REVERB ACOUSTICS

Noise and Vibration Consultants

Noise Impact Assessment
Hillsborough Indoor Stadium
62 & 62 A Hillsborough Road and 109-117 Waratah Avenue Hillsborough NSW

May 2020

Prepared for Basketball Association of Newcastle Limited
Report No. 20-2480-R1

Building Acoustics - Council/EPA Submissions - Modelling - Compliance - Certification

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1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the proposed Hillsborough Indoor Stadium at 62 & 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough. The assessment considers likely sources of noise that may impact upon nearby residential receivers from operation of the facility (i.e. amplified entertainment, crowd participation, patron activity in outdoor areas, and vehicle movements). The purpose of this report is to recommend appropriate acoustic measures that must be implemented to ensure compliance with the requirements of the NSW Environment Protection Authority (EPA), and Lake Macquarie City Council (LMCC)

The assessment was requested by Basketball Association of Newcastle Limited in support of and to accompany a Development Application to LMCC and to ensure any noise control measures required are incorporated during the design stages.

2 TECHNICAL REFERENCE / DOCUMENTS

Beranek, L.L and Istvan, L.V. (1992). *Noise and Vibration Control Engineering.* John Wiley and Sons, Inc.

Bies, D.A. and Hansen, C.H. (1996). *Engineering Noise Control: Theory and Practice*. London, E & F.N. Spon.

Gréhant B. (1996). *Acoustics in Buildings.* Thomas Telford Publishing.

Templeton, D. (1997). *Acoustics in the Built Environment.* Reed Education and Professional Publishing Ltd.

AS 2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

AS 1276.1-1999 *"Acoustics – Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation"*.

NSW Environment Protection Authority (2000). *Industrial Noise Policy*

NSW Environment Protection Authority (2017). *Noise Policy for Industry*

NSW Environment Protection Authority (1999). *Environmental Criteria for Road Traffic Noise*

Office of Environment and Heritage (2010). *NSW Road Noise Policy*

NSW Roads and Maritime Services (2001). *Environmental Noise Management Manual*

Seca Solution Pty Ltd (12 June 2020). *Traffic Assessment. Proposed New Indoor Stadium, 62 & 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough, NSW.*

Plans supplied by BKA Architecture Pty Ltd, dated 12 June 2020. Note that variations from the design supplied to us may affect the acoustic recommendations.

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

3 PROJECT DESCRIPTION

Basketball Association of Newcastle Limited seeks Development Consent to construct the Hillsborough Indoor Stadium at 62 & 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough. The proposal consists of a new basketball facility to include 10 full size courts and a 4000 seat show court or auditorium, a café, and on-grade carparking for 201 vehicles and bus drop-off. Additional overflow parking will be provided on a grassed area during major events.

This assessment considers mechanical plant (refrigeration, air conditioning, exhaust), amplified entertainment and crowd participation during major events, patron activity in outdoor areas, and vehicle movements. Other noise sources include garbage collection, trolley return and general site noise.

Only staff and service providers are expected to visit the site during the morning on weekdays, with the majority of practice courts utilised after 4pm. Occasional school galas, sport etc, are also expected in the early afternoon. On weekends major events may occur infrequently, together with school galas. Expected trading and operating hours are:

7am-9pm	Monday to Friday
7am-10pm	Saturday and Sunday

This assessment will focus on the noise impact at nearest sensitive receivers and it should be acknowledged that compliance with criteria at these locations will ensure satisfactory results at more remote locations. Plans supplied by BKA Architecture Pty Ltd show the layout of the site and the location of nearby land uses.

Nearest receivers identified during our site visits are as follows:

R1. Hillsborough Public School
R2. Residences SE across Waratah Ave
R3. Residences E across Waratah Ave
R4. Residences NE
R5. Residences NW across Hillsborough Road

Figure 1 – Site Plan

4 EXISTING ACOUSTIC ENVIRONMENT

A background noise level survey was conducted using a Class 1, Svan 977 environmental noise logging monitor, installed at the west side of Waratah Avenue (see Figure 1). The selected location is representative of the acoustic environment in the receiver area and is considered an acceptable location for determination of the background noise in accordance with Appendix B of the EPA's – Noise Policy for Industry (NPfI).

