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Blacktown Hospital Stage 2 - Main Building

Construction & Operational Noise & Vibration Impact Assessment

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1 INTRODUCTION

This report presents our assessment of potential noise impact associated with construction and operational noise generated by the proposed Blacktown Stage 2 Main Building.

This report will:

- Identify nearby noise sensitive receivers and anticipated operational noise sources with the potential to adversely impact nearby development.
- Identify relevant EPA acoustic criteria applicable to the development.
- Predict operational noise emissions and assess them against acoustic criteria.
- If necessary, determine building and/or management controls necessary to ensure ongoing compliance with noise emission goals.

In addition, this report will include an in-principle review of construction noise and vibration. Identify relevant EPA and Australian Standard criteria applicable to potential noise and vibration impacts on nearby developments arising during the construction of the subject development.

We note that a detailed construction methodology for the construction of the works is not available at present (this is not typically undertaken prior to project approval) and as such, a detailed construction noise assessment cannot be undertaken at this stage.

We recommend that a detailed assessment of noise emissions from construction activities be undertaken upon engagement of a contractor, once a construction programme has been determined. As such, only an indicative analysis is possible, as outlined below.

2 SITE DESCRIPTION / POTENTIALLY AFFECTED PROPERTIES

Noise sensitive properties and noise monitoring locations detailed in Figure 1. The proposed location of the proposed Stage 2 Main Building and a description of the works is presented in Figure 2.

Potentially affected residential receivers

Unattended noise monitors

Attended noise monitoring

Figure 1 – Blacktown Hospital

The scope of works for the Stage 2 new building works is summarised below:

The Stage 2 Main Building Expansion at the Blacktown Hospital campus comprises:

- Construction of a new 9 storey Acute Services Building (ASB) (approximately 36,000 m²), including the following critical services:
    - Emergency
    - Intensive Care Unit
    - Operating Suite
    - Sterile Supply
    - Birthing Suite
    - Newborn Care
    - Maternity & Women's Health Inpatient Units
    - Paediatric Inpatient Unit

- New entry atrium to connect the existing hospital building and Stage 1 Clinical Services Building (CSB) to the new Stage 2 ASB. This will include a new patient drop off and forecourt area as the main entry point;

- Provision of new patient drop-off and ambulance bay at entry to Emergency Department;

- Bridge link and tunnel connections to existing building, Stage 1 CSB and Multi Story Car Park; and

- Provision of engineering services connected to the infrastructure completed under Stage 1 Early Works Package (Road and Service Diversions).

The following engineering services will be provided within the ASB:

- Hydraulic services such as stormwater, subsoil and roof drainage, sewer connections, water pumps, pipework, fire hydrant and domestic cold water storage tanks and gas meters;

- Fire services such as sprinkler systems, isolation valves, pipework, fire alarm monitoring network and alarm signalling equipment;

- Mechanical and medical gas services such as air handling, smoke management, pneumatic tube system, medical gas, medical breathing and oxygen services; Additional chiller and cooling towers as an extension of the stage 1 central energy plant to meet the additional demands of Stage 2.

- Electrical services such as MSBs, building switchboards, distribution boards, generators, lighting, power, nurse call systems and new UPS; and

- New Endeavour Energy 3x 1500kVA transformer substation located south of the Stage 2 ASB.

- Central Energy Plant including 2x 800kVA diesel generators , underground diesel fuel tank, fuel pump and 2x Power Factor Correction units.

The Stage 2 expansion also involves refurbishment to existing hospital areas (approximately 4,700m^2), including:

- Conversion of the existing Emergency Department into Ambulatory Care;

- Refurbishment of the existing medical imaging;

- Refurbishment of the existing inpatient dialysis unit;

- Conversion of 50 per cent of the existing Operating Suite into an Endoscopy Procedure Suite; and

- Refurbishment of pathology into an administration unit.

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Figure 2 – Stage Two Main Building

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental 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.

In analysing 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 intervals.

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 15 minute 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 environmental noise.

4 BACKGROUND NOISE MONITORING

Unattended background noise monitoring was undertaken by this office from the 26 May to 1 June 2011, using Acoustic Research Laboratories noise monitors. The monitors were located in the positions detailed in Figures 1 and 2. The monitor was programmed to store 15-minute A-weighted statistical noise levels throughout the monitoring period. The monitor was calibrated at the beginning and end of the measurement period using a RION NC-73 sound level calibrator with no significant drift detected. All noise measurements were taken on A-weighted fast response mode. Noise logger data is provided in Appendix 1.

Attended background noise monitoring to supplement the unattended monitoring data was conducted on Panorama Parade on 23 June 2014 and 24 February 2016.

Table 1 summarises the background noise levels determined at the monitoring location.

Table 1 – Measured Background Noise Levels

Location	Background noise level dB(A)$L_{90(15minutes)}$		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
Panorama Parade	42	42	41

5 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

This section of report addresses noise impact associated with the proposed demolition, excavation and construction of the project.

5.1 HOURS OF WORK

The proposed hours of work are:

- Monday to Friday 7am to 6pm
- Saturdays 7am to 5pm.
- No work on Sundays or public holidays.

It is noted that the Saturday construction hours exceed the recommended "standard" hours in the EPA Interim Construction Noise Guidelines (8am to 1pm). The reasons for this are:

- The EPA guidelines are general guidelines that would be applicable in more sensitive situations - in quiet/rural residential suburbs, for example.

- Adopting the proposed hours will allow for efficient construction on Saturdays and the entire construction timetable will be expedited which will benefit the surrounding community.

- Noise restrictions are proposed to limit noise impacts outside the standard hours.

It is proposed that the following noise limits will be applied outside the standard hours:

- Between the hours of 7am and 8am on Saturday, only activities that comply with "background + 5dB(A)" criteria at residential receivers be permitted in accordance with EPA guideline.

