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WSP

GREAT ORMOND STREET HOSPITAL

Planning Condition 8 Discharge Acoustic Report

04/10/2016

Institute of Acoustics sponsoring organisation

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
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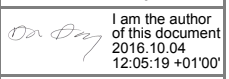
Signature				 I am the author of this document 2016.10.04 12:05:19 +01'00'
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Great Ormond Street Hospital

Planning Condition 8 Discharge Acoustic Report

04/10/2016

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1 Introduction

1.1.1 WSP | Parsons Brinckerhoff (WSP | PB) has been appointed by Skanska to provide acoustic consultancy services in relation to the Phase 2B development at Great Ormond Street Hospital (GOSH2B). Part of the acoustic consultancy services scope of work is to assist with the discharge of a planning condition relevant to noise.

1.1.2 Details of the Phase 2B development were submitted to the London Borough of Camden Council (LBCC) in planning application reference 2007/4116/P. Full planning application approval was granted in November 2007, subject to one planning condition relating to the control of noise from fixed plant.

1.1.3 The purpose of this report is to provide the relevant information to LBCC with the aim of discharge the planning condition.

1.1.4 This revision provides a revised assessment, as well as supplementary information, to the previous revisions to this report. This information was requested by LBCC Principal Environmental Health Officer, Joanne Stowell.

1.1.5 The scope of this supplementary information was agreed in person during a meeting on 15 March, through telephone conversation and email correspondence.

1.1.6 The following reports, guidance and standards are referred to throughout this report:

- The London Borough of Camden (LBC) '*Replacement Unitary Development Plan, Adopted June 2006*' (UDP 2006).
- The LBC '*Camden Development Policies 2010-2025: Local Development Framework*' (LDF).
- The WSP '*Great Ormond Street Hospital: Acoustic Survey Report*' (ref 12102153.mrc.rp1-Rev1, 2 November 2006, referred to as the '2006 WSP Acoustic Survey Report').
- ISO 9613-2:1996, '*Acoustics -- Attenuation of sound during propagation outdoors – Part 2: General method of calculation*'.
- BS EN 12354-4:2000: '*Building acoustics – Estimation of acoustic performance of building from the performance of elements – Part 4: Transmission of indoor sound to the outside'.*
- BS EN 12354-5:2009, '*Building acoustics – Estimation of acoustic performance of building from the performance of elements – Part 5: Sounds level dues to the service equipment*'.

1.1.7 This report is necessarily technical in nature. A glossary of technical terms used in this report is provided in Appendix A.

2 The Proposed Development

2.1 Site Description

2.1.1 The site of Great Ormond Street Hospital is bounded to the north by Guilford Road, to the east by Lambs Conduit Street, to the south by Great Ormond Street, and to the west by Queen Square. The Phase 2B development is located on the eastern portion of the GOSH site

2.1.2 The area contains a mix of uses including housing, retail, health and educational facilities.

2.1.3 Of the three roads bounding the site, Guilford Road was found to be relatively busy with Great Ormond Street and Lambs Conduit Street generally less busy.

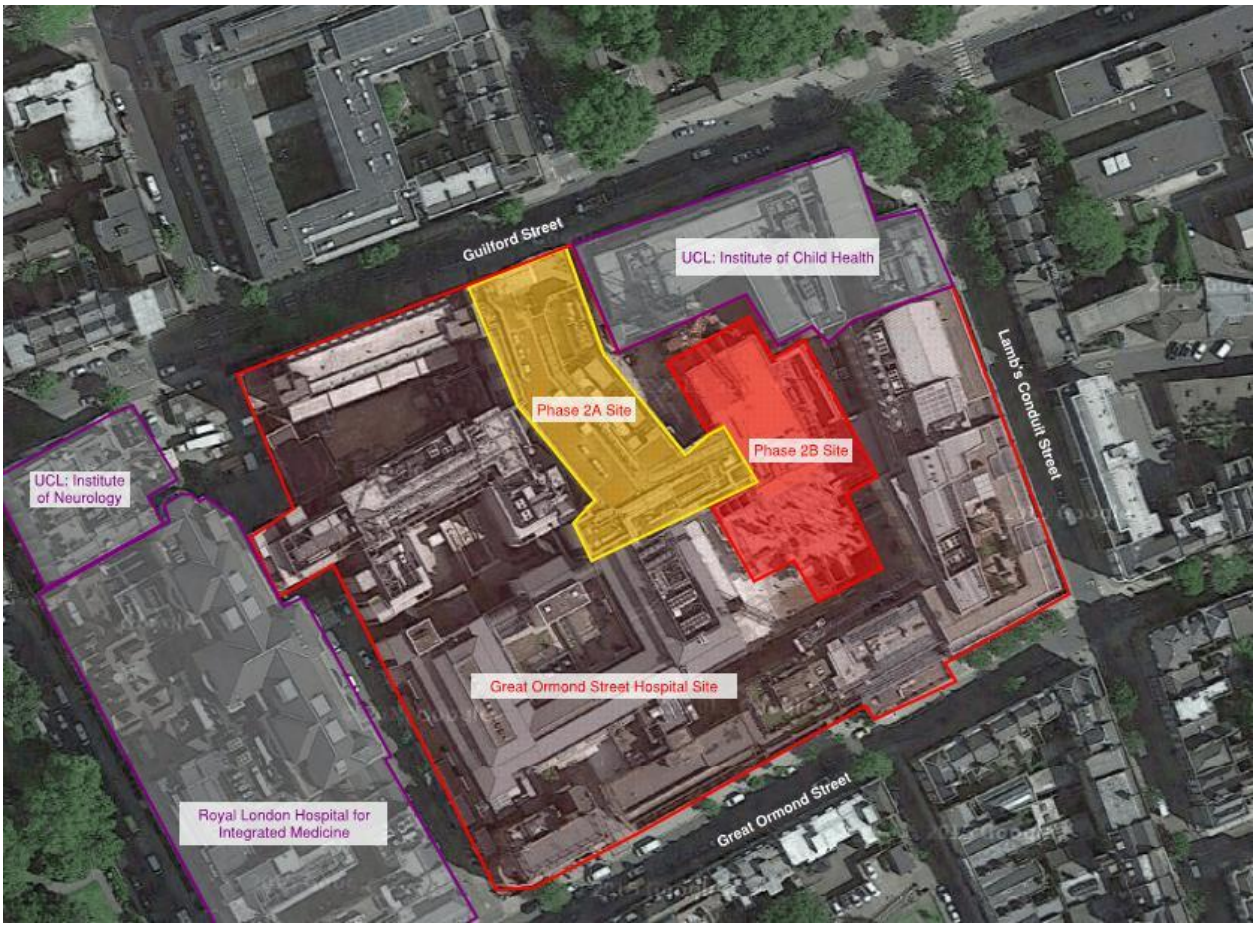
2.1.4 The main entrance to the hospital and access for ambulances is via Great Ormond St.

2.1.5 The nearest noise-sensitive receptors to the site were identified as follows:

- The dwellings on the south side of Great Ormond St.
- The dwellings on the east side of Lambs Conduit.
- The dwellings on to north side of Guilford St.

2.1.6 A map of the GOSH2B development and the surrounding area is shown in Figure 1.

Figure 2-1: Map of the development site



2.2 The Development Proposals

2.2.1 The development consists of a new building on the site of the old Cardiac Wing for which four floors of the old building will be retained and refurbished. Four additional upper floors will also be provided.

2.2.2 The proposed plant areas are mainly located on the eighth floor of the development and a fourth floor roof area. Some additional plant items are located within risers and a ground floor loading bay.

2.2.3 The proposed plant and machinery that will emit noise which could affect the surrounding area includes air handling units, supply and extract fans, pumps, a pressurisation unit, transformers, chillers, a combined heat and power (CHP) unit and an generator that would be used under emergency circumstances only (i.e. power failure).

2.2.4 Further information about the proposed plant and machinery is presented in Section 7.

3 Planning Context

3.1 GOSH2B Planning Application

3.1.1 A planning application for the GOSH2B was submitted to the London Borough of Camden Council in August 2007. The 2006 WSP Acoustic Survey Report was submitted as part of the application.

3.1.2 The 2006 WSP Acoustic Survey Report presented the relevant planning policies relevant to the control of noise that were current at the time of the application submission and the results of a noise measurement survey carried out in November 2005. Maximum permissible plant noise emission limits were derived based on the measurement data. No assessment of noise from mechanical plant was carried out at this stage as the development was at an early stage in the design process.

3.1.3 The GOSH2B development was granted planning approval in November 2007 (planning application ref: 2007/4116/P), with one condition relating to acoustics and noise (Planning Condition 8):

'Details of plant (including an acoustic report, sound attenuation and acoustic isolation from the structure) to be installed as part of the development shall be submitted to and approved by the local planning authority prior to commencement of each part of the development. The development shall only be carried out in accordance with such approved details, including specified maximum noise levels, and thereafter maintained.

REASON: To ensure that the appearance of any external plant is compatible with the appearance of the building are the area and to ensure that residential amenities are protect in accordance with the requirements of policy SD7 of the Camden Replacement Unitary Development Plan 2006.'

3.1.4 The above planning condition refers to the Camden Replacement Unitary Development Plan 2006 (2006 UDP). This is discussed in the following section.

3.2 Camden Replacement UDP

3.2.1 Planning Condition 8 of the GOSH2B planning application refers to the 2006 UDP, Policy SD7, the relevant sections of which are reproduced below:

'SD7 - Light, noise and vibration pollution

B - Noise/vibration pollution

Unless appropriate attenuation measures are available and are included, the Council will not grant planning permission for:

a) development likely to generate noise/vibration pollution; or

b) development sensitive to noise/vibration in locations with noise/vibration pollution.

In assessing applications against these criteria, the Council will have regard to the levels set out in Appendix 1 to this Plan.'

3.2.2 Appendix 1 of the 2006 UDP contains three tables presenting acceptable levels of noise and vibration for residential development and one table relating to noise from places of entertainment. A further table (Table E) presents limits on noise from plant and machinery which is considered relevant to the discharge of this planning condition, and is referenced in the 2006 UDP '*Policy SD8 – Disturbance*'. This policy, along with Table E of the 2006 UDP, are reproduced as follows:

'SD8 - Disturbance

A - Disturbance from plant and machinery

The Council will only grant planning permission for plant or machinery, including ventilation or air handling equipment, if it can be operated without causing a loss to local amenity and does not exceed the thresholds set out in Appendix 1 - Noise and Vibration (Table E).'

'Appendix 1 – Noise and Vibration Thresholds: Table E: Noise levels from plant and machinery at which planning permission will not be granted'

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external of a sensitive façade	Day, evening & night	00:00-24:00	5 dB(A) < L_{A90}
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive facade	Day, evening & night	00:00-24:00	10 dB(A) < L_{A90}
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening & night	00:00-24:00	10 dB(A) < L_{A90}
Noise at 1 metre external L_{Aeq} to sensitive façade where L_{A90} > 60dB	Day, evening & night	00:00-24:00	55 dB L_{Aeq}

3.2.3 It is noted that the 2006 UDP has since been superseded by the '*Camden Development Policies 2010-2025: Local Development Framework*' (LDF), as published on the LBCC internet site. Policy *'DP28 Noise and Vibration'* of the LDF presents the current noise and vibration policy for the LBCC.

3.2.4 It is noted that Table E of LDF Policy DP28, applicable to the noise from plant and machinery, presents the same noise level limits as the 2006 UDP Appendix 1 Table E. Therefore, the GOSH2B development will meet the requirements of the current policy as well as the 2006 UDP if these limits are achieved.

3.3 Consultation with the Local Authority

3.3.1 Previous applications have been submitted to LBCC to discharge condition 8 (ref: 2015/3935/P, dated 8 July 2015, and ref: 2015/4089/P, dated 9 July 2015). The information previously submitted included earlier revisions to this report

3.3.2 Following submission of the previous revisions of this report, consultation took place involving Daniel Doherty, Senior Consultant of WSP | Parsons Brinckerhoff, and Joanne Stowell, Principal Environmental Health Officer of LBCC.

3.3.3 Part of this consultation process involved a meeting on 15 March 2016 during which the following actions were agreed:

- WSP | PB to gather further noise measurement data during the weekend.
- LBCC to provide requirements for the assessment of noise from emergency plant [understood at the time that this would require a comparison of the equivalent continuous noise level (dB L_{Aeq}) with emergency plant vs. the existing ambient level].
- WSP | PB to provide likely hours of testing for emergency plant.
- WSP | PB to provide further information regarding the likelihood of noise from plant being tonal or impulsive. If this is not possible (e.g. information not available) then commissioning monitoring will be required to ensure, by measurement, that plant noise is at an acceptable level and not tonal or impulsive.

3.3.4 Following the meeting the following additional information was supplied by LBCC:

- Noise from emergency plant (including the noise from plant operating during normal conditions and would be operating simultaneously) to be assessed to demonstrate the following requirement is achieved:

  '*Prior to [commencement] [use] of the development, details shall be submitted to and approved in writing by the Council to confirm that noise emitted by standby or emergency generators during power outages or testing does not exceed the lowest daytime* $L_{Aeq(15min)}$ *as measured or calculated according to BS4142:2014.*'

- Post installation testing will need to be carried out during the commissioning phase.

3.3.5 With respect to the assessment method, the following detail was agreed via email between Dan Doherty and Joanne Stowell on 9 August 2016:

- WSP | PB are to determine the lowest background sound level for day and night (dB L_{A90}). This will be from the most recent noise surveys (2015/2016).
- WSP | PB are to determine the noise level (L_{Aeq}) due to the GOSH2B development and confirm that the limits in Appendix 1 Table E of the 2006 UDP are met.
- WSP | PB are apply the more onerous limit in Appendix 1 Table E (noise from the development, dB $L_{Aeq,15min}$, to be at least 10 dB below the background sound level). This will account for the presence of any tonal or impulsive features that could attract more attention to the sound.

3.3.6 The above assessment approach has been adopted for this report and is described in more detail in the following section.

4 Establishing the Assessment Criteria

4.1 Overview

4.1.1 This section presents the assessment methodology and criteria for noise from mechanical plant associated with the development.

4.1.2 Reference has been made to the requirements of Planning Condition 8 and LBCC noise and vibration policies, as presented in section 3.2 of this report.

4.1.3 The assessment methodology for plant operating during normal conditions is discussed further in section 4-2.

4.1.4 The assessment methodology for plant operating during emergency conditions, as agreed with LBCC, is discussed in section 4.3.

4.2 Plant Operating During Normal Conditions

4.2.1 Noise from plant operating during normal conditions shall be limited in order to achieve the noise level limits within the LBCC 2006 UDP policy SD8.

4.2.2 The assessment procedure is as follows, for each period of interest (daytime and night-time):

- **Determine the plant noise level** at the assessment location(s) during time intervals that are representative of the period of interest. For a source that is not yet operating the plant noise level is determined by calculation.
- **Measure the background sound level** at the assessment location(s) (or location at which the background sound level is comparable to the assessment location) during time intervals that are sufficient for the period of interest, and under representative weather conditions..
- **Determine the difference between the background sound level and the plant noise level** at the assessment location(s) and compare against the 2006 UDP limits. The limit that will be applied to the GOSH2B development is the more onerous limit in Appendix 1 Table E (noise from the development, dB $L_{Aeq,15min}$, to be at least 10 dB below the background sound level). This will account for the presence of any tonal or impulsive features that could attract more attention to noise from plant.
- **Provide mitigation** where the UDP limit cannot be achieved, and report the plant noise levels and results of the revised assessment with mitigation included.

4.2.3 The plant noise limits will, therefore, be established taking into account the background sound level at each assessment location. These limits are presented in Section 6.

Establishing the Background Sound Level

4.2.4 One of the main aspects of an assessment following the above method is the determination of the background sound level at the adjacent sensitive properties. During consultation with LBCC it was agreed the background sound level to be used in the assessment would be lowest background sound level value determined during recent baseline sound surveys.

4.2.5 The following approach has been adopted for this assessment, specifically:

- The measurement survey shall cover both weekdays and the weekend.
- The measurement positions shall be as used during the initial 2006 baseline sound survey. The background sound level measured at these positions is considered representative of the background sound level that would be experienced at the closest façades of the nearest noise sensitive properties.

- A lowest background sound level will be determined for each daytime and night-time period of the survey
- The lowest (daytime and night-time) background sound level will be presented for the weekday and weekend separately.

4.3 Noise from Emergency Plant

4.3.1 Confirmation of the required assessment approach was received from LBCC via email after the meeting on 15 March 2016.

4.3.2 The assessment approach shall be as follows:

- The 'lowest existing ambient sound level' shall be determined. This will be the lowest dB $L_{Aeq,15min}$ currently experienced at each representative assessment location.
- The 'plant noise level during emergency conditions' (dB $L_{Aeq,15min}$) shall be determined. This shall include noise from mechanical plant that operates only during emergency conditions (e.g. generators) and noise from mechanical plant that operates during both normal and emergency conditions (e.g. fans and air handling units, etc.).
- The 'plant noise level during emergency conditions' shall be limited so that it does not exceed the 'lowest existing ambient sound level' at any assessment location.

4.4 Adopted Assessment Criteria

4.4.1 On the basis of the above, the adopted assessment criteria for noise from mechanical plant shall be as shown in Table 4-1 and Table 4-2 below for normal and emergency conditions respectively.

Table 4-1: Maximum noise levels from plant or machinery: Normal conditions

Position	Period	Time	Noise Emission Limit
1 metre from any sensitive façade that could be affected by noise from plant and machinery	Day & Evening	07:00-23:00	Noise level during normal conditions (dB $L_{Aeq,15min}$) to no less than 10 dB below the lowest day-time background sound level, dB $L_{A90,15min}$
	Night	23:00-07:00	Noise level during normal conditions (dB $L_{Aeq,15min}$) to no less than 10 dB below the lowest night-time background sound level, dB $L_{A90,15min}$

Table 4-2: Maximum noise levels from plant or machinery: Emergency conditions

Position	Period	Time	Noise Emission Limit
1 metre from any sensitive façade that could be affected by noise from plant and machinery	Day & Evening	07:00-23:00	'Plant noise level during emergency conditions' to be no more than the 'lowest existing ambient sound level' for daytime hours
	Night	23:00-07:00	'Plant noise level during emergency conditions' to be no more than the 'lowest existing ambient sound level' for night-time hours

5 Acoustic Surveys

5.1 Introduction

5.1.1 Noise measurements were taken in 2005 as part of the original planning application. Following consultation with the LBCC it was agreed that the further noise measurements would be taken, due to the length of time that had passed since the planning application. An additional noise measurement survey was therefore carried out in December 2015.

