

Liverpool Hospital Redevelopment
Stage 2.1



Project Application and
Environmental Assessment

Appendix D

Acoustics and Vibration Report

Prepared By Acoustic Logic Pty Ltd

For Department of Planning

On behalf of NSW Health

July 2008



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Prepared for:

**LIVERPOOL HOSPITAL REDEVELOPMENT STAGE 2 PHASE 1,
LIVERPOOL**

ACOUSTIC ASSESSMENT

ACOUSTIC LOGIC CONSULTANCY PTY LTD

9 Sarah St, Mascot

Tel:8338 9888

Fax: 8338 8399

TABLE OF CONTENTS

1.	EXECUTIVE SUMMARY	4
2.	INTRODUCTION	5
3.	SITE DESCRIPTION	5
4.	TRAIN NOISE ASSESSMENT	6
4.1	MEASUREMENT POSITION	6
4.2	TIME OF MEASUREMENTS	6
4.3	MEASUREMENT EQUIPMENT	6
4.4	NOISE ASSESSMENT CRITERIA	6
4.5	MEASURED NOISE LEVELS	7
5.	EVALUATION OF NOISE INTRUSION	7
5.1	INTERNAL NOISE LEVELS	7
5.2	RECOMMENDED GLAZING	8
5.3	ROOF / CEILING	10
5.4	EXTERNAL WALLS	10
6.	RAILWAY VIBRATION	10
6.1	OBJECTIVES	10
6.1.1	Project criteria	10
6.2	RAIL TRAFFIC VIBRATION MEASUREMENTS	11
6.2.1	Measurement Positions	11
6.2.2	Time of Measurements	11
6.2.3	Measurement Equipment	11
6.2.4	Measurement Results: Vibration Dose Values	11
7.	INVESTIGATION OF HELICOPTER NOISE INTRUSION	12
7.1	HELICOPTER NOISE	12
7.2	HELICOPTER AIRBORNE NOISE CRITERIA	12
7.3	EVALUATION OF NOISE INTRUSION	13
8.	STRUCTURE DYNAMICS ACOUSTIC REVIEW	14
9.	ACOUSTIC PRIVACY AND PARTITIONS	15
9.1	GENERAL APPROACH	15

9.2	ACOUSTIC DESIGN APPROACH	16
9.3	IMPORTANCE OF SPACE CHARACTER TO PERCEPTION OF SOUND	16
9.4	DETERMINATION OF REQUIRED ACOUSTIC MEASURES	16
9.5	APPLICATION OF ABOVE STUDY TO THIS PROJECT.	18
9.6	NOMINATED STC/R _w RATINGS	19

1. EXECUTIVE SUMMARY

Environmental impact of helicopter noise, train noise and train vibration on the acoustic amenity of the proposed development of Liverpool Hospital Redevelopment Stage 2 Phase 1 has been assessed.

Noise and vibration levels of the existing rail corridor were measured on site and used to determine suitable façade and building constructions. The proposed rail corridor development works have been considered and included in our assessment.

Helicopter noise levels measured on other hospital facilities have been used for the assessment of the proposed Helipad and its potential impact on façade and building constructions to achieve suitable internal noise levels. Appropriate constructions to achieve the required internal noise levels have been selected and presented in Section 5.

Trains induce ground borne vibration that is transmitted through the subsoil. This vibration has been measured and assessed for the proposed project.

With the adoption of the proposed measures in Section 5, it is considered that environmental noise intrusion will meet project requirements. Train vibration was found to be acoustically acceptable and no further treatments are required.

An acoustic review of the structural design has been undertaken and the current design was found to fully comply with the project design intent.

An acoustic study on speech privacy and architectural partitions has been undertaken. The findings of the study are presented in Section 10.

2. INTRODUCTION

An assessment has been undertaken on the impact of helicopter noise, train noise and train vibration on the acoustic amenity of the proposed development of Liverpool Hospital Redevelopment Stage 2 Phase 1. The assessment has been based on façade noise levels from rail traffic and helicopter noise levels measured on other hospital facilities. The measured noise levels were used to predict the transmitted noise levels inside the hospital, and select appropriate constructions to achieve the required internal noise levels.

Trains induce ground borne vibration that is transmitted through the subsoil. This vibration has been measured and assessed for the proposed project.

3. SITE DESCRIPTION

The project site is located within the block bounded by Elizabeth St, Goulburn St, Campbell St, and the rail corridor, Liverpool. The south eastern façade faces the south line rail corridor which is used primarily to carry passenger and diesel hauled freight trains. The assessment documented in this report is for Zone A of the redevelopment Stage 2 Phase 1. The western façade joins Zone B of the Liverpool Hospital Complex. The northern façade faces the MHC building while the southern façade faces Elizabeth St.



Figure 1 Zone A of Stage 2 Phase 1 Liverpool Hospital Redevelopment

4. TRAIN NOISE ASSESSMENT

4.1 MEASUREMENT POSITION

The train noise measurements were obtained along the south eastern boundary near the expected location of the south eastern building façade, approximately 5 metres from the Railcorp boundary fence. Noise measurement locations are provided in Figure 1 below.

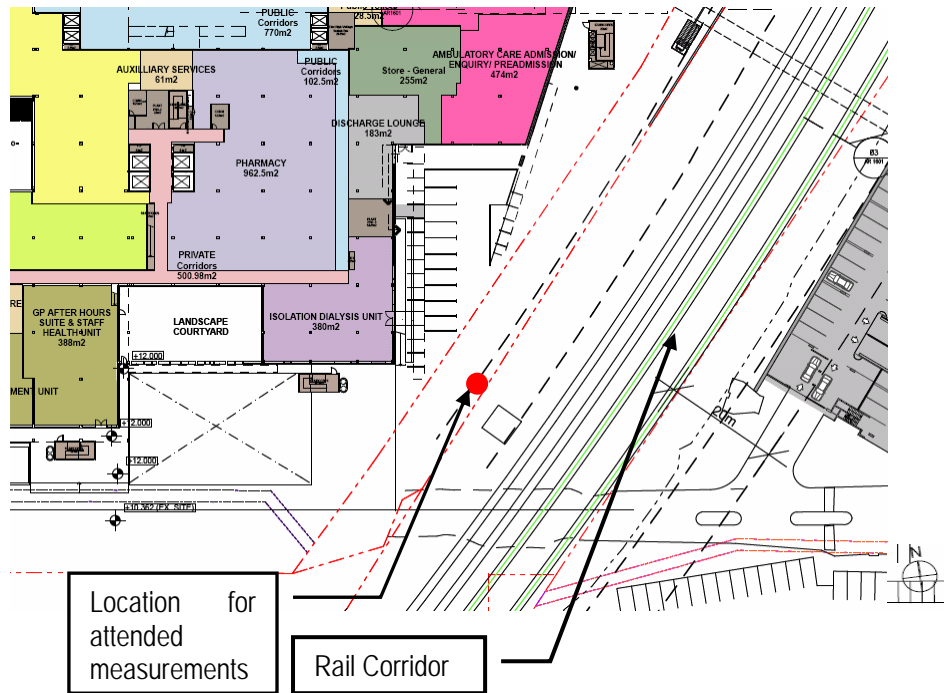


Figure 2 Measurement Location

4.2 TIME OF MEASUREMENTS

Attended noise measurements were obtained between 8am and 10am, 21st April 2008. Diesel freight train movements were recorded during the measurement period.

4.3 MEASUREMENT EQUIPMENT

Noise measurements were obtained using a CEL-593 Type 1 Sound Level Analyser, set to A-weighted fast response. The sound level meter was calibrated before and after the measurements using a RION NC-73 Sound Level Calibrator. No significant drift was recorded.

4.4 NOISE ASSESSMENT CRITERIA

Table 1 below provides acceptable noise levels for various spaces in the proposed hospital development. The criteria are expressed on the L_{eq} (1hour) descriptor. Internal requirements for hospital developments are assessed with windows closed.

Table 1 - NOISE CRITERIA IN HEALTH BUILDINGS FROM AS2107

SPACE/ACTIVITY TYPE	NOISE LEVEL L_{eq} dB(A)	
	Satisfactory Level	Maximum Level
Corridor and lobby spaces	40	50
Consulting rooms	40	45
Intensive care Wards	40	45
Laboratories	45	50
Office Areas	40	45
Pharmacies	45	50
Ward Spaces	35	40
Waiting Rooms Reception	40	45

4.5 MEASURED NOISE LEVELS

Train noise was measured utilising the SEL parameter with the L_{eq} train noise predicted based on the measured SEL levels and frequency of trains detailed in the current train time table. The measured/predicted noise levels are detailed in Table 2 below.

Table 2 – Measured/Predicted External Train Noise Levels

Location	dB(A) L_{eq} (1hour)
5m from Rail Corridor boundary	76.9

5. EVALUATION OF NOISE INTRUSION

5.1 INTERNAL NOISE LEVELS

Internal noise levels will primarily be as a result of noise transfer through the windows, as these are relatively light building elements that offer less resistance to the transmission of sound. The walls and roof are proposed to be heavy masonry elements that will not require upgrading.

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

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

In all cases, the selected glazing type (refer below) reduces internal noise levels to within the nominated criteria for the various space types.

5.2 RECOMMENDED GLAZING

The following tables list the recommended glazing assemblies for this project to achieve the requirements regarding train and traffic noise intrusion. All the windows and external doors listed are required to be fitted with acoustic seals. (Mohair Seals are unacceptable).

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

Table 3 - Recommended Glazing

Level	Space	Façade Orientation	Recommended Glazing	Acoustic seals
Ground Floor	Isolation Dialysis	West	6.38mm Lam or 6/40/6	Yes
		East/South	10.38mm Lam or 6/40/10	Yes
	After Hours Suite	East/South	12.38mm Lam or 6/40/10.38	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes
Level 1	Clinical Admin-Renal	East	12.38mm Lam or 6/40/10.38	Yes
		South	10.38mm Lam or 6/40/10	Yes
	Clinical Admin-Renal, Dialysis Unit	East/ South	12.38mm Lam or 6/40/10.38	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes
Level 2	Patient Bay	West	6.38mm laminated or 6/40/6	Yes
		East/ South	12.38mm Lam or 6/40/10.38	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes

Level 3	Cardiology IPU/ Cardiology	West	6.38mm laminated or 6/40/6	Yes
		East/ South	12.38mm Lam or 6/40/10.38	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes
Level 4	IPU	South	10.38mm Lam or 6/40/10	Yes
	Respiratory & Special Med	East	12.38mm Lam or 6/40/10.38	Yes
		West	6.38mm laminated or 6/40/6	Yes
	Respiratory Medicine	East	10.38mm laminated or 6/40/10	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes
Level 5	Orthopaedic IPU	South	12.38mm Lam or 6/40/10.38	Yes
	Orthopaedic & Trauma IPU	East	12.38mm Lam or 6/40/10.38	Yes
	Neurosurgery IPU	East	10.38mm laminated or 6/40/10	Yes
	Remaining	All	6.38mm laminated or 6/40/6	Yes
Level 6		North	10.38mm laminated or 6/40/10	Yes

In addition to meeting the minimum glazing thickness requirements given, the design of the window mullions, perimeter seals and the installation of the windows/doors in the building openings shall not reduce the STC rating of the glazing assembly below the values nominated in Table 4. Note that mohair type seals will not be acceptable for the windows requiring acoustic seals.

The window/door suppliers should provide evidence that the systems proposed have been tested in a registered laboratory with the recommended glass thicknesses and comply with the minimum listed STC requirements. Also, the glazing installer should certify that the window/doors have been constructed and installed in a manner equivalent to the tested samples.

Table 4 - Minimum STC of Glazing (with Acoustic Seals)

Glazing Assembly	Minimum STC of Installed Window
6.38mm Laminated	30
10.38mm Laminated	35
12.38mm Laminated	37
6mm float/40mm airgap/6mm float	31
6mm float/40mm airgap/10mm float	35
6mm float /40mm airgap /10.38mm laminated	37

5.3 ROOF / CEILING

The proposed concrete roof and metal deck roof with Mineral Fibre Tile ceiling will be sufficient to control road traffic and train noise intrusion.

5.4 EXTERNAL WALLS

External walls composed of concrete or masonry elements would not require upgrading. Walls other than concrete and masonry will be reviewed as part of ongoing detailed design and treated accordingly.

6. RAILWAY VIBRATION

Trains induce ground borne vibration that is transmitted through the subsoil. This vibration can be perceptible close to railways.

6.1 OBJECTIVES

6.1.1 Project criteria

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

Human response to vibration has been shown to be biased at particular frequencies which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the occupant is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 "Evaluation of Human Exposure to Vibration and Shock in Buildings (1 to 80Hz)" which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

This standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. For this project the aim will be for a low probability of adverse comment.

Table 5 - Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in commercial(hospital) buildings

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Commercial(hospital) buildings day time	0.4	0.8	1.6

6.2 RAIL TRAFFIC VIBRATION MEASUREMENTS

6.2.1 Measurement Positions

The rail vibration measurements were taken at ground level in line with the southern façade of the proposed development. Details are as shown in Figure 1.

6.2.2 Time of Measurements

The manned measurements were carried out from 8am to 10am on 21st April 2008. The measured vibration levels included diesel freight train movements.

6.2.3 Measurement Equipment

Svan 912 AE Sound Analyser was used for the vibration measurements. The analyser was connected to a SV08 four channel input module fitted with a Dytran triaxial accelerometer.

6.2.4 Measurement Results: Vibration Dose Values

The maximum train passby ground vibration acceleration, the typical passby period (gained from both the noise and vibration measurements) and the estimated number of train passbys were used to calculate the overall eVDV values for each period of the day. The results are presented in Table 6.

Table 6 - Vibration Dose Values

Location	Time Period	Calculated eVDV $m/s^{1.75}$	Criteria eVDV $m/s^{1.75}$	Complies
Measurement Location	Day (7am – 10pm)	0.08	0.4	Yes
	Night (10pm-7am)	0.05	0.4	Yes

7. INVESTIGATION OF HELICOPTER NOISE INTRUSION

This section details our preliminary review of potential helicopter noise and regenerated structure borne noise impact to the future occupants of the proposed Redevelopment of Liverpool Hospital. A detailed review will be undertaken following confirmation of the FATO.

7.1 HELICOPTER NOISE

There are no noise restrictions for emergency helicopter flights as detailed in Schedule 1 of the Protection of the Environment Operations Act. Notwithstanding this the EPA in Chapter 165 recommends the following to reduce the potential for noise impact;

- locating the helipad as far as possible from land zoned residential,
- setting flight paths to minimise noise exposure of residential land, and
- minimising ground idling time.