- Between the hours of 1pm and 5pm on Saturday, only operations complying with "background +10dB(A)" limit at residential receivers will be permitted. It is noted that the "background + 10dB(A)" will be a noise emission limit rather than a management level.

Situations, where construction work may need to be undertaken outside these hours are:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads;

- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;

- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours;

- Public infrastructure works that shorten the length of the project and are supported by the affected community; and

- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

5.2 CONSTRUCTION NOISE AND VIBRATION CRITERIA

5.2.1 Construction Noise

Relevant guidelines are:

- The EPA Interim Construction Noise Guidelines; and
- Australian Standard 2436.

5.2.1.1 EPA Interim Construction Noise Guideline

This guideline nominates acceptable external and internal management levels for noise emissions from construction activities, based on the existing background noise level in the area and type of receiver. For projects within the recommended standard hours, the guideline recommends a noise level of 10 dB(A) above the background – this level is referred to as the "noise affected level", for residential receivers. The noise emission goals for the nearby affected receivers are presented below:

Table 2 – Noise Emission Goal – Residential Properties

LOCATION	TIME OF DAY	MEASURED BACKGROUND LEVELS – dB(A)L_{90}	NOISE EFFECTED LEVEL BACKGROUND + 10dB(A)$L_{eq(15min)}$
Panorama Parade	Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	42	52

Table 3 – Noise Emission Goal – Hospital

TIME OF DAY	Space	Noise Emission Goal dB(A)$L_{eq(15min)}$
When in Use	Hospital Wards and Operating Theatres	45 (internal noise level)*
	Offices	70 (external most – affected point of the premises)

Assuming standard façade construction, and external noise level of 65 – 70 dB(A) will result in an internal noise level of 45dB(A).

Where noise from the construction works is above the "noise affected level", the proponent should apply any feasible and reasonable work practices to minimise noise.

If noise emissions are likely to exceed 75 dB(A)$L_{eq(15min)}$, the receiver is deemed to be "highly noise affected". Introduction of management controls such as scheduling of noisy periods, or respite periods is recommended.

5.2.1.2 Australian Standard 2436-1981 "Guide to Noise Control on Construction Maintenance and Demolition Site".

Where compliance with EPA cannot be achieved, noise emissions are to be managed in accordance with principles in AS2436:

- That reasonable suitable noise criterion is established (i.e. – adopt Council guidelines).
- That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes on parts of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours.
- The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the building site.

5.2.2 Construction Vibration

Vibration caused by construction should be limited to:

- For structural damage vibration, German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures; and*
- For human exposure to vibration (amenity), the evaluation criteria presented in the British Standard BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)* for low probability of adverse comment

The criteria and the application of this standard are discussed in separate sections below.

5.2.2.1 Structure Borne Vibrations

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria outlined in DIN 4150-3 (1999-02) are presented in Table 4.

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 4 – 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 (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

5.2.2.2 Assessing Amenity

The EPA's "Assessing Vibration: A Technical Guideline" (Feb 2006) is based on the guidelines contained in BS 6472:1992. This guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings.

The recommendations of this guideline should be adopted to assess and regulate vibration within the construction site. Where vibration exceeds, or is likely to exceed, the recommended levels then an assessment of reasonable and feasible methods for the management of vibration should be undertaken.

Table 5 – EPA Recommended Vibration Criteria

		RMS acceleration (m/s^2)		**RMS velocity (mm/s)**		**Peak velocity (mm/s)**	
Place	Time	Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous Vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or Night-time	0.005	0.01	0.1	0.2	0.14	0.28
Offices	Day or Night-time	0.02	0.04	0.4	0.8	0.56	1.1
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Impulsive Vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or Night-time	0.005	0.01	0.1	0.2	0.14	0.28
Offices	Day or Night-time	0.64	1.28	13.0	26.0	18.0	36.0
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0

5.3 VIBRATION TO SENSITIVE EQUIPMENT WITHIN HOSPITAL

Sensitive equipment (MRIs, Imaging Equipment, etc) located within existing Blacktown Hospital areas will have operational and damage vibration limits more stringent than EPA guidelines and vibration monitoring should be conducted during the initial stages of demolition and construction to ensure these vibration limits are not exceeded.

Manufacturers will be required to provide this operational and damage criteria for each piece of sensitive equipment.

Indicatively, a peak particle velocity of 2mm/s should be adopted for sensitive equipment until acceptable levels can be provided by the manufacturer.

5.4 NOISE IMPACTS

Noise impacts from the new building works on nearby development will be dependent on the type of construction activities and the relative location of the works on site. Work close to the western boundaries will have greatest impact on the surrounding residences.

Noise impacts associated with the excavation and piling works of the Stage 2 Building have been addressed in the early works package noise and vibration impact assessment. As such, assessment of noise emissions associated with construction works only will be addressed within this report.

Indicative analysis is as follows:

During construction, noise levels of 55-65 dB(A) at the nearest residents (at the boundary) will potentially be generated, indicating that EPA acoustic criteria (refer to tables 2 and 3) may be marginally exceeded from time to time. However, this predicted result is based on there being no shielding between the loudest activities and the residential receivers; in reality there will most likely be shielding by site hoarding and site sheds and these predicted noise levels are an absolute worst case scenario.

Noise impacts can be minimised using the following:

- Selection of equipment and process.
- Location of static plant (particularly concrete pumps and cranes) away from receivers
- Use of screens or enclosures (typically only feasible for static plant).
- Scheduling of noisy activities and provision of respite periods.

The following potential site specific treatments are being proposed at this stage, however these will be updated as details about construction planning are available:

- Where practicable, position major mobile temporary plant such as concrete crushers, concrete pumps, concrete trucks and the like as far as possible from sensitive receptors. The strategic positioning of these items can result in construction noise levels not exceeding the NAML around the site.
- Where feasible, begin morning site works at the eastern boundary of the site furthest from the residential receivers and progressively advance towards the residential receivers

throughout the day. In this way, noise emissions from the site will be least whilst residents are at home.