Noise levels were continuously monitored from 8 May to 15 May 2020, to determine the existing background and ambient noise levels for the area. The instrument was programmed to accumulate environmental noise data continuously and store results in internal memory. The data were then analysed to determine 15 minute Leq and statistical noise levels using dedicated software supplied with the instrument. The instrument was calibrated with a Brüel and Kjaer 4230 sound level calibrator producing 94dB at 1kHz before and after the monitoring period, as part of the instrument's programming and downloading procedure, and showed an error less than 0.5dB.

Table 1 shows a summary of our noise survey, including the Assessment Background Levels (ABL's), for the day, evening and night periods. From these ABL's the Rating Background Level (RBL) has been calculated, according to the procedures described in the EPA's NPfI and by following the procedures and guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures". A summary of the measured noise environment at the site appears in Table 2, taken from our logger results. Table 3 shows a summary of the measured traffic noise levels at the site. The measured noise levels are typical for residential areas near a busy road.

Table 1: Summary of Noise Logger Results, dB(A)

Time Period	Background L90			Ambient Leq		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
8-9 May	48.2	40.4	30.3	61.5	56.1	50.4
9-10 May	44.8	39.5	25.3	59.8	57.3	50.0
10-11 May	40.1	38.2	28.0	61.4	55.3	52.4
11-12 May	40.8	37.5	28.5	60.4	56.7	52.7
12-13 May	39.2	37.8	27.9	61.3	54.7	52.9
13-14 May	44.6	38.9	28.6	60.5	55.1	52.5
14-15 May	43.2	35.6	34.1	62.8	60.0	54.6
15-16 May	44.2	-	-	61.4	-	-
RBL	**43.7**	**38.2**	**28.5**	**--**	**--**	**--**
LAeq	**--**	**--**	**--**	**61.2**	**56.8**	**52.4**

Table 2: Existing Source Noise levels

Time Period	Leq		Lmax		L10		L90	
	Range	Average	Range	Average	Range	Average	Range	Average
Day	50-75	60	69-107	79	50-67	64	38-52	45
Evening	44-67	55	64-100	76	43-67	54	36-49	41
Night	31-61	48	43-85	70	35-64	45	23-51	35

Table 3: Measured Traffic Noise Levels – Waratah Avenue

Descriptor	Noise Level dB(A)	Time Interval
Leq,1hr (day)	61.2	07:00 to 22:00
Leq,1hr (night)	55.8	22:00 to 07:00
Leq,8hr	50.6	22:00 to 06:00
Leq,9hr	52.4	22:00 to 07:00
Leq,15hr	60.2	07:00 to 22:00
Leq,16hr	60.3	06:00 to 22:00
Leq,24hr	58.7	06:00 to 06:00

As part of our noise surveys we recorded a typical frequency spectrum of the background noise environment. This typical background frequency spectrum was then adjusted to give a total level equivalent to the average background noise level in the receiver area during the day (7am-6pm) and evening (6pm-10pm).

Table 4: Adopted Background Noise Level Spectrum, L(A)90 – Prior to 6pm

Octave Band Centre Frequency, Hz									
dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
44	28	33	35	38	39	36	32	29	26

Table 5: Adopted Background Noise Level Spectrum, L(A)90 – 6pm-10pm

Octave Band Centre Frequency, Hz									
dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
38	22	27	29	32	33	30	26	23	20

5 CRITERIA

5.1 Road Traffic Noise

The Roads and Maritime Services (RMS) base their assessment criteria on those outlined by EPA. Reference to Page 160 of the Environmental Noise Management Manual released in December 2001, indicates that noise reduction measures for new and existing developments should endeavour to meet the noise level targets set out in the EPA's Environmental Criteria for Road Traffic Noise (ECRTN). The ECRTN has been superceded by the NSW Road Noise Policy (RNP) which contains a number of criteria applied to a variety of road categories (freeway, arterial, sub-arterial and local roads) and situations (new, upgraded roads and new developments affected by road traffic). Table 6 shows the relevant categories, taken from Table 3 of the RNP:

Table 6: - Extract from Table 3 of RNP Showing Relevant Criteria.

