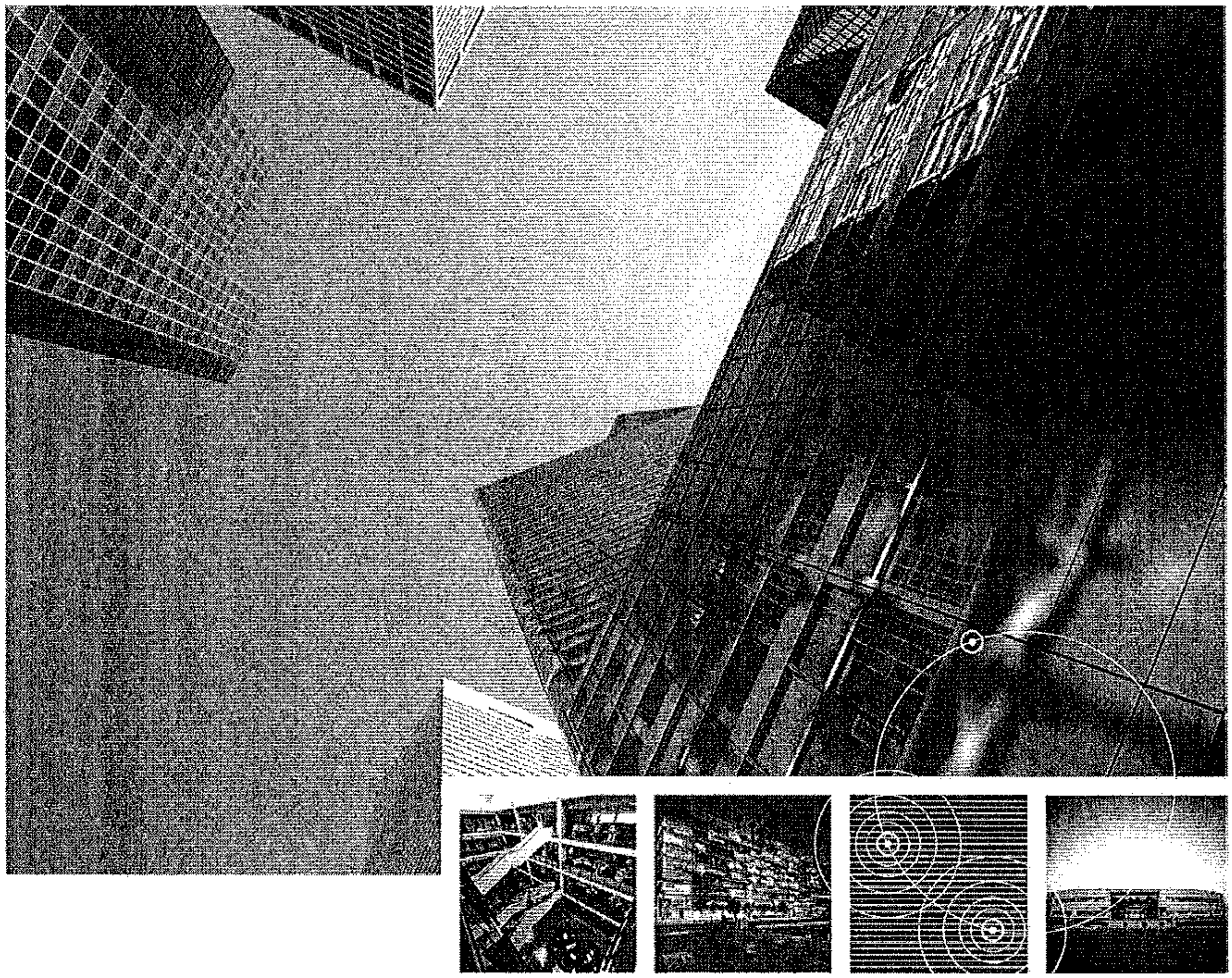

SCG Stage 2 Noble-Bradman Redevelopment Planning Application-Acoustic Assessment Report

MI Associates Pty Ltd

28 August 2008

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Planning Application-Acoustic Assessment Report

Prepared for

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Quality Information

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Prepared by Tom Cockings

Reviewed by Gayle Greer

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
01	16/07/2008	Draft	Tom Cockings Acoustic Engineer	[signature]
02	18/08/2008	First Issue	Tom Cockings Acoustic Engineer	[signature]
03	28/08/2008	Second Issue	Tom Cockings Acoustic Engineer	[signature]

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1.0 Introduction

1.1 Background

Sydney Cricket and Sports Ground Trust (SCSGT) wish to redevelop the Bradman and Noble Grandstands with modifications to the Messenger Grandstand. It is proposed that the Grandstands will have a 3 tiered stand (of 5 levels), similar to the new Hill stand.