Detailed construction noise planning is typically undertaken after engagement of a builder and a construction program is prepared (i.e. – after DA stage) and therefore, detailed planning is not possible at this stage.

In light of the above, we recommend:

- During preparation of the construction program (CC stage), consult with Blacktown Hospital to determine what areas of the hospital are particularly noise sensitive, and at what time (ward rooms, operating theatres etc).

- On completion of the construction program, acoustic review of proposed construction activities and plant/methods should be undertaken to identify work items likely to exceed EPA guidelines.

- For those noise intensive activities, the analysis should identify where on the construction site are the areas likely to result in high noise levels. This will then assist in determining the likely time period for which high noise levels will occur at nearby properties.

- Identify feasible acoustic controls or management techniques (use of screens, scheduling of noisy works, notification of adjoining land users, respite periods) when excessive levels may occur.

- For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby development is made aware of the time and duration of noise intensive construction processes.

Through adoption of the above, noise impacts on nearby development can be suitably managed to prevent excessive impact.

5.4.1 Vibration Impacts

Due to its proximity, vibration impacts on the residential properties to the west as a result of construction are unlikely to be higher than the levels of vibration to be generated at the boundary of the adjacent hospital buildings, especially the existing hospital development in the northern / eastern portion of the site. In particular, if excavating in rock or installing driven piles in close proximity to the façade of the hospital buildings, we recommend:

- Consultation with Blacktown Hospital prior to excavation/construction to determine if there is any particularly vibration sensitive equipment items on site boundaries (MRI, microscopes etc) in order to determine appropriate vibration criteria.

- Where practicable, excavation in rock should be done using rock saws as opposed to pneumatic hammers.

- If piling is required, use of augured piling should be used rather than impact piling.

- For the initial stages of excavation and piling, vibration monitoring within areas of the hospital housing sensitive equipment should be conducted to ensure excessive levels of vibration are not achieved. Any monitoring system should allow for rapid feedback to the contractor (for example, SMS notification) in the event that excessive levels are reached.

Adoption of the above will provide a framework to ensure that appropriate systems for monitoring and management of vibration can be implemented.

6 OPERATIONAL NOISE ASSESSMENT

6.1 NOISE EMISSION LIMITS – NOISE GENERATED ON THE SITE

The Environmental Protection Authority (EPA), Industrial Noise Policy provides guidelines for assessing noise impacts from development sites. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The EPA's Industrial Noise Policy has two requirements which both have to be complied with, namely an amenity criterion and an intrusiveness criterion. In addition, the EPA in its Environmental Noise Control Manual states that noise controls should be applied with the general intent to protect residences from sleep arousal.

6.1.1 EPA Intrusiveness Criterion

The EPA guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

6.1.2 EPA Amenity Criterion

The EPA guideline is intended to limit the absolute noise level from all industrial noise sources to a level that is consistent with the general environment.

The EPA's Industrial noise policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface.

Table 5 of the INP provides the recommended ambient noise levels for the suburban residential receivers for the day, evening and night periods. For the purposes of this condition:

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm; and
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Table 6 – EPA Recommended Amenity Industrial Noise Levels

Type of Receiver	Time of day	Recommended Acceptable Noise Level dB(A) L_{eq}
Residential	Day	55
	Evening	45
	Night	40

6.1.3 Sleep arousal

To minimise the potential for sleep arousal the $L_{1\ (1\ minute)}$ noise level of any specific noise source does not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom

window between the hours of 10pm and 7am. The L_1 noise level is the level exceeded for 1 per cent of the time and approximates the typical maximum noise level from a particular source. Where the typical repeatable existing L_1 levels exceed the above requirement then the existing L_1 levels form the basis for, sleep disturbance criteria.

6.1.4 Summary of Assessment Criteria

The EPA INP intrusiveness, amenity and sleep arousal criteria for this project have been determined using these guidelines and the noise monitoring results. These are summarised below. We note that the formulation of the assessment criteria has been based on the lowest ambient levels determined from all monitoring data.

6.1.4.1 Day Time Period

The following table sets out the measured L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The day period applies between 7am and 6pm Monday to Saturday; and 8am to 6pm Sundays and public holidays.

Table 7 - Measured L_{90} Noise Levels and Criteria - Daytime

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Panorama Parade Residences	42	55	47

6.1.4.2 Evening Period

The following table sets out the measured L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The evening period applies between 6pm and 10pm.

Table 8 - Measured L_{90} Noise Levels and Criteria - Evening

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Panorama Parade Residences	42	45	47

6.1.4.3 Night Time Period

The night period (that is, between 10pm and 7am) is the period where noise emissions can have the most significant effect on residential amenity. In addition to the quasi-steady state criteria the L_1 noise emission level should not exceed the background noise level by more than 15 dB(A) to prevent sleep arousal from intermittent events. The night time period applies between 10pm and 7am.

Table 9 – Measured L_{90} Noise Levels and Criteria - Night Time Period

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}	Night time Sleep Disturbance dB(A) $L_{1\ (1\ Min)}$
Panorama Parade Residences	41	40	46	56

6.2 MECHANICAL NOISE ASSESSMENT

As new plant selections required for the new building works are not available at this stage it is not possible to carry out a detailed examination of the ameliorative measures that may be required to achieve the noise targets.

Plant will be acoustically treated to prevent noise emissions from adversely impacting the surrounding properties in conjunction with the criteria detailed in this report. This may include selecting the quietest plant practicable, or treating the plant with enclosures, barriers, duct lining and silencers, etc as required to comply with the sound level recommendations.

Experience with similar projects indicates that it would be possible to achieve the requirement with appropriate treatment of the plant. General requirements for a number of potential plant items on the site are expanded on below.