Road Category	Day	Night
Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	60 LAeq,15hr (external)	55 LAeq,9hr (external
Existing residences affected by additional traffic on existing local roads generated by land use developments.	55 LAeq,1hr (external)	50 LAeq,1hr (external)

Road categories are defined in the RNP are as follows:

Freeway/arterial	Support major regional and inter-regional traffic movement. Freeways and motorways usually feature strict access control via grade separated interchanges.
Sub-arterial	Provide connection between arterial roads and local roads. May provide a support role to arterial roads during peak periods. May have been designed as local streets but can serve major traffic generators or non-local traffic functions. Previously designated as "collector" roads in ECRTN.
Local Road	Provide vehicular access to abutting property and surrounding streets. Provide a network for the movement of pedestrians and cyclists and enable social interaction in a neighbourhood. Should connect, where practicable, only to sub-arterial roads.

Based on the above definitions, Waratah Avenue is classified as a sub-arterial road or local road.

5.2 Site Activities/Mechanical Plant Noise

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the EPA's NPfI. However, local Councils and Government Departments may also apply the criteria for land use planning, compliance and complaints management. The NPfI specifies two separate criteria designed to ensure existing and future developments meet environmental noise objectives. The first limits intrusive noise to 5dB(A) above the background noise level and the other is based on the total industrial noise in an area in relation to the noise levels from the development to be assessed. Project Noise Trigger Levels are established for new developments by applying both criteria to the situation and adopting the more stringent of the two.

The existing L(A)eq for the receiver areas is dominated by traffic on nearby roads and neighbourhood activity during the day, evening and night. Reference to Table 2.2 of the NPfI shows that all receiver areas are classified as urban. The Project Amenity Level is derived by subtracting 5dB(A) from the recommended amenity level shown in Table 2.2. A further +3dB(A) adjustment is required to standardise the time periods to LAeq,15 minute. The adjustments are carried out as follows:

Recommended Amenity Noise Level (Table 2.2) – 5dB(A) +3dB(A)

Table 7 below specifies the applicable project intrusiveness and amenity noise trigger levels for the proposed redevelopment.

Table 7: - Intrusiveness and Amenity Noise levels

Period	Intrusiveness Criteria	Amenity Criteria
Day	49 (44+5)	58 (60-5+3)
Evening	43 (38+5)	48 (50-5+3)
Night	35 (30+5)	43 (45-5+3)
Receiver Type: Urban (See EPA's NPfI - Table 2.1)		

Project Noise Trigger Levels, determined as the more stringent of the intrusiveness criteria and the amenity / high traffic criteria, are as follows:

Day **49dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **43dB LAeq,15 Minute** 6pm to 10pm
Night **35dB LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

School Classroom:

35dB LAeq,15 Minute (internal) when in use

5.3 Maximum Noise Level Event Assessment - Sleep Arousal

Section 2.5 of EPA's NPfI requires a detailed maximum noise level event assessment to be undertaken where the subject development/premises night-time noise levels exceed the following:

- LAeq (15 minute) 40dB(A) or the prevailing RBL plus 5dB whichever is greater, and/or
- LAFmax 52dB(A) or the prevailing RBL plus 15dB, whichever is greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night period.

6 METHODOLOGY

6.1 Road Traffic Noise

Due to the non-continuous nature of traffic flow to and from the site, noise generated by traffic associated with the development, on public roads, is assessed using the EPA approved US Environment Protection Agency's Intermittent Traffic Noise guidelines.

