Bickerdike Allen Partners

THE AMERICAN CHURCH IN LONDON
PLANT NOISE ASSESSMENT

Report to

The American Church in London
Whitefield Memorial Church
79A Tottenham Court Road
London
W1T 4TD

A7663/R01-BT
2nd May 2007

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1.0 INTRODUCTION

Bickerdike Allen Partners (BAP) have been retained by The American Church in London to advise on noise issues regarding the proposed installation of an air handling unit and a boiler flue dilution system at the Whitefield Memorial Church.

This report sets out details of an environmental noise survey and a noise assessment of the proposed plant. Details of the proposed plant have been provided by Terry Pawson Architects and from the M&E Engineers on the project, Whitby Bird. A glossary of acoustical terminology is included in Appendix A.

2.0 THE SITE

The site is a church located on Tottenham Court Road, London W1. It is proposed to develop the church with the addition of a campanile at the front, on Tottenham Court Road, various internal works at low level (Sunday School/Meeting Rooms and Ancillary accommodation) and to build a residential building to the rear containing flats. As part of these works an Air Handling Unit (AHU) is to be installed at roof level, serving a function room, and a boiler flue dilution system for the boiler, which is at basement level. The boiler flue dilution system fans will be located at basement level, but the air inlet and outlets will be at roof level, near to the AHU.

The AHU is to be located on the roof as shown in Figure 1. The church roof is surrounded by a 1.7m high brickwork parapet wall. At present, the nearest dwellings are situated approximately 23m from the proposed plant location the south-east of the site. See Figure 2.

It is proposed to build a new residential development next to the church on the north-west side of the property (see Figure 1). Once this is complete, this building will become the nearest noise-sensitive property. The nearest unscreened receiver location is shown in green on Figure 1. A point 1m from the nearest affected window is 17m from the proposed location of the AHU. There are no windows on the façade of the proposed residential building which overlook the AHU. There is therefore no direct line of sight from any windows in this building to the proposed AHU.

We understand from the design consultants that the plant will be in operation only when the function room is in use. The function room is typically used for wedding receptions and the like, which are unlikely to continue longer than around 1am. We have however undertaken a 24 hour assessment to ensure compliance.

3.0 CRITERIA

We have spoken to Elaine Quigly at The London Borough of Camden to confirm their noise criteria. Their requirements for noise emissions are given in their Development Standard 6 document. The relevant extract is paragraph 16.34, and is repeated below;

"16.34 The council considers that for new developments involving noisy plant/equipment or other uses, design measures should be taken to ensure that the noise levels predicted at a point 1 metre external to sensitive façades are at least 5 dB(A) less than the existing background measurement (L_{A90}) when the equipment is in operation. Where it is anticipated that equipment will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are any distinct impulses in the noise (bangs, clicks, clatters, thumps), special attention should be given to reducing the noise levels from plant and equipment at any sensitive façade to at least 10 dB(A) below the L_{A90} level."

We do not consider the plant in question to be tonal or impulsive in nature, and therefore the criterion should be 5dB(A) below the lowest measured L_{A90}.

4.0 BACKGROUND NOISE SURVEY

In order to assess the prevailing ambient and background noise level a noise survey was carried out over a period of 24 hours, from 4pm Tuesday 17th April to 4pm Wednesday 18th April 2007. The measurement position can be seen in Figure 1.

The equipment used consisted of a Norsonic 118 type sound level meter along with a Brüel and Kjær type 4231 calibrator. The equipment was calibrated both prior to and after the survey and no significant drift was observed. The detailed results of the survey can be seen in Appendix B. The weather during the period of the survey was generally clear, with light winds and no rain. The measurement position was approximately 1 m away from the building façade.

The lowest recorded background noise level was 46 dB $L_{A90,15min}$ which occurred at around 0300 hours, 18th April 2007. The lowest recorded background noise level between 7am and 1am was 49 dB $L_{A90,15min}$.

The noise limit should therefore be 41 dB(A) at 1m from the nearest affected window.

On site observations indicated that the background noise level in the area was predominantly due to plant noise and distant road traffic.