7.2 HELICOPTER AIRBORNE NOISE CRITERIA

This section discusses the levels of helicopter noise which will be potentially heard within the proposed development and existing buildings in the vicinity of the Helipad and associated flight path.

The proposed buildings would potentially be significantly affected by noise from the proposed hospital's emergency helicopter service.

To determine suitable noise levels for the various space types with regards to the helicopter landing pad the following information was examined and evaluated;

1. The proposed location of the helicopter landing pad.
2. Typical frequency of use of the landing facility.
3. Recommended design sound levels for different areas of occupancy as specified in AS 2021.

It has been assumed that helicopter movements will be limited to emergency situations. Based on this assumption an acceptable noise level for rare and short term occurrences such as helicopter arrival and departures would be the recommended AS 2021 level plus 20 dB(A).

The nominated noise levels for the various spaces types selected following the methodology described above are shown in the table which follows.

Table 7 - Nominated Helicopter Noise Levels

SPACE TYPE	NOISE LEVEL OBJECTIVE dB(A)
Wards	70
Theatres	65
Treatment rooms	70
Consulting rooms	70
Laboratories	75
Service Areas	85
Private offices, conference areas	70
Offices - general	75

7.3 EVALUATION OF NOISE INTRUSION

Detailed Helipad location and fly path are not available at this stage. Noise intrusion into the habitable spaces within the proposed development can be predicted in addition to neighbouring buildings in the vicinity of the Helipad and flight path. The calculations will be based on the flight paths and assumed the worst case that helicopters pass directly over development.

Noise levels used for assessment will be obtained from measurements taken by this office of a Jet Ranger Helicopter during the following activities;

- ⇒ Starting up
- ⇒ Running hard during starting up
- ⇒ Taking off
- ⇒ Various approaches

Of the above activities, taking off was the loudest and thus this level will be used for assessment purposes.

The results of our preliminary review indicate that the building constructions as documented for general external noise intrusion will be adequate for the control of Helicopter noise intrusion. Lightweight roof elements will be assessed in detail considering the FATO and distance/orientation to the receiving roof.

Detailed helicopter noise assessment will be carried out once the FATO is available.

8. STRUCTURE DYNAMICS ACOUSTIC REVIEW

Acoustic Logic have reviewed the letter dated 15th April and the current structural design and provide our assessment below.

VIBRATION CRITERIA

Regarding appropriate design criteria for slab vibration according to AS 2670 the following base curve multiplication factors are recommended:

Zone 1 – sensitive medical equipment and sensitive areas – multiplier of 1. Depending on the equipment used and its location there may be a need to provide supplementary vibration isolation in the form of “floating” plinths or slabs. This would typically be incorporated into the design/capability of the equipment base and sub-supporting structure.

Zone 2 – Operating Theatres - multiplier of 1.

Zone 3 – Multiplier of 1.4

Zone 4 – Multiplier of 4.

MINIMUM SLAB THICKNESSES

A 120mm thick slab with a suspended ceiling tile or plasterboard ceiling will cover almost all situations to cover airborne noise transmission.

The thicknesses will generally be determined by structural (both strength requirements and floor dynamic characteristics).

The slab thicknesses noted on the drawings are typically well above 120mm and are therefore generally acceptable.

Major plant rooms will be assessed for noise containment once detailed plant selections and layouts are made available. Typical structural requirements for these areas would dictate a thicker slab. Acoustic upgrade including floating slabs will be determined once more detail is obtained for the mechanical systems.

LEVEL 6 AND LEVEL 3 PLANT ROOMS

Treatment will be confirmed once plant selections are available, nominally chiller/generator plant areas above ward areas and sensitive spaces such as operating theatres will likely need a floating concrete floor (nominally 100-125mm thick). TBA

SLAB THICKNESSES REQUIRED TO CONTROL PLANT VIBRATION

Minimum 170mm slab thicknesses indicated on the drawings will be sufficient to control plant vibration given that plant will be fitted with vibration isolators. In some cases, such as chillers and gen sets, if a floating floor is not used, there may be a requirement to install floating concrete plinths, but these will be located under the equipment similar to (and in place of) a normal plinth.

MINIMUM WALL THICKNESSES FOR LIFT SHAFTS

150mm thick Reinforced Concrete acoustically acceptable.

9. ACOUSTIC PRIVACY AND PARTITIONS

The objective of this section is to examine the acoustic requirements of the various space types and formulate suitable criteria to represent these requirements. The level of acoustic separation and background noise required is dependant on the nature and type of activities which take place in the various areas and rooms within the Hospital.

To determine suitable sound transmission class ratings for the various space types the following information was examined and evaluated.

1. The project specified STC/R_w ratings for the various space types.
2. The architectural layouts for the Hospital. These indicate the various space/activity relationships which will exist on this project.
3. Practices applied on other medical facilities and their degree of success.
4. Previous studies carried out to determine the perception of human speech with varying degrees of STC/R_w rated partitions.

The last point is of particular importance, as these studies have been performed for a number of recent projects with the aim of distilling the minimum acceptable sound for sound rated partitions system, taking into consideration both acoustic performance and buildability. An understanding of the perception of sound and general audibility and intelligibility of human speech with different sound rated partitions is fundamental to the determination the of correct STC/R_w ratings for this project.

A second principle in this process which requires consideration is that the attainment of the exact STC/R_w ratings and background noise levels should be balanced against the attainment of other project requirements such as reverberation control, provision of clear passage above ceiling spaces for the routing of the myriad of services.

9.1 GENERAL APPROACH

The acoustic advice for this project has been developed to encompass the broader requirements of this facility. The consulting rooms, counselling offices, executive offices, and specialised areas of the hospital are seen as the most critical, requiring adequate acoustic isolation to maintain speech and acoustic privacy. Other associated spaces such as waiting areas, patient wards, general treatment and medical areas will require acoustic standards which provide speech privacy under normal conditions. That is when people are talking at normal volumes, these conversations will not be clearly audible in adjoining spaces. Loud events such as screaming or shouting are not seen a normal and hence do not require consideration in these space.

The location of the space is also important in determining the required STC/R_w rating. For example a tutorial or consulting room located in the middle of a corridor and adjoined by storage areas should require a lower STC/R_w rating than the same room types adjoining a patient ward or another consulting room. Note corridors are transitory spaces, where people either pass along or spend short periods of time, and differ greatly from spaces where people are stationed and are in a position to hear or be disturbed by sound in an adjoining area.

9.2 ACOUSTIC DESIGN APPROACH

A suitable acoustic standard for the different space types was determined by evaluating space function against specific acoustic requirements. Accordingly, the required acoustic environment for a space can be seen as a composite of four elements, namely;

1. The perceived sound privacy requirements.
2. The ambient acoustic environment(background noise levels); this is a direct function of the activities which occur and mechanical services noise.
3. The acoustic character of the space.
4. The levels of noise which are likely to be generated within a space, and how they will affect adjoining spaces.

This evaluation process was carried out to determine the acoustic requirements of the various spaces within this development.

9.3 IMPORTANCE OF SPACE CHARACTER TO PERCEPTION OF SOUND

The acoustic character of a room will determine the quality of the sound, and may lead to a space being perceived to be noisy. Acoustic character specifically refers to the sound absorption properties of the room finishes and the resulting nature of sound. A space with little acoustic absorption will sound reverberant and hollow. Noise heard in such a space tends to sound loud and sharp. Where adequate acoustic absorption is provided, sounds tend to be more natural and intelligible. This also makes the space sound quieter and therefore aurally more comfortable. For this development, it is proposed to provide a room character which is suitable for a health facility environment, i.e. quiet and comfortable.

9.4 DETERMINATION OF REQUIRED ACOUSTIC MEASURES

In order to determine suitable acoustic measures for this project it is first necessary to understand the level of sound isolation provide by differently rated partition systems. (Note: a partition system as used in this report refers to the total performance of the wall and ceiling).

The best manner in which to describe the level of sound privacy provided by different partitions systems is by conducting a comparison between the levels of acoustic privacy provided by three differently rated partitions. In this discussion we will demonstration the level of acoustic privacy afforded by partitions having STC/R_w ratings of STC/R_w 30, 35 and 45. The data presented below was obtained in a simulation performed to actually demonstrate noise heard with each of the above ratings.

The table below provide an indication of various volumes of speech and resultant audibility with different partitions systems.

Speech Noise Level	Represents	STC/R _w Rating of partitions	Audibility of Speech In Adjacent Office
60 dB(A)	Normal conversation	25	Speech clearly audible
60 dB(A)	Normal conversation	30 partition	Speech barely audible. Content of speech not recognisable.
70 dB(A)	Raised voice	30 partition	Speech clearly audible. Content of speech not fully recognisable.
60 dB(A)	Normal conversation	35 ¹ partition	Speech generally not audible. Content of speech not recognisable.
70 dB(A)	Raised voice	35 ² partition	Speech audible. Content of speech not recognisable. Similar to STC 30 partition but not quite as loud.
70 dB(A)	Raised voice	45 partition	Speech inaudible.

¹:With the increase to STC/R_w 38 speech would not be audible and contents not recognisable. Note: this is the standard generally used for middle management offices in the private sector

²:With the increase to STC/R_w 38 speech would generally not be audible. STC/R_w 38 represents an improvement on STC/R_w 35.

From the above table it can be determined that;

- An STC/R_w 30 partition provides an moderate level of privacy for normal conversation levels.
- Raised conversation levels through an STC/R_w 30 partition would be clearly audible in an adjacent space.
- Increasing the rating from STC/R_w 30 to 35 marginally reduces the noise level from raised conversation in the adjacent room. However, speech was still audible, and the content of the speech still intermittently recognisable. However normal conversation levels are not audible.
- raising standard to STC/R_w 38 provides suitable level of speech privacy for normal and raised voices.
- An STC/R_w 45 partition would provide complete privacy.

From the above discussion it can be concluded that an STC/R_w 30 partition system provides adequate isolation for normal speech, but is not effective in isolating raised voices.

An STC/R_w 35 rating is similar to STC/R_w 30, but provides better isolation for raised voices.

An STC/R_w 38 rating provides a suitable level of isolation for normal and raised voices.

An STC/R_w 45 partitions was found to provide complete privacy for normal and raised voices.

9.5 APPLICATION OF ABOVE STUDY TO THIS PROJECT.

The findings discussed in the previous section generally indicate that three levels of STC/R_w rating would be adequate to address the acoustic privacy requirements for this project. This would be STC/R_w 35 for general spaces without strict privacy requirement, STC/R_w 38 where a moderate level of speech privacy is required and STC/R_w 45 where high levels of privacy are required.

However, prior to finalising the ratings which will be used for this project, it is necessary to refer back to the planned space relationships.

The determination of which space assigned the various sound separation grading is then a function of the following;

- Space and activity type.
- Relative location of space to other spaces
- Level of sound privacy required for a space type.
- Level of space privacy experienced in a particular space type. For example it can be stated that minimal acoustic privacy exists in a 2 and 4 bed ward, where as the opposite is true for a 1 bed ward.
- Background noise levels which will occur in the space type.
- Reverberant conditions in the space type.
- Is a door fitted to the space

From the above requirements three basic ratings were derived for this project and allocated accordingly.

These ratings are:

STC/R_w 35	To be applied to spaces requiring speech privacy under normal conversation levels
STC/R_w 38	To be applied to spaces requiring speech privacy under normal and raised conversation levels
STC/R_w 45	To be applied to spaces requiring high degrees of privacy

Notes: 1 STC/R_w 30 is not included on this project as it does not provide good isolation against raised voice.

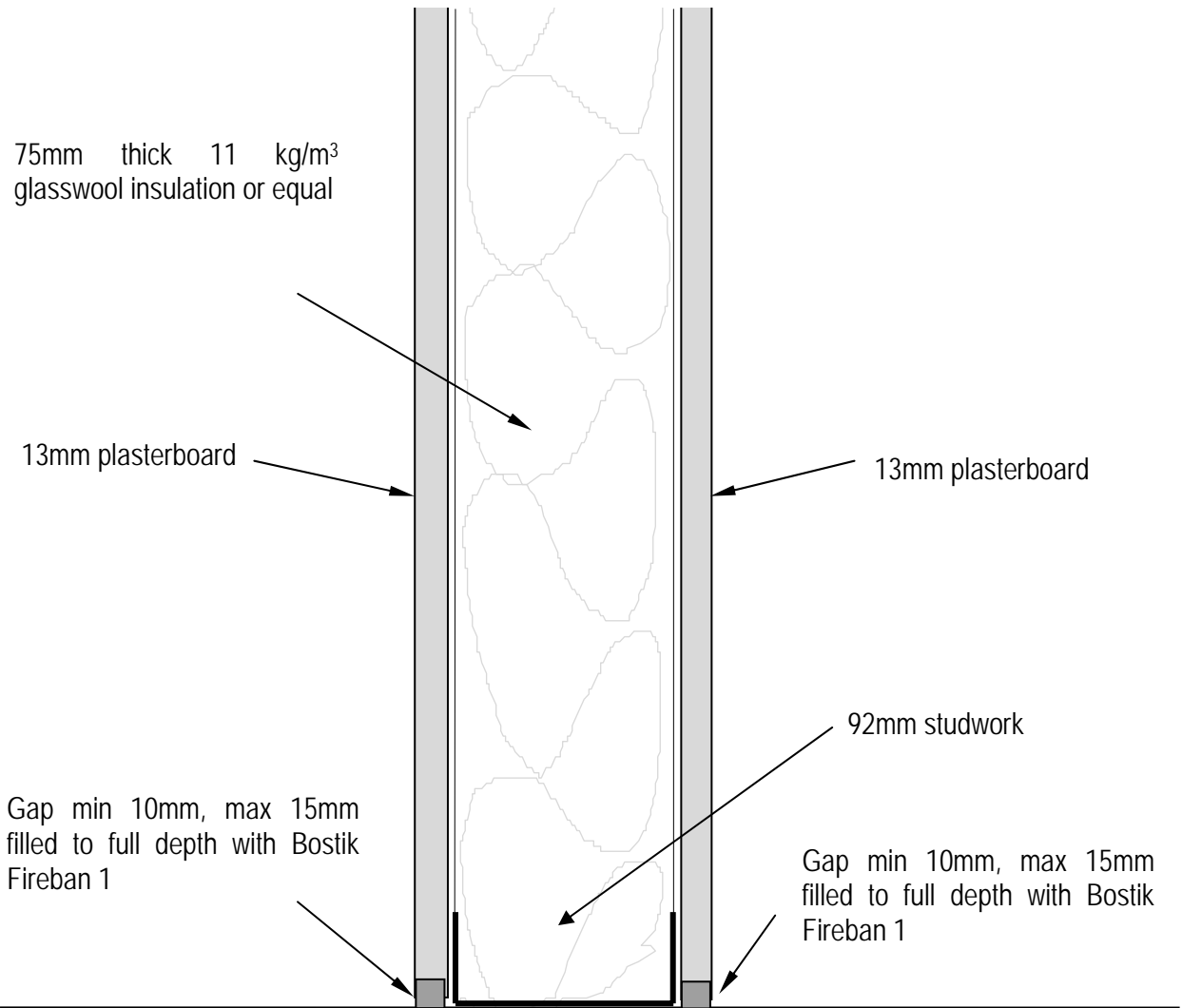
2 An STC/R_w 38 rating provides a superior isolation against raised speech and represents a higher levels of sound isolation than STC/R_w 35.