Equation 1 outlines the mathematical formula used in calculating the Leq,T noise level for intermittent traffic noise.

Equation 1:

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\,\max - Lb)\,/\,10}-1}{2.3}-\frac{\left(L_{\max}-L_b\right)}{10}\right)\right]$$

Where L_b background noise level (dB(A))
T is the time for each group of vehicles (min)
D is duration of noise of each vehicle (min)
L_{MAX} is vehicle noise (dB(A))
N is number of vehicle trips

Typical vehicle noise levels were sourced from our library of technical data, while background noise levels are those described in Section 4. The Lmax vehicle noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade of the residence by vehicles entering and departing the site.

6.2 Entertainment / Crowd Participation

A theoretical assessment of live and recorded entertainment with crowd participation during major events has been carried out to predict the noise level at the nearest potentially affected residential boundaries. Typical entertainment types include recorded popular music. Using noise data for the above scenario and the known criteria at nearby residences enabled calculation of the required transmission loss of each building element. Inspection of the supplied plans indicate that the roof and walls of the show court are the noise paths of concern.

Reverb Acoustics has completed many assessments for large auditoria, stadiums, etc, with peak noise levels above 100dB(A),Lmax and average noise levels in the order of 95dB(A),Leq at internal surfaces, with a frequency spectrum shown below in Table 8. Noise produced by the above activities is theoretically propagated to nearest residences taking into account reverberant field loss to internal surfaces and transmission loss through each building element.

Table 8: SPL Entertainment with Crowd Participation, dB(A),Leq

	Octave Band Centre Frequency, Hz								
dB(A)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
95	54	62	74	84	89	90	87	84	71

6.3 Outdoor Courtyard

An outdoor courtyard will be provided directly north of the show court for post-game functions. Reverb Acoustics has completed a detailed analysis of patron noise levels under various situations in licensed premises with the following findings:

Table 9: Noise Levels from Various Types of Occupied Areas within Licensed Premises

Situation/Location	Noise Rating	Typical Noise Levels dB(A),L10 #	Comments
Auditorium courtyard *Breakout for patrons during functions*	1	85+	During functions up to 1/3 of patrons may occupy outdoor area. Monitoring recommended.
General courtyard *Servicing lounge areas, public bars, etc*	2	80	Patrons may remain in area for extended periods. Monitoring recommended.
Bistros *Internal eating area*	3	75-80	Continuous conversation typical at self-service areas.
Alfresco dining *Seating outdoors*	4	70-75	Patrons generally quiet, although may remain for extended periods and produce higher noise levels.
Restaurant *Internal eating area with open doorway*	5	65-70	Generally quiet. Only low level conversation. Patrons typically vacate area once meal completed.
Club Gaming area *Poker machine, TAB areas*	6	60-65	Patrons typically quiet. Rarely talk. Some noise from machines, TV's, monitors, etc.
Gaming courtyard *Smokers breakout*	7	<60	Patrons typically quiet. Rarely talk. Anxious to return to gaming area.

 # Typical noise level at inside surfaces.

Table 9 reveals that the outdoor courtyard would have a noise rating of 1, i.e. 85dB(A) at perimeter. To create our acoustic model, we have assumed a worst-case situation where the area is operating at full capacity. The sources were placed randomly over the available space and the resulting sound pressure level at each surface opening was propagated to nearest residences using an equation[1] giving the sound field due to an incoherent plane radiator.

The combined sound pressure level (SPL) at the receiver is then compared to the criteria. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

[1] Equation (5.104), DA Bies and CH Hansen, *Engineering Noise Control*, E & FN Spon, 1996.