5.1.2 Following the submission of a previous revision of this report (Rev 01) further noise measurements were requested by LBCC, to cover the weekend period. A further noise measurement survey was therefore carried out between Friday 15 and Tuesday 19 April 2016 to supplement the 2015 survey.

5.1.3 All details of each noise measurement survey are provided in the Appendices to this report:

- Appendix B: Summary of the noise measurement survey carried out in 2005;
- Appendix C: Details of the noise measurement survey carried out in December 2015; and
- Appendix D: Details of the noise measurement survey carried out in April 2016, specifically to cover the weekend period.

5.1.4 Noise measurements were carried out at positions chosen to represent the nearest noise-sensitive properties in the vicinity of the development and are shown in Figure 5-1.

Figure 5-1: Noise monitoring positions

5.1.5 Background noise levels measured in both surveys are summarised in the following section.

5.2 Measured Background Sound Levels

5.2.1 Background sound level has been determined in accordance with the approach stated in section 4.2.

5.2.2 Full details of the baseline sound surveys are presented in Appendix C and D for the 2015 and 2016 surveys respectively.

5.2.3 The background sound levels that have been determined are summarised in Table 5-1. These and were determined by the following process:

- An analysis of the measurement data has been carried out in order to determine the lowest measured background sound level, dB $L_{A90,15min}$, for each period of the day and each day of the week (values for each day of the survey are shown in Table C-3 and D-3 in Appendix C and D).
- Considering weekdays and weekend days separately, the background sound level shown in Table 5-1 was determined as the lowest value for each day (considering both the 2015 and 2016 measurement data).

Table 5-1: Measured background sound levels from both acoustic surveys, corrected to façade conditions

Position	Period	Time	Representative Background Sound Level at Receptor [dB $L_{A90,15min}$]	
			Weekday	Weekend
1 (Great Ormond Street façade conditions)	Day	0700-2300	50 (47 dB free-field)	48 (45 dB free-field)
	Night	2300-0700	46 (43 dB free-field)	47 (44 dB free-field)
2 (Lambs Conduit Street, façade conditions)	Day	0700-2300	53 (50 dB free-field)	52 (49 dB free-field)
	Night	2300-0700	50 (47 dB free-field)	50 (47 dB free-field)
3 (Guilford Street façade conditions)	Day	0700-2300	50	49
	Night	2300-0700	46	46

5.2.4 The above values demonstrate that there is little difference between lowest background sound levels for weekdays and for the weekend .

5.2.5 Further information about each survey is presented in the Appendices to this report, including observations of the sources of noise apparent at each measurement location.

5.3 Measured Ambient Sound Levels

5.3.1 The methodology for assessing noise from emergency plant requires a comparison of the 'plant noise level during emergency conditions' with the 'lowest existing ambient sound level'. The existing ambient sound levels were measured as part of the acoustic surveys and are presented in Table 5-2.

5.3.2 The values presented show in minimum dB $L_{Aeq,15min}$ measured during any weekday and weekend day, considering both the 2015 and 2016 measurement. The individual daily values are shown in Table C-4 and D -4 in Appendix C and D.

Table 5-2: Lowest measured ambient sound levels from both acoustic surveys, corrected to façade conditions

Position	Period	Time	Lowest Measured Ambient Sound Level [dB $L_{Aeq,15min}$]	
			Weekday	Weekend
1 (Great Ormond Street façade conditions)	Day	0700-2300	58 (55 dB free-field)	58 (55 dB free-field)
	Night	2300-0700	48 (45 dB free-field)	51 (48 dB free-field)
2 (Lambs Conduit Street, façade conditions)	Day	0700-2300	58 (55 dB free-field)	57 (54 dB free-field)
	Night	2300-0700	52 (49 dB free-field)	52 (49 dB free-field)
3 (Guilford Street façade conditions)	Day	0700-2300	61	59
	Night	2300-0700	51	54

6 Plant Noise Emission Limits

6.1 Airborne Noise during Normal Conditions

6.1.1 Maximum noise levels from plant or machinery at each noise-sensitive receptor have been established based on the adopted assessment criteria presented in Table 4-1 in Section 4 and using the background noise levels measured in 2015, as presented in Table 5-1.

6.1.2 Noise limits are presented at each receptor in Table 6-1 below.

Table 6-1: Limits on noise from plant or machinery at the each sensitive receptor during normal conditions

Position	Period	Time	Plant noise limit, normal conditions
1 metre from any noise sensitive property on Great Ormond Street	Day & Evening	07:00-23:00	38 dB $L_{Aeq,15min,\ façade}$
	Night	23:00-07:00	36 dB $L_{Aeq,15min,\ façade}$
1 metre from any noise sensitive property on Lamb's Conduit Street	Day & Evening	07:00-23:00	42 dB $L_{Aeq,15min,\ façade}$
	Night	23:00-07:00	40 dB $L_{Aeq,15min,\ façade}$
1 metre from any noise sensitive property on Guilford Street	Day & Evening	07:00-23:00	39 dB $L_{Aeq,15min,\ façade}$
	Night	23:00-07:00	36 dB $L_{Aeq,15min,\ façade}$

6.1.3 Note that the limits shown in Table 6-1 allow for the presence of acoustic features that could attract more attention to the noise from plant (e.g. tones, impulses, etc.) since they are based on the more onerous noise level requirement in the LBCC 2006 UDP Appendix 1 Table E (as previously described in section 4.2).

6.2 Airborne Noise from Emergency Plant

6.2.1 Limits for noise during emergency conditions are based on the assessment method provided by LBCC and the observed lowest ambient noise levels shown in Table 5-2.

6.2.2 Maximum noise levels, in terms of dB $L_{Aeq,15min}$, are provided in Table 6-2.

Table 6-2: Limits on noise from plant or machinery at the each sensitive receptor during emergency conditions

Position	Period	Time	Plant noise limit, emergency conditions
1 metre from any noise sensitive property on Great Ormond Street	Day & Evening	07:00-23:00	58 dB $L_{Aeq,15,min,\ façade}$
	Night	23:00-07:00	48 dB $L_{Aeq,15,min,\ façade}$
1 metre from any noise sensitive property on Lamb's Conduit Street	Day & Evening	07:00-23:00	57 dB $L_{Aeq,15,min,\ façade}$
	Night	23:00-07:00	52 dB $L_{Aeq,15,min,\ façade}$
1 metre from any noise sensitive property on Guilford Street	Day & Evening	07:00-23:00	59 dB $L_{Aeq,15,min,\ façade}$
	Night	23:00-07:00	51 dB $L_{Aeq,15,min,\ façade}$

6.3 Structure-borne Noise

6.3.1 Planning Condition 8 requires that details of the acoustic isolation between the plant items and roof structure are to be provided to ensure that residential amenities are protected. However, whilst all plant will be mounted on anti-vibration treatment where necessary to protect the occupants of the hospital, the hospital is a detached building and negligible structural borne noise or vibration will be transmitted from the plant to the residential amenity in the surrounding area. Consequently this report does not include a review of the acoustic isolation i.e. anti-vibration mounts.

7 Building Services Plant

7.1 Proposed Plant

7.1.1 The GOSH2B development is served by various items of plant and machinery as follows:

- 5 no. supply fans;
- 7 no. extract fans;
- 21 no. air handling units;
- 14 no. pumps;
- 1 no. pressurisation set;
- 2 no. transformers;
- 2 no. chillers;
- 27 no. fan coil units in various rooms and risers within the development;
- CHP on the roof of the Phase 2A development; and
- A generator to be used in emergency circumstances (i.e. power failure).

7.1.2 These proposed items of plant and machinery have the potential to influence external noise levels in the area. Possible sources of noise are as follows:

- Duct-borne fan noise from various fans and air handling units;
- Case-radiated noise and fan noise break-out from externally located fans and air handling units and associated ductwork;
- Noise from other externally located plant such as the CHP unit, various pumps, and emergency generator;
- Noise break-out from rooms containing items of plant through acoustically weak points in the building envelope (e.g. louvres or doors).

7.1.3 Most items of plant are located on the Level 8 rooftop of the Phase 2B building, either located externally or within plant rooms.

7.1.4 The following items are enclosed within rooms on Level 8:

- Chiller rooms: This room contains AHU discharge louvres, two chillers units; and various pumps associated with the chillers.
- Boiler room: This room contains the pressurisation unit is located within the Level 8 Boiler Room along with the boilers and various pumps.
- Transformer rooms: These rooms contain the transformers.

7.1.5 In addition, two AHU's serving the operating theatre (AHU 06 & 07) will be located in a separate plant area on the fourth floor flat rooftop area on the east of the building. These two air handling units will be located within a partial enclosure.

7.1.6 AHU 08 and AHU ISO 12 & 13 will be located within ventilation risers at the southern and northern extents of the building respectively. These plant items will be ducted to the main roof level where they will discharge exhaust air.

7.1.7 Additional extract and supply fans and their associated terminals are located at lower levels, for example near the loading bay.

7.1.8 The CHP unit will be located on the roof of the Phase 2A part of the GOSH development.

7.1.9 The emergency generator will be located on the southwest corner of the main rooftop and comes with a manufacturer supplied noise control kit. This generator will operate in emergency circumstances only (e.g. during a power failure).

7.2 Sound Level Information

7.2.1 All information regarding plant noise data has been provided by the design team and the contractor.

7.2.2 Source level information, in the form of either sound power levels or sound pressure levels at a specified distance, has been supplied by the relevant manufacturers.

7.2.3 The source levels provided are reproduced in the plant noise schedule in Appendix E.

7.3 Acoustic Character of Sound from the Development

7.3.1 Further information about the character of sound from the items of mechanical plant has been supplied by the design team mechanical engineer. This was required to consider the character of noise from these items of plant during normal operating conditions.

7.3.2 Based on consultation with the mechanical engineer it is understood that the items of mechanical plant (excluding emergency plant) will operate 24 hours a day / 7 days a week, as is standard for a large hospital environment. This includes the CHP plant, the primary function of which is to provide electricity to the building all year round, and the absorption chillers, which are required to meet the year round cooling requirement for the building and maximise the use of waste heat from the CHP plant during the summer months.

7.3.3 The likelihood of the noise from plant containing acoustic feature that could attract attenuation are discussed below.

Tonality

7.3.4 The sound level information supplied for each item of plant is not sufficient to determine quantitatively whether the sound experienced at the receptor locations will be tonal. Therefore, it is necessary to rely upon a subjective and qualitative judgement regarding the likelihood of the sound being tonal at the receptor location.

7.3.5 Based on past experience it is likely that noise from the following sources would be tonal to some extent:

- Case-radiated noise from fans;
- Pumps;
- Chillers;
- Transformers; and
- CHP flue.

Impulsivity

7.3.6 It is understood that the proposed items of plant will operate on a 24 hours a day / 7 days a week basis and therefore noise from these items will be steady and continuous in nature.

7.3.7 It is considered unlikely that sounds of an impulsive nature (i.e. rapid changes in sound level, such as crashes and bangs) will be experienced at the nearest receptor locations.

7.3.8 It is possible that these types of sounds could be experienced should the items of plant fall into disrepair (for example rotating items such as fans), and adequate maintenance of all plant items will need to be provided to ensure this remains the case.

Intermittency

7.3.9 Based on the information provided by the mechanical engineer (that plant will operate on a 24 hours a day / 7 days a week basis) it is unlikely that noise from the development will be intermittent in nature (i.e. cyclic sound sources with identifiable on/off conditions).

7.3.10 Use of the generator would be intermittent as it will be used under emergency conditions only. However this does not form part of the assessment of noise from plant during normal conditions, and different acoustic criteria apply to this source, as discussed in section 4.3.

7.4 Incorporated Mitigation

7.4.1 Various attenuation measures have been incorporated into the design in order to control noise emissions from the Phase 2B development. These measures have been incorporated into the assessment.

7.4.2 The ventilation system has been designed to include attenuators, the specification of which was carried out previously by another consultant. The minimum required insertion loss of each of the proposed attenuators has been supplied by the design team. Further information regarding the proposed attenuators is given in Appendix F.

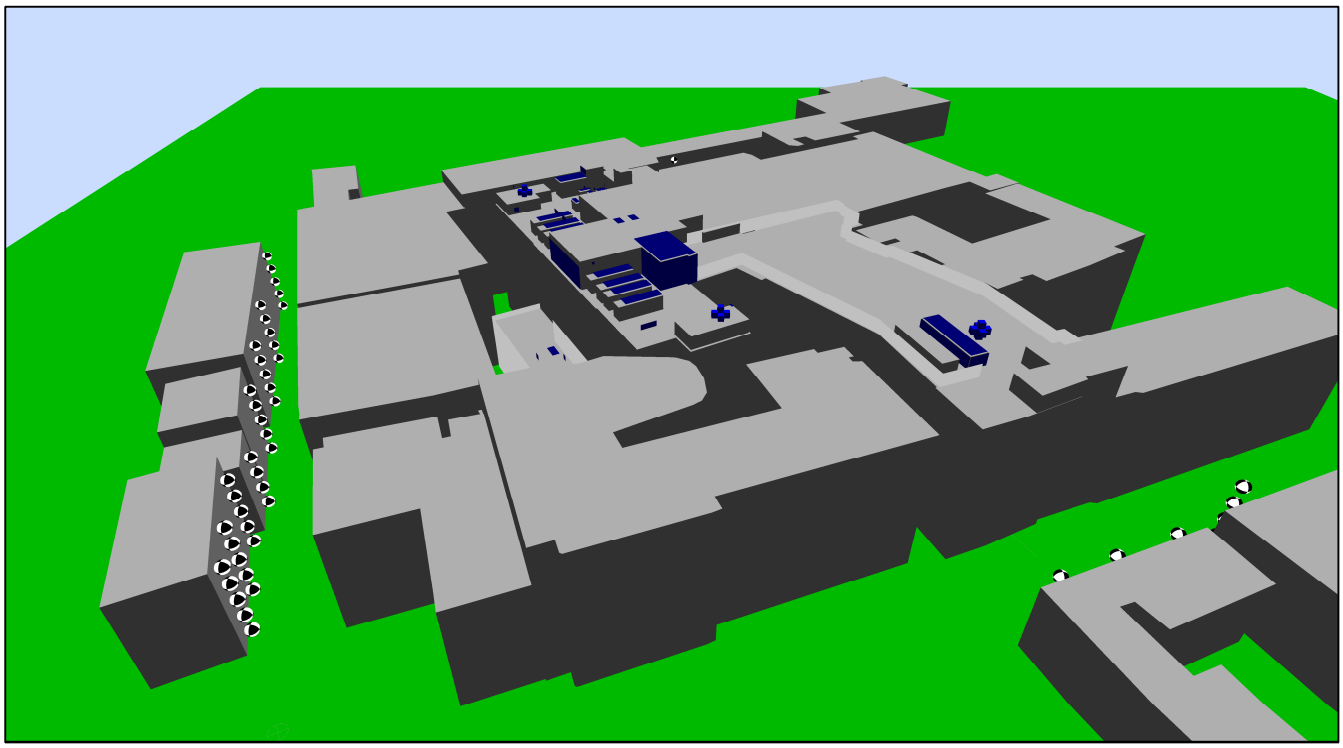
8 Building Services Plant Noise Assessment

8.1 Methodology

8.1.1 The assessment of building services plant has been based on information provided by the design team and contractor, as described in Section 7. This information was used to create a three dimensional acoustic model of the hospital and the surrounding area.

8.1.2 The acoustic model was created in the Datakustik Cadna/A software which implements the ISO9613-2 '*Acoustics -- Attenuation of sound during propagation outdoors – Part 2: General method of calculation'* procedure. A screenshot of the three dimensional acoustic model is shown in Figure 8-1.

Figure 8-1: Screenshot of three-dimensional acoustic model (viewed from the north)



8.1.3 Where extract or supply grilles are located externally, the sound power level of duct-borne fan noise at the grille has been determined using the methodology within BS EN 12354-5:2009, '*Building acoustics – Estimation of acoustic performance of building from the performance of elements – Part 5: Sounds level dues to the service equipment'*. The grille sound power levels incorporate the effect of the attenuators shown in Appendix E.

8.1.4 Large noise sources were represented by area sources, the dimensions of which were consistent with those supplied by the manufacturer. Smaller sources were represented by point sources.

8.1.5 Where sources of noise were located in rooms with acoustically weak elements (for example louvres), the reverberant sound pressure level in the room due to these sources were determined. This calculation takes into account the dimensions of the room and the sound absorption properties of the internal surfaces of the room materials (which were assumed to be highly reflective to sound). Noise break-out from these rooms was predicted using the methodology within BS EN 12354-4:2000.

8.1.6 External plant noise levels were predicted outside the nearest noise sensitive properties; those located on Great Ormond Street, Guilford Street and Lambs Conduit Street, to the south, north and east of the hospital respectively.

8.1.7 Two scenarios have been considered, and noise levels have been predicted for each:

- Normal operation: All plant apart from the emergency generator operating simultaneously.
- Emergency operation: As above, with emergency generator operating.

8.1.8 It is assumed that either of these scenarios could occur at any time of day, and the effects of noise during both the daytime and night-time periods has been assessed.

8.1.9 Noise levels were predicted at 1 m from the closest façade of the nearest noise sensitive properties, and include the effect of façade reflections. The range of predicted noise levels at each location is reported in the following section.

8.1.10 Other residential receptors located further from the development will be subject to lower levels of noise than those predicted at the above locations and are not considered in detail.

8.2 Noise Predictions and Assessment: Normal Conditions

Noise Predictions: No Design Changes

8.2.1 Predicted noise levels at the adjacent noise sensitive receptors during normal conditions are shown in Table 8-1. These predictions allow for the incorporated mitigation shown in section 7.4.