9.6 NOMINATED STC/R_w RATINGS

The nominated STC/R_w ratings for the various spaces types selected following the methodology described above are shown in the table which follows. The ratings below are generally in accordance with Sydney South West Area Health Service Liverpool Hospital Redevelopment 12th September 2007. Ratings where modified have been based on vast experience with hospitals and the methodology afore mentioned.

SPACE TYPE	NOMINATED STC VALUES
Conference/Seminar Rooms	45
Lecture Rooms	45
Speech Pathology Rooms	45
Maintenance Workshops	38
Plant Rooms	to be determined based on equipment selections
Tutorial/Case Conference Room	45
Tutorial/Library/Medical Conference and Audiovisual Room.	45
Ward - Inpatient(1 bed)	38
En-Suite (1 Bed)	38
Ward - Inpatient(4 beds)	35
En-suite (4 bed)	35
Bedrooms - Residential	45
Offices -upper management	45
Offices -general	38
Chapel/Quiet Room	45
Consultative and Examination Rooms	38/45*
Counselling Rooms	45
Paediatric observation room(Emergency)	38
Group Room	38/45*
Interview Room	45
Meeting room	45
Procedures and Treatment Rooms	38
Recovery	35
Ultrasound /endoscopy	45
Audiology Speech Observation	50
Clean Utility areas	no rating
Dirty Utility areas	35
Bathrooms	35
Toilets/change Rooms	38
Reception/Security	38
Potwash and Dishwash to Kitchen	35

* - depending on adjacent space

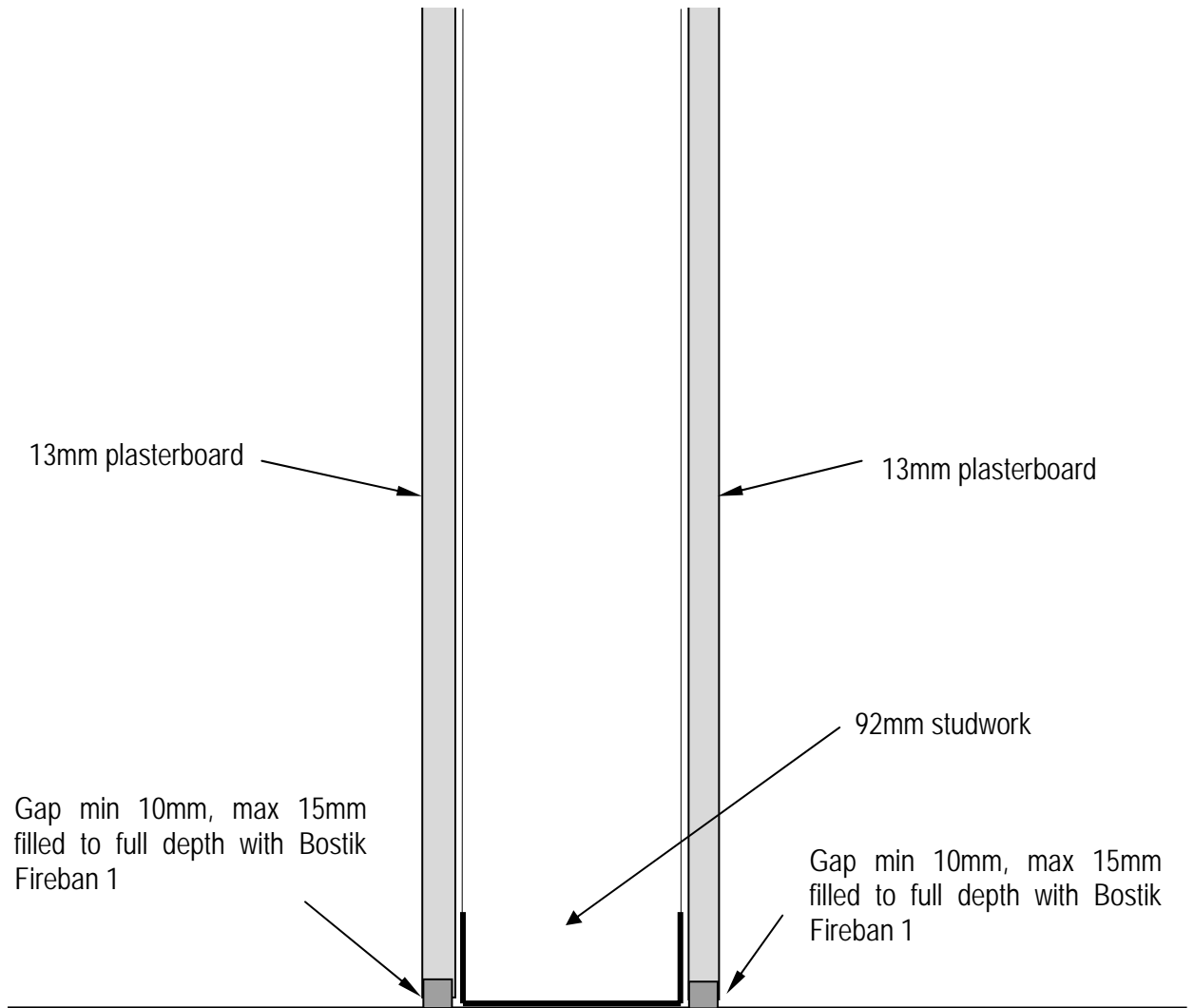


SECTIONAL ELEVATION OF STC45 WALL SYSTEM

Acoustic Logic Consultancy Pty Ltd
 9 Sarah Street, Mascot
 Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
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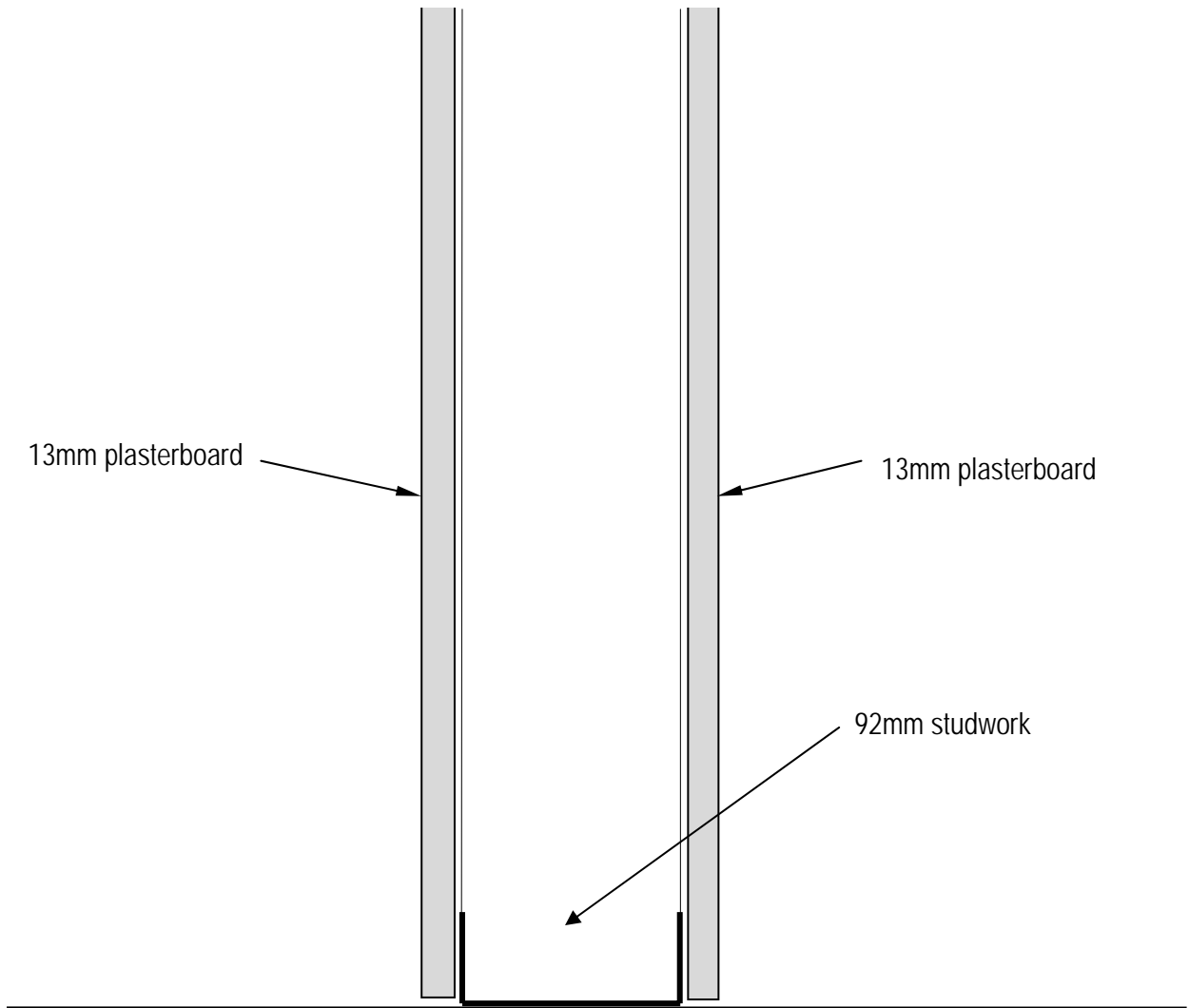


SECTIONAL ELEVATION OF STC 38 WALL SYSTEM

Acoustic Logic Consultancy Pty Ltd
 9 Sarah Street, Mascot
 Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
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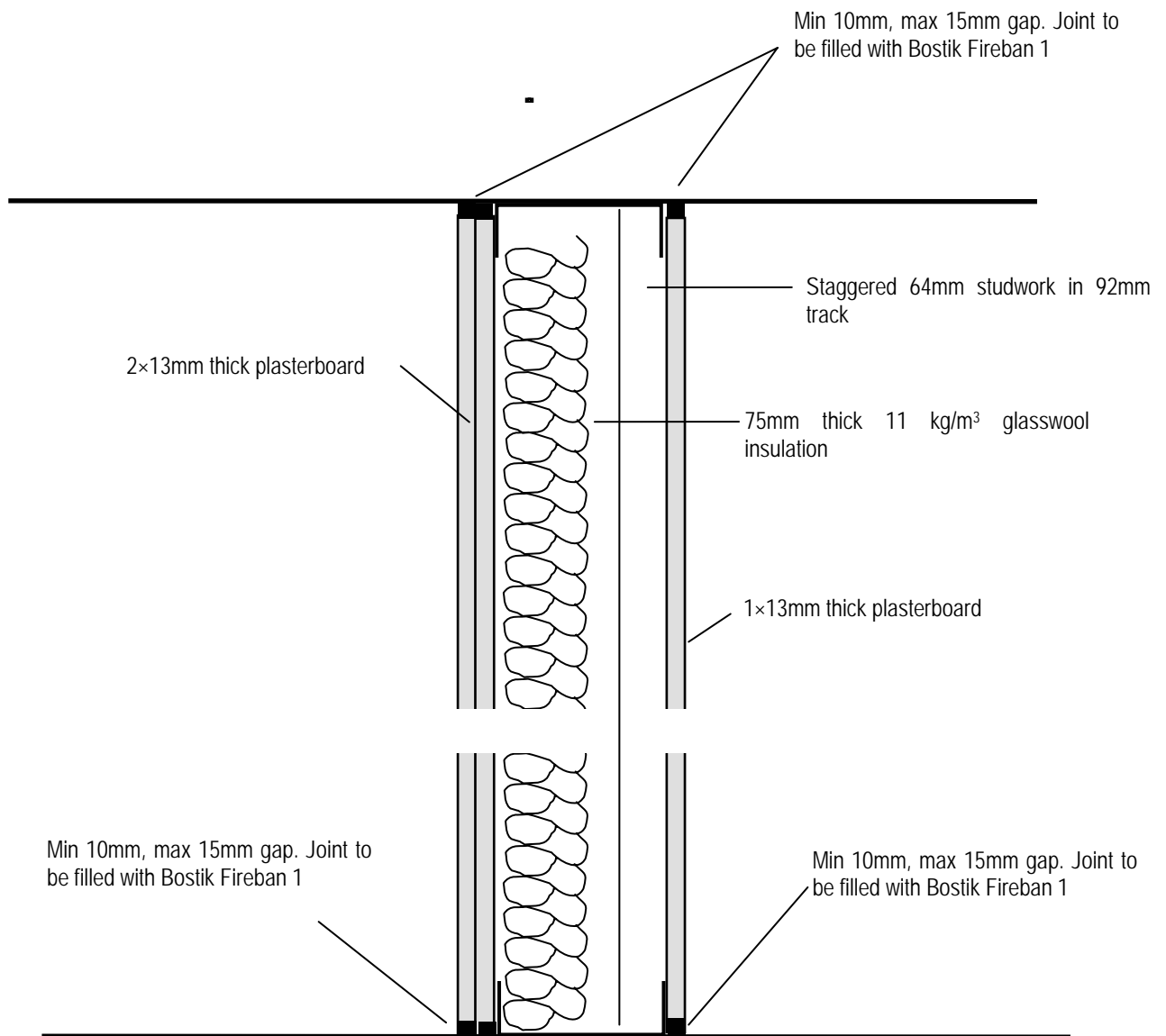