7 ANALYSIS AND DISCUSSION

7.1 Received Noise Levels - Road Traffic

Traffic due to the proposal travelling on nearby public roads is assessed separate to site noise and is subject to the criteria described in Section 5.1 of this Report. The Traffic report[2] indicates that site will generate up to 160 vehicle movements/hour during weekday busy periods and 380 vehicle movements/hour during busy weekend periods at the conclusion of a special event. All vehicles will enter the site via the entry point on the Newcastle Inner City Bypass, although up to 1/3 of vehicles may exit the site via the Waratah Avenue exit. This equates to the following traffic distribution:

Table 10: Traffic Distribution

Vehicle Type	Traffic Generation	
	Weekday (Peak)	Weekend (Special Event)
Newcastle Inner City Bypass		
Cars	105/hour	255/hr
Waratah Avenue		
Cars	55/hour	125/hour

Cars typically produce an average sound power of 92dB(A) however, wide variations are noted particularly with smaller modern cars and larger V8 or diesel powered vehicles. Our calculations present the worst case for the situation, as the noise produced by a typical car accelerating at full power is used to determine the received noise level.

In reality, many people will not leave the site at full acceleration but will depart more sedately. The following Table shows calculations to determine received traffic noise levels at typical residential receivers along Waratah Avenue. Given the large volume of traffic along the Newcastle Inner City Bypass, the acoustic barrier at the bypass boundaries and the location of nearest residences, we believe a traffic noise assessment along the bypass is not warranted.

Table 11: Traffic Noise Calculations Waratah Avenue - dB(A)Leq (T)

Traffic and Receiver	Peak Weekday	Weekend Special Event
Vehicle Type	Cars	Cars
Movements per hour	55	125
Vehicle Sound Power	92	92
Received Noise Level, Lmax	60.5	60.5
Average Distance to Rec, m	15	15
Received Noise Level	46.8	50.4
Criteria	**55dB(A),Leq 1hr**	
Impact	**0**	**0**

The above Table shows the noise impact from traffic movements associated with the development are predicted to be compliant with the criteria during day (7am-10pm) at all residential receivers and considered acceptable.

[2] Seca Solution Pty Ltd (12 June 2020). *Traffic Report for Proposed New Indoor Stadium, 62 & 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough, NSW.*

7.2 Received Noise Levels – Entertainment

Table 12 shows calculations of noise propagated through the roof of the Show Court, during a special event with entertainment and crowd participation, and the resulting impact at the nearest residential boundaries east of the site (R3). Table 13 shows a summary of calculations to predict the resulting noise impact at nearest residential receivers from entertainment.

Table 12: Calculated SPL Entertainment - East Residence (R3)
Propagated through Roof of Show Court

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
SPL at surface	**95**	54	62	74	84	89	90	87	84	71
TL[1] roof		6	10	20	34	43	51	55	47	58
Exterior SPL	58	48	52	54	50	46	39	32	37	13
SPL at rec	**39**	**29**	**33**	**35**	**31**	**27**	**20**	**13**	**18**	**-**
Criteria (evening)	**43**									
Impact	**-**									

1. Roof sheeting, building blanket purlins insulation 1 x 13mm plasterboard or 9mm FC sheeting.

Table 13: Calculated SPL Entertainment
Propagated to Nearest Residential Receivers dB(A),Leq

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
R2. Residence SE	**38**	28	32	34	30	26	19	12	17	-
R3. Residence E	**39**	29	33	35	31	27	20	13	18	-
R4. Residences NE	**39**	27	33	35	31	27	19	12	14	-
R5. Residences NW	**34**	24	28	30	26	22	15	8	13	-
Criteria (evening)	**43**									

Theoretical results in the above Table shows that noise emissions from entertainment and crowd participation will be compliant with the overall criteria at all nearby receivers, subject to acoustic recommendations detailed in Section 8.

While we consider that the controls recommended to reduce entertainment noise to acceptable levels will be satisfactory, the wide variation in output from entertainment providers may cause higher than predicted noise in the residential area. Should this occur, we recommend the installation of an electronic Noise Limiter in the affected area. These devices have been proven capable of controlling low frequency emissions and are a cost effective solution for minor noise exceedances.