5.0 PLANT NOISE ASSESSMENT

It is proposed to install a Swegon Air Handling Unit on the roof of the Church, and a boiler flue dilution system at basement level, with the air intake and exhaust at roof level.

5.1 AHU Calculation

The following sound power levels have been provided for the AHU by the M&E consultants, Whitby Bird and Partners.

	63	125	250	500	1000	2000	4000	8000	dBA
SWL @ Fresh Air Inlet	69	61	44	47	32	33	29	37	49
SWL @ Exhaust	85	64	66	60	66	61	62	57	70
Supply fan casing radiated	69	57	46	59	44	41	42	37	57
Extract fan casing radiated	70	58	47	60	45	42	43	38	58
Cooler	94	60	69	56	67	55	46	44	71

Table 1 – AHU Sound Power Levels

We have been informed by Swegon that the inlet and exhaust sound power levels shown in Table 1 above include for the effects of the included attenuators.

At this early design stage the boiler flue dilution system fans, which are to be installed in the basement, have not been selected or specified.

The nearest affected residential windows will be, in order of proximity;

- Windows on the north-east face of the proposed residential building (approx 10m). These windows are screened from the AHU by the brickwork roof access/storage room at roof level. There is no direct line of site to the AHU.

- Windows on the South-west face of the proposed residential building (approx 17m). There is no direct line of site to the plant from the façade.

- Windows of the existing residential properties above a coffee shop on Tottenham Court Road, shown in Figure 2. The top floor has a direct line of site to some of the plant and the distance is 25m. All other floors will be screened by the parapet wall.

The nearest affected window will therefore be the upper levels of the south-west face of the proposed development, as shown by the green circle in Figure 1. This is 17m from the proposed AHU location.

Our detailed calculation is shown in Table 2 below

Component	Inlet Fan duct-borne	Supply fan casing radiated	Exhaust Fan duct-borne	Extract fan casing radiated	Cooler
Sound power level / dB(A)	49	57	70	58	71
Correction for distance (20log(r)-11) r=17m	-36	-36	-36	-36	-36
Correction for reflections from nearby hard surfaces (source)	+6	+6	+6	+6	+6
Screening effect of edge of residential building	-5	-5	-5	-5	-5
Sound pressure level at 1m from nearest affected window	14	22	35	23	36
Combined Total outside nearest affected residential window				**39 dB(A)**	**Difference**
Lowest measured background noise level				**46 dB(A)**	**-7 dB**
Lowest measured background noise level (0700-0100)				**49 dB(A)**	**-10 dB**

Table 2 – Calculation of noise impact of AHU – new residential building.

Calculations to the existing residential buildings are shown in Table 3 below.

Component	Inlet Fan duct-borne	Supply fan casing radiated	Exhaust Fan duct-borne	Extract fan casing radiated	Cooler
Sound power level / dB(A)	49	57	70	58	71
Correction for distance (20log(r)-11) r=25m	-39	-39	-39	-39	-39
Correction for reflections from nearby hard surfaces (source)	+6	+6	+6	+6	+6
Screening effect of parapet wall	-5	-5	-5	-5	-5
Façade reflection at receiver	+3	+3	+3	+3	+3
Sound pressure level at 1m from nearest affected window	14	22	35	23	36
Combined Total outside nearest affected residential window				**39 dB(A)**	**Difference**
Lowest measured background noise level				**46 dB(A)**	**-7 dB**
Lowest measured background noise level (0700-0100)				**49 dB(A)**	**-10 dB**

Table 3 – Calculation of noise impact of AHU – new residential building.

At both dwellings considered, the noise level produced by the AHU will be 7 dB(A) lower than the lowest background noise level recorded at night. However, we have been told that the AHU will only be operational when the function room is in use, when the level is expected to be at least 10 dB(A) below the background noise level. Therefore, we do not believe any additional noise mitigation measures would need to be carried out to reduce the noise level further.

5.2 Boiler Flue Dilution System

We understand a boiler flue dilution system is to be installed at basement level. At this stage, no fans have been specified. However, in order to achieve the noise levels required by Camden, it will be necessary to attenuate the fans so as not to cause any increase in the AHU noise. They boiler flue fans must therefore be attenuated to a maximum of 36 dB(A), in order to not exceed the criteria..