SECTIONAL ELEVATION OF STC 38 WALL SYSTEM

Acoustic Logic Consultancy Pty Ltd
 9 Sarah Street, Mascot
 Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC003_R0
Issue	Scale:	Approved		
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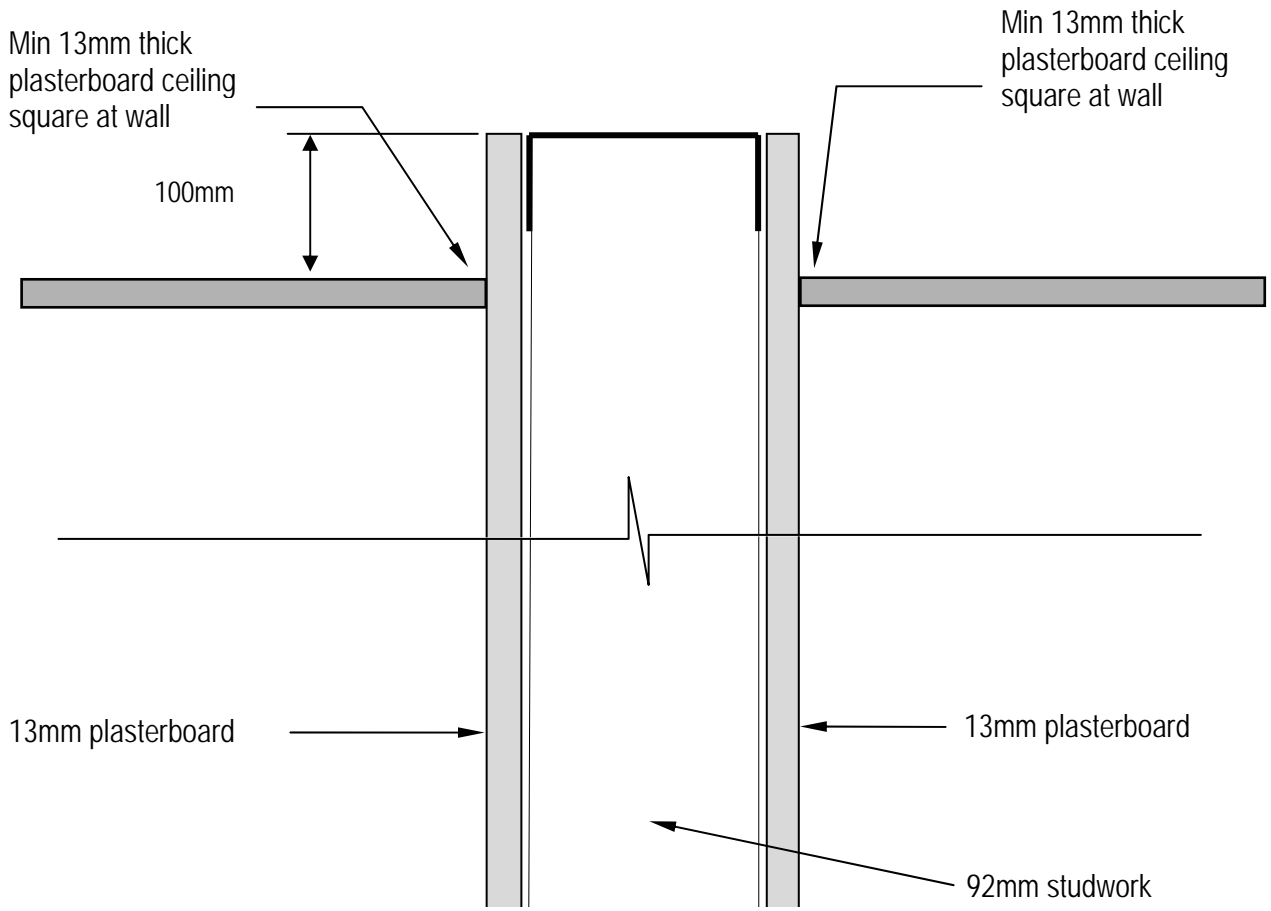


SECTIONAL ELEVATION OF STC 50 WALL SYSTEM

Acoustic Logic Consultancy Pty Ltd
 9 Sarah Street, Mascot
 Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

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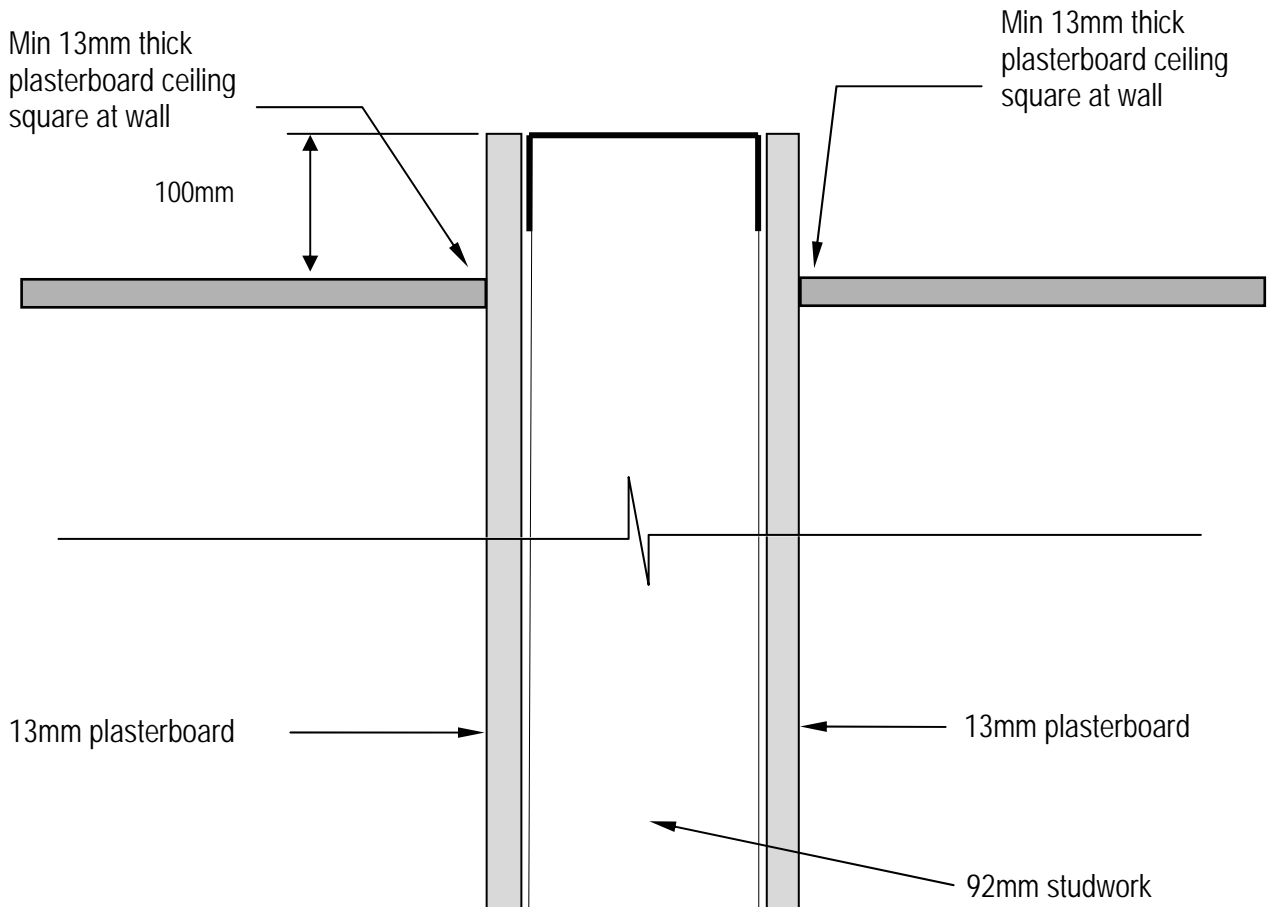


**SECTIONAL ELEVATION OF STC 35
WALL/CEILING SYSTEM**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

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June, 2008	BW		2008402	AC005_R0
Issue	Scale:	Approved		
0	NTS			



**SECTIONAL ELEVATION OF STC 38
WALL/CEILING SYSTEM**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

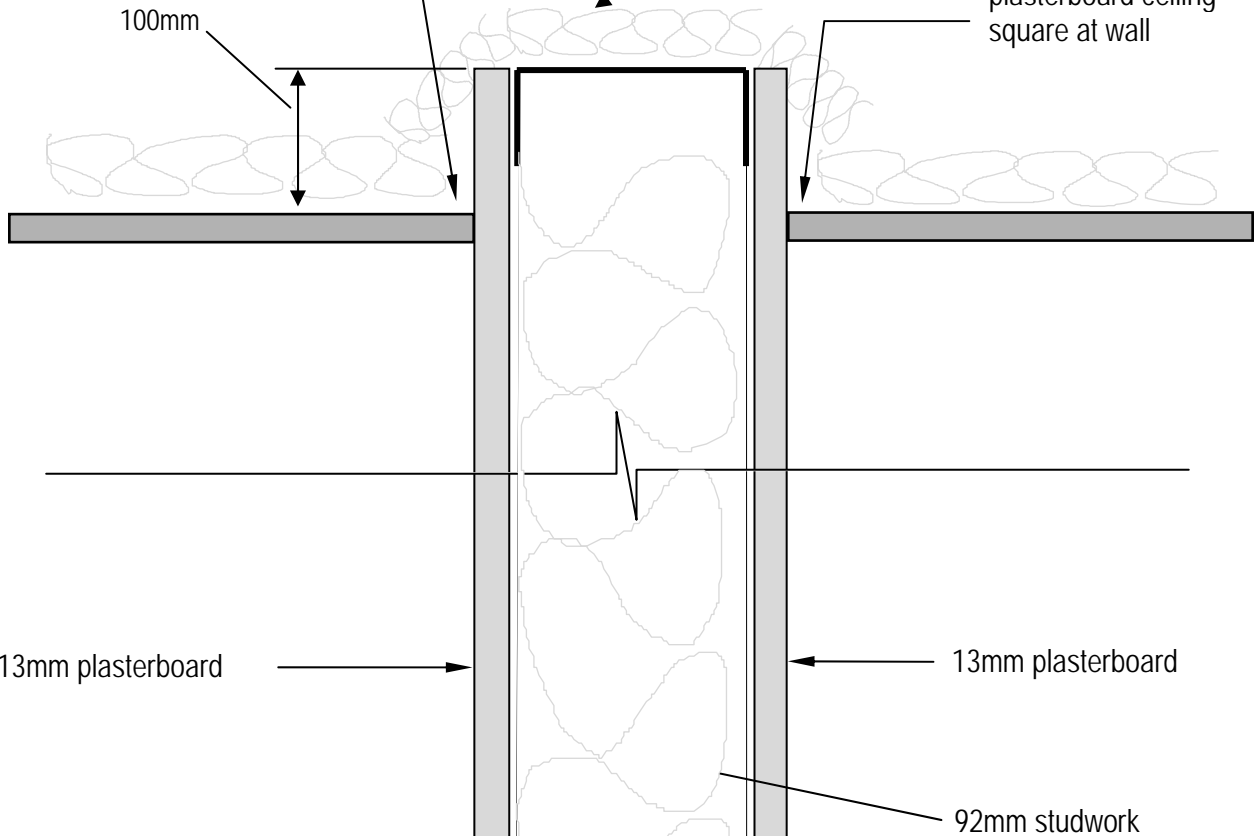
Date: June, 2008	Drawn: BW	Checked:	Project No: 2008402	Drawing No: AC006_R0
Issue 0	Scale: NTS	Approved		