Currently the capacity of the combined Bradman, Noble and Messenger stands/concourses is 11,275 seats. The proposed redevelopment would increase the stand capacity to 14,080 seats.

Bassett Acoustics was commissioned by MI Associates Pty Ltd on behalf of Sydney Cricket and Sports Ground Trust to provide an Acoustic Assessment report for the Planning Application for the proposed redevelopment of the Bradman and Noble Grandstands with modifications to the Messenger Grandstand, Sydney Cricket Ground, Moore Park, NSW.

This report has been prepared having regard to the Director-General's Requirements issued pursuant to Section 75F of the Environmental Planning and Assessment Act 1979 dated 10 July 2008. The Director-General's Requirements specifically relevant to this report are as follows:

> ***Acoustics and Noise***
> *Construction noise impact (e.g. the effects of noise omission on the Sound Stages as well as adjacent tenants of Fox Studio Australia) should be addressed against relevant guidelines with the relevant agencies where appropriate.*

Additionally, this report has been prepared cognisant of the responses from government agencies and others to the Department of Planning's request for key issues and assessment requirements forwarded to the Proponent with the Director-General's Requirements. We acknowledge, however, that these responses were provided for information only and do not form part of the Director-General's Requirements for the environmental assessment.

This assessment will investigate the noise and vibration impacts associated with the construction works required for the redevelopment and the typical operational noise impacts associated with hosting events in the SCG. A previous assessment of this kind has been performed by PKA Acoustic Consulting for the Hill Grandstand development (REF:206 056 R03 Project Application Acoustic Assessment). The measurements and assumptions used in this report will be used as the basis for our investigations. In addition, the construction methodology and plan as per Construction Management Plan (CMP) prepared by McLachlan Lister dated 18th August 2008 will be used to assess the construction works of this project.

The acoustic terminology used in this report is explained in Appendix A.

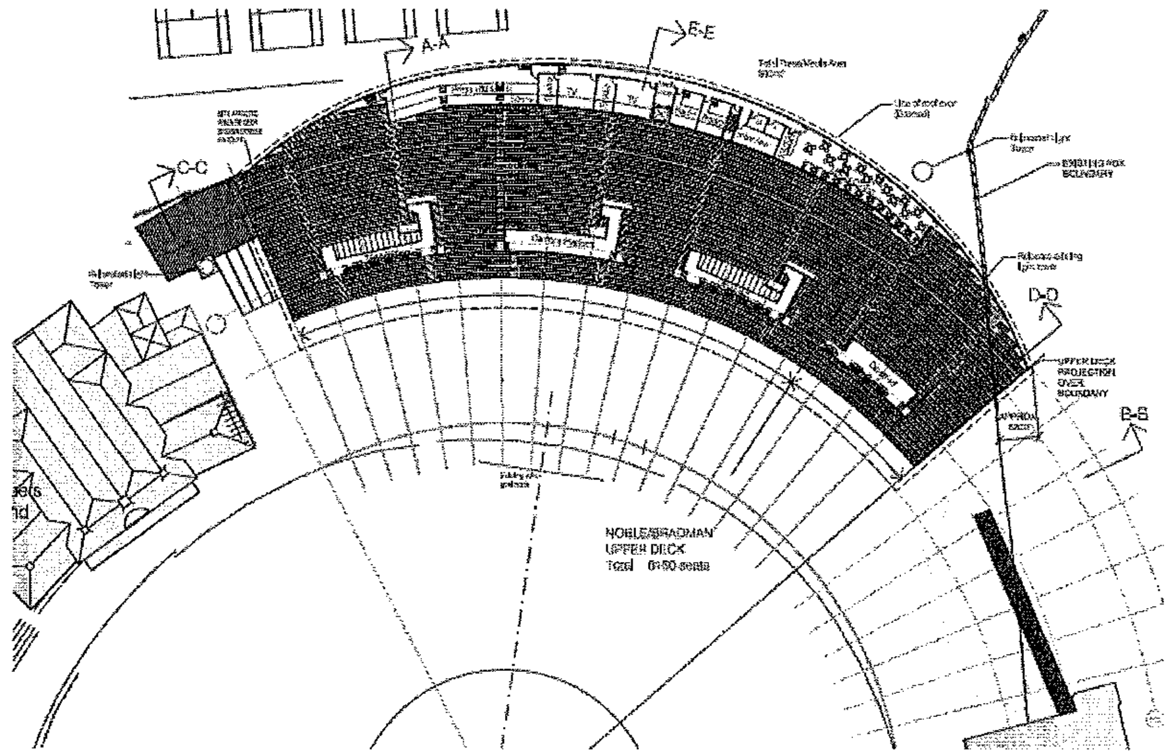
1.2 Site Description

The SCG is located in Moore Park. The site is bounded by Driver Avenue to the west, Sydney Football Stadium is located to the northeast and Fox Studio Buildings are located to the east and south. The nearest residential properties are located to the north east adjacent to Moore Park Road and to east along Poate Lane. These residences are approximately 300 m from the SCG.