Detailed acoustic design of mechanical plant cannot be undertaken at approval stage, as plant selections and locations are not finalised. However, an indicative assessment of primary plant items is presented below.

Primary plant items will include:

- Cooling towers (approximately 3 off).
- Air handling plant (air handling units, supply/exhaust/outside air fans).
- Chillers
- Emergency Generators

With respect to the above, we note:

- Cooling towers
    - In the event that a cooling tower sound power level exceeds 95dB(A), there is potentially an exceedance of INP noise emission requirements at Panorama Parade if roof top cooling towers are not acoustically treated.
    - To ensure compliance with INP requirements during day, evening and night time:
        - All cooling towers are to have variable speed drives, to allow for reduced fan speed during periods of low load. Typically, a fan speed of no more than 50% would be expected at night time.

- Acoustic screening around the cooling towers will likely to be required to all four sides (using fc sheet or similar) or acoustic louvres. At a minimum, the screen/louvre would need to be 500mm higher than the top of the tower. Alternatively, acoustic attenuators will be required to the tower intake and discharge. Detailed acoustic treatments to be determined based on final selection of cooling towers.

- Chillers (assumed sound power of 102dB(A)).
    - Chillers should be located in plant rooms without any external ventilation opening/louvre. If ventilation is required, attenuators must be implemented on façade louvres (indicatively 1200mm long 45% open area rectangular attenuators based on a 1500 x 1500mm opening size).
    - Light weight cladding to plant room walls and ceiling will potentially require internal plasterboard sheeting to ensure noise breakout through wall/roof are compliant with INP requirements. Final plant room building shell design to be conducted following final chiller section and plant room location.

- Emergency power back-up generators (assumed 105dB(A) sound power level):
    - Generator to be used only in emergency. Testing of the generator should be done outside of office hours.
    - Generator to be installed on a concrete plinth. Plinth is to be isolated from the structural slab by two layers of 10mm thick Vibramat (from Acoustic Supplies) or equal. There should be not rigid connection between plinth and structural slab.
    - Generator should be isolated from the plinth using 50mm static deflection spring vibration isolators.
    - **Plant room construction:**
        - Generator room walls to consist 190mm hollowcore blockwork.
        - Generator room doors to be 45mm solid core doors with full perimeter acoustic seals. Raven RP24 seels should be applied to the head and jamb, Raven RP16si should be installed at the meeting stile of double doors and RP32si seals should be installed at the door base.
        - Fuel lines within 20m of the generator are to have 25mm static deflection spring isolators.
        - Any pipe penetration to slab or plant room walls as per Appendix 1.

- Air intake (indicative):
    - Indicatively, a 1200mm long 45% open area attenuator will be required.

- Air discharge (indicative):
    - Install a 1800mm long attenuator (200mm wide splitters) at the penetration with all other duct internally lined

In the event that the generator comes with a proprietary acoustic enclosure, the length of attenuators will potentially be reduced/removed.

- Gas discharge:
    - We assume generator manufacturer will produce a proprietary gas discharge muffler. Muffler should achieve a noise level of no more than 70dB(A) at one meter from the discharge point and there should be no line of sight between the discharge point and any residential property.
    - Gas discharge to be vibration isolated using 25mm static deflection spring isolators.
    - Detailed acoustic performance of plant room (or any acoustic enclosure) to be finalised following final generator selection/location.

- Fans and air-handling units.
    - Air handling units do not typically require extensive acoustic treatment to ensure compliant noise emissions at nearby properties.
    - Air handling unit exhaust and outside air ducting (both of which are typically ducted to outside) are to be acoustically reviewed following layout design by mechanical engineer/contractor to determine whether internal lining to this ductwork is required.
    - Major fans (typically with a sound power over 90(A) – such as kitchen exhaust, major toilet exhaust and major relief air fans) will require acoustic treatment if located externally. This treatment would include internal lining to any external ductwork. Potentially acoustic treatment of fan casing will also be required. Review of all external fans (including fans ducted to external locations) must be conducted once selected to ensure compliant noise emissions to external areas.

Cumulative assessment of both plant noise with other noise sources is recommended when conducting acoustic design of plant items. This is particularly important for plant noise near the western property boundary.

Compliance with INP acoustic criteria as set out in Section 6 will be achievable, provided that detailed acoustic review of plant items is undertaken once plant is selected, and acoustic treatments similar to those outlined above are adopted.

7 CONCLUSION

This report provides the results of the Noise and Vibration Impact Assessment for the Stage Two Main Building. In accordance with relevant acoustic standards for the site, noise at the site has been measured and noise goals have been set with reference to the requirements of the relevant statutory/regulatory authorities including the Environmental Protection Authority.

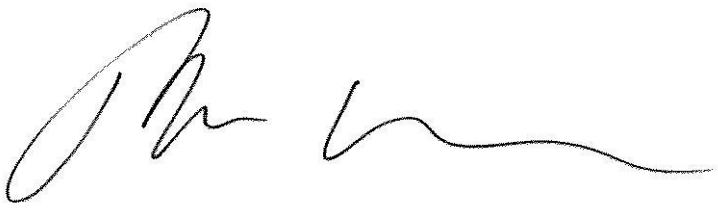
The following has also been addressed within the report:

- An assessment of excavation and construction noise and vibration emissions associated with the new building works.

- Operational noise associated with the development such as mechanical plant noise.