8.2.2 The predicted range of noise levels is shown and corresponds to varying positions across the façade (both horizontally and at all floors of each building). The worst affected location is also described.

8.2.3 Further detailed information is provided in Appendix F, showing the contribution of each item of plant to the total noise level at the worst affected locations.

Table 8-1: Predicted plant noise levels: Normal condition with no design changes

Location	Normal Operation, No Design Changes	
	Predicted noise levels across the façade [dB $L_{Aeq,T}$]	Worst affected location
89-92 Guilford St	32 - 40	1st floor, eastern end of façade
International Hall (University of London), Guilford St	28 - 34	4th floor, eastern end of façade
19-27 Great Ormond St	26 - 29	3rd floor, eastern end of façade
29-41 Great Ormond St	26 - 29	3rd floor, western end of façade
3-6 Guilford Place / 86-94 Lamb's Conduit St	31 - 38	4th floor, north end of façade
Spens House / 70 Lamb's Conduit St	29 - 33	4th floor, north end of façade
The Lamb PH	31 - 32	3rd floor

8.2.4 In general, the highest noise level due to the development is predicted at the top floor of the sensitive properties. This is due to the fact that the roof top plant will be screened by the surrounding buildings.

8.2.5 At 89-92 Guildford Street, the highest noise level is predicted at first floor level and is mainly due to case-radiated noise from fan EF07 (located under the ground floor canopy north of the development).

Assessment: No Design Changes

8.2.6 The highest predicted noise levels are compared to the established assessment criteria in Table 8-2 and Table 8-3 for normal conditions during the daytime and night-time conditions respectively.

Table 8-2: Assessment of plant noise: normal conditions during the daytime

Location (worst affected receptor)	Predicted Plant Noise Level, dB $L_{Aeq,15min,façade}$	Daytime Noise Limit Assuming Tonal or Impulsive Features are Present, dB $L_{Aeq,15min,\ facade}$	Daytime Assessment Conclusion (and Exceedance)
89-92 Guilford St	40	39	**Limit exceeded (+1)**
International Hall (University of London), Guilford St	34	39	Limit not exceeded (-5)
19-27 Great Ormond St	29	38	Limit not exceeded (-9)
29-41 Great Ormond St	29	38	Limit not exceeded (-9)
3-6 Guilford Place / 86-94 Lamb's Conduit St	38	42	Limit not exceeded (-4)
Spens House / 70 Lamb's Conduit St	33	42	Limit not exceeded (-9)
The Lamb PH	32	42	Limit not exceeded (-10)

Table 8-3: Assessment of plant noise: normal conditions during the night-time

Location (worst affected receptor)	Predicted Specific Sound Level, dB $L_{Aeq,15min,façade}$	Night-time Noise Limit Assuming Tonal or Impulsive Features are Present, dB $L_{Aeq,15min,\ facade}$	Night-time Assessment Conclusion (and Exceedance)
89-92 Guilford St	40	36	**Limit exceeded (+4)**
International Hall (University of London), Guilford St	34	36	Limit not exceeded (-2)
19-27 Great Ormond St	29	36	Limit not exceeded (-7)
29-41 Great Ormond St	29	36	Limit not exceeded (-7)
3-6 Guilford Place / 86-94 Lamb's Conduit St	38	40	Limit not exceeded (-2)
Spens House / 70 Lamb's Conduit St	33	40	Limit not exceeded (-7)
The Lamb PH	32	40	Limit not exceeded (-8)

8.2.7 Table 8-2 and Table 8-3 demonstrate that the noise emission limits will be achieved at the worst affected part of all receptors apart from at 89-92 Guilford St, during the daytime (limit exceeded by 1 dB $L_{Aeq,15min}$) and the night-time (limit exceeded by 4 dB $L_{Aeq,15min}$).

8.2.8 As the plant noise limit is exceeded at parts of this property, further acoustic modelling was carried out to determine the most effective additional mitigation.

Noise Predictions: With Further Mitigation

8.2.9 As the dominant source of noise at 89-92 Guilford Street is case-radiated noise from extract fan EF07 (located under the ground floor canopy north of the development), the need for mitigation of this item has been communicated to the contractor and design team.

8.2.10 In order to reduce case-radiated noise from this extract fan it is necessary to either lag the fan casing or locate the fan with an enclosure.

8.2.11 The minimum required insertion loss of the lagging or enclosure are shown in Table 8-4. An example product that can fulfil these requirements is Muftilag (supplied by Hodgson and Hodgson Group Ltd).

Table 8-4: Minimum insertion loss requirements for extract fan (EF07) lagging

Item	Minimum insertion loss per octave frequency band [dB rel. to 20 μPa]					
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Lagging, 25mm depth with 10 kg/m^2 mass barrier	4	6	16	20	24	25

8.2.12 Predicted noise levels at the adjacent noise sensitive receptors with this additional mitigation during normal conditions are shown in Table 8-5. Further detailed information is provided in Appendix F, showing the contribution of each item of plant to the total noise level at the worst affected locations.

Table 8-5: Predicted plant noise levels: Normal condition with further mitigation

Location	Normal Operation, with Further Mitigation	
	Predicted noise levels across the façade [dB $L_{Aeq,T}$]	Worst affected location
89-92 Guilford St	32 - 36	1st floor, eastern end of façade
International Hall (University of London), Guilford St	28 - 33	4th floor, eastern end of façade
19-27 Great Ormond St	26 - 29	3rd floor, eastern end of façade
29-41 Great Ormond St	26 - 28	3rd floor, western end of façade
3-6 Guilford Place / 86-94 Lamb's Conduit St	30 - 37	4th floor, north end of façade
Spens House / 70 Lamb's Conduit St	29 - 33	4th floor, north end of façade
The Lamb PH	31 - 32	3rd floor

Assessment: With Further Mitigation

8.2.13 The highest predicted noise levels are compared to the established assessment criteria in Table 8-6 and Table 8-7 for normal conditions during the daytime and night-time conditions respectively.

Table 8-6: Assessment of plant noise: normal conditions during the daytime

Location (worst affected receptor)	Predicted Plant Noise Level, dB $L_{Aeq,15min,façade}$	Daytime Noise Limit Assuming Tonal or Impulsive Features are Present, dB $L_{Aeq,15min,\ facade}$	Daytime Assessment Conclusion (and Exceedance)
89-92 Guilford St	36	39	Limit not exceeded (-3)
International Hall (University of London), Guilford St	33	39	Limit not exceeded (-5)
19-27 Great Ormond St	29	38	Limit not exceeded (-9)
29-41 Great Ormond St	28	38	Limit not exceeded (-10)
3-6 Guilford Place / 86-94 Lamb's Conduit St	37	42	Limit not exceeded (-5)
Spens House / 70 Lamb's Conduit St	33	42	Limit not exceeded (-9)
The Lamb PH	32	42	Limit not exceeded (-10)

Table 8-7: Assessment of plant noise: normal conditions during the night-time

Location (worst affected receptor)	Predicted Specific Sound Level, dB $L_{Aeq,15min,façade}$	Night-time Noise Limit Assuming Tonal or Impulsive Features are Present, dB $L_{Aeq,15min,\ facade}$	Night-time Assessment Conclusion (and Exceedance)
89-92 Guilford St	36	36	Limit not exceeded (0)
International Hall (University of London), Guilford St	33	36	Limit not exceeded (-3)
19-27 Great Ormond St	29	36	Limit not exceeded (-7)
29-41 Great Ormond St	28	36	Limit not exceeded (-8)
3-6 Guilford Place / 86-94 Lamb's Conduit St	37	40	Limit not exceeded (-3)
Spens House / 70 Lamb's Conduit St	33	40	Limit not exceeded (-7)
The Lamb PH	32	40	Limit not exceeded (-8)

8.2.14 Table 8-6 and Table 8-7 demonstrate that, with the additional mitigation, the noise emission limits will be achieved at the worst affected part of all receptors.

8.3 Noise Predictions and Assessment: Emergency Conditions

Noise Predictions: Emergency Conditions

8.3.1 Predicted noise levels at the adjacent noise sensitive receptors during emergency conditions are shown in Table 8-8. These predictions allow for the incorporated mitigation shown in section 7.4 and the further mitigation of extract fan EF07, as shown in Table 8-4.

Table 8-8: Predicted plant noise levels: Emergency Conditions

Location	Emergency Operation	
	Predicted noise levels across the façade [dB $L_{Aeq,T}$]	Worst affected location
89-92 Guilford St	33 - 40	1st floor, eastern end of façade
International Hall (University of London), Guilford St	29 - 37	4th floor, eastern end of façade
19-27 Great Ormond St	28 - 31	3rd floor, eastern end of façade
29-41 Great Ormond St	28 - 33	3rd floor, middle of façade
3-6 Guilford Place / 86-94 Lamb's Conduit St	30 - 37	4th floor, north end of façade
Spens House / 70 Lamb's Conduit St	29 - 33	4th floor, north end of façade
The Lamb PH	31 - 32	3rd floor

Assessment: Emergency Conditions

8.3.2 The highest predicted noise level at each receptor during emergency conditions has been compared against the assessment criteria for emergency conditions. These assessment criteria were developed using the results of the 2015 and 2016 surveys, as shown in section 6.2.

8.3.3 The comparisons and assessment conclusions is shown in Table 8-9 below for the daytime and night-time conditions respectively.

Table 8-9: Assessment of plant noise: emergency conditions

Location (worst affected receptor)	Predicted Sound Pressure Level, dB $L_{Aeq,15min,façade}$	Plant Noise Limit dB $L_{Aeq,15min,façade}$		Assessment Conclusion (and Exceedance)	
		Daytime	Night-time	Daytime	Night-time
89-92 Guilford Street	36	59	51	Limit not exceeded (-23)	Limit not exceeded (-15)
International Hall (University of London), Guilford Street	33	59	51	Limit not exceeded (-26)	Limit not exceeded (-18)
19-27 Great Ormond Street	31	58	48	Limit not exceeded (-27)	Limit not exceeded (-17)
29-41 Great Ormond Street	33	58	48	Limit not exceeded (-25)	Limit not exceeded (-15)
3-6 Guilford Place / 86-94 Lamb's Conduit Street	37	57	52	Limit not exceeded (-20)	Limit not exceeded (-15)
Spens House / 70 Lamb's Conduit Street	33	57	52	Limit not exceeded (-24)	Limit not exceeded (-19)
The Lamb PH	32	57	52	Limit not exceeded (-25)	Limit not exceeded (-20)

8.3.4 Table 8-9 demonstrates that the noise emission limits for emergency conditions will be achieved at the worst affected part of all receptors.

8.4 Summary

8.4.1 Plant noise level predictions have been carried out based on the information provided by the design team and contractor. These predictions have been carried out considering the items of plant that will operate during normal conditions and emergency conditions.

8.4.2 Plant noise levels have been compared against the noise emission limits that have been set in order to meet the requirements of LBCC.

8.4.3 During normal conditions, with no design changes, the noise emission limits are achieved at all adjacent properties apart from 89-92 Guilford Street. At this property the noise emission limits are exceeded by up to 4 dB $L_{Aeq,15min}$, primarily due to case-radiated noise from extract fan EF07 (located under the ground floor canopy north of the development).

8.4.4 For this reason, further mitigation is required in order to reduce plant noise levels at this property. Minimum requirements for lagging or enclosing the extract fan have been presented (Table 8-4)

8.4.5 The contractor has confirmed that lagging will be installed in order to meet these minimum requirements and in order to meet the plant noise limits of LBCC.

8.4.6 During emergency conditions the noise emission limits are achieved at all adjacent properties.

8.4.7 It is therefore concluded that, provided that noise from extract fan EF07 is controlled, noise from the proposed plant and machinery will meet the requirements of LBCC at all times.

9 Post-Installation Noise Monitoring

9.1 Overview

9.1.1 During consultation with the LBCC Principal Environmental Health Officer it was requested for post-installation noise monitoring to be carried out to confirm that noise from mechanical plant meets the assessment criteria. This was requested in order to remove any uncertainty associated with the prediction of noise levels for plant that is not yet installed or operating.

9.1.2 The noise monitoring methodology that should be followed is described in this section.

9.2 Methodology

9.2.1 The purpose of the acoustic testing is to demonstrate that the operation of the fixed plant does not exceed the noise limits specified in Section 6.

9.2.2 Due to the nature of the noise criteria, the specific noise levels to be measured are likely to be similar to or below the prevailing background noise level at the nearest noise-sensitive locations.

9.2.3 As it is not practicable to determine the specific noise level at the nearest noise-sensitive locations directly by measurement, the specific noise source should be determined by a combination of measurement and calculation. This would involve taking measurements close to the fixed noise sources and using calculation methods to predict the specific noise level at the nearest noise-sensitive locations. Predictions would be carried out following the methodology presented in ISO 9613-2 '*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*'.

9.2.4 Noise surveys must be carried out by suitably competent person(s) experienced in the measurement of noise from fixed plant and who is also a corporate member of the Institute of Acoustics.

9.2.5 Measurements of the sound pressure levels of the fixed plant should be carried out while the systems are in operation, under typical operational duties.

9.2.6 The influence of noise from other sources should be minimised during the sound pressure level measurements, so far as is reasonably practical. In locations where ambient noise limits are high the survey would need to be undertaken during the quietest hours of day (for example in the late evening). The specific noise level should be obtained by measuring the ambient noise level at the measurement position, and correcting for the influence of noise from other sources.

9.2.7 Sound pressure level measurements must be of sufficient duration to account for any variation in the noise output of each source, and the duration of the sample measurement must be noted.

9.2.8 Each measurement must be carried out a minimum of three times to demonstrate stability and repeatability of the measured values.

9.2.9 Measurements shall only be considered valid if conditions are dry and the mean wind speeds are below 5 ms^{-1}.

9.2.10 All equipment will need to be calibrated in the field before and after the measurement survey. A drift in calibration of 0.5 dB or greater will be considered significant and will necessitate a repeat survey.

9.2.11 The position of the fixed measurement positions will need to be discussed with the client before the survey as the may be access restrictions. However the following indicative positions are proposed:

- Roof top Fans and AHUs: In close proximity to each fan or AHU intake and discharge grille; in close proximity to the fan units themselves to determine case radiated noise;

- Roof top Emergency Generator: Measurements with the generator operating at typical duty, in a position where noise from the generator unit is dominant; and at positions in close proximity to the intake and discharge grilles.
- Phase 2A Rooftop CHP: Measurements with the CHP unit operating at typical duty, in a position where noise from the CHP unit is dominant;;
- Level 04 Plant Area: In close proximity to each AHU intake and discharge grille; and in a position where case radiated noise from each unit is dominant;
- Level 01 Fans: In close proximity to each discharge grille; and in a position where case radiated noise from each fan is dominant;
- Plant rooms: Measurement of reverberant sound pressure level within these rooms and outside any louvres at a position where noise egress from this room is dominant.

9.2.12 Measurement positions will need to be chosen to limit the effect of contribution from any on-site construction operations.

9.2.13 Observations shall be made to assess the character of noise from plant. Observations should note any tonal, impulsive or intermittent characteristics and any other features which could attract attention to the source of the sound.

9.3 Reporting

9.3.1 The results of the commissioning and acceptance testing should be presented in a technical test report, to include all relevant measurement data as well as equipment details.

9.3.2 Where it is has been found impracticable to obtain the plant noise level at the relevant receptors, the calculation approach should also be presented along with estimated plant noise levels.

9.3.3 Finally, estimated plant noise levels at the adjacent noise sensitive receptors shall be compared against the acoustic criteria in section 6.

10 Conclusions

10.1.1 WSP | PB has been commissioned to undertake a noise impact assessment of the proposed building services in relation to Phase 2B of the redevelopment of Great Ormond Street Hospital.

10.1.2 Conditional planning permission has been granted for the redevelopment works at the hospital. Condition 8 of the permission requires that an acoustic report and assessment be submitted to and approved by the local planning authority prior to commencement of the works on site.

10.1.3 As part of the assessment, various additional noise surveys have been taken at locations representing the nearest noise-sensitive properties. These surveys were carried out in December 2015 and April 2016, the most recent of which was carried out to obtain noise level data for the weekend.

10.1.4 An assessment methodology for normal and emergency plant has been developed following consultation with the London Borough of Camden Council. The assessment of normal plant has been carried out in accordance with the 2006 LBCC UDP. The assessment of emergency plant has been carried out to demonstrate compliance with an example condition supplied by the LBCC Principal Environmental Health Officer.

10.1.5 The noise measurement data has analysed to determine the lowest background sound level (dB $L_{A90,15min}$) and the lowest ambient sound level (dB $L_{Aeq,15min}$) during the daytime and night-time periods for each day of the week. These values have then been used to establish noise emission limits for normal and emergency plant respectively.

10.1.6 An assessment of noise from building services plant has been carried out based on information provided by the design team and equipment manufacturers. Plant noise levels have been predicted at the most nearest noise sensitive receptors for normal and emergency plant.

10.1.7 Predicted plant noise levels during normal operating conditions have been compared against the more onerous noise level limits within the LBCC UDP, in order to allow for the presence of tonal or impulsive features.

10.1.8 Plant noise levels during normal operating conditions achieve the noise level limits at all adjacent properties apart from 89-92 Guilford Street. Noise limits are exceeded at this property due to case-radiated noise from fan EF07. For this reason, additional mitigation of this plant item has been specified in terms of a minimum insertion loss (Table 8-4).

10.1.9 The contractor has confirmed that this additional mitigation is to be installed. For this reason, plant noise levels during normal operating conditions will achieve the requirements of the LBCC UDP at all properties.

10.1.10 Predicted noise levels during emergency conditions have been compared against the relevant limits. Noise from emergency plant is predicted to be significantly below the limit at the worst affected part of all receptors, at all times of day.

10.1.11 On the basis of this above assessments, noise from the proposed plant and machinery will meet the requirements of the London Borough of Camden Council.

10.1.12 At the request of the local authority, and to eliminate any uncertainty in the above assessment, it is recommended that post-installation noise monitoring is carried out to confirm that the acoustic criteria are achieved. The required noise monitoring methodology has been presented.