The site location is shown in Figure 1 below.

Figure 1. Location Plan

Figure 2. Proposed plan for Stage 2 works – Noble and Brandman stands



1.3 Proposed Construction Works

The redevelopment of the two stands will require the following stages of works:

- Site Establishment
- Services Diversions
- Waste Management
- Materials Handling
- Demolition
- Excavation
- Foundations
- Structure
- Roof and Upper seating structure
- Light Towers
- Finishes and Fit-out
- Services

The noisiest stages of work will be Demolition, Excavation and Foundations.

Demolition

The demolition of the existing concrete structures will be carried out using a combination of concrete saws, pulverisers and rock breakers. Where practical, precast concrete elements will be removed from the site in one piece for recycling offsite.

The light towers are substantial structures and will need to be removed by methods other than heavy rock breakers (e.g. limited use of low intensity explosives) to mitigate the noise and vibration impacts on neighbours. The use of explosives in this manner to fracture massive foundations is not uncommon and is well understood. The works would be undertaken by a specialist with experience in the field.

An excavator and rock breaker will be used to break up the lower Noble and Bradman ground slabs. A concrete pulveriser will be used to demolish the elevated sections of these stands, but larger precast elements that can be removed from their seatings intact will be transported offsite, to be crushed and recycled at a less sensitive location.

Excavation

The excavation of the existing Noble and Bradman stands will commence upon completion of the demolition and the relocation of all in ground services. Soil material will be removed with the use of excavators and trucks. During this period, access will be via the rear of the Noble and Bradman Stands.

Foundations

Cast in-situ bored concrete friction bearing piles will be used. This will mitigate the noise and vibration impacts of using displacement piles. Following installation of piles, traditional detailed excavation and installation of pile caps will occur.

2.0 Existing Noise Environment

2.1 Aircraft Noise Impacts

The PKA report measured aircraft noise impacts around the SCG and adjacent Fox studio sites. In order for Fox Studios to operate under normal conditions the various buildings and Stages must be insulated against the average aircraft flyover noise affecting the Moore Park site. The aircraft flyover noise is typically due to aircraft using runway 34R of the Kingsford Smith Airport and an average flyover event is **77 dB(A)**.

This level was used as the baseline for the construction noise impacts from the redevelopment on the surrounding Fox Studio buildings i.e. if the construction noise levels are greater than 77 dB(A) then it is likely that the Fox Studio buildings will not be able to operate normally. Bassett Acoustics will adopt the same level for use in this assessment as it is deemed reasonable and practical.

3.0 Construction Noise and Vibration

3.1 Construction Noise Goals

At this stage no background noise monitoring has been performed – from which the applicable Construction noise criteria can be defined as per the requirement of the City of Sydney Council. In order to perform a preliminary assessment we will base construction noise goals worst case aircraft fly-over noise levels given in Section 2.1. Therefore, the construction noise goals will be to reduce noise from construction to less than or equal to the noise events from aircraft fly-over of 77 dB(A) L_{Aeq}.

It should be noted that this noise goals will typically apply during the day-time period. After consultation with Fox Studio certain construction works will occur during the evenings and over weekends. These construction activities will take place at the request of Fox Studios to facilitate their working schedule.

3.2 Construction Equipment

The following equipment is currently proposed for use during the redevelopment works. This information includes typical sound power levels for piece of equipment.

Table 1. Proposed Construction Equipment.

Description[1]	Construction Stage	Sound Power Level, L_w (re 10^{-12} W) in dB(A)
Rock breaker (<75mm diameter)	Demolition	120
Concrete Muncher	Demolition	115
Oxy-acetylene Welder	Demolition	96
Stone Saw	Demolition	118
Mobile Crane	Demolition	118
Piling - Rotary Bored	Excavation	120
Excavator	Excavation	115
Concrete Vibrator	Construction	105
Circular Saw	Construction	112
Electric Grinder	Construction	103
Electric Hammer	Construction	106
Electric Drill	Construction	94
Generator (+110kVa)	Construction	108
Tower Crane	Construction	106
Concrete Pump	Construction	105
24T Concrete Mixer	Construction	110
10-20T Truck	All stages	105

3.3 Construction Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (eg dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency and number of occurrences of a vibration, all play an important role in both the annoyances caused and the strains induced in structures.