Min 13mm thick
plasterboard ceiling
square at wall

75mm thick 11 kg/m³ glasswool (1.2m
metre wide) strip straddled across wall

Min 13mm thick
plasterboard ceiling
square at wall

100mm



13mm plasterboard

13mm plasterboard

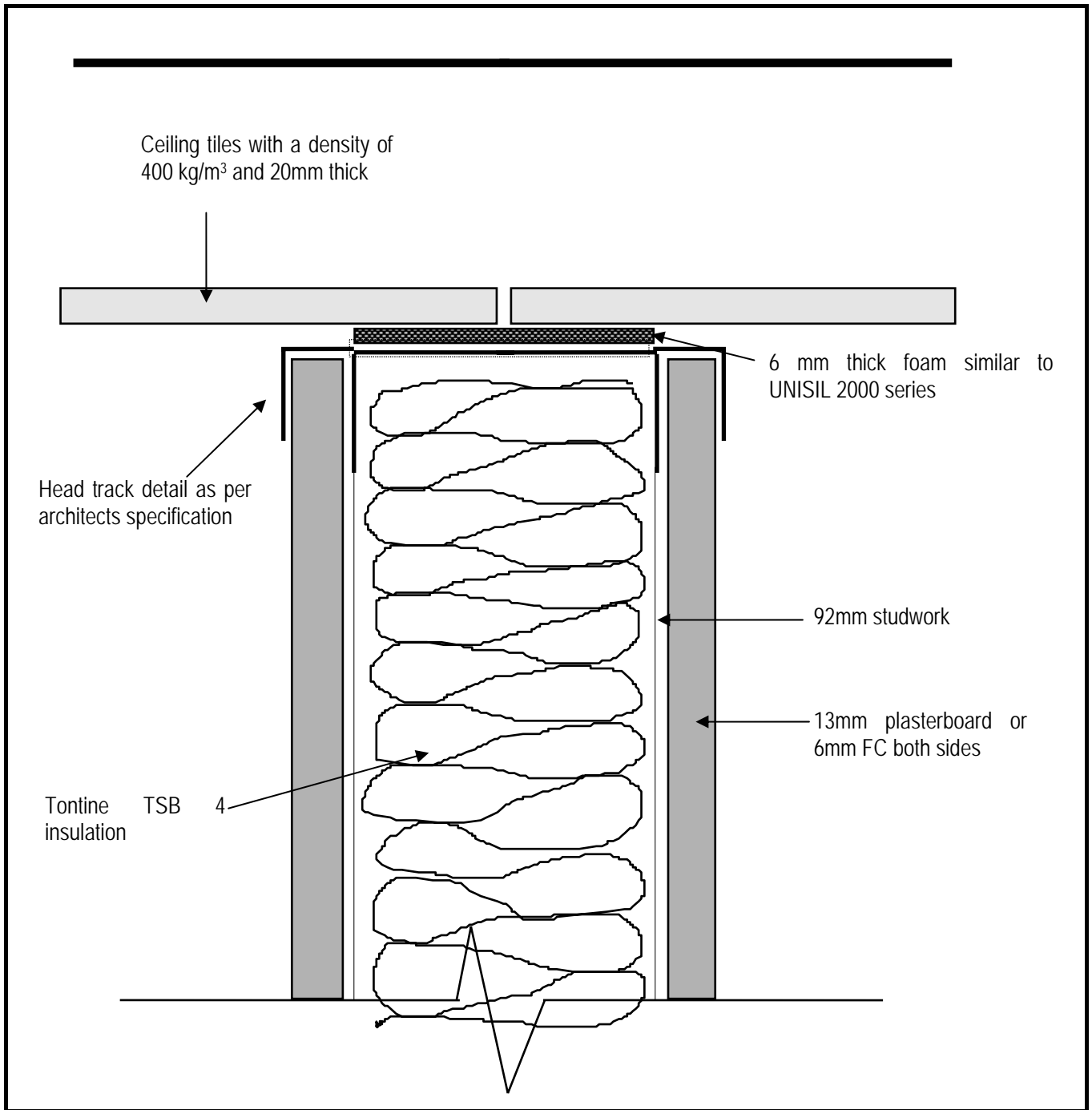
92mm studwork

**SECTIONAL ELEVATION OF STC 45
WALL/CEILING SYSTEM**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC007_R0
Issue	Scale:	Approved		
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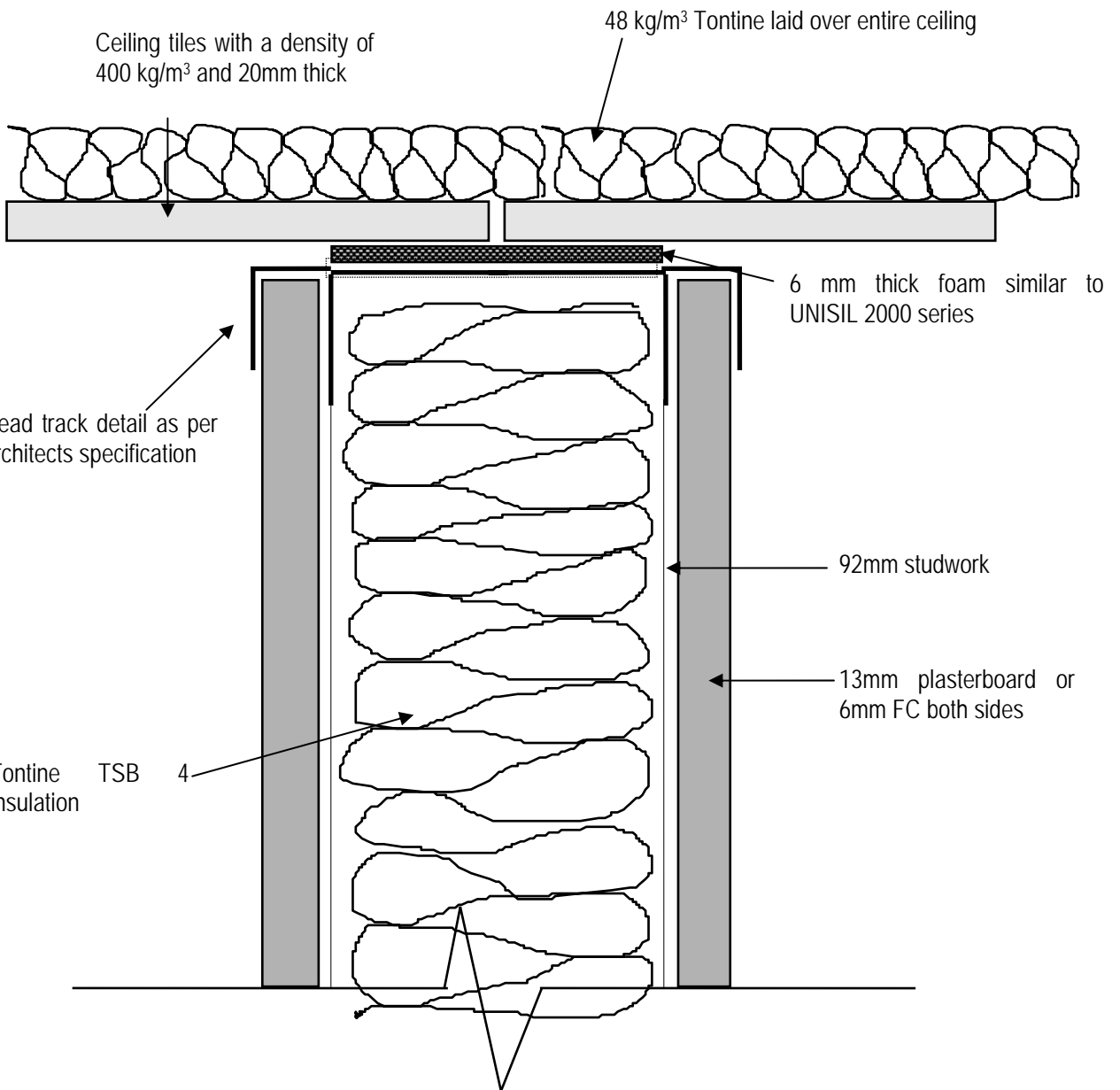


**SECTIONAL ELEVATION STC 40 WALL,
HEAD TRACK CONNECTION TO CEILING**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC008_R0
Issue	Scale:	Approved		
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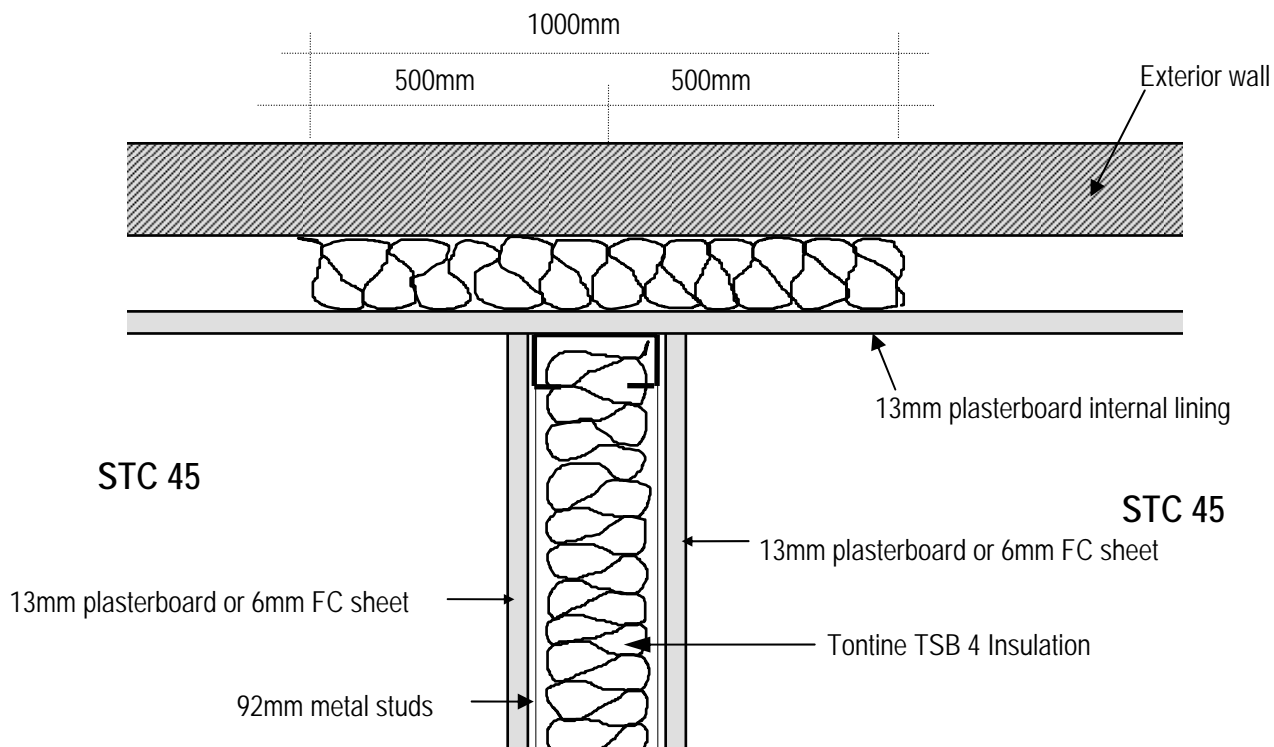


**SECTIONAL ELEVATION OF STC 45
WALL/CEILING SYSTEM**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date: June, 2008	Drawn: BW	Checked:	Project No: 2008402	Drawing No: AC009_R0
Issue 0	Scale: NTS	Approved		

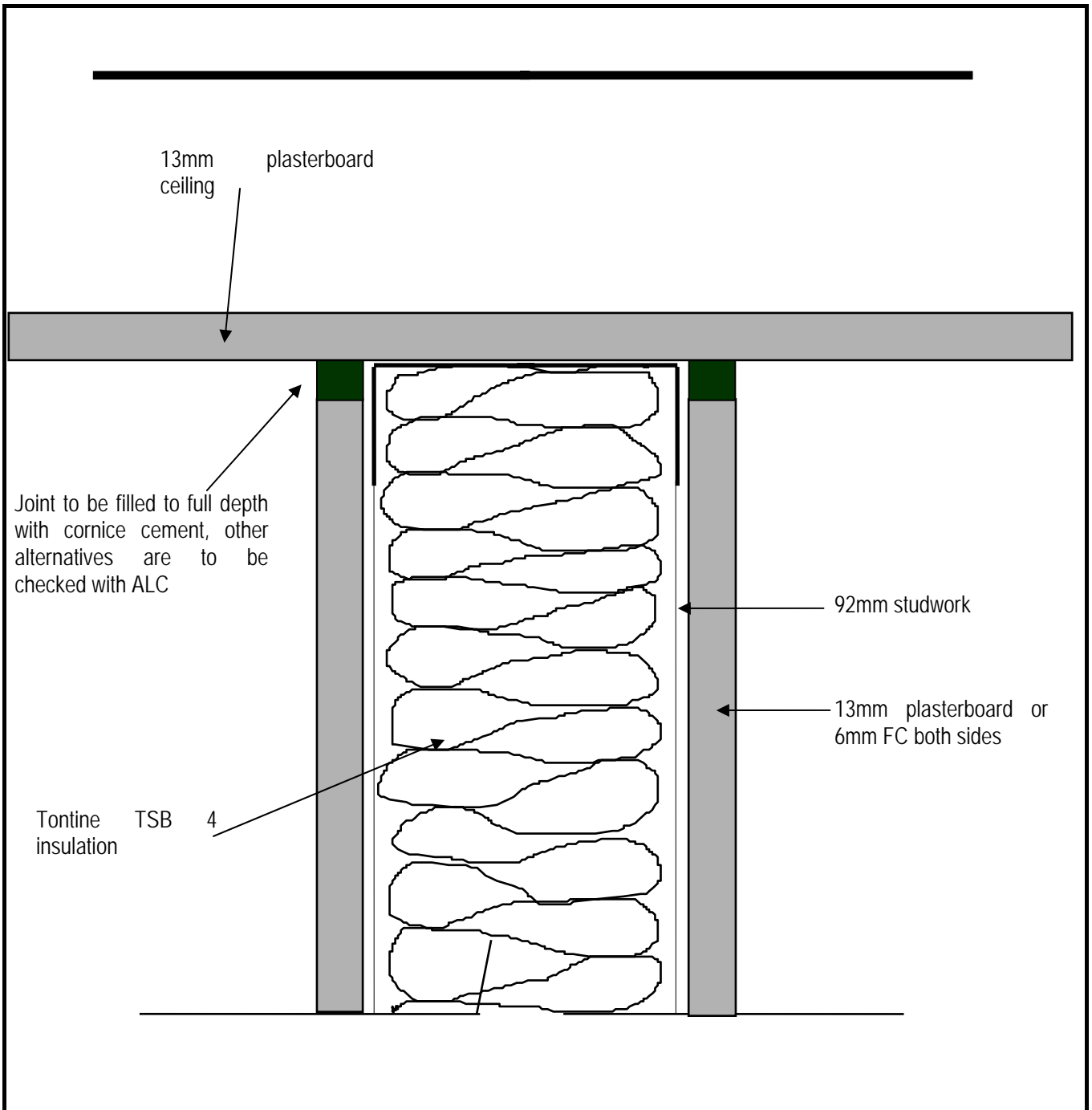


PLAN STC 45 WALL JUNCTION ON BUILDING EXTERIOR BETWEEN SPACES

Acoustic Logic Consultancy Pty Ltd
 9 Sarah Street, Mascot
 Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC010_R0
Issue	Scale:	Approved		
0	NTS			