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

Yours faithfully,

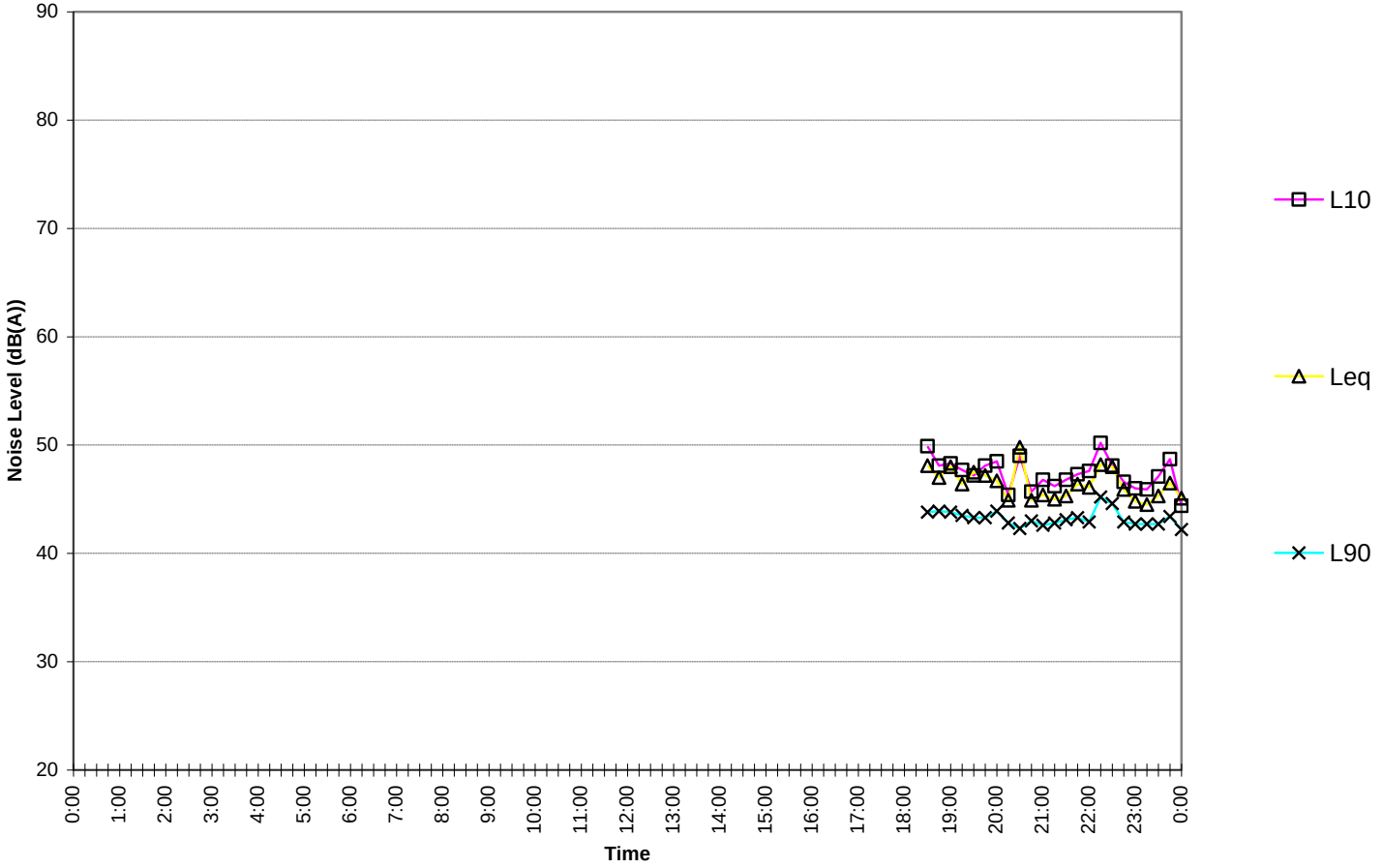


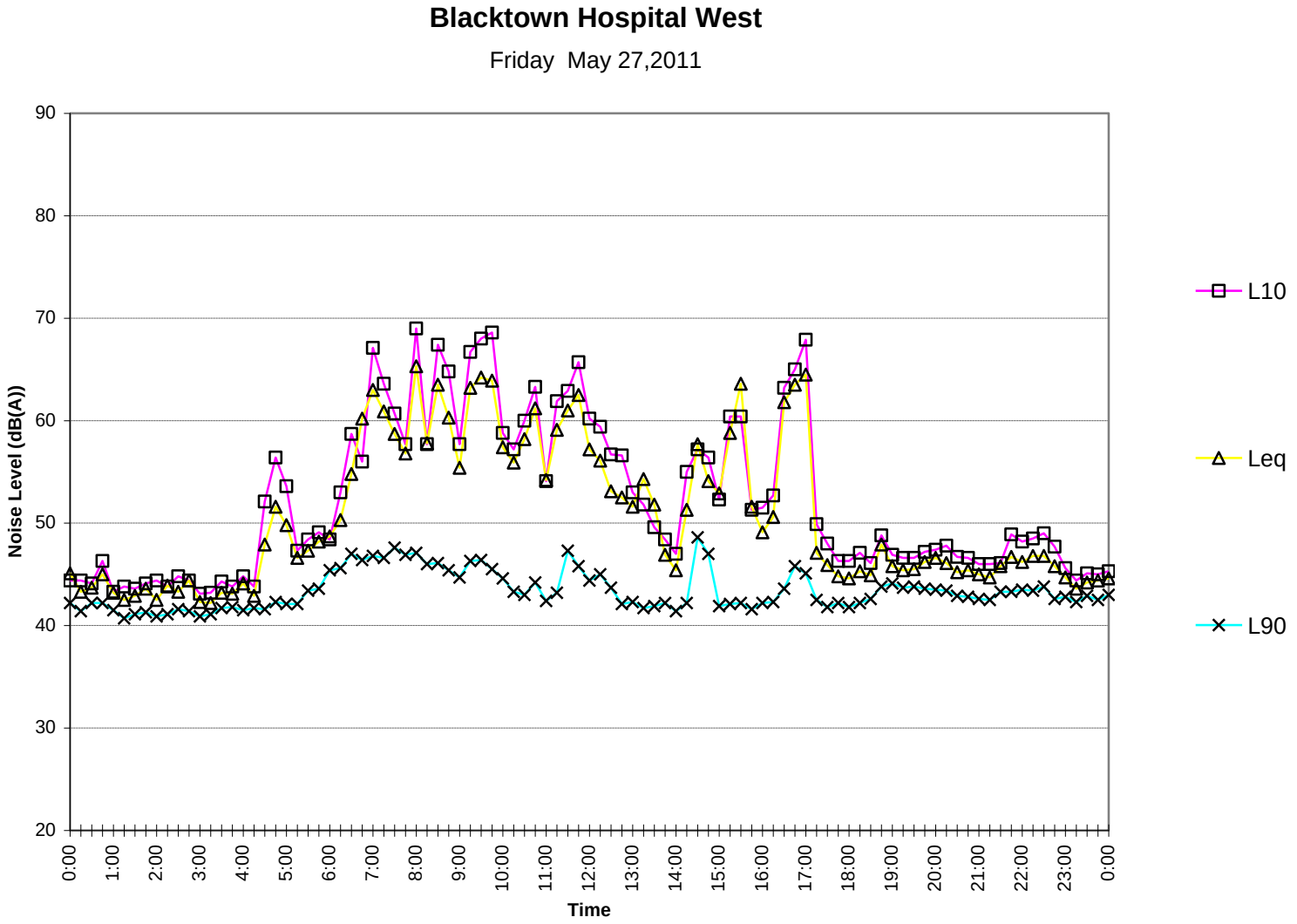
Acoustic Logic Consultancy Pty Ltd
Tom Aubusson MAAS