The pattern of vibration radiation is very different to the pattern of airborne noise radiation, however the potential for vibration to cause disturbance to residents, or structural damage to buildings is still largely dependent on the distance between the vibration generator and the receiver.

Major sources of ground vibration include bulldozers (ripping) and hydraulic rock breakers. The foundation work will use bored piles. Vibration generated by bored piling would be less than that generated by pile driving. Typical levels of ground vibration from these sources are shown in Table 2 below.

[1] Taken from PKA Acoustic Consulting Report - REF:206 056 R03 Project Application Acoustic Assessment.

Table 2. Typical vibration levels from the proposed construction equipment.

Activity	Typical levels of ground vibration
Hydraulic rock breakers (levels typical of a large rock-breaker operating in hard sandstone)	4.50 mm/s at 5 m 1.30 mm/s at 10 m 0.40 mm/s at 20 m 0.10 mm/s at 50 m
Rotary bore piling	0.38 mm/s and 0.3 mm/s at distances of 20 m to 30 m depending heavily on ground conditions and the energy of the rotary piling bore. These levels are well below the threshold of any possibility of damage to structures in the vicinity of these works. At closer distances to the piling operations, some compaction of loose fill would occur due to vibratory effects.
Bulldozers	1 mm/s to 2 mm/s at distances of approximately 5 m. At distances greater than 20 m, vibration is usually below 0.2 mm/s.
Truck traffic (over normal (smooth) road surfaces)	0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m-20 m from a roadway.
Truck traffic (over irregular surfaces)	0.1 mm/s to 2.0 mm/s at the footings of buildings located 10 m-20 m from a roadway.

3.3.1 Structural Damage Vibration Criteria

The German Standard DIN 4150-Part 3 'Structural vibration in buildings – Effects on Structures' provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. The standard presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor of a building. Damage is defined as minor non-structural effects such as cracking in cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. Table 3 indicates the vibration limits to ensure structural damage does not occur.

Table 3.Structural Damage Vibration Limits

Type of Structure	Vibration Velocity Limit in mm/s (PPV) The measured value of the three orthogonal components measured at the foundation at a frequency of:			The maximum value measured in the plane of the floor of the uppermost storey
	Less than 10 Hz	10 Hz to 50 Hz	50Hz to 100 Hz	All Frequencies
1. Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2. Residential dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	5 to 20 mm/s	15 mm/s

3.3.2 Human Comfort Vibration Criteria

Structural vibration in buildings can be detected by the occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon the use of the building and the time of day.

The Department of Environment and Climate Change (DECC) document 'Assessing Vibration : a technical guideline' presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement, and evaluation techniques. The document recommends that intermittent construction noise be assessed on the basis of a vibration dose value. Acceptable values detailed in the guideline document are listed in Table 4 below.

Table 4. Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Time Period	Preferred Value	Maximum Value
Residential Buildings Day (16 hr)	0.20	0.40
Residential Building Night (8hr)	0.13	0.26
Offices	0.40	0.80
Workshops	0.80	1.60

Note: Daytime is 7.00am to 10.00pm; Night-time is 10.00pm to 7.00am
For continuous vibration such as that caused by the use of rollers and compactors the document recommends that the vibration be assessed on the basis of weighted rms acceleration values presented in Table 5. Impulsive vibration caused by piling activities should also be assessed on the basis of weighted rms acceleration values presented in Table 5.

Table 5. Human Comfort Vibration Limits (8Hz to 80Hz)

Type of Space Occupancy	Time of Day	Vibration Levels over the frequency range 8 Hz to 80Hz likely to cause "adverse comment"							
		Continuous Vibration				Impulsive Vibration excitation with several occurrences per day			
		Vertical		Horizontal		Vertical		Horizontal	
		mm/s (peak)	mm/s^2 (rms)	mm/s (peak)	mm/s^2 (rms)	mm/s (peak)	mm/s^2 (rms)	mm/s (peak)	mm/s^2 (rms)
Residential	Day	0.28-0.56	10-20	0.8-1.6	7-14	8.6-17.0	300-600	24.1-36.2	214-418
Office	All	0.56-1.1	20-40	1.6	14-28	18.0	640-1280	51.5	460-920
Workshop	All	1.1-2.2	40-80	3.2	29-58	18.0	640-1280	51.5	460-920

Note: Adapted from BS 6472

It should be noted that the human comfort criteria are more stringent than the building damage criteria.