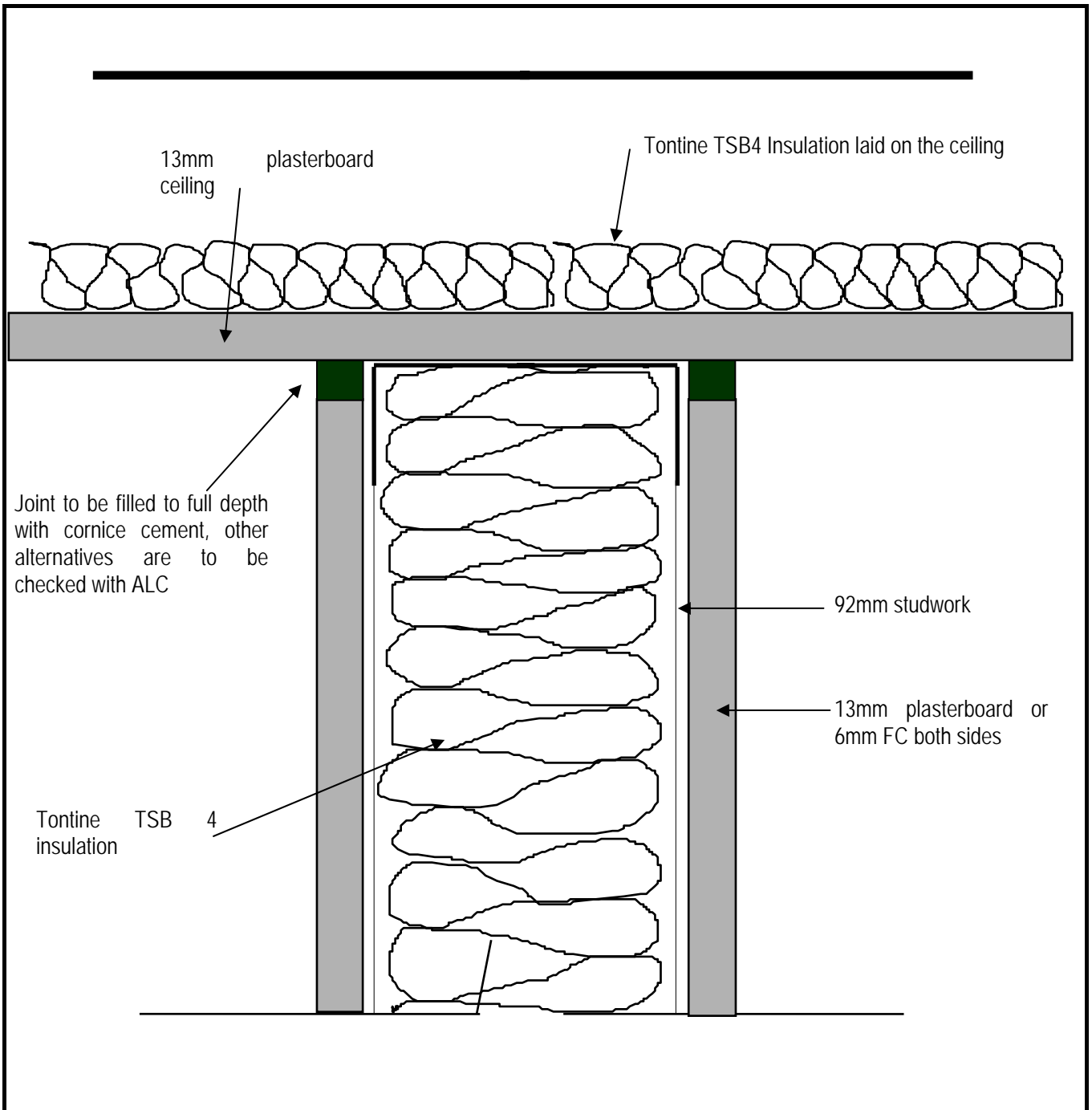


**SECTIONAL ELEVATION STC 40 WALL, SET
PLASTERBOARD CEILING**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC011_R0
Issue	Scale:	Approved		
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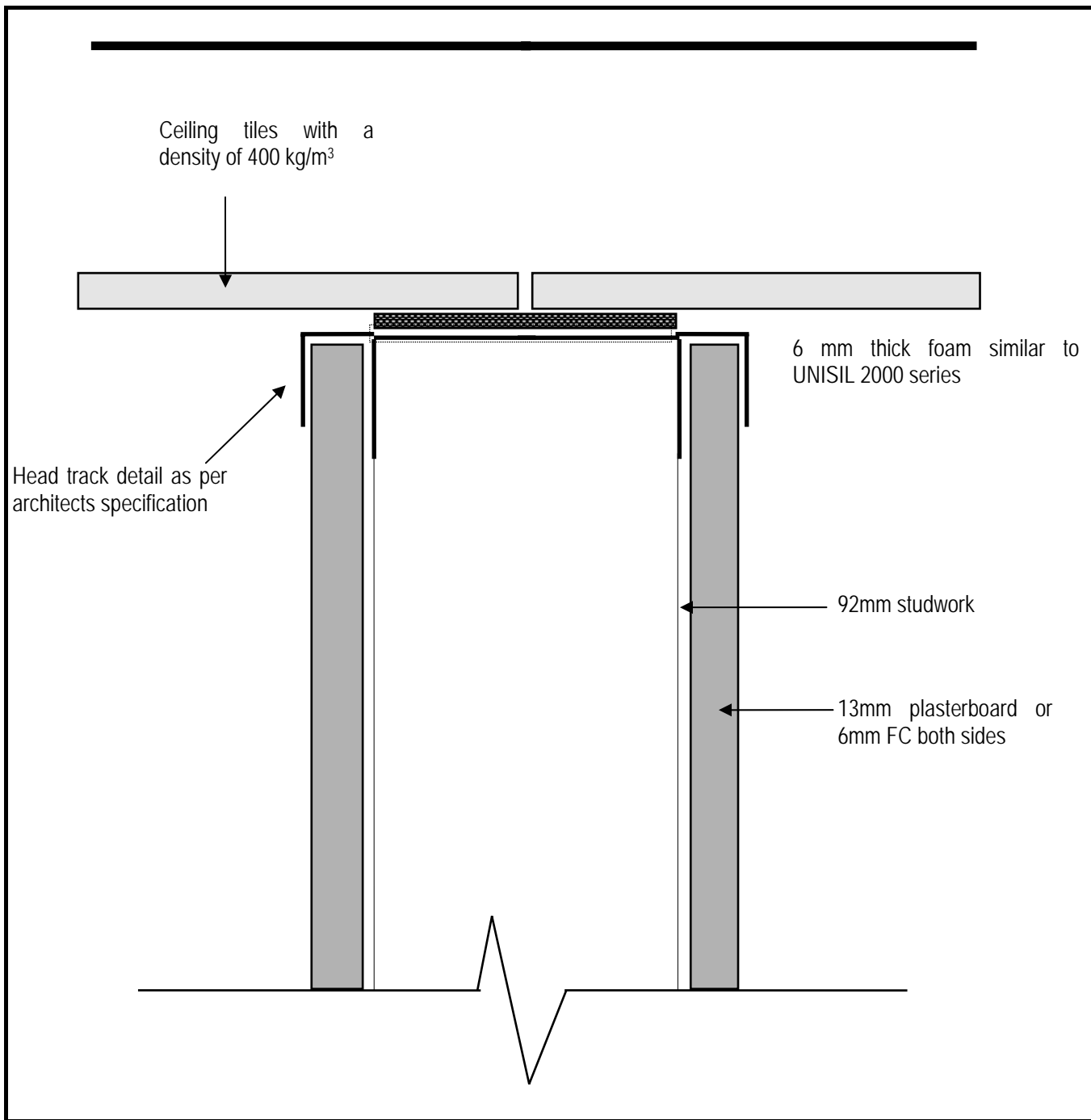


**SECTIONAL ELEVATION STC 45 WALL, SET
PLASTERBOARD CEILING**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

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June, 2008	BW		2008402	AC013_R0
Issue	Scale:	Approved		
0	NTS			



**SECTIONAL ELEVATION STC 35 AND 38
WALL, HEAD TRACK CONNECTION TO
CEILING**

Acoustic Logic Consultancy Pty Ltd
9 Sarah Street, Mascot
Tel: 8338 9888 Fax: 8338 8399

LIVERPOOL HOSPITAL

Date:	Drawn:	Checked:	Project No:	Drawing No:
June, 2008	BW		2008402	AC014_R0
Issue	Scale:	Approved		
0	NTS			

CSB MILESTONE 1, LIVERPOOL HOSPITAL

DEMOLITION AND EXCAVATION NOISE IMPACT STATEMENT

Prepared for

BOVIS LEND LEASE

ACOUSTIC LOGIC CONSULTANCY PTY LTD

NOISE AND VIBRATION CONSULTANTS

9 Sarah St, Mascot NSW 2020

TEL: 8338 9888

FAX: 8338 8399

CONTENTS

1.	SUMMARY	3
2.	NOISE CONTROL STRATEGY	5
2.1	CONSTRUCTION NOISE CRITERION	5
2.2	SUITABLE NOISE STANDARD FOR CONSTRUCTION NOISE ASSESSMENT	6
2.3	NOISE MANAGEMENT	6
3.	STUDY OVERVIEW	7
4.	CONSTRUCTION NOISE.....	7
4.1	CATEGORISATION OF CONSTRUCTION ACTIVITIES	7
4.2	EXCAVATION.....	8
4.3	DISCUSSION	9
5.	SITE DESCRIPTION AND POTENTIALLY AFFECTED LOCATIONS.....	10
6.	NOISE CRITERIA.....	10
7.	VIBRATION CRITERIA	10
7.1	AS2187	10
7.2	BRITISH STANDARD BS 6472:1992.....	11
8.	DETERMINATION OF CONSTRUCTION NOISE IMPACT.....	12
9.	SOUND POWER LEVELS	12
10.	DEMOLITION	13
11.	EXCAVATION	14
12.	VIBRATION - ACCEPTABLE WORK PRACTICES	15
13.	ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES	15
14.	STATEMENT OF INTENT TO COMPLY	15
15.	FINAL STATEMENT	16
Appendix:	Construction Noise Management Plan	

1. SUMMARY

This report presents an approach to noise associated with the demolition and excavation of the new CSB, Milestone 1, Liverpool Hospital. This report was commissioned by Bovis Lend Lease and presents an advanced study of noise emanating from the site. The study has been undertaken to determine the levels of noise emissions, which will result at the various premises which either border or are in close proximity to the site.

The report identifies that noise levels will vary from the different construction processes, and that piling will be the noisiest activity. Noise levels from all activities are calculated to all potentially worst affected receiver locations. If noise levels are acceptable at these locations they will also be acceptable further a field. The receiver locations studied in this report are:

1. Clinical Services Building adjacent to western boundary with 6.38mm Laminated fixed windows on the nearest facade.
2. MHC Building adjacent to northern boundary with 6.38mm Laminated fixed glazing and openable doors facing the project site.
3. Residential buildings located immediately across Goulburn St which are approximately 150m distance western to the site separated by the existing clinical services building.

Detailed site map and noise receiver locations refer to Figure 1 below.

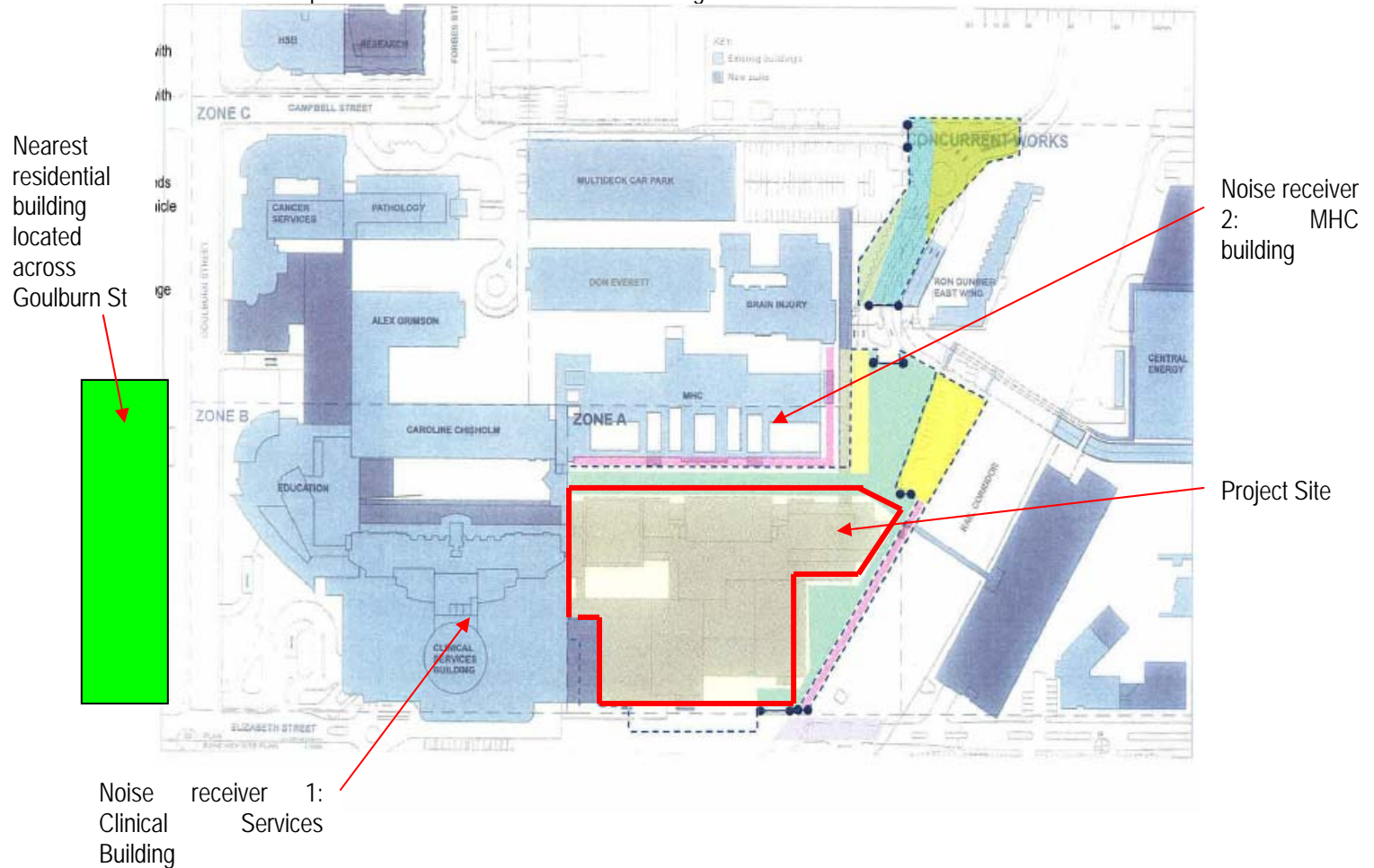


Figure 1 Site Map and Noise Receiver Locations

The results of the calculations are presented in a tabulated form for each receiver location. The tables identify provide the following information;

1. The time period,
2. The subject construction activity,
3. The resultant noise level at the affected premises, the calculated noise levels also take into account any mitigate measures which will be applied to the construction activities, and represent the attenuated level.
4. The measured background noise levels,
5. The relative magnitude of the activity to the background noise level.
6. The resultant internal noise levels at the receiver location from the subject construction activity,
7. The relative magnitude of the activity to the nominated internal noise criterion.
8. The construction noise criterion,
9. The nomination whether noise from the construction activity complies with the nominated criterion.

A critical component of this report is the formulation of noise control strategies for all the different construction processes. These strategies include the formulation of site management procedures, whether they can be operational or time based. The formulation of noise mitigative treatments including the erection of noise barriers, wrapping of hydraulic hammers and the selection of alternate equipment have been reviewed. The practical achievable noise reduction from the attenuation measures is determined and included in the calculations of noise impact. The level of attenuation which may be potentially provided is either calculated or based on measurements taken on other construction projects. A detailed noise management plan forms part of this report.

The objective of this study in all cases is to minimise noise emissions from the construction process.

In the report construction noise criteria are formulated based on the following factors;

1. The sensitivity of the various receiver locations,
2. A consideration of the procedures and requirements set out Australian Standard 2436-1981' Guide to Noise Control on Construction, Maintenance and Demolition Sites".
3. The requirements to control noise emissions from the construction site to levels, which does not cause undue disturbance to the identified receiver locations.
4. The noise mitigation measures available.
5. EPA Construction Noise Objective

The calculated noise levels presented in this report will be verified by on-site measurements, and a noise monitoring programme. In addition, the implementation of noise control measures as detailed in this report will also be monitored, and an appropriate reporting format will be devised so that this information can be presented to Council on a regular basis.

In conclusion, provided all measures outlined in this report are fully implemented, excavation and construction noise from the project site will be strictly controlled, and the impact on the surrounding environs minimised.

2. NOISE CONTROL STRATEGY

This report presents the strategy which will be followed to regulate noise emissions from the Civil Place Chatswood Site.

2.1 CONSTRUCTION NOISE CRITERION

All construction work shall comply with the NSW EPA Environmental Noise Manual for the control of construction noise that specifies that:

Construction period of 4 weeks and under – The L_{10} level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background level by more than 20 dB(A).