Appendix A – Glossary of Acoustic Terminology

A-Weighting: The human ear is not equally sensitive to all frequencies of sound. It is relatively much less sensitive to very low frequencies such as 'mains hum', and to very high frequencies such as the call of a bat, than to the 'mid-frequencies' important for human voice communication. In order to make sound level meters, which would otherwise be indiscriminate in registering sound pressures, respond in a way which reflects human perception of sound, they usually are fitted with a set of filters to progressively filter out the high and low frequency energy. The filters are made to an internationally standardised specification and the filtered noise level is said to be 'A-weighted'. Sometimes A-weighted decibel levels are denoted 'dB(A)', but the correct, internationally standardised format for reporting requires the 'A' to be appended to the noise descriptor e.g. $L_{Aeq,T}$, L_{Amax}, etc.

Airborne Sound: Sound transmitted through the air rather than through the structure of a building or the ground.

Ambient Noise: This is the totally encompassing sound at the measurement position over a specified time interval and usually comprises sound from many different sources both near and far. Usually this is measured as an $L_{Aeq,T}$ where T is the time interval.

Attenuation: A general term used to indicate the reduction of noise or vibration, or the amount (in decibels) by which it is reduced.

Averaging: In the absence of a dominant steady source, the sound level at a point, indoors or outdoors, varies continuously. For example, the variation may be over a few dB about an average value in a quiet room, or over 10 dB or more in a noisy outdoor environment. In order to define a level to represent the noisiness of the space it is necessary to define that average value. The most common averaging methods are energy averaging (L_{Aeq}) and statistical averaging (L_{AN} where N is a percentage between 1 and 100).

Background Noise Level, $L_{A90,T}$: Background noise level is a term used to describe that level to which the noise falls during quiet spells, when there is a lull in passing traffic for example. It is quantified by the $L_{A90,T}$ which is the noise level that is exceeded for 90% of the measurement time interval, T. It is typically measured using the fast time weighting (see below), whereby the levels is denoted $L_{AF90,T}$ or $L_{A90,T,fast}$.

Decibels: Noise conventionally is measured in decibels (dB). The decibel is a logarithmic unit and decibel levels do not add and subtract arithmetically. An increase or decrease of 3 dB in the level of a steady noise is about the smallest that is noticeable. It represents a doubling or halving of noise energy. An increase or decrease of 10 dB represents a ten-fold change in noise energy, and is perceived as a doubling or halving of loudness.

The threshold of hearing for a typical young, healthy adult is 0 dB A-weighted sound pressure level. A noise level of 140 dB(A) can cause physical pain. Most people listen to their televisions at about 60 dB(A) to 65 dB(A). Alongside a busy main road the ambient noise level may be in the 70 dB(A) to 80 dB(A) range; on a quiet day in the country it might be as low as 30 dB(A), in town 40 dB(A) to 50 dB(A).

Decibel Addition: If two similar noise sources operate together their combined noise level at an observer's position some distance away is 3 dB higher than the noise level generated by just one of them. If two further machines are switched on the noise level generated by all four at the observer's position is 3 dB higher than the level generated by the two. If the number of machines is again doubled, to eight, the noise level increases by another 3 dB, and so on.

Equivalent Continuous A-Weighted Sound Pressure Level, $L_{Aeq,T}$: The 'equivalent continuous A-weighted sound pressure level' is an average of the fluctuating sound energy in a space. It is the value of the

A-weighted sound pressure level of a continuous, steady sound that, over the specified time period, *T* seconds, has the same root mean square sound pressure as the varying sound. It can be likened to the mean petrol consumption of a car over a specific journey during which the instantaneous consumption peaked during periods of acceleration and fell during periods of coasting or braking.

Façade Sound Level: Road and railway traffic noise levels often are specified in terms of the sound level at a position 1 m in front of the most exposed façade of potentially noise sensitive premises. Such levels are assumed to be 3 dB(A) higher than sound levels measured at an equivalent position away from the reflections from the building and any other surfaces (excluding the ground).

Fast Time Weighting: An averaging time used in sound level meters, corresponding to a 125 ms time constant.

Free-field Sound Level: The free-field refers to sound level measurement positions in an open area well away from any buildings or other sound reflecting surfaces other than the ground. Generally the minimum distance from building façades for free-field measurements is taken to be 3.5 m.

Maximum Sound Level, L_{Amax}: This is the maximum instantaneous sound level occurring during the measurement period. It is typically measured using the fast time weighting (see above), whereby the levels is denoted L_{AFmax} or $L_{Amax,fast}$.

Appendix B – Summary of the 2005 Noise Survey

Introduction

An environmental noise survey was carried out at the site in November 2005, and was reported in a previous 2006 WSP Survey Report. These noise levels formed the basis on which the noise control design was based.

Survey Methodology

WSP conducted a series of noise measurement surveys to establish the prevailing ambient noise and background noise levels at key locations around the site. The surveys comprised 24 hour unattended noise surveys at three positions and attended short term measurements at an additional three locations.

The unattended noise surveys were undertaken at the following positions and times:

- Position 1 – 1 metre from the southern façade of level 1 of the hospital facing Great Ormond Street. This survey was undertaken between 13:00 hrs on 7 November and 14:00 hrs on 8 November 2005. This position was adjacent the main hospital entrance on top of the first floor balcony.
- Position 2 – in line with the façade on the roof of The Lamb public house located on the eastern side of Lambs Conduit Street. This survey was undertaken between 14:00 hrs on 4 November and 01:00 hrs on 6 November 2005. The meter on this survey stopped recording prematurely, however this has not affected the survey significantly.
- Position 3 – 1 metre from the northern façade of level 1 of the hospital facing Guilford Street. This survey was undertaken between 13:00 hrs on 7th November and 14:00 hrs on 8 November 2005.

The attended noise surveys were undertaken at the following positions and times:

- Position 4 – 1 metre from the southern façade of the hospital facing Great Ormond Street. This position was exposed to similar noise levels as to position 1 described above.
- Position 5 – 1 metre from the eastern façade of the hospital facing Lambs Conduit Street. This position was exposed to similar noise levels as to position 2 described above.
- Position 6 – 1 metre from the northern façade of the hospital facing Guilford Street. This position was exposed to similar noise levels as to position 3 described above.

All attended measurements were undertaken at 1 metre from the façade of the GOSH and at 1.5 metres above the ground.

Each of the attended measurements lasted for a period of between 20 and 30 minutes during the day and night, which apart from some low level construction noise audible at positions 4 and 6 during the day, no atypical noise sources were observed.

It should be noted however, that the construction noise was infrequent and at such a low level as not to be dominant and unlikely to significantly affect the reported background noise levels. It is possible the construction noise levels had a small effect on the ambient levels.

The weather during all surveys was conducive to the measurement of noise, it being fine and dry with only a little wind.

Details of the equipment used to take the measurements are presented in Table B-1.

Table B-1: Noise measurement equipment used for the survey

Equipment	Item	Make & Model	Serial No.
Solo A	Sound Level Meter	01dB-Stell Solo Master	10330
	Pre-amplifier	01dB-Stell PRE 21 S	10423
	Microphone	Microtech Gefell GmbH MCE212 Condenser	37991
Solo B	Sound Level Meter	01dB-Stell Solo Master	10712
	Pre-amplifier	01dB-Stell PRE 21 S	11349
	Microphone	Microtech Gefell GmbH MCE212 Condenser	39755
Solo C	Sound Level Meter	01dB-Stell Solo Master	10706
	Pre-amplifier	01dB-Stell PRE 21 S	11464
	Microphone	Microtech Gefell GmbH MCE212 Condenser	39648
Calibrator	Calibrator	01dB-Stell Cal 21	51031216

Each meter was calibrated by a UKAS accredited laboratory within the previous 24 months to the date of the survey. The equipment was also field calibrated at the commencement and conclusion of the survey using the above calibrators, which had themselves been calibrated by a UKAS accredited laboratory within the previous twelve months. Each meter was found to have no significant drift in calibration (< 0.5 dB) across the measurement period.

Survey Results

Table B-2 below presents a summary of the ambient noise levels, in terms of the equivalent continuous sound pressure level, measured during the unattended noise surveys.

Table B-2: Unattended ambient noise level measurement results

Position	Period	Time	T	Measured Equivalent Continuous Noise Level [dB $L_{Aeq,T}$]
1 (Great Ormond Street, façade conditions)	Day	0700-1900	12h	65
	Evening	1900-2300	4h	60
	Night	2300-0700	8h	56
2 (Lambs Conduit Street, free-field conditions)	Day	0700-1900	12h	65
	Evening	1900-2300	4h	65
	Night	2300-0700	8h	55
3 (Guilford Street, façade conditions)	Day	0700-1900	12h	71
	Evening	1900-2300	4h	65
	Night	2300-0700	8h	65

The background noise level has been measured and determined for a time period of 1 hour during the day (07:00-23:00) and 5 minutes during the night (23:00-07:00). The lowest measured background noise levels during the day and night at each receptor position is shown in Table B-3.

Table B-3: Unattended background noise level measurement results

Position	Period	Time	T	Lowest Measured Background Noise Level [dB $L_{A90,T}$]
1 (Great Ormond Street, façade conditions)	Day	0700-2300	1 hr	47
	Night	2300-0700	5 min	44
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	1 hr	49
	Night	2300-0700	5 min	47
3 (Guilford Street, façade conditions)	Day	0700-2300	1 hr	50
	Night	2300-0700	5 min	41

In addition to the unattended measurements, attended measurements were made at positions 4, 5 and 6. These positions were located at street level (microphone height of 1.5 metres). The results of these attended measurements are presented in Table B-4.

Table B-4: Attended noise level measurement results

Position	Time	Duration, T	Measured Equivalent Continuous Noise Level [dB $L_{Aeq,T}$]	Lowest Measured Background Noise Level [dB $L_{A90,T}$]
4 (Great Ormond Street, ground floor level, façade conditions)	10:07	45 min	68	58
	01:38	20 min	50	45
5 (Lambs Conduit Street, ground floor level, façade conditions)	11:35	25 min	67	57
	02:01	20 min	52	45
6 (Guilford Street, ground floor level, façade conditions)	10:56	35 min	70	58
	02:01	20 min	62	48

Appendix C – 2015 Acoustic Survey Details

Introduction

A further environmental noise survey was carried out at the site in December 2015. This section describes the survey method and the noise measurement results.

Survey Methodology

A baseline sound survey was undertaken by Daniel Doherty MIOA and Jon Jones MIOA of WSP | Parsons Brinckerhoff to determine the prevailing sound levels on and around the site. This survey consisted of long-term unattended monitoring as follows:

- Long-term unattended monitoring was carried out at three positions between the afternoon of Wednesday 9 December 2015 and the afternoon of Friday 11 December 2015.
- Due to an equipment fault at one position, further long-term unattended monitoring was carried out at one position between the afternoon of Tuesday 15 December 2015 and the afternoon of Thursday 17 December 2015.

Measurements were taken at positions representing the nearest noise-sensitive receptors.

The sound monitoring equipment was configured to record the various acoustic parameters including the equivalent continuous sound level, dB $L_{Aeq,15min}$, the maximum event sound level, dB $L_{AFmax,15min}$, and the background sound level, dB $L_{A90,15min}$.

The unattended monitoring equipment also gathered sound level data that was used to determine long-term parameters such as the daytime (07:00-23:00) and night-time (23:00-07:00) equivalent continuous sound level, dB $L_{Aeq,16hr}$ and dB $L_{Aeq,8hr}$. This parameter are presented for information only and do not affect the outcome of this assessment.

The sources of ambient sound, both distant and local, that contributed to measured sound levels were noted upon installation and collection of the equipment.

Prevailing weather conditions were observed during the installation and collection of the equipment. These observations were supplemented with historical data from local weather stations.

The monitoring positions used during the survey were as close as possible to the monitoring positions used in 2005, and were as follows:

- Position 1 – on the first floor balcony area south of the GOSH Frontage Building, overlooking Great Ormond Street. The microphone was positioned in free-field conditions, roughly 6 m above street level. This position represents the nearest noise-sensitive properties to the development on Great Ormond Street.
- Position 2 – in line with the south-west façade on the roof of The Lamb public house (a four storey building) located on the eastern side of Lamb's Conduit Street. The microphone was positioned in free-field conditions, roughly 15 m above street level. This position represents the nearest noise-sensitive properties to the development on Lamb's Conduit Street.
- Position 3 – on temporary site compound scaffolding located on Guilford St, approximately 5 m from the façade of the new Phase 2A building, facing Guilford Street. The microphone was positioned in façade conditions, roughly 9 m above street level, representing second floor level. This position represents the nearest noise-sensitive properties to the development on Guilford Street.

Photographs of the monitoring positions are shown in Figures C.1 to C.3.

Figure C-1: Photograph of Position 1

Figure C-2: Photograph of Position 2

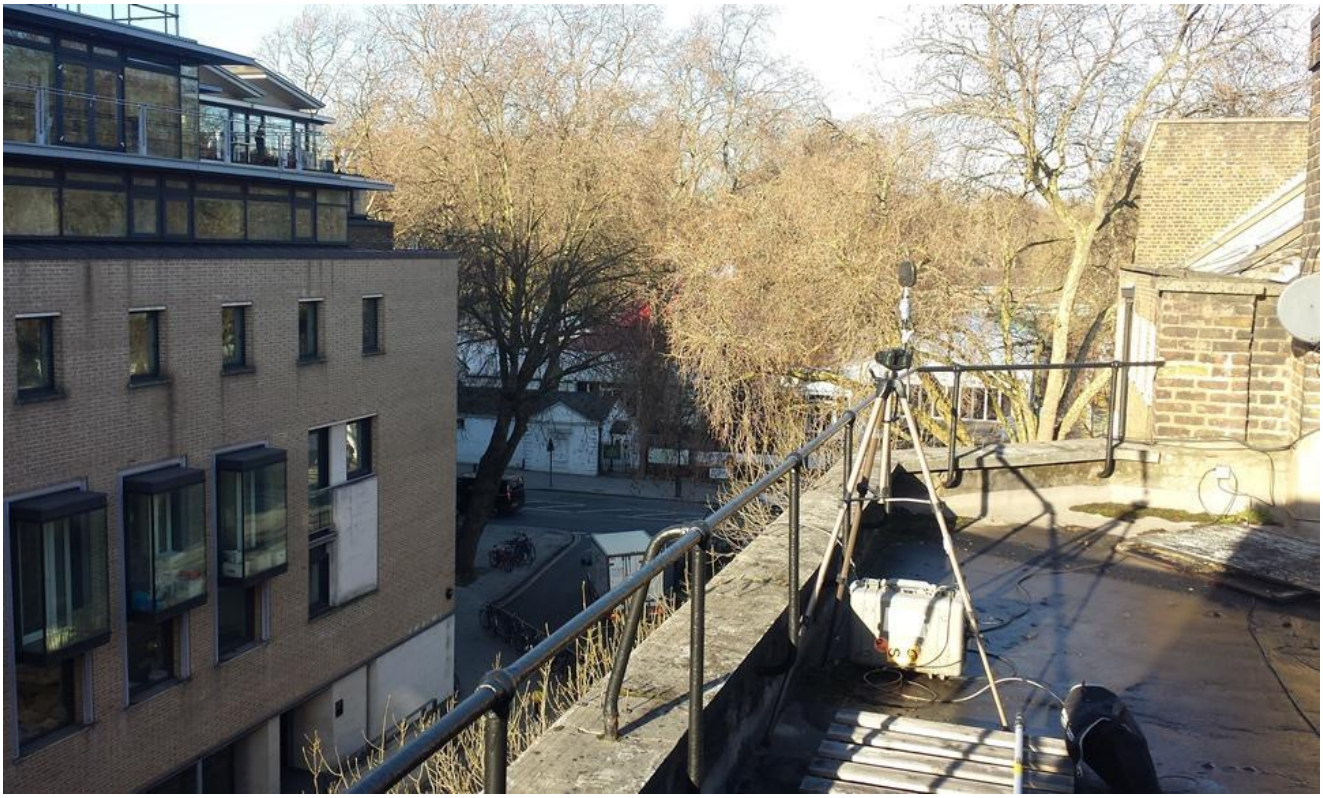


Figure C-3: Photograph of Position 3

The sound monitoring equipment used during the survey is shown in Table C-1.

Table C-1: Noise measurement equipment used for the survey

Equipment	Item	Make & Model	Serial No.	Calibration due date
Duo 6	Sound Level Meter	01 dB-Metravib DUO	10328	12 August 2016
	Pre-amplifier	01 dB Metravib PRE 22	10233	
	Microphone	GRAS 40CD	154531	
	Calibrator	01 dB-Stell CAL 21	34134166	09 January 2016
Solo 13	Sound Level Meter	01dB-METRAVIB Solo Master	65303	16 August 2017
	Pre-amplifier	01dB-Stell PRE 21 S	15976	
	Microphone	Microtech Gefell GmbH MCE212	142812	
	Calibrator	01dB-Stell Cal 21	34213780	16 August 2016
Solo 20	Sound Level Meter	01dB-METRAVIB Solo Master	65811	1 November 2017
	Pre-amplifier	01dB-Stell PRE 21 S	16485	
	Microphone	Microtech Gefell GmbH MCE212	166394	
	Calibrator	01dB-Metravib Cal 21	34634224	09 January 2016

Each meter has been calibrated by a UKAS accredited laboratory within the previous 24 months. The equipment was also field calibrated at the start and end of the survey using calibrators that were, themselves, calibrated by a UKAS accredited laboratory within the previous 12 months.

Before and after the use of any sound level meter, the calibration level was checked with a field calibrator. The field calibrator had a reference level of 94.0 dB at 1 kHz. No significant drift in calibration was observed (maximum of 0.1 dB).