4.0 Impact Assessment

4.1 Sensitive Receivers

The buildings surrounding the site have been reviewed. The noise sensitive receivers likely to be worst affected are listed in Table 6 below.

Table 6. Nearest sensitive receivers

Building	Fox Studio Building Number	Usage	Distance to Construction Activities, m
Stage 1	1	Sound Stage	62
Stage 2	2	Sound Stage	110
Stage 3	3	Sound Stage	160
Stage 4	4	Sound Stage	200
Stage 5	5	Sound Stage	210
Stage 6	6	Sound Stage	250
Stage 7	7	Sound Stage	240
Stage 8	8	Sound Stage	170
Elsa Chauvel House	11	Office	250
Cecil Holmes	16	Office	200
FW Thring	17	Office	215
Stanely Crick House	19	Office	180
George Heath	20	Office	130
Damien Parer	21	Office	130
Gary Hansen	22	Office	130
Bill O'Reilly Office	23	Office	30
Arthur Higgins	24	Office	30
Building 25	25	Office	30
Building 26	26	Office	20
Building 28	28	Office	50
Building 29	29	Workshop	30
Building 33	33	Office	180
Building 34	34	Workshop	180
Building 36	36	Art / Costume	220
Building 37	37	Art / Costume	220
Poate Lane Residents	-	Residential	265
Moore Park Road Residents	-	Residential	280

4.2 Construction Noise Assessment

The construction noise assessment has been performed with the following assumptions:

- All sources act as point sources
- No shielding or barrier effects have been included
- No weather effects have been considered
- All predictions represent the worst possible case for construction noise. For the majority of the time during construction noise levels will be less than given here.

The prediction for internal noise levels from the construction activities are given below in Table 7.

Table 7. Predicted Noise levels at the nearest sensitive receivers.

Building	Fox Studio Building Number	External Noise Level, L_{Aeq}[2] dB(A)	Recommended External Noise Goal dB(A)	Estimated Exceedance dB(A)
Stage 1	1	76	77	0
Stage 2	2	71	77	0
Stage 3	3	68	77	0
Stage 4	4	66	77	0
Stage 5	5	66	77	0
Stage 6	6	64	77	0
Stage 7	7	64	77	0
Stage 8	8	67	77	0
Elsa Chauvel House	11	64	77	0
Cecil Holmes	16	66	77	0
FW Thring	17	65	77	0
Stanely Crick House	19	67	77	0
George Heath	20	70	77	0
Damien Parer	21	70	77	0
Gary Hansen	22	70	77	0
Bill O'Reilly Office	23	82	77	**5**
Arthur Higgins	24	82	77	**5**
Building 25	25	82	77	**5**
Building 26	26	86	77	**9**
Building 28	28	78	77	**1**
Building 29	29	82	77	**5**
Building 33	33	67	77	0
Building 34	34	67	77	0
Building 36	36	65	77	0
Building 37	37	65	77	0
Poate Lane Residents	230	64	77	0
Moore Park Road Residents	-	63	45	0

[2] These levels are expected <u>only</u> during the worst case construction activities and are not expected to occur for prolonged periods.

These results show that a small number of buildings will be affected during the construction phase. The exceedances are not excessive, but consultation with the appropriate stakeholders should be undertaken to minimise annoyance and disturbance. It should be noted that these levels are only expected in the worst case. The majority of construction activities are therefore not expected to generate exceedances of these noise goals.

4.3 Construction Vibration Assessment

The following assumptions have been assumed for this assessment:

- The ground between vibration source and receiver is a solid, compact and a good transmitter of ground vibration i.e. typical bedrock found in Australian conditions, not loosely compacted soil or fill.
- There are no intervening structures or vibration attenuating constructions between the vibration source and the receiver.
- The vibration sources are acting as point sources.
- Typical geometric propagation. Surface waves have not been taken into account.