Construction period greater than 4 weeks and not exceeding 26 weeks- The L_{10} level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background level by more than 10 dB(A).

Silencing- All possible steps should be taken to silence construction site equipment.

The application of the standard EPA environmental criterion to a major construction site represents a non-workable and unrealistic approach. Activity on a building site takes place over a period of time and involves a series of complicated processes and activities, from, demolition/excavation, the delivery of materials to site, to the pumping of concrete, and the erection of building structure. All these processes generally occur in the open, and are required for the erection of a building. It is practically impossible to reduce noise emissions from these activities to a standard such as 10dB(A) above background.

Sydney City Council is currently in the process of reviewing their Code of Practice for Construction Hours/Noise 1992, as they have found the criteria in the Code to be unworkable. Construction sites are not able to comply with the criteria, and this is leading to unnecessary complications and restriction of work.

In this regard, it is appropriate to note that if the standard EPA criterion of 10 dB(A) above background was applied to building sites throughout Sydney, and was strictly enforced, no building work would take place for the simple reason that it would be impossible to comply. The EPA and Council's would have to halt all building work. Nothing would be built.

This does not only apply to commercial construction but also to small scale domestic work. For example, the noise emission from a single detached dwelling being built in the suburbs would easily exceed 10dB(A) above background. Every time an electric saw or a hammer used, a bobcat brought on-site, or a cement mixer arriving to pour a ground slab, noise levels would exceed background by between 10 to 40dB(A).

It is relevant to note that the noise level criterion for major construction sites recently completed or currently under construction in Sydney generally have adopted the SAA standards. Where a specific noise criterion has been applied to a site and has been found to be inappropriate and/ or unworkable, the authorities have exhibited suitable flexibility in amending the criterion to permit construction work to proceed as expeditiously as possible. Appropriate noise management plans have been prepared and submitted to the authorities to satisfy concern that all reasonable construction management techniques are being applied to mitigate noise levels at adjacent residential and/ or business premises.

Examples of such major construction works are:

- A. The Pinnacle Residential Development
- B. Innovation Place, North Sydney
- C. 40 Miller Street, North Sydney
- D. Broadway Shopping Centre
- E. Broadway Student Accommodation project.

2.2 SUITABLE NOISE STANDARD FOR CONSTRUCTION NOISE ASSESSMENT

The standard typically used on construction sites to regulate noise is Australian Standard 2436-1981 *"Guide to Noise Control on Construction Maintenance and Demolition Site"*.

AS2436-1981 is the standard, which is applied by other inner city councils for the regulation of construction noise and represents a practical and acceptable application for the control of construction noise. The standard recommends in Section 3, that care be taken in applying criteria that normally would be used to regulate noise emitted from industrial, commercial and residential premises to construction, particularly for those activities which are transitory and of short duration. In other words, AS2436-1981 clearly recommends against the used of highly conservative criteria for construction sites.

For the control and regulation of noise from demolition, excavation and construction sites AS2436 nominates the following:

1. That reasonable suitable noise criterion is established.
2. 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.
3. The undertaking of noise monitoring to assist in the management and control of noise emission from the building site.

The following external noise criteria are nominated for each of the receiver locations, individually recognising the requirements and the levels of sensitivity of each location;

- Residential areas, 'Background + 20 dB(A)': The residential buildings located at approximately 100m distance away from the construction site, and the increase in internal noise levels with windows closed will be no more than 10dB(A) above the levels recommended in AS2107.
- Retail and Commercial areas, 'Background + 25 dB(A)': These spaces will generally have internal background noise levels which are 5 to 10dB(A) higher than the hospitall and residential premises, therefore the criteria have been adjusted. With doors closed the internal noise levels will generally be no more than 10dB(A) above the existing background noise levels.

2.3 NOISE MANAGEMENT

The finding of this report, which studied the noise impact of the site, indicates that *'the site can work during normal construction hours and fully comply with the above proposed criteria'*.

3. STUDY OVERVIEW

This report presents evaluation of potential noise emissions from the CSB Milestone 1 Liverpool Hospital demolition and excavation activities as part of the proposed redevelopment.

The following report presents a number of proposed strategies to be used by the Bovis Lend Lease to reduce *Environmental Noise Impact* and the possibility of complaint.

The aim of this study is to undertake an analysis of noise impact arising from site activities undertaken in normal construction hours, i.e. 7:00am to 5:00pm Monday to Friday, and 7:00am to 1:00pm Saturday. No work is permitted on Sundays or Public Holidays.

During the above hours it is anticipated that works will fully comply with suitable noise control criteria. These activities will be carefully managed and appropriate noise mitigative measures will be strictly implemented where required. The formulation of noise management plans for the various activities will arise from the assessment carried out in this report and the strict enforcement of all determined control measures.

4. CONSTRUCTION NOISE

The level of noise generated by a construction site is largely dependent on the activities, which are in progress. It can not be categorically stated that all construction sites emit the same level of noise no matter what stage or part of the construction programme they are at.

The generalisation, that all construction work is noisy is fallacious. The levels of noise generated are dependent on the activities occurring. In addition, it is possible to undertake construction work in a controlled manner so that noise is minimised. This requires the formulation of noise control strategies, and stringent supervision.

A study of a typical construction site is presented below to show the varying levels of noise generation from various activities.

4.1 CATEGORISATION OF CONSTRUCTION ACTIVITIES

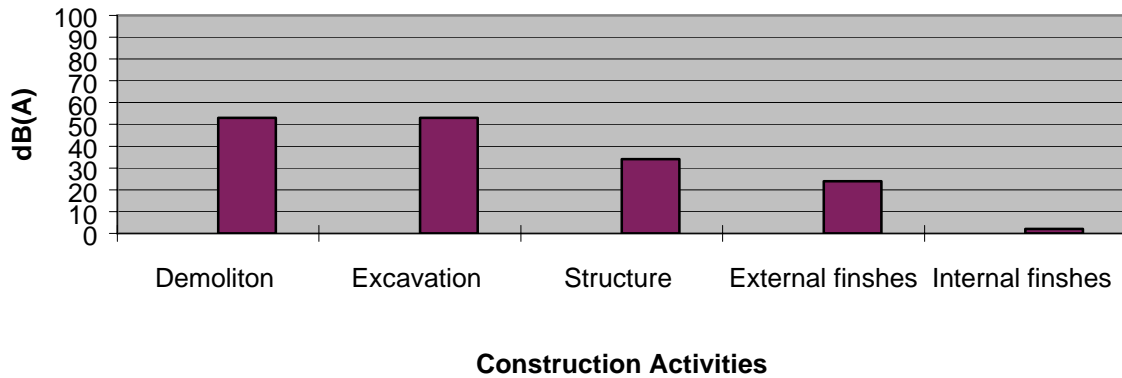
The construction activities, which occur during the typical process in constructing a building from start to finish, can be separated into five categories, namely;

1. Demolition
2. Excavation

The noise levels generated by each of these activities will vary and be largely dependent on the process undertaken. The graph below illustrates typical sound pressure levels resultant at a residential location (approximately 55 metres) from an active construction site. The levels in the table below are derived from measured field attenuation from the GPO Re-Development, No. 1 Martin Place site to a residential receiver. As such these levels represent a real case scenario and are not theoretical. The objective of presenting these sound levels is to present a relative comparison between the five categories of construction activities described above. The comparative levels presented below indicate the maximum noise, which can be generated by the specific activities.

The histogram below shows that the noisiest construction activities are the demolition and excavation, which generate equivalent noise levels due to the similar activities

Comparison Between Noise Emitted by Different Construction Activities

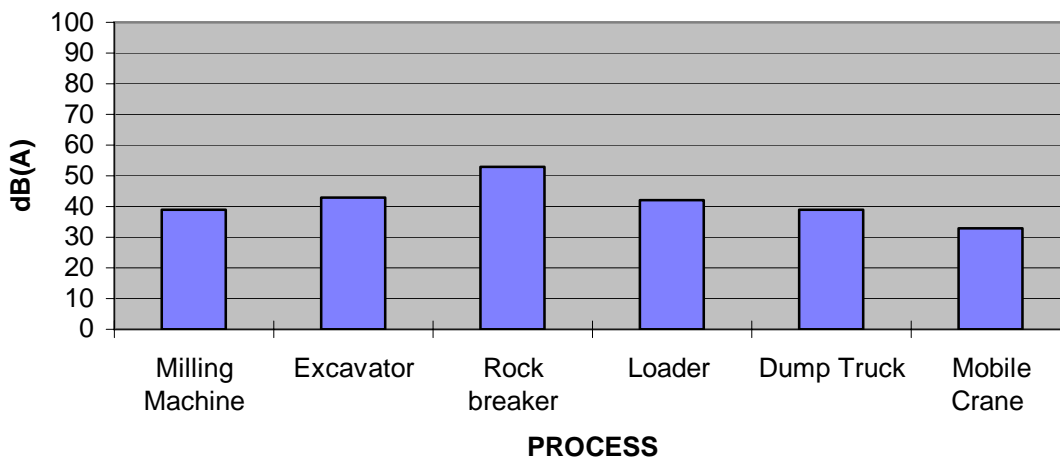


Erection of the structure is next, and then external finishes. Internal finishes is the quietest of activities as it occurs internally. The histogram above represents the maximum noise levels emitted by the entire construction activity, but does not take into account, that within each process there are loud and quiet component processes. To further clarify this point each of the five construction activities outlined above will be further broken down into discrete processes. This will permit the determination of which components of a particular process generate the highest noise levels.

4.2 EXCAVATION

The excavation process on the site involves the removal of top soil/clay/fill layers with the remainder of spoil being predominately Shale which is easier to remove than other materials such as sandstone and therefore less noise is generated during excavation. The work is generally undertaken by the use of a bulldozer and scraper attached, rock breakers and milling machines. The spoil will be excavated and relocated internally on site and the use of off site trucks will not be involved in this process which will have less noise impact upon the local residential and commercial areas.

COMPARISON OF NOISE LEVELS EMITTED BY DIFFERENT PROCESSES DURING EXCAVATION



The above histogram clearly illustrates that the noisiest part of the excavation process is the use of hydraulic hammers the other process are generally 10 to 15dB(A) quieter.

4.3 DISCUSSION

From the information presented in the above Section it can be clearly seen that the noise emitted from a construction site will be dependent on which activities are taking place. More specifically, the particular process within those activities. For example there is a difference of 16dB(A) between using a hydraulic hammer and loading a truck during demolition. A difference of 16dB(A) is substantial. Therefore by limiting the activities which take place on a construction site at particular time's, noise emissions can also be regulated.

5. SITE DESCRIPTION AND POTENTIALLY AFFECTED LOCATIONS

The site of the subject development is located on the corner of Elizabeth St and South line rail corridor. The project site is set primarily amongst existing hospital buildings and commercial land uses. Residential buildings are approximately 150m distance away from the site separated by the existing clinical services building. The following are the noise sensitive locations in close proximity to the site.

Location 1. Clinical Services Building adjacent to western boundary with 6.38mm Laminated fixed windows on the nearest facade.

Location 2. MHC Building adjacent to northern boundary with 6.38mm Laminated fixed glazing and openable doors facing the project site.

Location 3. Residential buildings located immediately across Goulburn St.

As construction will be carried out during 7am to 5pm Mondays to Fridays and 7am to 1pm on Saturdays the above listed premises will not be affected at night.

6. NOISE CRITERIA

- Residential/hospital areas, 'Background + 20 dB(A)': The residential buildings located approximately 100m distance away to the construction site, and the increase in internal noise levels with windows closed will be no more than 10dB(A) above the levels recommended in AS2107.
- Retail and Commercial areas, 'Background + 25 dB(A)': These spaces will generally have internal background noise levels which are 5 to 10dB(A) higher than the commercial and residential premises, therefore the criteria have been adjusted. With doors closed the internal noise levels will generally be no more than 10dB(A) above the existing background noise levels.

7. VIBRATION CRITERIA

Two sets of vibration criteria will be used on this project, namely;

- Australian Standard 2187
- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

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

7.1 AS2187

Australian Standard 2187-1993, "SAA Explosives Code, Part 2 - Use of Explosives" stipulates in Section 11 acceptable levels of ground vibration to limit the probability of structural damage and human discomfort. The criteria presented in this Standard are summarised below.

AS2187 RECOMMEND PEAK PARTICLE VELOCITY

Type of building or structure	Particle velocity (V _p) mm/s
1. Historical buildings and monuments, and buildings of special value and significance	2
2. House and low rise residential buildings: Commercial buildings not included in item 3 below	10
3. Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

This standard will be used principally for the determination of potential structural damage to surrounding buildings. The Standard does not provide suitable criteria for the determination of acceptable levels of vibration for human comfort in sensitive areas such as dental surgeries for example.

7.2 BRITISH STANDARD BS 6472:1992

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

BS 6472:1992 Criteria to Avoid *“Adverse Comment”*

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

8. DETERMINATION OF CONSTRUCTION NOISE IMPACT

Using the noise levels presented in Table 1 below, the resultant noise impact was determined at the worst affected locations. These locations were identified in Section 7, above. If noise levels comply with the criteria at these locations, then they will be acceptable at all other locations.

All construction noise sources were assumed to be located at the nearest point on the construction site to the receiver locations under study. In this way the worst and majority case noise level situations are determined, with noise levels arising from an activity occurring on any other part of the site being equal to or lower than those determined for the nearest point scenario.

The calculations determine the A-Weighted max noise levels over a 15-minute period, from all sources, which may operate simultaneously. Noise emanating from the respective activities will comply with the required criterion, provided all noise from all individual plant and equipment comply.

9. SOUND POWER LEVELS

Noise impact will be determined from all processes and equipment, which are involved in the activities outlined below by defining the levels of sound, which they generate.

The A-weighted sound power levels for all the component parts of the above-described activities are outlined in the tables below.

Table 1: Sound Power Levels

CONSTRUCTION ACTIVITY	EQUIPMENT /PROCESS	SOUND POWER LEVEL - dB(A)
Excavation	Bored Pier	90
	Excavator	114
	Truck	105
	Bulldozer	114
Demolition	Hydraulic Crusher	105

The noise levels presented in the above table are derived from the following sources, namely:

1. On-site measurements
2. Table D2 of Australian Standard 2436-1981
3. Data held by this office from other similar studies.

10. DEMOLITION

LOCATION 1 CLINICAL SERVICES BUILDING CORRIDOR - MONDAY TO SATURDAY							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	INTERNAL NOISE LEVEL AT AFFECTED L _{avmax} dB(A)	MEASURED EXISTING INTERNAL AMBIENT NOISE LEVELS dB(A)	LEVEL OF ACTIVITIES RELATIVE TO INTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Demolition	72	47 ¹	40-49	-2 to +7	10	YES

Notes 1. The above assessment assumes that 6.38mm glass is used in the windows of Services Building.