Observations and Meteorological Conditions

Upon set up and collection of the unattended sound level meters the following sources were observed:

- Road traffic noise from the adjacent road network, including occasional heavy vehicles, and vehicles idling on Great Ormond Street;
- Intermittent clattering sounds and noise from earth-moving plant on a site to the east of the pub (20 Guilford Street). This was on the opposite side of the building to the noise monitoring position. It is considered that although it may have influenced the background sound levels during day-time, the evening or night-time background sound levels, on which this assessment is based, would not have been affected.
- Occasional clattering sounds were observed at Position 1 due to people using the lightweight temporary staircase to access the Frontage House site office.
- Construction noise from the GOSH2B development itself was not significant at the monitoring positions due to the screening effect of the adjacent buildings.
- At position 2, there was some rooftop plant visible on the building on the opposite side of Lamb's Conduit Street. No noise from this plant was audible during the day-time.

The weather upon set up and collection of the measurement equipment was conducive to the measurement of environmental sound, being dry and with wind speeds within acceptable magnitudes (below 5 m/s). There was some very light rain on the 11 December (during equipment collection) but this did not affect the noise measurements.

The weather during the remainder of the survey has been reviewed based on weather station data at University College London and was as follows:

- The temperature was between 10 to 13 ºC between 9 and 11 December, mostly with a high proportion of cloud cover. The temperature was between 13 to 16 ºC between 15 and 17 December.
- The average wind speed was no more than 5 m/s except for brief periods during the night of the 9 December and morning of the 10 December where the maximum average speed was 6 m/s. The wind speed was no more than 5 m/s for all measurements between 15 and 17 December.
- The wind was consistently from the south or south-west between 9 and 11 December. Between 15 and 17 December the wind was consistently from the south.
- On the evening and night of 10 December and a brief period at 01:00 on 11 December there was some light rain. The data does not show any notable change in background sound level during this period.
- On the evening of 15 December there was rain between 16:00 and 20:00, with further light rain in the early hours of 16 December before 03:00. During the remainder of the measurements on 16 December and 17 December the conditions were dry. Background noise levels were higher during the rain on the 15 December; however, the assessment is not based on measurements taken during these periods.

Survey Results

Overall long-term values are summarised in Table C-2 and Table C-3 for the equivalent continuous sound pressure level and the background noise level respectively.

The long-term noise measurement results are presented in Figures C-4 to C-6.

Table C-2: Unattended ambient noise level measurement results

Position	Period	Time	T	Measured Equivalent Continuous Noise Level [dB $L_{Aeq,T}$]						
				Wed 9 Dec 2015	Thurs 10 Dec 2015	Fri 11 Dec 2015	Tues 15 Dec 2015	Wed 16 Dec 2015	Thurs 17 Dec 2015	Average
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	16h	63#	62	63#	-	-	-	
	Night	2300-0700	8h	56	56*	-	-	-	-	
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	16h	63#	62	64#	-	-	-	**63**
	Night	2300-0700	8h	56	56	-	-	-	-	**56**
3 (Guilford Street, façade conditions)	Day	0700-2300	16h	-	-	-	68#	68	67#	**68**
	Night	2300-0700	8h	-	-	-	63#	62	-	**62**

***with alarm sound excluded; #partial measurement interval**

The background sound level has been measured and determined for a time period of 15 minutes during the day (07:00-23:00) and the night (23:00-07:00). An analysis of this measurement data has been carried out in order to determine the lowest measured background sound level during each period.

The lowest background sound level for each daytime and night-time period at each receptor position is shown in Table C-3.

Table C-3: Unattended background sound level measurement results

Position	Period	Time	Lowest Measured Background Sound Level [dB $L_{A90,15min}$]						
			Wed 9 Dec 2015	Thurs 10 Dec 2015	Fri 11 Dec 2015	Tues 15 Dec 2015	Wed 16 Dec 2015	Thurs 17 Dec 2015	Lowest (Weekday)
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	48	50	49	-	-	-	**48**
	Night	2300-0700	44	43	-	-	-	-	**43**
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	55	50	50	-	-	-	**50**
	Night	2300-0700	47	47	-	-	-	-	**47**
3 (Guilford Street, façade conditions)	Day	0700-2300	-	-	-	57	55	55	**55**
	Night	2300-0700	-	-	-	48	48	-	**48**

The minimum existing ambient sound level, in terms of dB $L_{Aeq,15min}$, also been determined for each daytime and night-time period. The measurement results are shown in Table C-4.

Table C-4: Unattended ambient sound level measurement results

Position	Period	Time	Minimum Ambient Sound Level [dB $L_{Aeq,15min}$]						
			Wed 9 Dec 2015	Thurs 10 Dec 2015	Fri 11 Dec 2015	Tues 15 Dec 2015	Wed 16 Dec 2015	Thurs 17 Dec 2015	Lowest (Weekday)
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	57	58	58	-	-	-	**57**
	Night	2300-0700	45	46	-	-	-	-	**45**
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	58	56	57	-	-	-	**56**
	Night	2300-0700	49	50	-	-	-	-	**49**
3 (Guilford Street, façade conditions)	Day	0700-2300	-	-	-	65	64	65	**64**
	Night	2300-0700	-	-	-	57	56	-	**56**

Figure C-4: Noise measurement results at Position 1 (free-field conditions)

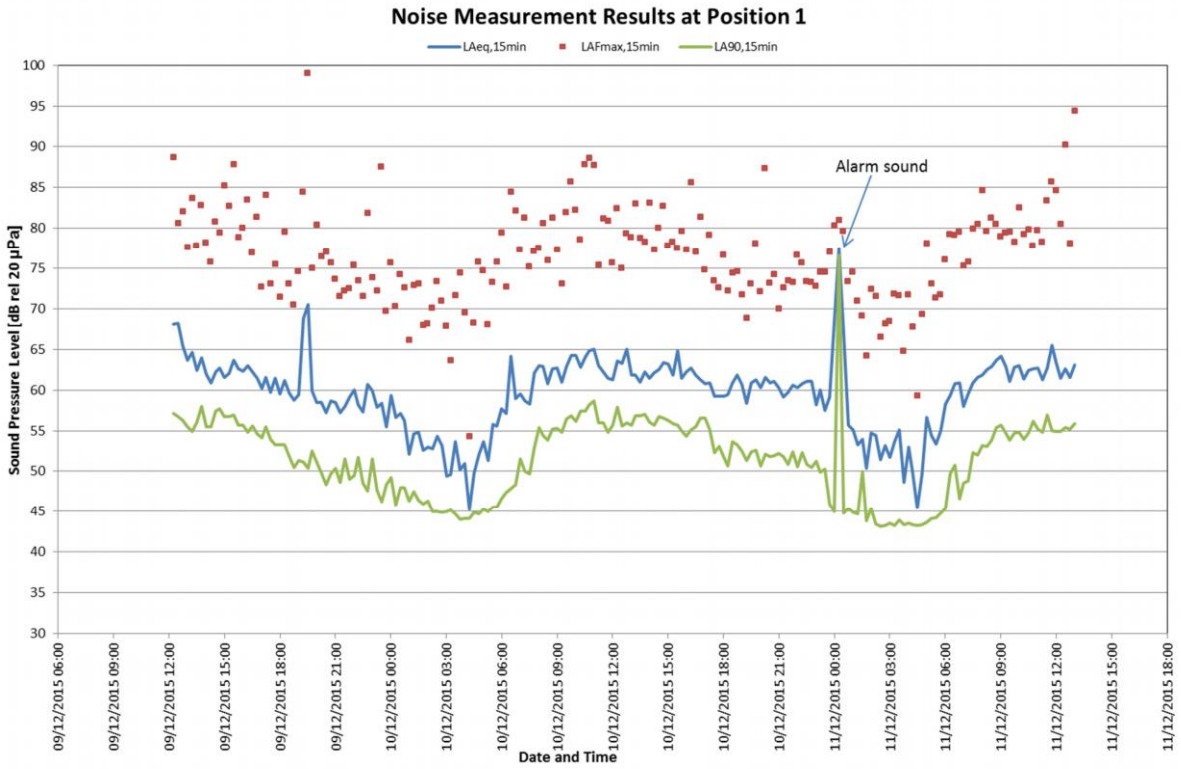


Figure C-5: Noise measurement results at Position 2 (free-field conditions)

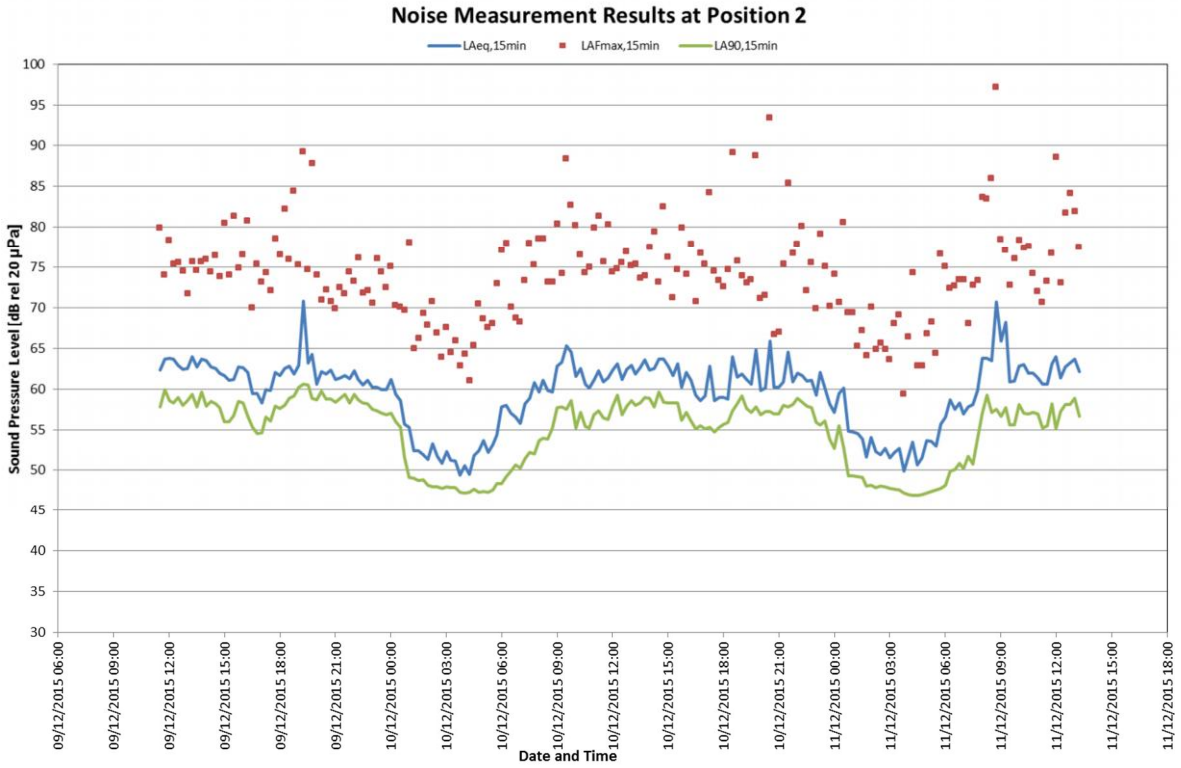
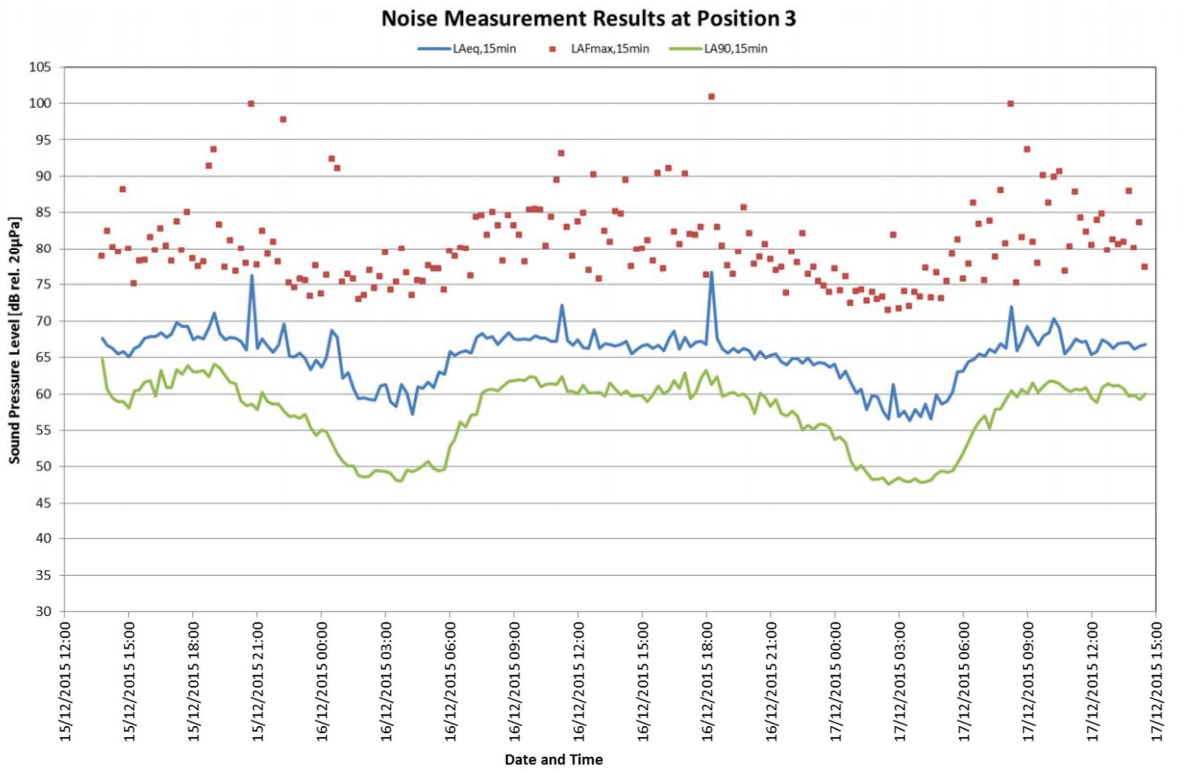


Figure C-6: Noise measurement results at Position 3 (façade conditions)



Appendix D – 2016 Supplementary Acoustic Survey

Introduction

Following the submission of a previous draft of this report, the Local Authority Environmental Health Officer requested that further noise monitoring was carried out specifically to cover the weekend.

This section describes the survey method and the noise measurement results.

Survey Methodology

A baseline sound survey was undertaken by Chris Holmes AMIOA of WSP | Parsons Brinckerhoff to determine the prevailing sound levels on and around the site. This survey consisted of long-term unattended monitoring was carried out at three positions between the morning of Friday 15 April 2016 and the morning of Tuesday 19 April 2016.

Measurements were taken at the same positions and the equipment configured to record the same acoustic parameters as the December 2015 survey.

The sources of ambient sound, both distant and local, that contributed to measured sound levels were noted upon installation and collection of the equipment.

Prevailing weather conditions were observed during the installation and collection of the equipment. These observations were supplemented with historical data from local weather stations.

The sound monitoring equipment used during the survey is shown in Table C-1.

Table D-1: Noise measurement equipment used for the survey

Equipment	Item	Make & Model	Serial No.	Calibration due date
Solo 10	Sound Level Meter	01dB-METRAVIB Solo Master	60531	25 August 2017
	Pre-amplifier	01dB-Stell PRE 21 S	16422	
	Microphone	Microtech Gefell GmbH MCE212	166401	
	Calibrator	01dB-Stell Cal 21	1558662	16 August 2016
Solo 12	Sound Level Meter	01dB-METRAVIB Solo Master	65242	9 July 2016
	Pre-amplifier	01dB-Stell PRE 21 S	16781	
	Microphone	Microtech Gefell GmbH MCE212	153334	
	Calibrator	01dB-Stell Cal 21	35242306	31 March 2017
Solo 14	Sound Level Meter	01dB-METRAVIB Solo Master	65469	1 April 2018
	Pre-amplifier	01dB-Stell PRE 21 S	15983	
	Microphone	Microtech Gefell GmbH MCE212	142646	
	Calibrator	01dB-Metravib Cal 21	35113822	29 June 2016

Each meter has been calibrated by a UKAS accredited laboratory within the previous 24 months. The equipment was also field calibrated at the start and end of the survey using calibrators that were, themselves, calibrated by a UKAS accredited laboratory within the previous 12 months.

Before and after the use of any sound level meter, the calibration level was checked with a field calibrator. The field calibrator had a reference level of 94.0 dB at 1 kHz. No significant drift in calibration was observed (less than 0.5 dB).

Observations and Meteorological Conditions

Upon set up and collection of the unattended sound level meters similar sources of noise were observed to the 2015 survey, as follows:

- Road traffic noise from the adjacent road network, including occasional heavy vehicles, and vehicles idling on Great Ormond Street;
- The sound of pedestrian activity and voices on the adjacent roads;
- Occasional clattering sounds were observed at Position 1 due to people using the lightweight temporary staircase to access the Frontage House site office.
- Intermittent clattering sounds and noise from earth-moving plant on a site to the east of the pub (20 Guilford Street). Construction noise from the GOSH2B development itself was not significant at the monitoring positions due to the screening effect of the adjacent buildings.
- At position 2, there was some rooftop plant visible on the building on the opposite side of Lamb's Conduit Street. No noise from this plant was audible during the day-time.
- Other sources of noise were noted to be aircraft and birdsong.

The weather upon set up and collection of the measurement equipment was conducive to the measurement of environmental sound, in terms of the wind speed being within acceptable magnitudes (below 5 m/s). There was some light rain on the 15 April (during equipment installation).

The weather during the remainder of the survey has been reviewed based on weather station data at University College London and was as follows:

- The temperature was between 4 and 16 ºC during the duration of the survey. Typical daytime temperatures were between 8 and 15 ºC.
- The average wind speed was no more than 5 m/s during the whole survey. Highest wind speeds were recorded on the Monday 18 April during the daytime
- The wind direction was variable through the survey.
- There was some rain during the afternoon and evening of 15 April. Otherwise the remainder of the survey period was dry.

Survey Results

Overall long-term values are summarised in Table C-2 and Table C-3 for the equivalent continuous sound pressure level and the background noise level respectively.

The long-term noise measurement results are presented in Figures D-1 to D-3.