Table 8. Predicted vibration levels at the nearest sensitive receivers

Building	Fox Studio Building Number	Estimated Vibration Levels mm/s				
		Rock breaking	Piling	Bulldozers	Truck Traffic (smooth road)	Truck Traffic (rough road)
Stage 1	1	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 2	2	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 3	3	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 4	4	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 5	5	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 6	6	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 7	7	<0.1	<0.3	<0.2	<0.01	<0.1
Stage 8	8	<0.1	<0.3	<0.2	<0.01	<0.1
Elsa Chauvel House	11	<0.1	<0.3	<0.2	<0.01	<0.1
Cecil Holmes	16	<0.1	<0.3	<0.2	<0.01	<0.1
FW Thring	17	<0.1	<0.3	<0.2	<0.01	<0.1
Stanely Crick House	19	<0.1	<0.3	<0.2	<0.01	<0.1
George Heath	20	<0.1	<0.3	<0.2	<0.01	<0.1
Damien Parer	21	<0.1	<0.3	<0.2	<0.01	<0.1
Gary Hansen	22	<0.1	<0.3	<0.2	<0.01	<0.1
Bill O'Reilly Office	23	0.1 – 0.4	0.3 to 0.38	<0.2	0.01 to 0.2	0.1 to 2
Arthur Higgins	24	0.1 – 0.4	0.3 to 0.38	<0.2	0.01 to 0.2	0.1 to 2
Building 25	25	0.1 – 0.4	0.3 to 0.38	<0.2	0.01 to 0.2	0.1 to 2
Building 26	26	0.1 – 0.4	0.3 to 0.38	<0.2	0.01 to 0.2	0.1 to 2
Building 28	28	0.1 – 0.4	<0.3	<0.2	<0.01	<0.1

Building 29	29	0.1 – 0.4	0.3 to 0.38	<0.2	0.01 to 0.2	0.1 to 2
Building 33	33	<0.1	<0.3	<0.2	<0.01	<0.1
Building 34	34	<0.1	<0.3	<0.2	<0.01	<0.1
Building 36	36	<0.1	<0.3	<0.2	<0.01	<0.1
Building 37	37	<0.1	<0.3	<0.2	<0.01	<0.1
Poate Lane Residents	-	<0.1	<0.3	<0.2	<0.01	<0.1
Moore Park Road Residents	-	<0.1	<0.3	<0.2	<0.01	<0.1

These are worst case vibration levels and are not expected to occur long-term as these activities will not occur for extended periods. From these predictions no exceedances of the human comfort criteria are expected.

At <u>no</u> point do construction induced vibrations reach levels that are potentially damaging to buildings. All building types, including Heritage listed buildings, will not be exposed to damaging levels of vibration.

5.0 Operational Noise Assessment

5.1 Noise from Patrons in the Noble and Bradman Stands

Currently the capacity of the combined Bradman, Noble and Messenger stands/concourses is 11,275 seats. The proposed redevelopment would increase the stand capacity to 14,080 seats. If we assume that all patrons make vocal noise at the same time we can calculate the effective increase in noise levels due to the increase in capacity.

$10\log_{10}(\text{Future Capacity}) - 10\log_{10}(\text{Existing Capacity}) = \text{Increase in Noise Levels (dB(A))}$

So,

$10\log_{10}(14{,}080) - 10\log_{10}(11{,}275) \approx$ **1 dB(A)**

This is an estimated increase in the potential noise that can be generated by the crowds attending the SCG. However, the new stand designs will effectively enclose more of the crowd – thereby increasing the shielding experienced by the surrounding buildings. Therefore, the noise levels experienced at the surrounding buildings are not predicted to increase from the current level.

5.2 PA System

The new stands will be serviced by a new Public Address system. The spill of noise from the PA system into the surrounding areas will have to be carefully controlled with the use of directional speakers and correct use of absorptive finishes. The new PA system should be designed to maintain the levels of noise from the current PA system and where possible reduce the noise impacts on adjacent premises. The use of a greater number of low power speakers, with careful aiming will reduce the noise impact of the PA systems – effectively more speakers are positioned around the stadium which are closer to the intended audience meaning the sound output of each speaker can be reduced.

5.3 Mechanical Plant

All mechanical plant used by the new developed sections of the stadium will have to comply with the noise criteria as defined by the Department of Environment and Climate Change, DECC (formerly the EPA) Industrial Noise Policy (INP). These criteria will affect all ancillary spaces and adjoining businesses. The criteria are based on the background noise levels currently experienced by residents and affected commercial premises. The design of mechanical plant to satisfy these criteria should be completed during the detailed design stage of the project. It is predicted that *typical* noise control measures will be sufficient for the mechanical plant associated with this project.

6.0 Ameliorative Measures

This section contains both general and specific procedures and systems to manage noise and vibration from the project.

Noise level emissions and potential annoyance from construction equipment depend significantly on the condition of the equipment, the type of operation, its duration and the time of day it is conducted. Priority is to source plant and equipment which performs at or better than industry expectations. All major items of plant will be checked on commencement on site and sub-contractors will be asked to provide noise monitoring results at commencement and after major service. Solutions to reduce and contain noise emissions from equipment will be implemented as required (e.g. keeping construction machinery well maintained, the use of low noise equipment or special shielding).