Based on the octave band spectrum of the lowest measured background noise level, and a distance of 5m from the inlet/outlet to the nearest window, the sound power level leaving the boiler flue ductwork (i.e. post attenuator) should be no higher than the values specified in Table 4 below.

	63	125	250	500	1000	2000	4000	8000	dBA
Max SPL @ window	42	38	37	34	32	26	16	5	36
Distance correction (5m) (20 log r + 11)	25	25	25	25	25	25	25	25	
Limiting SWL / dB	**67**	**63**	**62**	**59**	**57**	**51**	**41**	**30**	**61**

Table 4 – Boiler flue dilution system fans limiting sound power level.

A tolerance of +/- 2dB may be applied to each octave band of the above limiting sound power levels, so long as the dB(A) value does not exceed 61 dB(A).

Considering the size and noise level of a typical boiler flue extract fan, and the length of ductwork into which an attenuator can be fitted, we consider it a simple matter to reduce the boiler flue dilution system fans to the limiting sound power levels specified above.

6.0 RECOMMENDATIONS

We recommend that the above sound power level limits are written in the plant specification to ensure the noise levels are achieved. We also recommend that in order to protect the occupiers of the church, and in line with good engineering practice, that the AHU is mounted on appropriate anti-vibration equipment.

7.0 SUMMARY AND CONCLUSIONS

Bickerdike Allen Partners have undertaken an environmental noise survey assessment of the proposed installation of an Air Handling Unit and a boiler flue dilution system as part of a proposed development of the Whitefield Memorial Church, Tottenham Court Road, London.

Background noise measurements have been made along with predictions of future plant noise at the windows of the nearby residential dwellings.

Predictions indicate that the proposed plant will produce noise levels which are more than 5 dB below the lowest measured existing background noise level at the nearest residential dwellings at any time, and at least 10 dB below at the times at which the plant is likely to be operational.

This meets the London Borough of Camden's standard noise requirement.