Table D-2: Unattended ambient noise level measurement results

Position	Period	Time	T	Measured Equivalent Continuous Noise Level [dB $L_{Aeq,T}$]						
				Fri 15 April 2016	Sat 16 April 2016	Sun 17 April 2016	Mon 18 April 2016	Tues 19 April 2016	Average (Weekday)	Average (Weekend)
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	16h	63*	61	58	61	62*	**62**	**60**
	Night	2300-0700	8h	55	55	55	55	-	**55**	**55**
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	16h	64*	63	61	63	65*	**64**	**62**
	Night	2300-0700	8h	56	55	55	54	-	**55**	**55**
3 (Guilford Street, façade conditions)	Day	0700-2300	16h	69*	67	65	68	68*	**69**	**66**
	Night	2300-0700	8h	62	61	60	60	-	**61**	**60**

The background sound level has been measured and determined for a time period of 15 minutes during the day (07:00-23:00) and the night (23:00-07:00. An analysis of this measurement data has been carried out in order to determine the lowest measured background sound level during each period.

The lowest background sound level for each daytime and night-time period at each receptor position is shown in Table D-3.

Table D-3: Unattended background sound level measurement results

Position	Period	Time	Lowest Measured Background Sound Level [dB $L_{A90,15min}$]						
			Fri 15 April 2016	Sat 16 April 2016	Sun 17 April 2016	Mon 18 April 2016	Tues 19 April 2016	Lowest (Weekday)	Lowest (Weekend)
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	48	45	45	47	50	**47**	**45**
	Night	2300-0700	45	44	44	44	-	**44**	**44**
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	54	50	49	50	51	**50**	**49**
	Night	2300-0700	48	48	47	47	-	**47**	**47**
3 (Guilford Street, façade conditions)	Day	0700-2300	53	51	49	50	57	**50**	**49**
	Night	2300-0700	47	47	46	46	-	**46**	**46**

The minimum existing ambient sound level, in terms of dB $L_{Aeq,15min}$, also been determined for each daytime and night-time period. The measurement results are shown in Table D-4.

Table D-4: Unattended ambient sound level measurement results

Position	Period	Time	Minimum Ambient Sound Level [dB $L_{Aeq,15min}$]						
			Fri 15 April 2016	Sat 16 April 2016	Sun 17 April 2016	Mon 18 April 2016	Tues 19 April 2016	Lowest (Weekday)	Lowest (Weekend)
1 (Great Ormond Street, free-field conditions)	Day	0700-2300	57	55	55	55	60	**55**	**55**
	Night	2300-0700	49	50	48	49	-	**49**	**48**
2 (Lambs Conduit Street, free-field conditions)	Day	0700-2300	59	57	54	55	58	**55**	**54**
	Night	2300-0700	51	50	49	49	-	**49**	**49**
3 (Guilford Street, façade conditions)	Day	0700-2300	64	62	59	61	65	**61**	**59**
	Night	2300-0700	56	55	54	51	-	**51**	**54**

Figure D-1: Noise measurement results at Position 1 (free-field conditions)

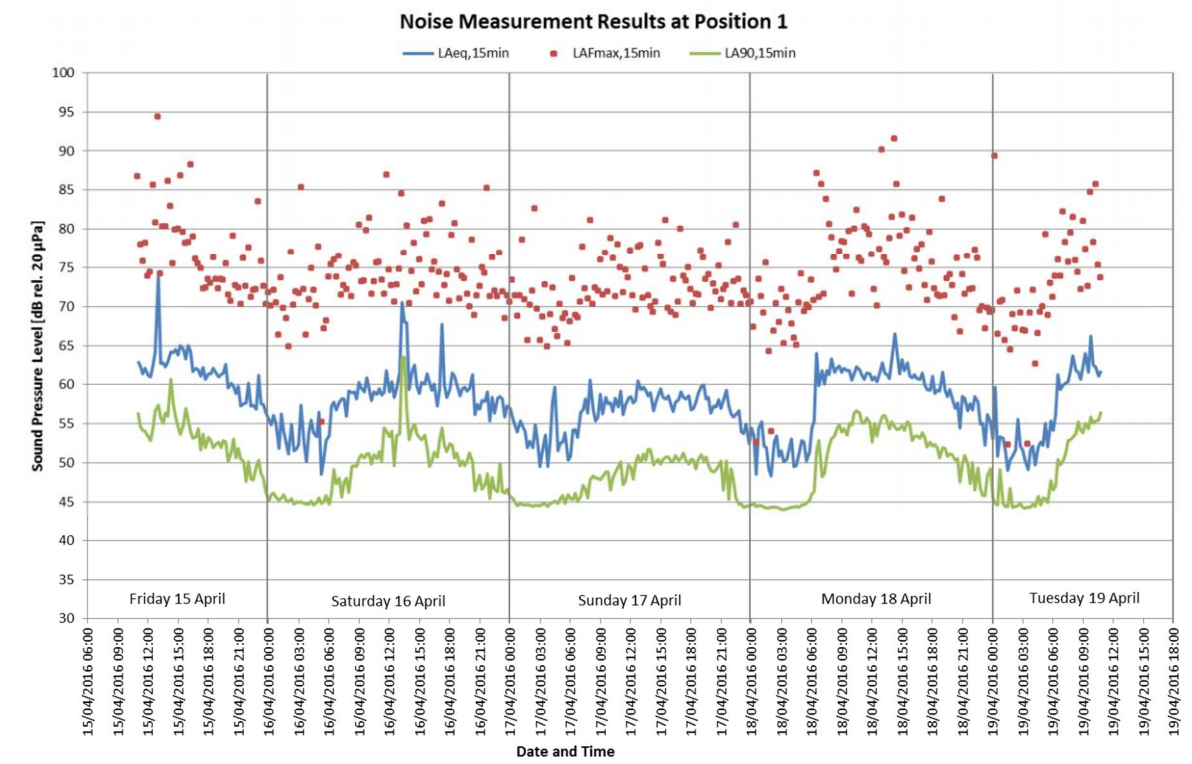


Figure D-2: Noise measurement results at Position 2 (free-field conditions)

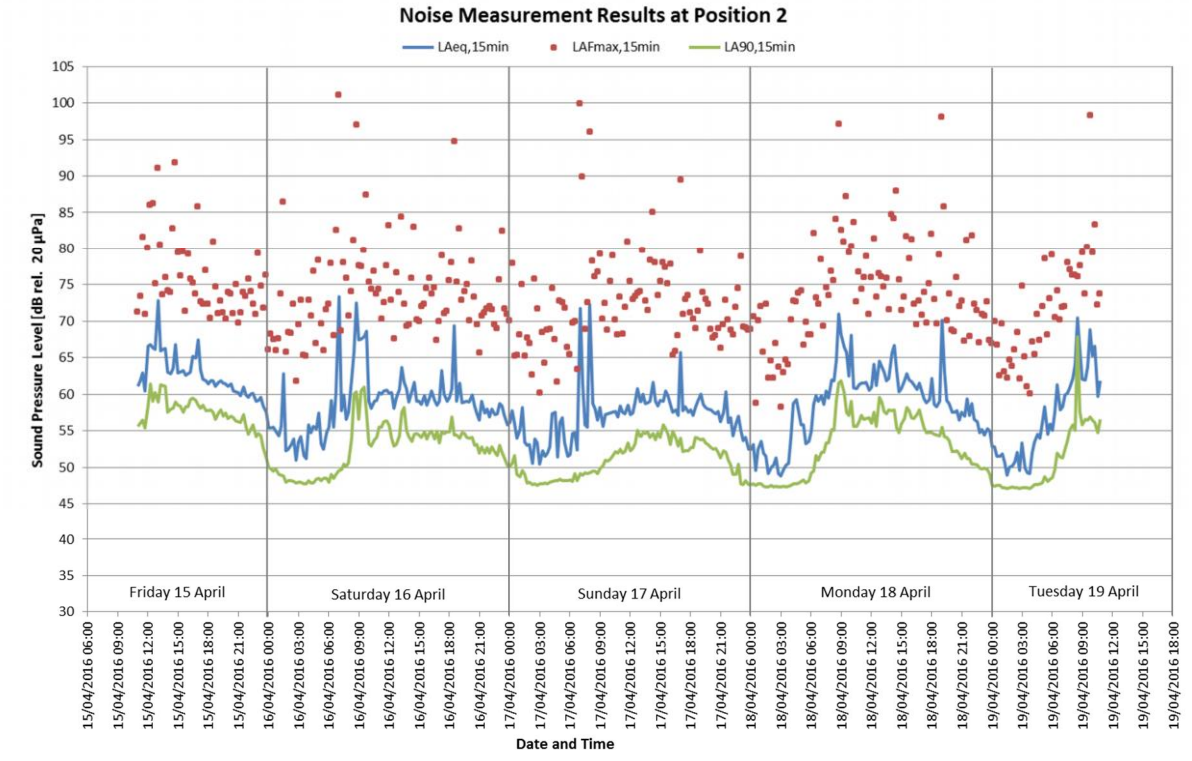
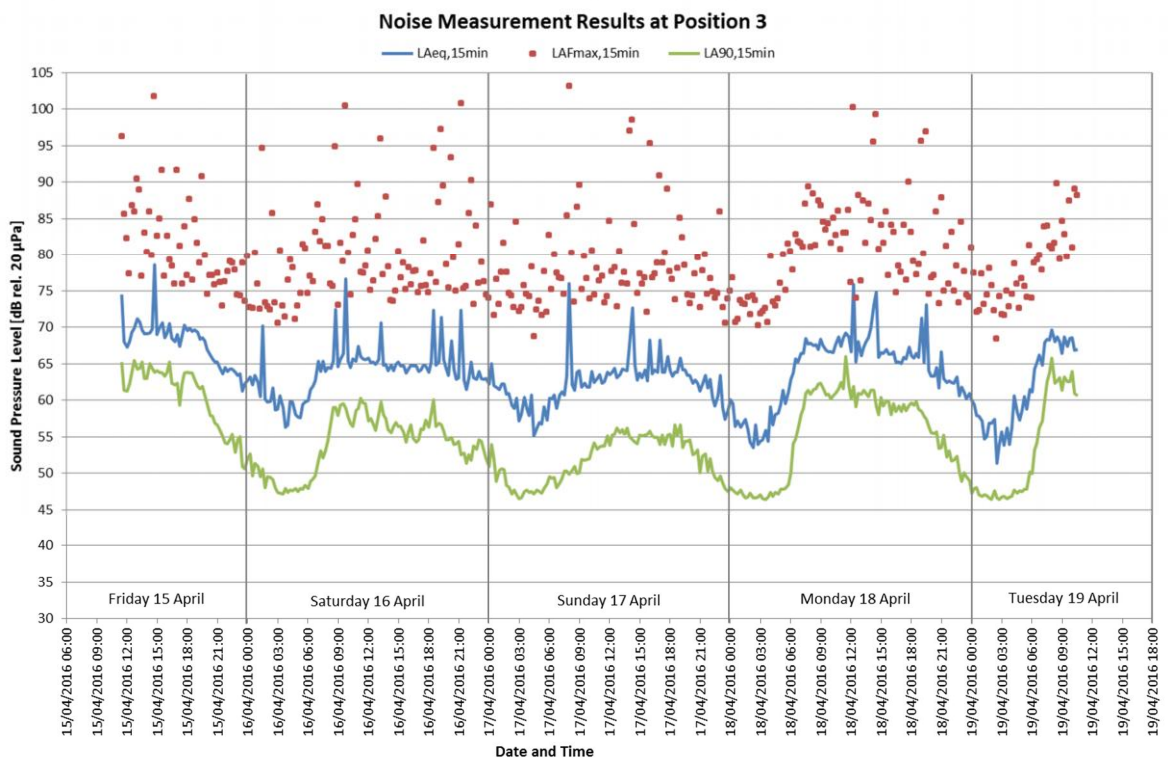


Figure D-3: Noise measurement results at Position 3 (façade conditions)



Appendix E – Plant Noise Schedule

See overleaf.

GOSH 2B
Plant Noise Schedule

Plant Description		Details						Octave Band Noise Level (dB)								dBA
Plant Ref.	Description	Space Served / Location	Mfr/Emp Data	SWL / SPL	Power (kW)	Vol (m^3/s)	ESP (Pa.)	63	125	250	500	1K	2K	4K	8K	
AHU01-04	Supply fan inlet	Various zones L01 to L07	Mfr	SWL	TBC	8.0	515	88	88	87	82	81	77	71	66	86
AHU01-04	Supply fan outlet	Various zones L01 to L07	Mfr	SWL	TBC	8.0	515	89	85	91	89	84	79	76	73	90
AHU01-04	Extract fan inlet	Various zones L01 to L07	Mfr	SWL	TBC	8.0	380	85	87	81	77	77	72	67	62	81
AHU01-04	Extract fan outlet	Various zones L01 to L07	Mfr	SWL	TBC	8.0	380	88	89	87	86	80	76	77	71	87
AHU01-04	Case-radiated	L08 Plantroom	Mfr	SWL	TBC	-	-	84	84	75	62	56	55	48	43	71
AHU05	Supply fan inlet	L03 PACU area	Mfr	SWL	TBC	5.6	353	89	80	79	76	76	70	68	64	80
AHU05	Supply fan outlet	L03 PACU area	Mfr	SWL	TBC	5.6	353	86	80	90	88	85	78	77	77	90
AHU05	Extract fan inlet	L03 PACU area	Mfr	SWL	TBC	5.6	262	88	79	86	75	75	69	67	63	81
AHU05	Extract fan outlet	L03 PACU area	Mfr	SWL	TBC	5.6	262	85	79	89	87	84	77	76	76	89
AHU05	Case-radiated	L08 Plantroom	Mfr	SWL	TBC	-	-	83	76	75	62	57	53	48	47	69
AHU06-07	Supply fan inlet	L03 Op. Theatre Suite 11	Mfr	SWL	TBC	2.1	510	87	84	92	98	95	91	85	81	99
AHU06-07	Supply fan outlet	L03 Op. Theatre Suite 11	Mfr	SWL	TBC	2.1	510	77	80	98	97	92	87	82	79	98
AHU06-07	Extract fan inlet	L03 Op. Theatre Suite 11	Mfr	SWL	TBC	2.1	195	84	89	98	96	94	92	86	84	99
AHU06-07	Extract fan outlet	L03 Op. Theatre Suite 11	Mfr	SWL	TBC	2.1	195	77	81	93	91	87	83	81	78	93
AHU06-07	Case-radiated	L04 Plantroom	Mfr	SWL	TBC	-	-	66	67	75	75	71	59	34	29	75
AHU08	Supply fan inlet	L03 Op. Theatre Suite 12	Mfr	SWL	TBC	2.1	303	90	91	99	97	94	92	86	84	99
AHU08	Supply fan outlet	L03 Op. Theatre Suite 12	Mfr	SWL	TBC	2.1	303	78	81	99	93	89	85	83	80	96
AHU08	Extract fan inlet	L03 Op. Theatre Suite 12	Mfr	SWL	TBC	2.1	245	84	89	98	96	94	92	86	84	99
AHU08	Extract fan outlet	L03 Op. Theatre Suite 12	Mfr	SWL	TBC	2.1	245	77	81	93	91	87	83	81	78	93
AHU08	Case-radiated	S. Riser Shaft	Mfr	SWL	TBC	-	-	68	70	77	74	70	60	34	30	75
ISO AHU01-13	Supply fan inlet	Various Isolation Suites	Mfr	SWL	TBC	0.5	590	74	74	75	82	80	81	77	73	86
ISO AHU01-13	Supply fan outlet	Various Isolation Suites	Mfr	SWL	TBC	0.5	590	67	66	70	77	74	71	72	68	80
ISO AHU01-13	Extract fan inlet	Various Isolation Suites	Mfr	SWL	TBC	0.5	858	74	74	75	82	80	81	77	73	86
ISO AHU01-13	Extract fan outlet	Various Isolation Suites	Mfr	SWL	TBC	0.5	858	67	66	70	77	74	71	72	68	80
ISO AHU01-13	Case-radiated	L08 Plantroom/N. Riser(12/13)	Mfr	SWL	TBC	-	-	55	54	52	59	56	48	25	19	59

Comments: Mfr: Manufacturer
Emp: Empirical
SWL: Sound Power Level
SPL: Sound Pressure Level
ESP: Extenal Static Pressure

SWL*: Sound Power Level estimated from manufacturers' sound pressure level data

GOSH 2B
Plant Noise Schedule

Plant Description		Details						Octave Band Noise Level (dB)								dBA
Plant Ref.	Description	Space Served / Location	Mfr/Emp Data	SWL / SPL	Power (kW)	Vol (m^3/s)	ESP (Pa.)	63	125	250	500	1K	2K	4K	8K	
SF02	Supply fan: inlet	North riser vent supply	Mfr	SWL	TBC	0.29	236	76	80	82	82	80	72	65	59	84
SF02	Supply fan: outlet	North riser vent supply	Mfr	SWL	TBC	0.29	236	77	80	86	83	81	73	65	60	85
SF02	Case-radiated	L07 N. Riser shaft	Mfr	SWL	TBC	-	-	77	80	86	83	81	73	65	60	85
SF03	Supply fan: inlet	South riser vent supply	Mfr	SWL	TBC	0.22	210	80	85	87	93	89	84	76	68	93
SF03	Supply fan: outlet	South riser vent supply	Mfr	SWL	TBC	0.22	210	81	86	87	93	89	84	76	70	93
SF03	Case-radiated	L07 S. Riser shaft	Mfr	SWL	TBC	-	-	81	86	87	93	89	84	76	70	93
SF04	Supply fan: inlet	L08 Elect Plant rooms	Mfr	SWL	TBC	3.76	183	86	82	85	84	80	79	74	68	86
SF04	Supply fan: outlet	L08 Elect Plant rooms	Mfr	SWL	TBC	3.76	183	88	82	86	84	81	80	76	72	87
SF04	Case-radiated	L08 Plant room	Mfr	SWL	TBC	-	-	78	61	60	59	56	52	56	49	63
SF05	Supply fan: inlet	Loading Bay FA supply	Mfr	SWL	TBC	0.33	102	67	69	69	69	61	59	53	47	69
SF05	Supply fan: outlet	Loading Bay FA supply	Mfr	SWL	TBC	0.33	102	69	71	69	69	63	59	54	49	69
SF05	Case-radiated	L01 Loading Bay canopy	Mfr	SWL	TBC	-	-	69	71	69	69	63	59	54	49	69
EF02	Extract fan: inlet	N. Riser Vent. Extract	Mfr	SWL	TBC	0.27	83	51	60	62	56	53	50	47	37	59
EF02	Roof extract fan: outlet+case-radiated	L07 N. Riser shaft	Mfr	SWL	TBC	0.27	83	55	58	64	60	57	52	46	36	62
EF03	Extract fan: inlet	S. Riser Vent. Extract	Mfr	SWL	TBC	0.22	75	61	60	66	58	59	58	53	49	64
EF03	Roof extract fan: outlet+case-radiated	L07 S. Riser shaft	Mfr	SWL	TBC	0.22	75	58	59	63	64	61	64	55	53	68
EF04	Wall mounted fan	L03 Bottle Store	Mfr	SPL at 3 m	TBC	0.03	25	Not available								43
EF05	Extract fan: inlet	L01 Nuclear Med	Mfr	SWL	TBC	0.51	201	68	71	78	73	77	68	62	55	79
EF05	Extract fan: outlet	L01 Nuclear Med	Mfr	SWL	TBC	0.51	201	69	71	81	74	77	69	62	55	80
EF05	Case-radiated	L07 N. Riser shaft	Mfr	SWL	TBC	-	-	69	71	81	74	77	69	62	55	80
EF06	Extract fan: inlet	L01 Nuclear Med	Mfr	SWL	TBC	0.51	201	68	71	78	73	77	68	62	55	79
EF06	Extract fan: outlet	L01 Nuclear Med	Mfr	SWL	TBC	0.51	201	69	71	81	74	77	69	62	55	80
EF06	Case-radiated	L07 N. Riser shaft	Mfr	SWL	TBC	-	-	69	71	81	74	77	69	62	55	80