6.1 General Mitigation for Construction

The following measures are proposed to minimise the specific construction noise impacts and should be applied generally to all construction activities and equipment:

- Construction activities to be limited to between 7 am and 6 pm Monday to Friday and 8 am to 1 pm Saturday;
- Construction of noise bunds or barriers, where feasible, at the early construction stage;
- Use of temporary barriers for stationary noisy equipment;
- Possible restrictions to construction hours (beyond the above hours) where noise impacts are significant;
- Use of the quietest plant equipment available fitted with appropriate mufflers and regularly maintained;
- Consultation with property owners likely to be affected prior to works being carried out.
- Conduct a letter drop to all residential receivers surrounding the site to inform them of the proposed works;
- Provide a community complaint and inquiry phone line – this will allow direct two-way communication between concerned residents and the builders.
- Noise monitoring at sensitive locations as agreed with DECC with any excessive noise or noise complaints being assessed and appropriate action taken;
- Measures as outlined in Table 9;
- Vibration monitoring at selected properties deemed to be sensitive (within 40 m of construction activities); and
- Inspection of properties deemed at risk of vibration damage prior to construction commencement.

The specific types and condition of plant, construction methods and programming or staging of works all affect the predicted construction noise levels. More detailed information and design would enable a refined and more accurate noise prediction and mitigation approach, normally at the pre-construction stage.

Table 9. Noise Control Measures for Likely Construction Plant.

Plant Description	Screening	Acoustic Enclosures	Engine Silencing	Alternative Process
Concrete Leveller	√	x	√	x
Mobile Crane	√	√	√	x
Front End Loader	√	x	√	x
Bulldozer	√	x	√	x
Tracked Excavator	√	x	√	x
Dump Trucks	√	x	√	x
Concrete Trucks	√	x	√	x
Concrete Pump	√	√	√	√
Concrete Vibrator	√	x	x	x

These general mitigation measures are likely to reduce noise levels further by as much as 10 dB(A).

6.2 Noise Mitigation Management Strategy

A Noise Management Strategy can mitigate noise intensity, frequency and/or duration to affected residential locations. Such a strategy considers the proposed construction methodology and the relative phasing of different construction activities in different areas to minimise noise. The impact depends on the type of construction, the distance to the affected residences or other noise sensitive uses, any natural or introduced shielding and the duration of the construction.

A basic construction noise mitigation strategy for sensitive locations aims to:

- Minimise construction duration;
- Maximise opportunities for simultaneous activities (minimising total duration);
- Minimise equipment noise generation – quietest (or quietening) equipment; and
- Minimise the use of certain "noisy" equipment in certain sensitive locations.

6.3 Special Construction Noise Mitigation Measures for Locations Likely to be Adversely Affected

A weekly communication meeting should be held involving the trust project manger, trust contractor, and Fox Studio project manager. This meeting will provide a forum to coordinate and schedule construction activities for the benefit of all involved parties. The meeting should also be used to review noise monitoring as required.

Additional special noise mitigation measures should include:

- Apply time restrictions on noisy tonal or repetitive activities;
- Provide respite periods for rock breaking, rock hammering, sheet piling and any other activities that result in impulsive or tonal noise generation;
- Consider the timing and duration of noisy construction activities and identify opportunities to reduce their noise impact;

- Minimise requirements for vehicle movements outside normal daytime working hours;
- Select site access points and roads away from sensitive receivers;
- Apply noise source controls to reduce noise from plant and equipment;
- Select plant and equipment based on its acoustic performance;
- Ensure all equipment is operated and maintained in the correct manner (ie engine covers are in place, rattling components are tightened);
- Combine noisy activities to reduce their impact and duration;
- Offset distances between noisy plant items and sensitive receivers;
- Orient equipment away from sensitive areas;
- Switch off equipment during break times;
- Place work compounds, parking areas, equipment and material stockpiles away from noise sensitive locations (where practical);
- Carry out loading and unloading away from sensitive areas where practicable;
- Where practicable install operational noise mitigation measures as soon as possible in the construction program;
- Use portable enclosures where possible around fixed plant producing high noise levels, or operations conducted in close proximity to residences. This may apply to compressors, generators or similar plant items located outside a particular residence for an extended period of time;
- Provide induction and training to staff and sub-contractors outlining their responsibilities with regard to noise;
- Consult regularly with the community and affected stakeholders and keep them informed of upcoming works; and
- Where variable pitch reversing alarms are fitted to plant, they will be required to be set on the lowest safe level, and where practicable, endeavour to provide drive-through facilities to minimise utilisation of reverse warning devices.

7.0 Conclusion

Sydney Cricket and Sports Ground Trust (SCSGT) wish to redevelop the Bradman and Noble Grandstands, with modifications to the messenger Grandstand to increase the overall capacity of these Grandstands to 14,080 seats.