7.3 Received Noise Levels – Outdoor Courtyard

Table 14 shows sample calculations to predict the noise impact from patrons in the outdoor courtyard on the west side of the facility, propagated to the nearest residential boundaries north west of the site (R5).

Table 14 Noise Impact, Patrons in Outdoor Courtyard
Propagated North West to Nearest Residential Boundaries (R5) dB(A),Leq

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
SPL at perimeter	85	26	43	79	80	78	77	76	67	59
Barrier loss[1]		2	3	4	6	8	10	12	14	17
SPL at rec	**18**	**-**	**-**	**14**	**13**	**9**	**6**	**3**	**-**	**-**
Crit (evening)	**43**									
Impact	**0**									

1. Intervening structures

Theoretical results in the above Tables show that the combined noise impact from patrons in the outdoor courtyard are compliant with the criteria at nearest residential boundaries. Note that amplified entertainment is not permitted in the outdoor area, although background "incidental". See Sections 8 for noise control strategies.

7.4 Received Noise Levels – Carpark Activities

Vehicles entering, leaving and manoeuvring on the site have the potential to impact on nearest residents. Peak vehicle numbers are expected at the conclusion of a special event. Based on peak vehicle numbers of 380vtp/hr, this equates to 380 vehicle movements in the carpark and 125 vehicle movements along the Waratah Avenue driveway and exit during a 15 minute assessment period. Table 15 shows calculations to predict the noise impact at nearest residences from vehicles movements (R2/R3).

Table 15: Noise Impact from Activities in Carpark - dB(A),Leq
Propagated to Nearest Residences Waratah Avenue

Activity	Car Door	Car Engine (enter/leave)	Car Engine (parking)
Lw dB(A),Leq	86	78	76
Ave Dist to rec (m)	200	200	200
Duration	0.25 sec	5 sec	10 sec
No. of Events	900	380	380
Barrier loss	5	5	6
Rec dB(A),Leq	**21**	**22**	**23**
Combined	**27**		
Crit (evening)	**43dB(A),Leq**		
Impact	**-**		

Vehicles will also exit the site along the driveway off Waratah Avenue. This exit is opposite residences (R3)

Table 16 shows calculation to predict received noise levels from site vehicles travelling along access road, propagated to nearest residential boundaries. All calculations are based on distances scaled from plans supplied by our client and through physical measurement during our site visits.

Table 16: Vehicle Along Driveway, dB(A) - Propagated to Nearest Residences (R5/R7)

Activity	Car Enter/Leave	Car Idle at Exit	Car Accelerate at Exit
Lw dB(A),Leq	78	75	85
Ave Dist to rec (m)	80	30	25
Duration	5	10	2
No. of Events	125	75	125
Barrier loss	5	5	5
Rec dB(A),Leq	25	31	37
Combined	**38**		
Crit (evening)	**43dB(A),Leq**		
Impact	**-**		

As can be seen by the above results, noise from vehicles entering, leaving and manoeuvring on the site during peak periods is predicted to be compliant with the criteria, subject to recommendations detailed in Section 8.

7.5 Cumulative Noise Impact

The noise impact from all noise sources activities associated with the development must be considered to confirm compliance. The cumulative noise impact from all sources is shown in the following Table.

Table 17: Cumulative Noise Impact-Propagated to Nearest Res's, dB(A),L10 (DAY/EVEN)

Receiver/Item	Entertainment	Courtyard	Carpark	Sum
R1. Classroom NE	-	<20	31	**31 #**
R2. Residence SE	38	<20	36	**41**
R3. Residence E	39	<20	38	**42**
R4. Residences NE	39	<20	<20	**39**
R5. Residences NW	34	18	<20	**34**
Criteria (D/E)	**49/43**			

Internal Noise Level.

As can be seen by the above results, the cumulative noise impact from activities associated with operation of the site is predicted to be compliant with the criteria prior during the day and evening, subject to recommendations detailed in Section 8.