Comments: Mfr: Manufacturer
Emp: Empirical
SWL: Sound Power Level
SPL: Sound Pressure Level
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SWL*: Sound Power Level estimated from manufacturers' sound pressure level data

GOSH 2B
Plant Noise Schedule

Plant Description		Details						Octave Band Noise Level (dB)								dBA
Plant Ref.	Description	Space Served / Location	Mfr/Emp Data	SWL / SPL	Power (kW)	Vol (m^3/s)	ESP (Pa.)	63	125	250	500	1K	2K	4K	8K	
EF07	Extract fan: inlet	Loading Bay extract	Mfr	SWL	TBC	0.60	138	81	72	75	73	73	72	71	66	79
EF07	Extract fan: outlet	Loading Bay extract	Mfr	SWL	TBC	0.60	138	82	73	76	74	74	73	71	66	80
EF07	Case-radiated	L01 Loading Bay canopy	Mfr	SWL	TBC	-	-	82	73	76	74	74	73	71	66	80
EF08	Extract fan: inlet	Cooling air circulation	Mfr	SWL	TBC	1.35	120	76	75	71	69	65	64	60	56	72
EF08	Extract fan: outlet	Cooling air circulation	Mfr	SWL	TBC	1.35	120	77	75	71	69	65	64	61	57	72
EF08	Case-radiated	L01 Medical Air Plantroom	Mfr	SWL	TBC	-	-	77	75	71	69	65	64	61	57	72
Pressure burner	Overall sound power (high-fired)	L08 Plantroom	Mfr	SWL*	TBC	-	-	70	86	86	88	88	86	84	85	93
ABS2/L08	Chiller	Level 8 Chiller Room	Mfr	SWL*	TBC	TBC	N/A	84	83	83	84	83	82	77	75	88
ABS4/L08	Chiller	Level 8 Chiller Room	Mfr	SWL*	TBC	TBC	N/A	84	83	83	84	83	82	77	75	88
CHP	CHP (aggregate, no casing)	Phase 2A roof	Mfr	SPL at 1m	TBC	TBC	N/A	84	98	95	91	86	88	92	89	97
CHP	CHP (aggregate, with casing)	Phase 2A roof	Mfr	SPL(est) at 1m	TBC	TBC	N/A	84	67	74	68	55	59	60	63	70
CHP	CHP (exhaust, no silencing)	Phase 2A roof	Mfr	SPL at 1m	TBC	TBC	N/A	117	115	113	108	105	108	109	107	115
CHP	CHP (exhaust, no silenced)	Phase 2A roof	Mfr	SPL(est) at 1m	TBC	TBC	N/A	91	64	24	<20	<20	<20	<20	<20	65
Transformer	Transformer	Transformer Room	Mfr	SWL	TBC	TBC	N/A	Not available								70
Emerg. Gen.	Emergency Generator (walls)	L08 Plant room	Mfr	SPL at 1m	TBC	TBC	N/A	70	79	71	65	59	52	47	43	68
Emerg. Gen.	Emergency Generator (inlet)	L08 Plant room	Mfr	SPL at 1m	TBC	TBC	N/A	84	82	67	49	49	48	47	60	67
Emerg. Gen.	Emergency Generator (outlet)	L08 Plant room	Mfr	SPL at 1m	TBC	TBC	N/A	90	66	67	62	58	57	48	26	68
Pump 4/L08	MTHW / Boiler Pump 4	L08 Plant room	Mfr	SPL at 1m	2 x 11	TBC	N/A	Not available								53
Pump 7/L08	MTHW / Absorption Chiller 2 & 4 Heating	L08 Plant room	Mfr	SPL at 1m	2 x 7.5	TBC	N/A	Not available								51
Pump 11/L08	MTHW to EnPOD 1 / DHWS Calrs / L08 AHUs Heating	L08 Plant room	Mfr	SPL at 1m	2 x 18.5	TBC	N/A	Not available								60
Pump 12/L08	MTHW to LG-LTHW PHE's	L08 Plant room	Mfr	SPL at 1m	2 x 2.2	TBC	N/A	Not available								51
Pump 5/L08	Secondary LG-LTHW	L08 Plant room	Mfr	SPL at 1m	2 x 15	TBC	N/A	Not available								54
Pump 2/L08	CHW / Absorption Chiller 2 & 4 Heating	L08 Plant room	Mfr	SPL at 1m	2 x 11	TBC	N/A	Not available								53
Pump 6/L08	HG-CHW to OT AHU's + HUBs + Kitchens	L08 Plant room	Mfr	SPL at 1m	2 x 7.5	TBC	N/A	Not available								51
Pump 7/L08	HG-CHW to L08 AHU's	L08 Plant room	Mfr	SPL at 1m	2 x 15	TBC	N/A	Not available								54

Comments: Mfr: Manufacturer
Emp: Empirical
SWL: Sound Power Level
SPL: Sound Pressure Level
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SWL*: Sound Power Level estimated from manufacturers' sound pressure level data

GOSH 2B
Plant Noise Schedule

Plant Description		Details						Octave Band Noise Level (dB)								dBA
Plant Ref.	Description	Space Served / Location	Mfr/Emp Data	SWL / SPL	Power (kW)	Vol (m^3/s)	ESP (Pa.)	63	125	250	500	1K	2K	4K	8K	
Pump 8/L08	CHW / Absorption Chiller 4	L08 Plant room	Mfr	SPL at 1m	2 x 7.5	TBC	N/A	Not available								51
Pump 2/L08	LG-CHW / Chilled Beams	L08 Plant room	Mfr	SPL at 1m	2 x 11	TBC	N/A	Not available								53
Pump 5A/B/L08	2B Absorption Chiller 2	L08 Plant room	Mfr	SPL at 1m	18.5	TBC	N/A	Not available								60
Pump 7A/B/L08	2B Absorption Chiller 4	L08 Plant room	Mfr	SPL at 1m	11	TBC	N/A	Not available								53
Pump 8/L08	TW to LG-CHW HX2-L08	L08 Plant room	Mfr	SPL at 1m	2 x 4	TBC	N/A	Not available								54
HWSR Pump 1/L03	HWSR Pump	L03 South Riser	Mfr	SPL at 1m	0.1	TBC	N/A	Not available								<43

Comments: Mfr: Manufacturer
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SWL*: Sound Power Level estimated from manufacturers' sound pressure level data

Appendix F – Attenuator Schedule

See overleaf.

Technical Submittal

IMPERIAL DUCTWORK SERVICES LTD

Project: Great Ormond Street Hospital	
From: Chris Tancock	**Ref:** TS-016
To: Kesh Jehanathan	**Date:** 25th October 2015

Equipment: Attenuators	**Manufacturer:** Allaway Acoustics Ltd
IDSL to propose to use Attenuators manufactured by Allaway Acoustics Ltd on the Great Ormond Street Hospital Phase 2B Project.	
Specification Ref: WSP Specification – Volume 2, Part 3 – Section 11.2 Skanska Volume 2 – July 2015	

Supporting Documentation Issued					
(i)	Equipment Specifying Schedule		(vii)	Builders Work Requirements	
(ii)	Manufacturers Data	✓	(viii)	Assembly & Installation Details	
(iii)	Design Check Calculations	✓	(ix)	O&M Instructions	
(iv)	Certified Performance Levels		(x)	List of Recommended Spares	
(v)	QA /QC Documents		(xi)	Deviation Schedule	
(vi)	Sample Enclosed		(xii)	Other	

Additional Information

M&E Contractor: Skanska	**Name:**	**Sign:**	**Date:**
Main Contractor: Skanska	**Name:**	**Sign:**	**Date:**
Services Consultant: WSP	**Name:**	**Sign:**	**Date:**

ALLAWAY ACOUSTICS LTD

EQUIPMENT SCHEDULE

PROJECT NAME: GREAT ORMOND STREET HOSPITAL-PHASE 2B
DATE: 24/07/2015

PROJECT No: 34924
SCHEDULE No: 12734924Q28

Item	System Reference	Suffix	DWG	L1	L2/ID	W	H/Dia	Vol	PD	Wt		Performance, dB							
				mm	mm	mm	mm	m^3/s	Pa	kg		63	125	250	500	1k	2k	4k	8k
1	ATT01 - AHU01 & 02 COMMON FAI*	GM2	A02E	1800		3000	1200	12.938	50	613	IL	7	18	25	43	55	51	42	27
2	ATT02 - AHU01 & 02 EXHAUST*	G	A02E	1800		3000	1200	12.938	50	578	IL	13	23	37	53	55	55	47	31
3	ATT03 - DELETED																		
4	ATT04 -DELETED																		
5	ATT05 - NORTH COMMON SUPPLY DUCTWK*	GM2	A02E	1800		2100	1400	12.938	39	443	IL	9	18	26	42	52	38	33	21
6	ATT06 - NORTH COMMON EXTRACT DUCTWK*	GM2	A02E	1800		2100	1400	12.938	39	443	IL	9	18	26	42	52	38	33	21
7	ATT07 - AHU03 FAI	GM2	A02E	1800		2000	1000	8	50	374	IL	7	18	25	43	55	51	42	27
8	ATT08 - AHU03 & 04 COMMON EXHAUST	G	A02E	1800		3000	1200	13.824	50	578	IL	13	23	37	53	55	55	47	31
9	ATT09 - AHU04 FAI	GM2	A02E	1800		2000	1000	8	50	374	IL	7	18	25	43	55	51	42	27
10	ATT10 - DELETED																		
11	ATT11 - SOUTH COMMON SUPPLY DUCTWK*	GM2	A02E	1800		1925	1600	13.824	45	476	IL	6	15	23	41	52	42	35	23
12	ATT12 - SOUTH COMMON EXTRACT DUCTWK*	GM2	A02E	1800		1925	1600	13.824	45	476	IL	6	15	23	41	52	42	35	23
13	ATT13 - AHU05 SUPPLY*	GM2	A02E	900		3000	1400	5.526	35	431	IL	9	19	22	34	46	39	32	28
14	ATT14 - AHU05 EXTRACT*	GM2	A02E	900		3000	1400	5.526	35	431	IL	9	19	22	34	46	39	32	28
15	ATT15 - AHU05 FAI*	GM2	A02E	900		3000	1400	5.526	35	431	IL	9	19	22	34	46	39	32	28
16	ATT16 - AHU05 EXHAUST*	G	A02E	900		2500	1000	5.526	35	274	IL	6	13	22	34	55	52	48	33
17	ATT17 - ISO 01 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
18	ATT18 - ISO 01 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
19	ATT19 - ISO 01 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
20	ATT20 - ISO 01 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
21	ATT21 - ISO 02 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
22	ATT22 - ISO 02 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
23	ATT23 - ISO 02 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
24	ATT24 - ISO 02 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
25	ATT25 - ISO 03 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
26	ATT26 - ISO 03 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
27	ATT27 - ISO 03 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
28	ATT28 - ISO 03 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25

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EQUIPMENT SCHEDULE

Item	System	Suffix	DWG	L1	L2/ID	W	H/Dia	Vol	PD	Wt		Performance, dB							
29	ATT29 - ISO 04 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
30	ATT30 - ISO 04 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
31	ATT31 - ISO 04 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
32	ATT32 - ISO 04 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
33	ATT33 - ISO 05 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
34	ATT34 - ISO 05 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
35	ATT35 - ISO 05 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
36	ATT36 - ISO 05 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
37	ATT37 - ISO 06 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
38	ATT38 - ISO 06 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
39	ATT39 - ISO 06 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
40	ATT40 - ISO 06 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
41	ATT41 - ISO 07 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
42	ATT42 - ISO 07 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
43	ATT43 - ISO 07 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
44	ATT44 - ISO 07 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
45	ATT45 - ISO 08 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
46	ATT46 - ISO 08 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
47	ATT47 - ISO 08 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
48	ATT48 - ISO 08 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
49	ATT49 - ISO 09 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
50	ATT50 - ISO 09 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
51	ATT51 - ISO 09 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
52	ATT52 - ISO 09 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
53	ATT53 - ISO 10 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
54	ATT54 - ISO 10 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
55	ATT55 - ISO 10 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
56	ATT56 - ISO 10 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
57	ATT57 - ISO 11 AHU SUPPLY	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
58	ATT58 - ISO 11 AHU RETURN	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
59	ATT59 - ISO 11 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
60	ATT60 - ISO 11 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25

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EQUIPMENT SCHEDULE

Item	System	Suffix	DWG	L1	L2/ID	W	H/Dia	Vol	PD	Wt		Performance, dB							
61	ATT61 - ISO 12/13 COMMON AHU'S SUPPLY*	GM2J	A02E	1800		950	650	1	25	142	IL	19	32	37	55	55	55	44	37
62	ATT62 - ISO 12 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
63	ATT63 - ISO 12 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
64	ATT64 - ISO 12 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
65	**ATT65 - DELETED**																		
66	ATT66 - ISO 13 AHU EXTRACT	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
67	ATT67 - ISO 13 AHU FAI	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
68	ATT68 - ISO 13 AHU EXHAUST	GM2J	A02E	1500		800	400	0.5	34	74	IL	17	28	32	45	55	42	31	25
69	ATT69 - DELETED																		
70	ATT70 - DELETED																		
71	ATT71 - DELETED																		
72	ATT72 - DELETED																		
73	ATT73 - SHAFT VENT FA FAN INLET*	GM2	A02E	1200		450	450	0.182	35	48	IL	7	16	24	41	55	47	40	29
74	ATT77 - OT AHU06 SUPPLY*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
75	ATT78 - OT3 AHU06 EXTRACT*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
76	ATT79 - OT AHU06 FAI*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
77	ATT80 - OT AHU06 EXHAUST*	G	A02E	1500		900	750	2.037	35	128	IL	8	17	33	47	55	55	55	36
78	ATT81 - OT AHU07 SUPPLY*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
79	ATT82 - OT AHU07 EXTRACT*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
80	ATT83 - OT AHU07 FAI*	GM2	A02E	1500		900	750	2.037	35	128	IL	9	19	29	42	55	44	34	25
81	ATT84 - OT AHU07 EXHAUST*	G	A02E	1500		900	750	2.037	35	128	IL	8	17	33	47	55	55	55	36
82	ATT85 - ON-FLOOR SUPPLY L01*	GM2	A02E	2700		900	750	2.42	50	199	IL	21	35	44	55	55	46	37	25
83	ATT86 - ON-FLOOR EXTRACT L01*	GM2	A02E	2700		900	750	2.2	50	199	IL	21	35	44	55	55	46	37	25
84	ATT87 - ON-FLOOR SUPPLY L02*	GM2	A02E	2700		900	750	1.819	50	199	IL	21	35	44	55	55	46	37	25
85	ATT88 - ON-FLOOR EXTRACT L02*	GM2	A02E	2700		900	750	1.8	50	199	IL	21	35	44	55	55	46	37	25
86	ATT89 - ON-FLOOR SUPPLY L03*	GM2J	A02E	2100		900	600	0.719	50	148	IL	18	33	44	55	55	55	50	41
87	ATT90 - ON-FLOOR EXTRACT L03*	GM2J	A02E	2100		900	600	0.703	50	148	IL	18	33	44	55	55	55	50	41
88	ATT91 - ON-FLOOR SUPPLY L04*	GM2J	A02E	2400		900	750	1.677	50	188	IL	22	37	44	55	55	55	42	34