Appendix One -
Unattended Monitoring Results

Blacktown Hospital West

Thursday May 26,2011




Blacktown Hospital West
Friday May 27,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
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5:00
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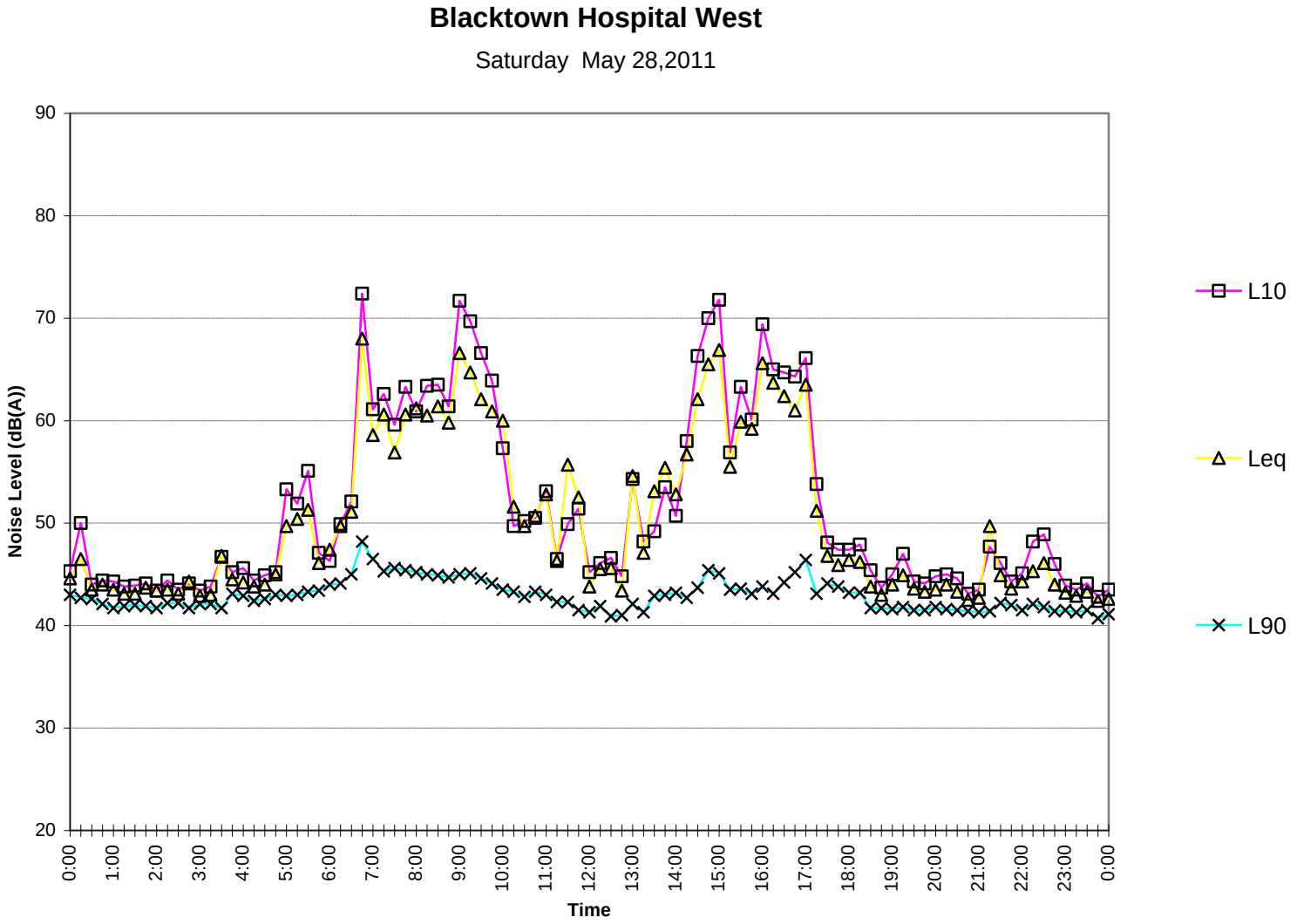
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Saturday May 28,2011