Ben Tomlin
for Bickerdike Allen Partners

John Miller
Partner

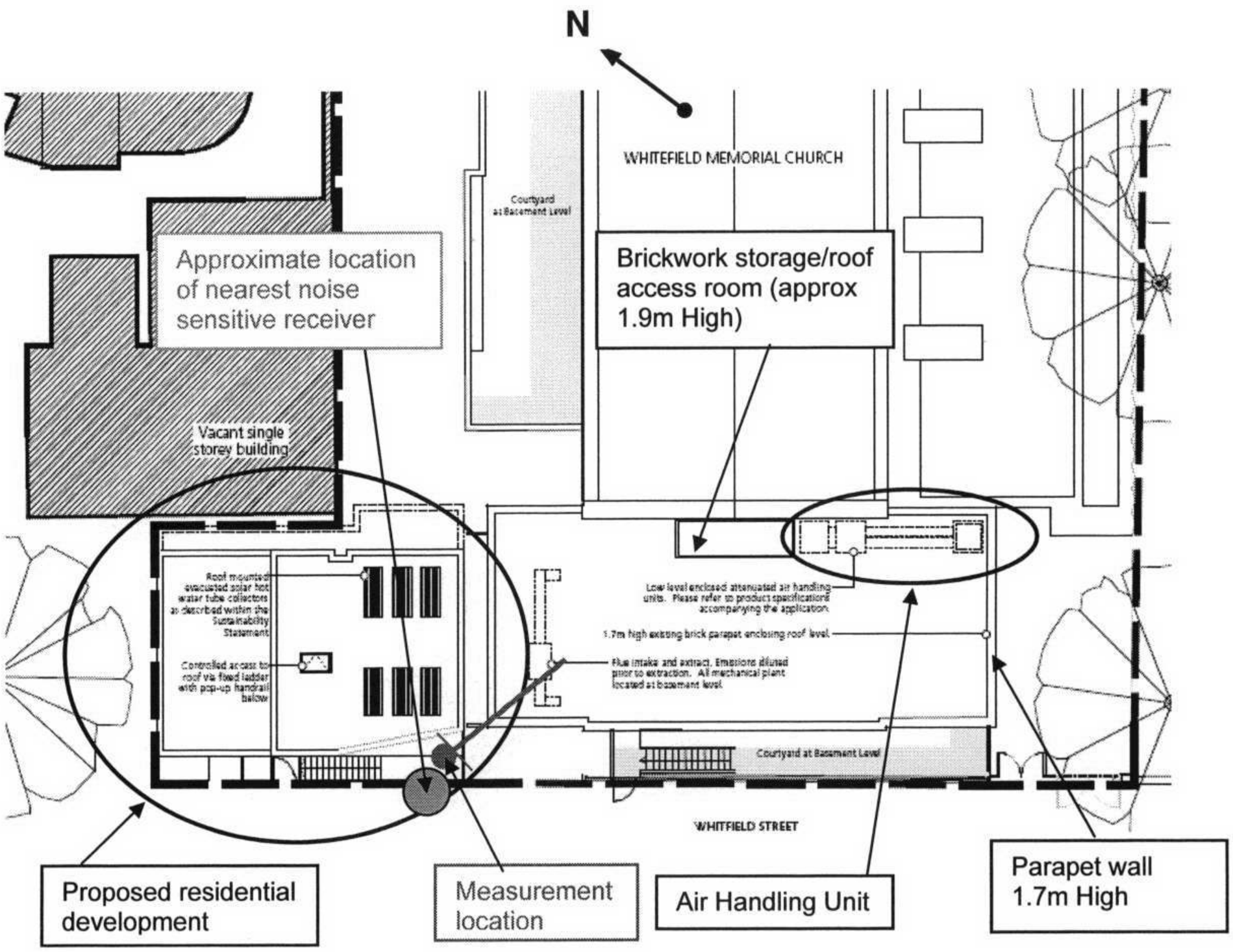


Figure 1 – Site Plan

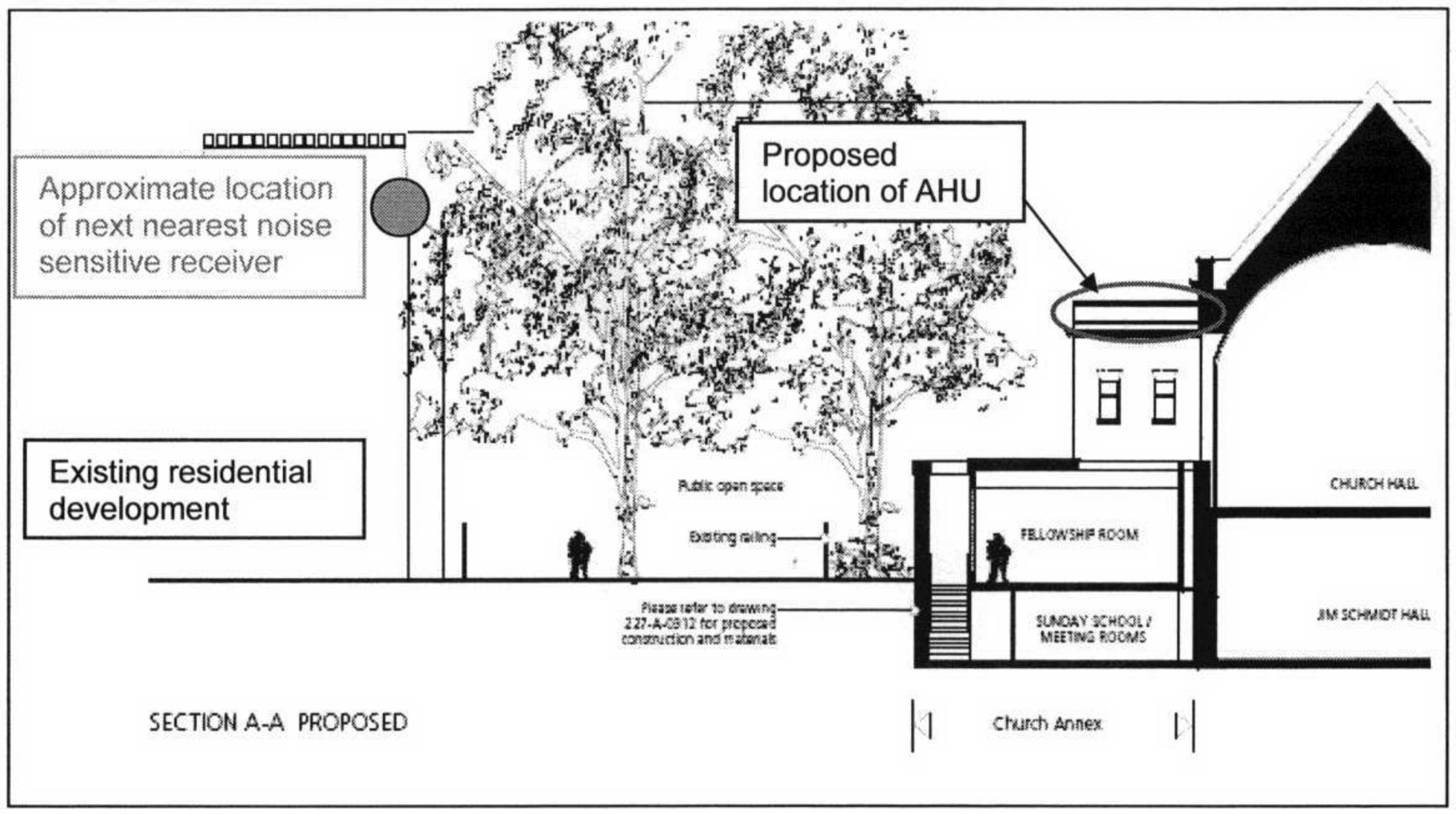


Figure 2 – Section A-A. Current nearest residential location, facing west.

Figure 3 – Photograph of measurement set-up.

APPENDIX A
GLOSSARY OF ACOUSTIC TERMINOLOGY

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2×10^{-5} pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

Noise Rating

The Noise Rating (NR) system is a set of octave band sound pressure level curves used for specifying limiting values for building services noise. The Noise Criteria (NC) and Preferred Noise Criteria (PNC) systems are similar.

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

$L_{Aeq, T}$ The most widely applicable unit is the equivalent continuous A-weighted sound pressure level ($L_{Aeq, T}$). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.

L_{A90} The level exceeded for 90% of the time is normally used to describe background noise.