8 NOISE CONTROL RECOMMENDATIONS

8.1 Show Court/Auditorium

8.1.1 Roof Construction is to consist of the following:

- Metal roof sheeting (minimum 0.46mm BMT).
- 30-40mm foil faced anticon blanket.
- C purlins (minimum 200mm).
- R2/S2 cavity insulation, to be installed in addition to building blanket not in lieu).
- 1x taped and set 13mm fire rate plasterboard or 9mm FC sheeting.

8.1.2 Wall Construction is to consist of the following:

- Metal wall sheeting (minimum 0.46mm BMT) or similar.
- Steel studs (minimum 90mm).
- C purlins (minimum 200mm).
- R1.5/S1.5 cavity insulation.
- 1x taped and set 13mm impact plasterboard or 9mm FC sheeting.

8.1.3 , in the event that complaints arise from amplified music, we recommend installing an electronic Noise Limiter. These devices have been proven capable of controlling low frequency emissions and are a cost effective solution for minor noise exceedances. Suppliers include:
https://www.waveformacoustics.com.au/noise-and-sound-limiters
https://www.acousticaldesign.com.au/noise-volume-limiters-indicators

8.1.4 Incidental "background" music be limited to an SPL of 65dB(A),Lmax at a distance of 3000mm from speaker.

8.2 Practice Courts

8.2.1 Roof Construction is to consist of the following:

- Metal roof sheeting (minimum 0.46mm BMT).
- 30-40mm foil faced anticon blanket.
- C purlins (minimum 200mm).
- R2/S2 cavity insulation, to be installed in addition to building blanket not in lieu).
- 1x taped and set 13mm plasterboard or 9mm FC sheeting.

8.2.2 Wall Construction is to consist of the following:

- Metal wall sheeting (minimum 0.46mm BMT) or similar.
- Steel studs (minimum 90mm).
- C purlins (minimum 200mm).
- R1.5/S1.5 cavity insulation.
- 1x taped and set 13mm impact plasterboard or 9mm FC sheeting.

8.3 Outdoor Courtyard

8.3.1 No amplified entertainment is permitted in any outdoor area.

8.3.2 Incidental "background" music be limited to an SPL of 65dB(A),Lmax at a distance of 3000mm from speaker.

8.4 Mechanical Plant

8.4.1 No acoustic barriers are required adjacent to mechanical plant providing noise emissions for individual items are below the specified limits:

Item	*Max SPL at a Dist of 1 metre*	*Lw*
Air Conditioning Condenser	69dB(A)	75dB(A)
Refrigeration Condenser	70dB(A)	76dB(A)
Exhaust Discharge	70dB(A)	76dB(A)

8.4.2 Acoustic barriers are to be constructed at the fan discharge of exhaust plant that exceeds the limits specified in 8.4.1 above. Barriers must fully enclose at least three sides towards any residence. In our experience, a more efficient and structurally secure barrier is one that encloses all four sides. The barrier must extend at least 600mm above and below the fan centre and/or the discharge outlet and must be no further than 1200mm from the edges of the exhaust. Barrier construction should consist of *either* Acoustisorb panels (available through Modular Walls) *or* an outer layer of one sheet of 12mm fibre cement sheeting (Villaboard, Hardiflex), or 19mm marine plywood. The inside (plant side) is to be lined with an absorbent foam to reduce reverberant sound (fibrous infills are not recommended as they will deteriorate if wet), Note that variations to barrier construction or alternate materials are not permitted without approval from the acoustical consultant. Barrier construction is based solely on acoustic issues. Visual, wind load issues must be considered and designed by appropriately qualified engineers.

8.4.3 Acoustic barriers are to be constructed adjacent to air conditioning and refrigeration plant that exceeds the limits specified in 8.4.1 above. Acoustic barriers 300mm above the highest plant item must be erected between the plant and residences. Barrier construction is to consist of *either* Acoustisorb panels (available through Modular Walls) *or* an outer layer of 12mm fibre cement sheeting, 25mm construction plywood, Hebel Powerpanel, or similar material, with an absorbent inner surface of perforated metal (minimum 10-15% open area) backed with a water resistant acrylic batt or blanket. The acoustic barrier must continue at least 300mm below the top of the plant deck. Alternatively, plant can be located in the service yard or similar shielded location.