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
12:00
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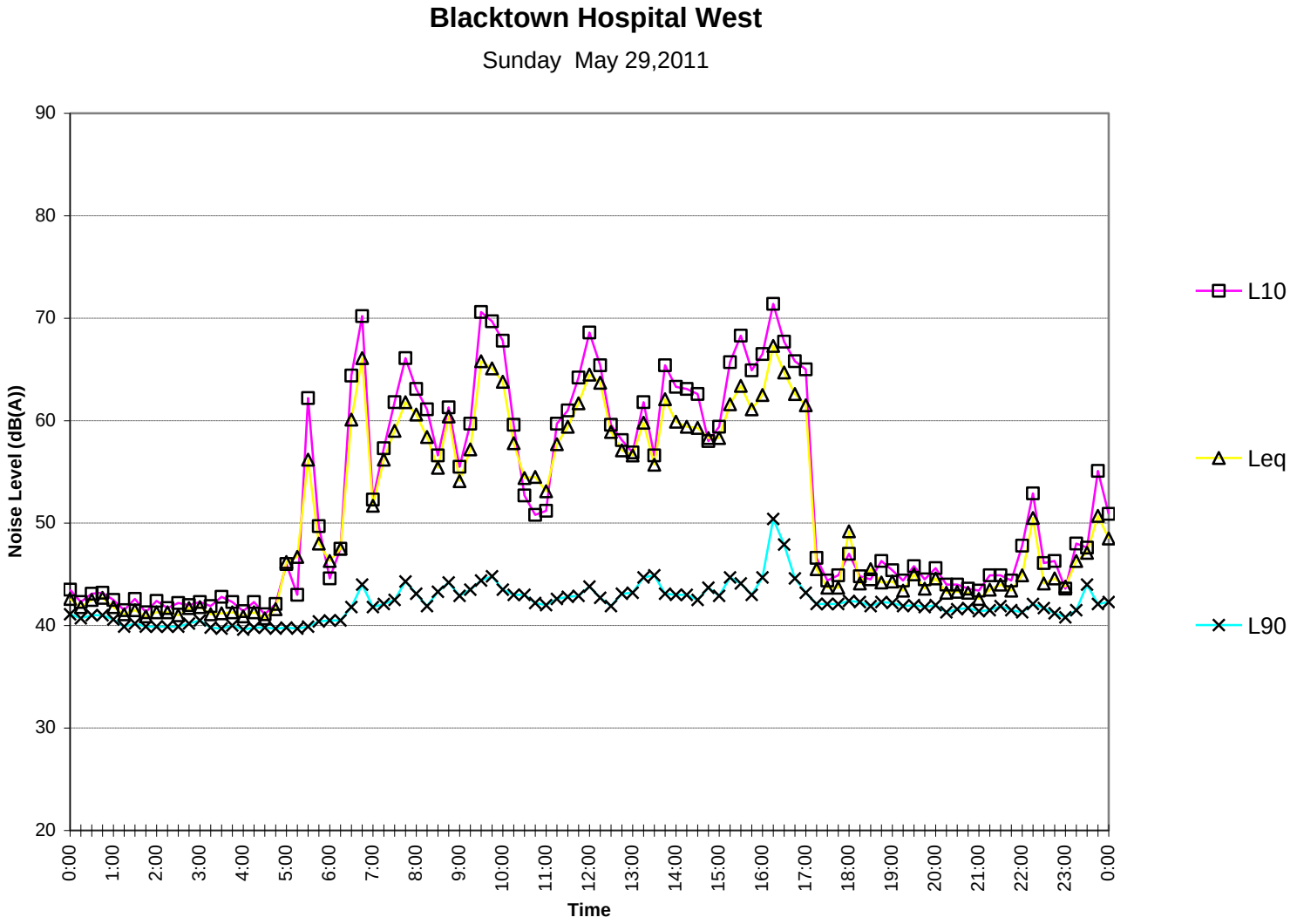
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Sunday May 29,2011
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
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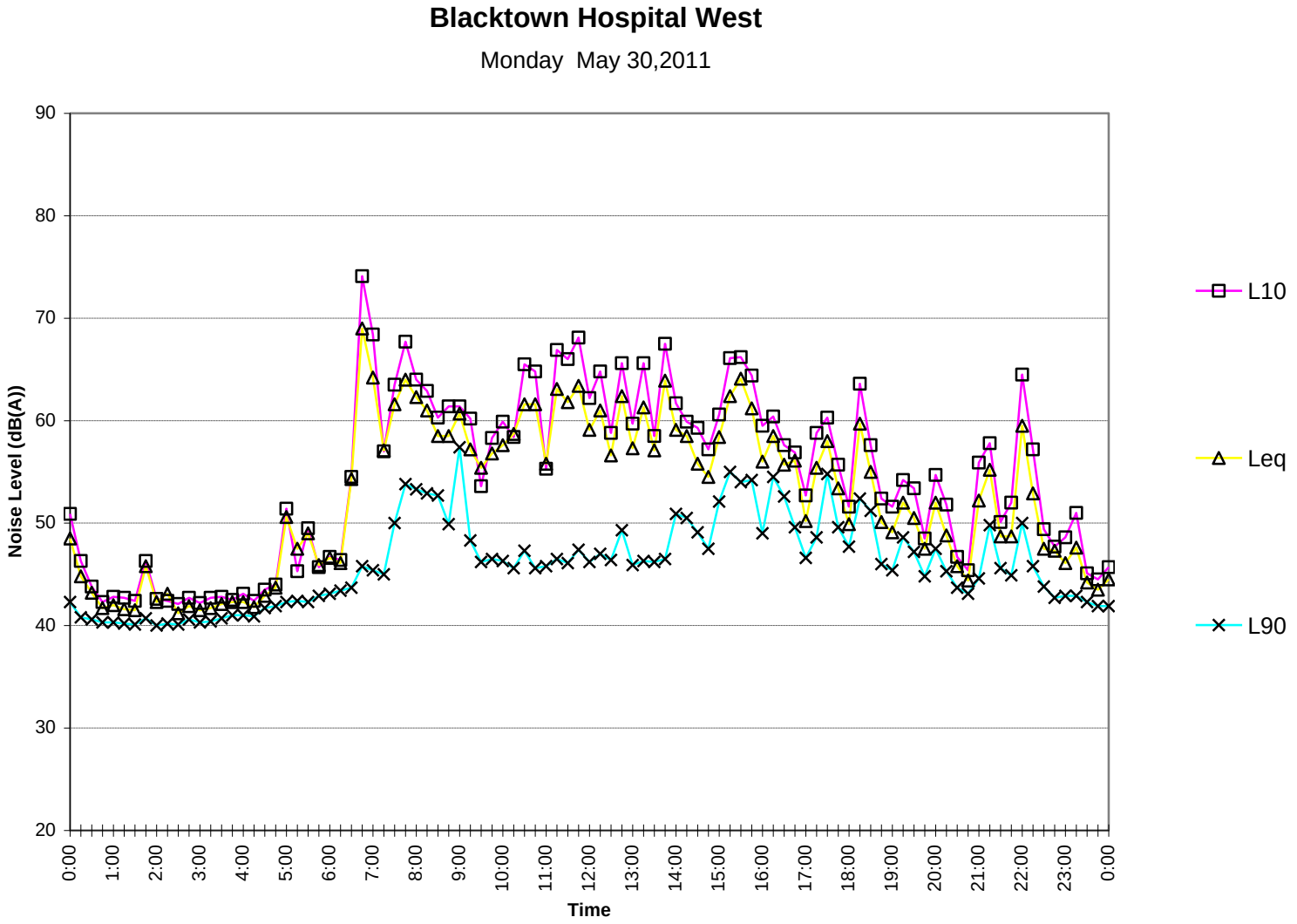