Bassett Acoustics was commissioned by MI Associates Pty Ltd on behalf of Sydney Cricket and Sports Ground Trust to provide an Acoustic Assessment report for the Planning Application for the proposed redevelopment of the Bradman and Noble Grandstands with modifications to the Messenger Grandstand, Moore Park, NSW.

This report has been prepared having regard to the Director-General's Requirements issued pursuant to Section 75F of the Environmental Planning and Assessment Act 1979 dated 10 July 2008. The Director-General's Requirements specifically relevant to this report are as follows:

> ***Acoustics and Noise***
> *Construction noise impact (e.g. the effects of noise omission on the Sound Stages as well as adjacent tenants of Fox Studio Australia) should be addressed against relevant guidelines and legislation, such as NSW DECC (EPA) guidelines in consultation with relevant agencies where appropriate.*

This report has identified all the nearest potentially affected noise and vibration sensitive receivers surrounding the development. Since noise monitoring has not been undertaken at this stage, noise goals relevant to the receiver building types have been established. Vibration criteria have been defined by the most applicable national and international standards for human perception / disturbance and building damage. The noise and vibration impacts from the expected construction activities and equipment have been predicted and compared against defined noise goals and relevant vibration criteria.

The general findings of this report are:

- A small number of Fox Studios buildings will experience noise and vibration impacts during the worst construction activities. These impacts are not excessive and are not predicted to occur for long periods, so the overall disturbance and annoyance will be small;
- No buildings will be exposed to damaging levels of vibration, and;
- No residential receivers will suffer adverse noise and vibration impacts.

Section 6.0 of this report provides a detailed list of ameliorative measures and strategies to minimise the noise and vibration generated by the construction activities. Implementation of these measures is considered to be reasonable and feasible.

Appendix A Acoustic Terminology

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The following is a brief description of the acoustic terminology used in this report:

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Decibel (dB)	The Decibel scale is logarithmic as this corresponds best to the response of human hearing. A 10 dB increase in the sound pressure level is approximately perceived as a doubling of the volume of the sound. For a typical person, 0 dB is the threshold of hearing and 120 dB the threshold of pain. The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
Reverberation	The persistence of sound in a space after a sound source has been stopped (the reverberation time is taken to be the time taken for a reverberant sound field to decay 60 dB)
Sound reduction index (R)	A measure of airborne sound insulation calculated from the ratio of the sound power incident on a partition to the sound power transmitted through a partition.
Weighted sound reduction index (R_w)	A single figure rating, in decibels, for the airborne sound insulation of a building element calculated from the range of R values tested in a laboratory. A higher value provides better insulation.
Level difference (D)	The difference, in decibels, of the sound pressure levels of the source and receiving rooms in an on site sound insulation test.
Weighted level difference (D_w)	The difference, in decibels weighted
Normalised level difference (D_n)	Level difference, in decibels, normalised for the absorption area of the receiving room.
Standardised level difference (D_{nT})	The level difference, in decibels, standardised for the reverberation time in the receiving room.
Weighted standardised level difference ($D_{nT,w}$)	A single number rating, in decibels, for airborne sound insulation of a building element calculated from one third octave standardised level differences tested on site.
Sound transmission class (STC)	Laboratory test measurement procedure that provides a single number indication of the acoustic performance of a partition or single building element. The higher the STC, the greater the noise isolation between enclosed spaces.
Field sound transmission class (FSTC)	Sound transmission class calculated using values of field transmission loss measured on site.
Impact sound insulation	Characteristic of a building element to reduce sound resulting form direct impact on the building element.
Impact sound pressure level	Impact sound pressure level, in decibels, for one third octave bands

(L_i)	in the receiving room when the floor under test is excited by the standardised impact sound source.
Normalised impact sound pressure level (L_n)	Impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level ($L_{n,w}$)	Single number rating of impact sound insulation property of a floor tested in a laboratory. A lower value provides better insulation.
Weighted standardised impact sound pressure level ($L'_{nT,w}$)	Single number rating of impact sound insulation between dwellings tested on site. A lower value provides better insulation.
Spectrum adaptation term (C_1 , C_{tr})	A value, in decibels, to be added to a single number rating (eg R_w, D_{nt}, L_{nw}) to take account of the characteristics of particular sound spectra. C_{tr} allows for low frequency noise like DVD and HiFi/TV sound and C_1 for footfall on floors.
Energy Equivalent Sound Pressure Level ($L_{Aeq,T}$)	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level ($L_{Ax,T}$)	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.