LOCATION 2 MHC BUILDING CORRIDOR - MONDAY TO SATURDAY							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	INTERNAL NOISE LEVEL AT AFFECTED L _{avmax} dB(A)	MEASURED EXISTING INTERNAL AMBIENT NOISE LEVELS dB(A)	LEVEL OF ACTIVITIES RELATIVE TO INTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Demolition	72	47 ¹	38-40	+7 to +9	10	Yes

Notes 1. The above assessment assumes that 6.38mm glass is used in the windows of Services Building.

LOCATION 3 RESIDENTIAL BUILDINGS LOCATED IMMEDIATELY ACROSS GOULBURN ST.							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	MEASURED EXISTING EXTERNAL AMBIENT NOISE LEVELS L ₉₀ dB(A)	LEVEL OF ACTIVITIES RELATIVE TO EXTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO	
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Demolition	47	43	+4	20	Yes	

11. EXCAVATION

LOCATION 1 CLINICAL SERVICES BUILDING CORRIDOR - MONDAY TO SATURDAY							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	INTERNAL NOISE LEVEL AT AFFECTED L _{avmax} dB(A)	MEASURED EXISTING INTERNAL AMBIENT NOISE LEVELS dB(A)	LEVEL OF ACTIVITIES RELATIVE TO INTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Excavation	72-74	47-49 ¹	40-49	-2 to +7	10	YES

Notes 1. The above assessment assumes that 6.38mm glass is used in the windows of Services Building.

LOCATION 2 MHC BUILDING CORRIDOR - MONDAY TO SATURDAY							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	INTERNAL NOISE LEVEL AT AFFECTED L _{avmax} dB(A)	MEASURED EXISTING INTERNAL AMBIENT NOISE LEVELS dB(A)	LEVEL OF ACTIVITIES RELATIVE TO INTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Excavation	73	48 ¹	38-40	+8 to +10	10	Yes

Notes 1. The above assessment assumes that 6.38mm glass is used in the windows of Services Building.

LOCATION 3 RESIDENTIAL BUILDINGS LOCATED IMMEDIATELY ACROSS GOULBURN ST.							
PERIOD HOURS	ACTIVITY	EXTERNAL LEVEL OF NOISE AT AFFECTED OCCUPANCY L ₁₀ dB(A)	MEASURED EXISTING EXTERNAL AMBIENT NOISE LEVELS L ₉₀ dB(A)	LEVEL OF ACTIVITIES RELATIVE TO EXTERNAL CRITERION	PERMISSIBLE EXCEEDENCE ABOVE B'GROUND/ CRITERION	COMPLIES YES/NO	
Mon – Fri 07.00 to 17.00 Sat 07.00 to 13.00	Excavation	48	43	+5	20	Yes	

12. VIBRATION - ACCEPTABLE WORK PRACTICES

To regulate vibration emanating from both the demolition and excavation processes the demolition and excavation contractors will need to operate particular machinery at certain distance from affected buildings to comply within the criteria. The following is an estimate of the distances that may be required for the various equipments.

Hydraulic hammers

10m from commercial building with 25mm/sec PPV and 0.6mm/sec RMS for human comfort.

Ripping

10m from hospital/commercial building to comply with 25mm/sec PPV and 0.6mm/sec RMS for human comfort.

13. ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES

In order for any construction noise management programme to work effectively, continual communication is required between all parties, which may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process, which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation process is to:

Inform and educate the groups about the project and the noise controls being implemented.

Increase understanding of all acoustic issues related to the project and options available.

Identify group concerns generated by the project, so that they can be addressed.

14. STATEMENT OF INTENT TO COMPLY

The calculation procedure used to predict the noise levels above has been verified with field measurements on building sites in the inner city including the Grace Plaza, GPO, 400 George Street, Aston and Sydney Central Plaza projects.

In addition, a contact number of the Liaison Officer will be advertised outside the building site, so that residents and other interested parties may contact him, should they believe a noise breach is occurring.

15. FINAL STATEMENT

The finding of this document indicates that noise levels from demolition and excavation activities taking place on the new CSB Milestone 1 will comply with the criteria nominated in Section 2 of this report at all times, provided times of operation indicated in this document and the recommendations are observed.

Vibration levels from construction activities will fully comply with the vibration criteria nominated in Section 7, provided the recommendations in this document are observed.

Report prepared by,

A handwritten signature in black ink, appearing to read 'George Wei', written in a cursive style.

Acoustic Logic Consultancy Pty Ltd

George Wei

APPENDIX: CONSTRUCTION NOISE MANAGEMENT PLAN

22 July, 2008

Report: 2008402/2107A/R0/GW

Prepared for: BOVIS LEND LEASE

NEW CSB, MILESTONE 1

LIVERPOOL HOSPITAL

CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

ACOUSTIC LOGIC CONSULTANCY PTY LTD

9 Sarah St Mascot, NSW 2020

Tel: 8338 9888 Fax: 8338 8399

TABLE OF CONTENTS

1.	INTRODUCTION	3
2.	PROJECT OBJECTIVE	4
3.	NOISE CRITERIA	4
4.	VIBRATION CRITERIA	4
5.	CONTROL OF CONSTRUCTION NOISE	4
6.	NOISE CONTROL METHODS	6
6.1	SELECTION OF ALTERNATE APPLIANCE OR PROCESS	6
6.2	ACOUSTIC BARRIER	6
6.3	SILENCING DEVICES	6
6.4	MATERIAL HANDLING	7
6.5	TREATMENT OF SPECIFIC EQUIPMENT	7
6.6	ESTABLISHMENT OF SITE PRACTICES	7
6.7	REGULAR NOISE CHECKS OF EQUIPMENT	7
6.8	NOISE MONITORING	9
6.9	COMBINATION OF METHODS	9
7.	ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES	9

1. INTRODUCTION

This document presents a discussion on the process which will be followed in order to manage noise from the construction of the proposed new CSB, Milestone 1, Liverpool Hospital.

In recognition of the requirement to minimise noise emissions from the site to surrounding residential and commercial premises the Bovis Lend Lease have commissioned this study. The principal objective of this study is to undertake advance evaluation of all work to be performed during the demolition, excavation and construction phase of the project and forecast the potential impact of noise. The noise forecasts will be used to formulate and streamline effective regulation and mitigation measures. As a part of this process on going testing will be used to evaluate the noise regulation strategies and ensure that they are effective.

To further ensure compliance with appropriate standards on going monitoring will be instigated.

The principal issues which will be addressed in this document are:

- Identification of the specific activities that will be carried out and associated noise sources,
- Identification of all potentially affected sensitive receivers including residences, schools and properties containing noise sensitive equipment,
- Determination of appropriate noise and vibration objectives for each identified sensitive receiver,
- Noise and vibration monitoring, reporting and response procedures.
- Assessment of potential noise and vibration from the proposed construction activities including noise from construction vehicles and any traffic diversions,
- Description of specific mitigation treatments, management methods and procedures that will be implemented to control noise and vibration during construction
- Identification of the noise and vibration standards which will be applicable to this project.
- Formulation of a strategy for construction to comply with the standards identified in the above point.
- Construction timetabling to minimise noise impacts including time and duration restrictions, respite period and frequency,
- Procedures for notifying residents of construction activities that are likely to affect their amenity through noise and vibration,
- Establishment of direct communication networks between affected groups, Planning NSW, Bovis Lend Lease and Acoustic Logic Consultancy.

2. PROJECT OBJECTIVE

The objective of this management plan is to minimise noise & vibration emissions from the construction work associated with this project and assist in maintaining a satisfactory environment around the site. .

3. NOISE CRITERIA

- Residential areas, 'Background + 20 dB(A)': The residential buildings located at approximately 100m distance away from the construction site, and the increase in internal noise levels with windows closed will be no more than 10dB(A) above the levels recommended in AS2107.
- Retail and Commercial areas, 'Background + 25 dB(A)': These spaces will generally have internal background noise levels which are 5 to 10dB(A) higher than the hospital and residential premises, therefore the criteria have been adjusted. With doors closed the internal noise levels will generally be no more than 10dB(A) above the existing background noise levels.

4. VIBRATION CRITERIA

Australian Standard 2187-1993, "SAA Explosives Code, Part 2 - Use of Explosives" stipulates in Section 11 acceptable levels of ground vibration to limit the probability of structural damage and human discomfort. The criteria presented in this Standard are summarised below.

AS2187 RECOMMEND PEAK PARTICLE VELOCITY

Type of building or structure	Particle velocity (Vp) mm/s
1. Historical buildings and monuments, and buildings of special value and significance	2
2. House and low rise residential buildings: Commercial buildings not included in item 3 below	10
3. Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

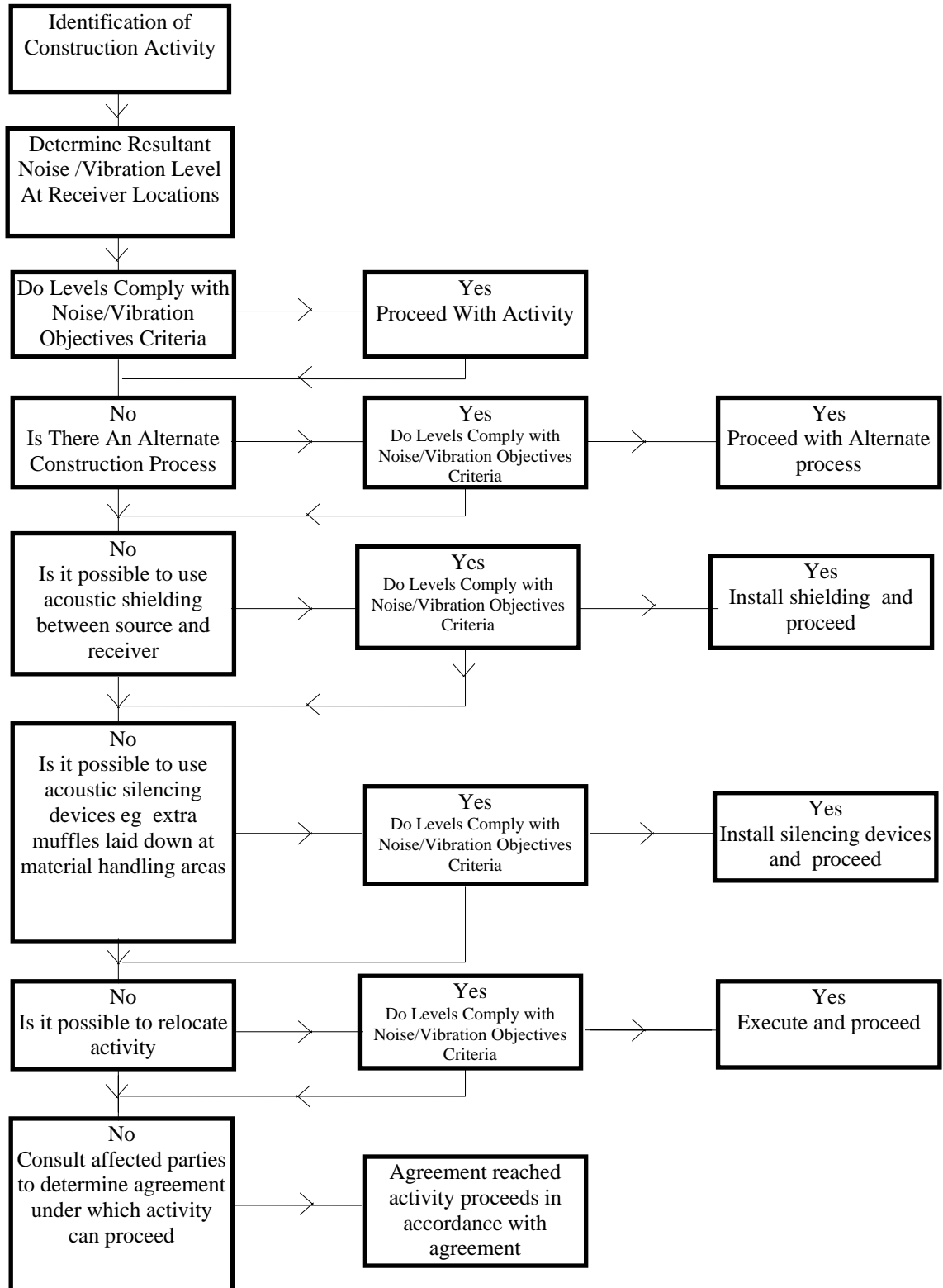
5. CONTROL OF CONSTRUCTION NOISE

As a part of the noise management plan a detailed study will be undertaken of each of the proposed activities which will occur as a part of the demolition, excavation and construction works on this project.

The execution of this work will facilitate the formulation of noise control strategies for this project.

The flow chart which follows illustrates the process which will be followed in assessing construction activities.

CONTROL OF NOISE AND VIBRATION



6. NOISE CONTROL METHODS

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

6.1 SELECTION OF ALTERNATE APPLIANCE OR PROCESS

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

6.2 ACOUSTIC BARRIER

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

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

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

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

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

6.3 SILENCING DEVICES

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

6.4 MATERIAL HANDLING

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

6.5 TREATMENT OF SPECIFIC EQUIPMENT

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

6.6 ESTABLISHMENT OF SITE PRACTICES

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

6.7 REGULAR NOISE CHECKS OF EQUIPMENT

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

A record of these measurements will be kept on a form similar to that shown below.

This measure is expected to maintain noise at constant levels, and prevent any increases.

Bovis Lend Lease

NEW CSB MILESTONE 1, LIVERPOOL HOSPITAL

Construction Appliance Compliance Certificate

Month

Year

Plant Item

Allowable Noise Level

Measured Noise Level

Complies

Yes

No

Issuing Engineer

Sub-Contractor

Project Manager

6.8 NOISE MONITORING

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

6.9 COMBINATION OF METHODS

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

7. ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES

In order for any construction noise management programme to work effectively, continual communication is required between all parties which may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation processes is to:

Inform and educate the groups about the project and the noise controls being implemented.

Increase understanding of all acoustic issues related to the project and options available.

Identify group concerns generated by the project, so that they can be addressed.

Ensure that concerned individuals or groups are aware of and have access to the Bovis Lend Lease. Complaints Register which will be used to address any construction noise related problems should they arise.

To ensure that this process is effective, regular scheduled meetings will be required for a finite period, until all issues have been addressed and the evidence of successful implementation is embraced by all parties.

An additional step in this process is to produce a newsletter informing the groups of the progress of the works and the upcoming construction activities.