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Monday May 30,2011
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
12:00
13:00
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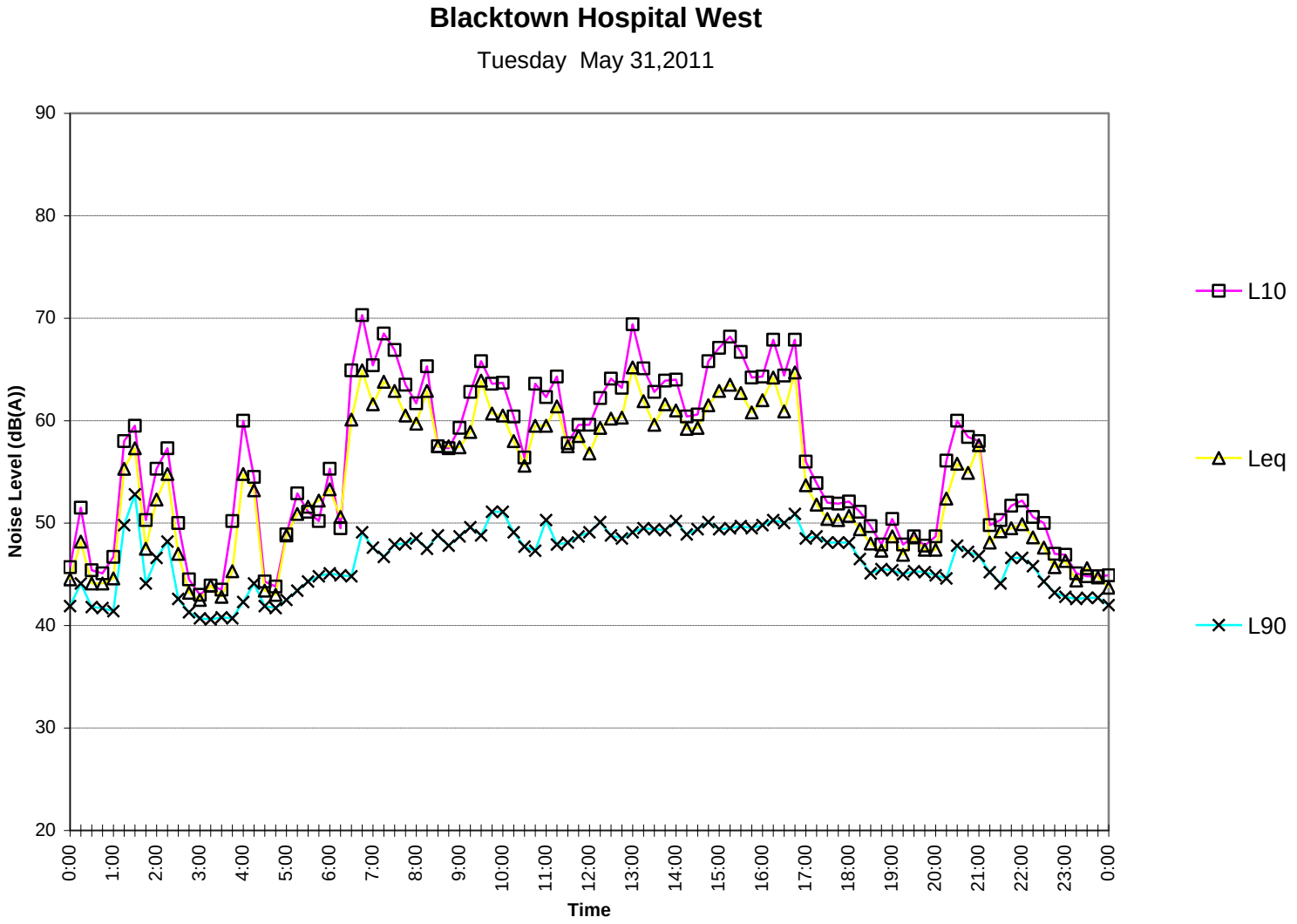
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Tuesday May 31,2011
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
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90