9 NOISE MANAGEMENT PLAN

9.1 Noise Management Objectives

The objectives of the NMP are to minimise noise related impacts during functions by:

9.1.1 Complying with strategies detailed in Section 8.

9.1.2 Operating within prescribed time limits.

9.1.3 Responding to complaints and documenting action taken.

9.1.4 Identifying and implementing alternate measures where necessary on an annual basis.

9.2 Noise Control Strategies

9.2.1 The site may operate up until 10pm.

9.2.2 Only acoustic (no amplification, bass, drums, etc) or "incidental" background music is permitted in outdoor areas. A limiting SPL of **65dB(A),max** is to be set at a distance of 3 metres from the speakers. Once this level is achieved, corresponding references should be assigned to the sound system controls.

9.2.3 A suitable complaints handling procedure is to be implemented. See Section 9.3.

9.2.4 An Event Manager must be on site at all times during special events.

9.2.5 All staff and employees directly involved with the facility should receive informal training with regard to noise control procedures. Additional ongoing on the job environmental training should be incorporated with the introduction of any new process or procedure. This training should flow down contractually to all promoters or sub-contractors.

9.2.6 Contact details of the Event Manager must be readily available on the facility website.

9.2.7 The facility website must inform interested parties of the date, start time and duration of all special events.

9.2.8 In the event that complaints arise from amplified music, we recommend installing an electronic Noise Limiter. These devices have been proven capable of controlling low frequency emissions and are a cost effective solution for minor noise exceedances. Suppliers include:
https://www.waveformacoustics.com.au/noise-and-sound-limiters
https://www.acousticaldesign.com.au/noise-volume-limiters-indicators

9.3 Complaints Handling Procedure

9.3.1 Management must implement a noise management strategy where regular patrols by appropriately trained staff or security personnel are undertaken throughout the venue and carpark during special events.

9.3.2 In the event of complaint, a subjective audibility assessment of noise emissions should be undertaken at the site boundary nearest to the complaint origin.

9.3.3 If noise emissions at any residence are deemed to be unacceptable, then the staff member must immediately investigate the source of noise and rectify the problem. The results and recommendations from the staff audibility survey must be recorded in a Complaints Handling Register for future reference and presentation to Council on request. The log book should contain the following:

i) Time and date of survey.
ii) Name, address and contact details of complainant.
iii) Description of noise source(s) audible during subjective assessment.
iv) In the event of unsatisfactory noise emissions, a description of action taken.
v) Action reported to complainant.
vi) Signature.

9.3.4 The Event Manager should take responsibility and be available to consult with residents at any time during operating hours. Response to complaints or comments should be made in a timely manner and action reported to the concerned party.

10 CONCLUSION

A noise impact assessment for proposed Hillsborough Indoor Stadium, has been completed, resulting in noise control recommendations summarised in Section 8 and 9 of this Report. The site is suitable for the intended purpose providing recommendations outlined in this report are incorporated into the design. With these or equivalent measures in place, noise from the site will be either within the criteria or generally below the existing background noise level in the area for the majority of the time.

Theoretical results show compliance with the criteria can be achieved subject to implementing noise control strategies detailed in Sections 8 and 9. In the unlikely event of complaints arising, appropriate noise management strategies are available and described in Section 9.3.

Providing the recommendations presented in this report are implemented, operation of the facility will not have any long-term adverse noise impact upon the acoustic amenity of nearby residents. We therefore see no acoustic reason why the proposal should be denied.

Steve Brady M.A.S.A. A.A.A.S.
Principal Consultant

APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and was previously used in Australia as the descriptor for intrusive noise (usually in dBA).