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

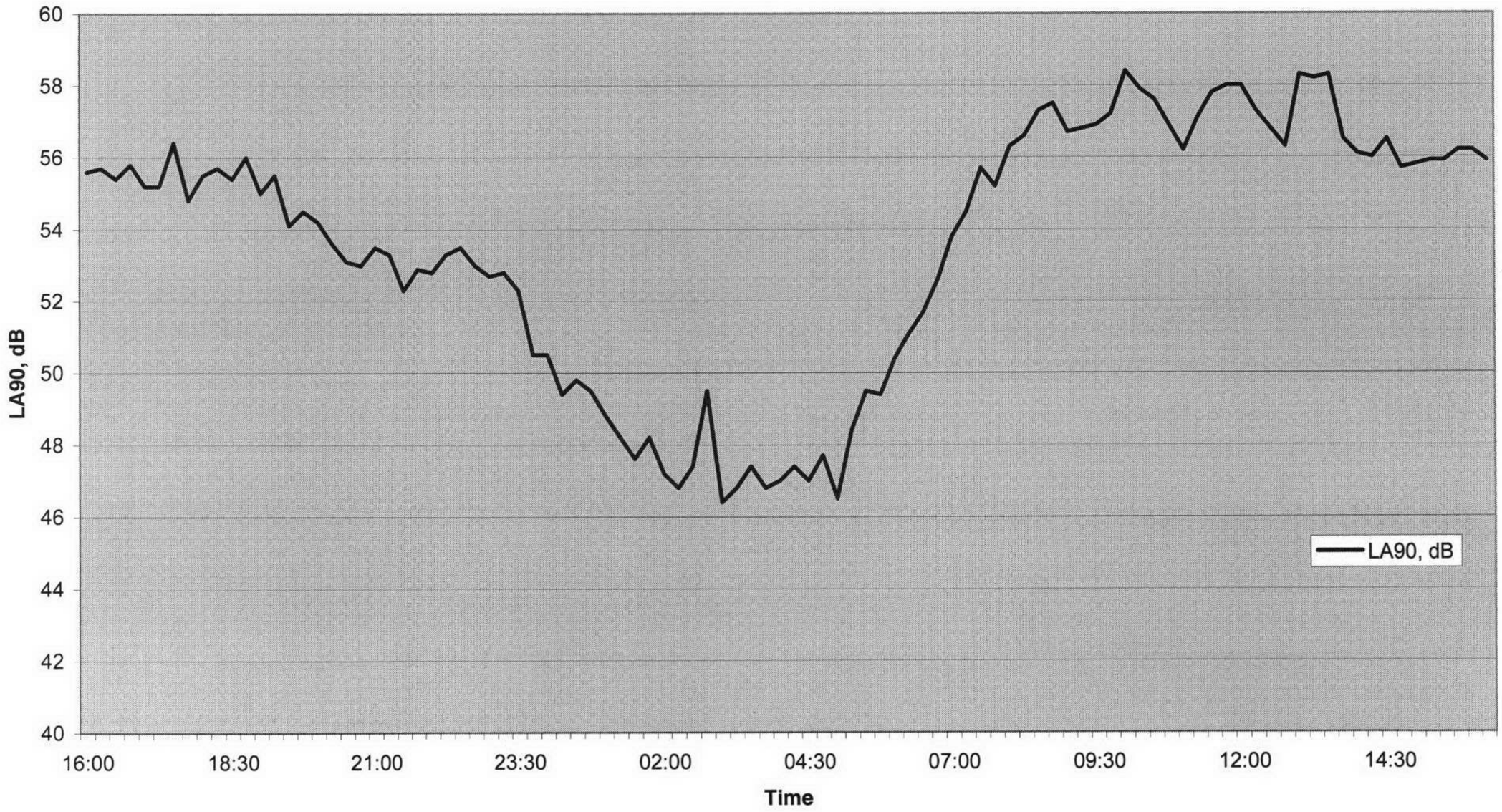
Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation, however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

APPENDIX B
BACKGROUND NOISE SURVEY, DETAILED RESULTS
(All noise levels are given in decibel re $2x10^{-5}Nm^{-2}$)

Bickerdike Allen Partners

Background Noise Survey, The American Church In London
17th - 18th 2007



APPENDIX C
AHU MANUFACTURER'S NOISE DATA

Sound power level												
Frequency band	**Hz**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**		**All**	
To supply air duct		76	65	57	64	63	61	66	59	dB	70	dB(A)
To outdoor air duct		69	61	44	47	32	33	29	37	dB	49	dB(A)
To surrounding		69	57	46	59	44	41	42	37	dB	57	dB(A)
To surrounding incl. exh. air		73	61	50	63	48	45	46	41	dB	61	dB(A)

Unit silencer, TBDA-1-100-040-065

Total pressure drop								21	Pa
Frequency band	63	125	250	500	1k	2k	4k	8k	Hz
Attenuation	4	6	12	16	14	13	10	9	dB

Figure C1 – AHU Supply fan noise data from Swegon.

Sound power level												
Frequency band	**Hz**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**		**All**	
To extract air duct		72	64	49	54	39	40	36	44	dB	54	dB(A)
To exhaust air duct		85	64	66	60	66	61	62	57	dB	70	dB(A)
To surrounding		70	58	47	60	45	42	43	38	dB	58	dB(A)

(Cooling unit CoolDX)

Condenser coil

Accesssories and other technical data, see supply air									
Pressure drop								78	Pa
Air velocity								1.9	m/s

Unit silencer, TBDA-1-100-040-065

Total pressure drop								21	Pa
Frequency band	63	125	250	500	1k	2k	4k	8k	Hz
Attenuation	4	6	12	16	14	13	10	9	dB

Figure C2 – AHU Extract fan noise data from Swegon.