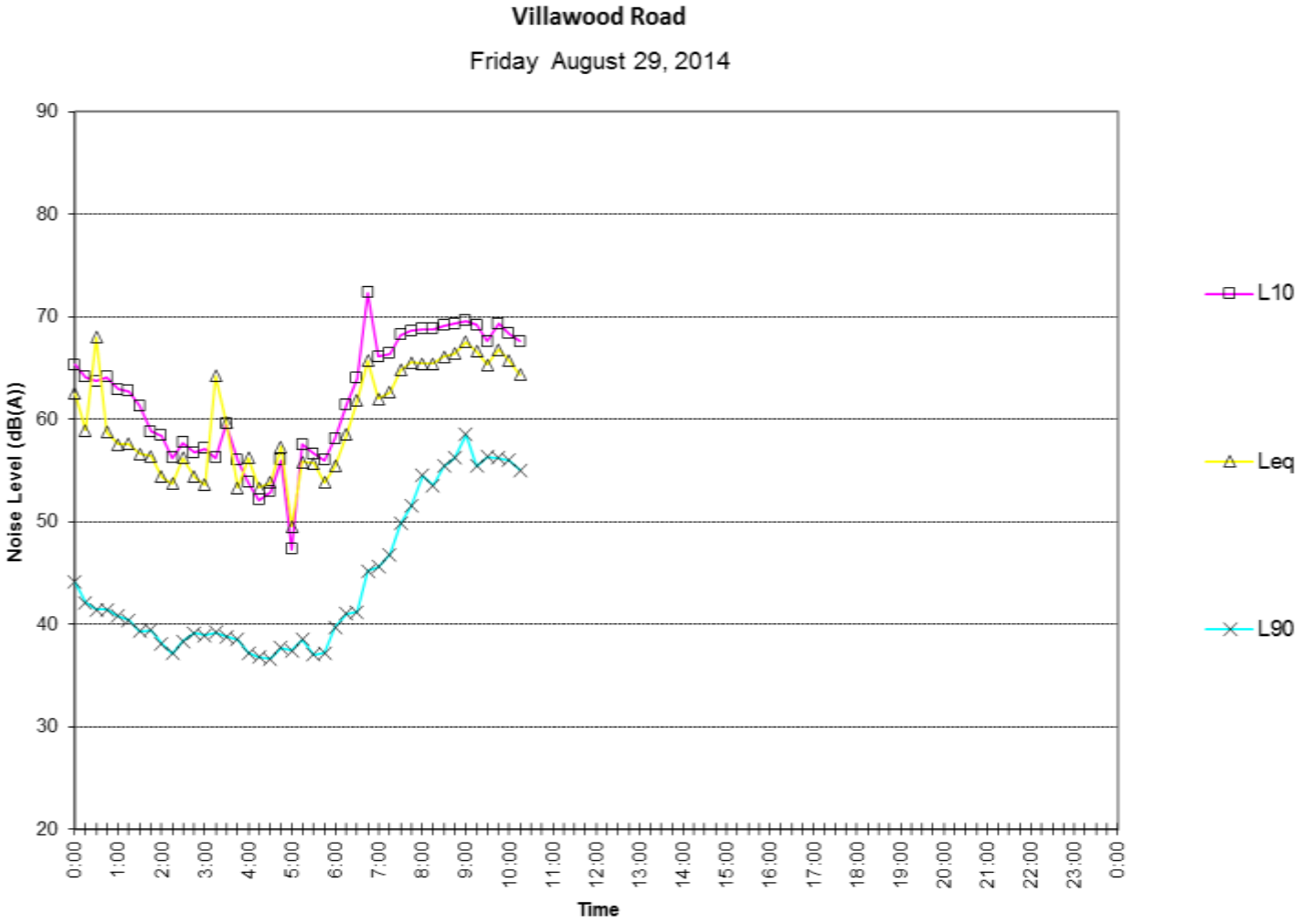
0:00
Time
L10
Leq
L90


Villawood Road
Friday August 29, 2014
Noise Level (dB(A))
90
80
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22:00
23:00
0:00
Time
L10
Leq
L90