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EQUIPMENT SCHEDULE

Item	System	Suffix	DWG	L1	L2/ID	W	H/Dia	Vol	PD	Wt		Performance, dB							
89	ATT92 - ON-FLOOR EXTRACT L04*	GM2J	A02E	2400		900	750	1.682	50	188	IL	22	37	44	55	55	55	42	34
90	ATT93 - ON-FLOOR SUPPLY L05*	GM2J	A02E	2100		900	750	1.137	50	174	IL	22	36	44	55	55	55	46	40
91	ATT94 - ON-FLOOR EXTRACT L05*	GM2J	A02E	2100		900	750	1.137	50	174	IL	22	36	44	55	55	55	46	40
92	ATT95 - ON-FLOOR SUPPLY L06*	GM2	A02E	2700		900	750	1.92	50	199	IL	21	35	44	55	55	46	37	25
93	ATT96 - ON-FLOOR EXTRACT L06*	GM2J	A02E	2400		900	750	1.751	50	188	IL	22	37	44	55	55	55	42	34
94	ATT97 - ON-FLOOR SUPPLY L07*	GM2	A02E	2700		900	750	2.492	50	199	IL	21	35	44	55	55	46	37	25
95	ATT98 - ON-FLOOR EXTRACT L07*	GM2	A02E	2700		900	750	2.207	50	199	IL	21	35	44	55	55	46	37	25
96	ATT99 - ON-FLOOR SUPPLY L08*	GM2	A02E	2700		900	750	2.2	50	199	IL	21	35	44	55	55	46	37	25
97	ATT100 - ON FLOOR EXTRACT L01*	GM2	A02E	2700		900	750	2.2	50	199	IL	21	35	44	55	55	46	37	25
98	ATT101 - ON FLOOR SUPPLY L02*	GM2	A02E	2700		900	800	2.759	50	208	IL	21	35	44	55	55	46	37	25
99	ATT102 - ON FLOOR- EXTRACT L02*	GM2	A02E	2700		900	800	2.708	50	208	IL	21	35	44	55	55	46	37	25
100	ATT103 - DELETED																		
101	ATT104 - DELETED																		
102	ATT105 - DELETED																		
103	ATT106 - DELETED																		
104	ATT107 - ON-FLOOR SUPPLY L04*	GM2	A02E	2700		900	800	2.775	50	208	IL	21	35	44	55	55	46	37	25
105	ATT108 - ON-FLOOR EXTRACT L04*	GM2	A02E	2700		900	800	2.574	50	208	IL	21	35	44	55	55	46	37	25
106	ATT109 - ON-FLOOR SUPPLY L05*	GM2	A02E	2700		900	800	2.608	50	208	IL	21	35	44	55	55	46	37	25
107	ATT110 - ON-FLOOR EXTRACT L05*	GM2	A02E	2700		900	800	2.621	50	208	IL	21	35	44	55	55	46	37	25
108	ATT111 - ON-FLOOR SUPPLY L06*	GM2	A02E	2700		900	800	2.547	50	208	IL	21	35	44	55	55	46	37	25
109	ATT112 - ON-FLOOR SUPPLY L06*	GM2	A02E	2700		900	800	2.514	50	208	IL	21	35	44	55	55	46	37	25
110	ATT113 - ON-FLOOR SUPPLY L07*	GM2	A02E	2400		800	600	0.825	50	152	IL	23	38	44	55	55	55	41	34
111	ATT114 - ELECT PLANT ROOMS VENT FAN SUCTION L08*	GJ	A02E	600		1300	1200	3.757	35	125	IL	7	12	17	23	34	30	25	19
112	ATT115 - ELECT PLANT ROOMS VENT FAN	GJ	A02E	600		1300	1200	3.757	35	125	IL	7	12	17	23	34	30	25	19

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Item	System	Suffix	DWG	L1	L2/ID	W	H/Dia	Vol	PD	Wt		Performance, dB							
	DISCHARGE L08*																		
113	ATT116 - L01 NUCLEAR MED EXT FAN EF05 INLET	G	A02E	1200		600	500	0.5	30	63	IL	12	23	32	46	55	55	55	45
114	ATT117 - L01 NUCLEAR MED EXT FAN EF06 OUTLET	G	A02E	1200		600	500	0.5	30	63	IL	12	23	32	46	55	55	55	45
115	ATT118 - L01 NUCLEAR MED EXT FAN EF07 INTLET	G	A02E	1200		600	500	0.5	30	63	IL	12	23	32	46	55	55	55	45
116	ATT119 - L01 NUCLEAR MED EXT FAN EF07 OUTLET	G	A02E	1200		600	500	0.5	30	63	IL	12	23	32	46	55	55	55	45
117	ATT120 - ON-FLOOR EXTRACT L07	GM2	A02E	2100		800	600	0.851	50	135	IL	21	36	44	55	55	52	39	31
118	ATT121 - AHU08 SUPPLY	GM2	A02E	1500		900	750	1.825	35	128	IL	9	19	29	42	55	44	34	25
119	ATT122 - AHU08 EXTRACT	GM2J	A02E	1200		1000	600	1.8	35	96	IL	9	17	29	42	55	44	34	25
120	ATT123 - AHU08 FAI	GM2J	A02E	1200		1000	600	1.825	35	96	IL	9	17	29	42	55	44	34	25
121	ATT124 - AHU08 EXHAUST	GM2	A02E	1500		900	750	1.8	35	128	IL	9	19	29	42	55	44	34	25
122	ATT125 - OMITTED																		

NOTES

LABEL WITH ITEM NO. & SYSTEM REF.

IL = INSERTION LOSS (dB)

REFER TO DATA SHEET NO. A02E FOR ATTENUATOR CONSTRUCTIONAL DETAILS.

ATTENUATORS TO BE DELIVERED WITH HEAVY DUTY POLYTHENE BLOCKED ENDS.

SUFFIX M2: ATTENUATORS TO HAVE THE ACOUSTIC INFILL BAGGED/SEALED IN MELINEX FOR HOSPITAL APPLICATION.

*REQUESTED LENGTHS/DIMENSIONS HAVE BEEN AMENDED (AS NECESSARY) TO SUIT PERFORMANCE REQUIREMENTS.

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DATA SHEET **A02E**
RECTANGULAR ATTENUATOR
MODEL **SP**

THIS IS NOT A STAND ALONE DOCUMENT AND UNLESS REFERRED TO IN A DATED EQUIPMENT SCHEDULE IS SUBJECT TO REVISION WITHOUT NOTICE.

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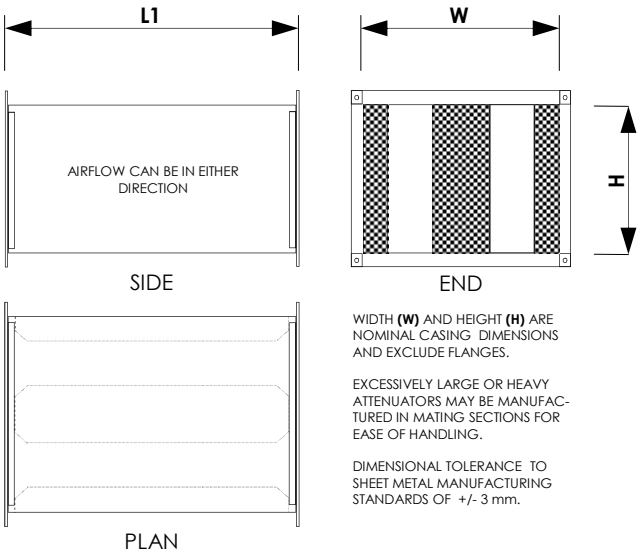
DIMENSIONS



WIDTH **(W)** AND HEIGHT **(H)** ARE NOMINAL CASING DIMENSIONS AND EXCLUDE FLANGES.

EXCESSIVELY LARGE OR HEAVY ATTENUATORS MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

DIMENSIONAL TOLERANCE TO SHEET METAL MANUFACTURING STANDARDS OF +/- 3 mm.

SPECIFICATION

ATTENUATORS ARE CONSTRUCTED TO DW144 SPECIFICATION FOR MEDIUM PRESSURE DUCTWORK.

CASES ARE FORMED FROM PRE-GALVANISED STEEL OF THE SPECIFIED GAUGE, BUT IN NO INSTANCE LESS THAN 0.8 mm. CASE SEAMS ARE LOCK FORMED AND MASTIC SEALED.

CASES ARE STIFFENED AND FITTED WITH PROPRIETARY FLANGES.

SOUND ABSORBENT ELEMENTS ARE ARRANGED WITHIN THE CASING TO FORM A SERIES OF CENTRAL SPLITTERS AND SIDE LININGS. SPLITTER FRAMES ARE FORMED FROM PRE-GALVANISED STEEL, AND CONTAIN A FIBROUS INFILL THAT IS NON-SHEDDING, NON-COMBUSTIBLE, NON-HYGROSCOPIC AND CHEMICALLY INERT. THE INFILL IS FACED WITH GLASS CLOTH AND PRE-GALVANISED PERFORATED STEEL.

SPLITTER ELEMENTS HAVE AERODYNAMIC FAIRINGS ON AIR ENTRY AND AIR EXIT END OF ATTENUATOR.

NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE.

EXCESSIVELY LARGE OR HEAVY ATTENUATORS MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

ATTENUATORS WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, BRACKETS, FIXINGS, GASKET, MASTIC OR OTHER SUCH ITEMS, UNLESS OTHERWISE STATED.

ATTENUATOR SEAMS AND JOINTS WILL BE FACTORY SEALED, HOWEVER, THE FLANGE CONNECTION SEAL , INCLUDING THE FLANGE CORNERS, IS THE RESPONSIBILITY OF THE INSTALLER.

THE PRESSURE LOSS STATED ON THE EQUIPMENT SCHEDULE IS DERIVED FROM TESTS CARRIED OUT IN ACCORDANCE WITH ISO 7235.

DIMENSIONAL TOLERANCE TO SHEET METAL MANUFACTURING STANDARDS OF +/- 3 mm.

WEIGHT

WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE.

CODE

THE ATTENUATOR CODE DEFINES THE SPLITTER AND AIRWAY DIMENSIONS AND IS GIVEN ON THE EQUIPMENT SCHEDULE.

SUFFIX

THE SUFFIX DEFINES ADDITIONAL FEATURES OR SPECIAL CONSTRUCTIONAL DETAILS.

G - GALVANISED STEEL CONSTRUCTION.

S - STAINLESS STEEL CONSTRUCTION.

U - UPVC/GRP CONSTRUCTION TO DW154 SPECIFICATION (SEPARATE DRAWING)

H1 - 2 HOUR/300ºc CONSTRUCTION.

H2 - FIRE DUCT CONSTRUCTION (FINAL TREATMENT BY SPECIALIST CONTRACTOR)

C - CHLORINATED RUBBER PAINT TO INSIDE SURFACES.

J - SPLITTERS ARRANGED HORIZONTALLY.

L - SPLITTERS ONLY (REFER TO DATA SHEET A10 FOR DETAILS).

D - DOUBLE SKIN CASING.

M1 - MELINEX LINED INFILL.

M2 - MELINEX ENCAPSULATED INFILL.

X - SPECIAL CONSTRUCTION, REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

FLANGE DETAILS

ATTENUATORS ARE FITTED WITH PROPRIETARY FLANGES AS FOLLOWS:

GREATEST DIMENSION (W or H)	FLANGE
0 - 1000 mm	DOBY 20
1001 - 1250 mm	DOBY 30
1251 and above	DOBY 40

NOTE: IT IS THE INSTALLERS RESPONSIBILITY TO PROVIDE THE FLANGE SEAL TO THE CONNECTING DUCT, INCLUDING THE FLANGE CORNERS.

STANDARD SIZES

THERE ARE NO STANDARD SIZES. ALL ATTENUATORS ARE MADE TO ORDER.

Appendix G – Detailed Calculation Results

Table G-1: Detailed plant noise predictions at the worst affected positions: normal conditions, no design changes

Item of Plant	Predicted Façade Noise Level due to Item of Plant at Specified Location [dB L_{Aeq}]						
	89-92 Guilford Street	International Hall, Guilford Street	19-27 Great Ormond Street	29-41 Great Ormond Street	3-6 Guilford Place / 86-94 Lamb's Conduit Street	Spens House / 70 Lamb's Conduit Street	The Lamb PH
L8 AHUs	13	11	19	16	23	19	17
L4 AHUs	11	<10	12	10	17	18	19
L1 Extract Fans	39	26	<10	22	25	26	24
L8 Extract Fans	<10	<10	<10	<10	<10	<10	<10
Phase 2A CHP	32	31	17	25	28	22	23
Chiller Room Break-out	23	17	28	21	36	31	30
Break-out from other rooms	18	11	13	17	26	21	19
Riser Break-out	14	11	17	19	20	17	13
L1 Supply Fans	31	15	10	<10	<10	10	<10
L8 Supply Fans	<10	<10	<10	13	<10	<10	<10
Emergency Generator	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	**40**	**32**	**29**	**29**	**38**	**33**	**32**

Table G-2: Detailed plant noise predictions at the worst affected positions: normal conditions, additional mitigation

Item of Plant	Predicted Façade Noise Level due to Item of Plant at Specified Location [dB L_{Aeq}]						
	89-92 Guilford Street	International Hall, Guilford Street	19-27 Great Ormond Street	29-41 Great Ormond Street	3-6 Guilford Place / 86-94 Lamb's Conduit Street	Spens House / 70 Lamb's Conduit Street	The Lamb PH
L8 AHUs	13	11	19	16	23	19	17
L4 AHUs	11	<10	12	10	17	18	19
L1 Extract Fans	31	20	<10	11	16	13	15
L8 Extract Fans	<10	<10	<10	<10	<10	<10	<10
Phase 2A CHP	32	31	17	25	28	22	23
Chiller Room Break-out	23	17	28	21	36	31	30
Break-out from other rooms	18	11	13	17	26	21	19
Riser Break-out	14	11	17	19	20	17	13
L1 Supply Fans	31	15	10	<10	<10	10	<10
L8 Supply Fans	<10	<10	<10	13	<10	<10	<10
Emergency Generator	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	**36**	**32**	**29**	**28**	**37**	**32**	**32**

Table G-3: Contribution from each item of plant or machinery at the worst affected position: emergency conditions

Item of Plant	Predicted Façade Noise Level due to Item of Plant at Specified Location [dB L_{Aeq}]						
	89-92 Guilford Street	International Hall, Guilford Street	19-27 Great Ormond Street	29-41 Great Ormond Street	3-6 Guilford Place / 86-94 Lamb's Conduit Street	Spens House / 70 Lamb's Conduit Street	The Lamb PH
L8 AHUs	13	11	19	16	23	19	17
L4 AHUs	11	<10	12	10	17	18	19
L1 Extract Fans	31	20	<10	11	16	13	15
L8 Extract Fans	<10	<10	<10	<10	<10	<10	<10
Phase 2A CHP	32	31	17	25	28	22	23
Chiller Room Break-out	23	17	28	21	36	31	30
Break-out from other rooms	20	11	13	17	27	21	20
Riser Break-out	14	11	17	19	20	17	13
L1 Supply Fans	31	15	10	<10	<10	10	<10
L8 Supply Fans	<10	<10	<10	13	<10	<10	<10
Emergency Generator	13	13	27	31	21	24	19
Total	**36**	**32**	**31**	**33**	**37**	**33**	**32**

Figure G-1: Noise level contour: Plant noise level during normal operational conditions, with further mitigation

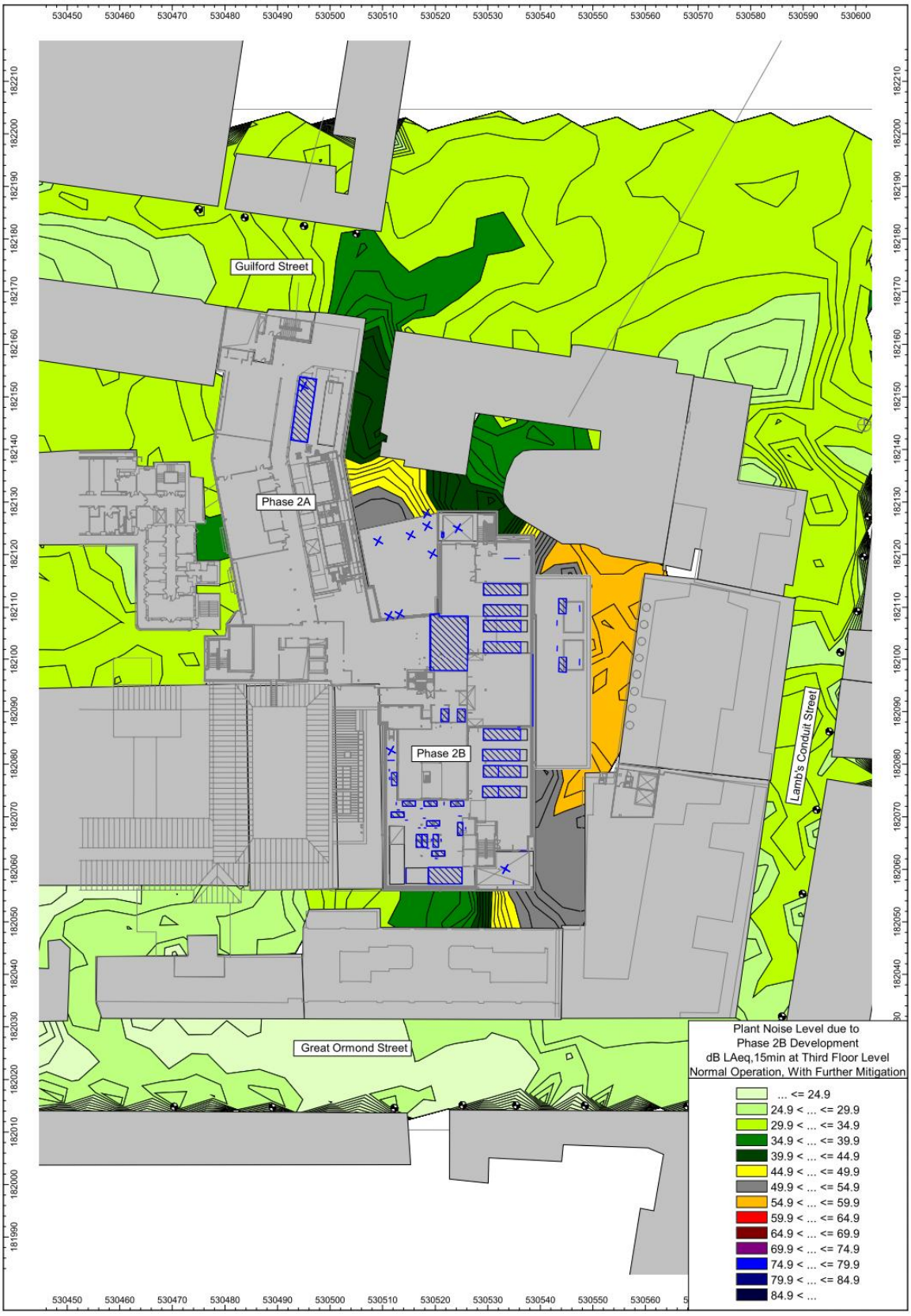
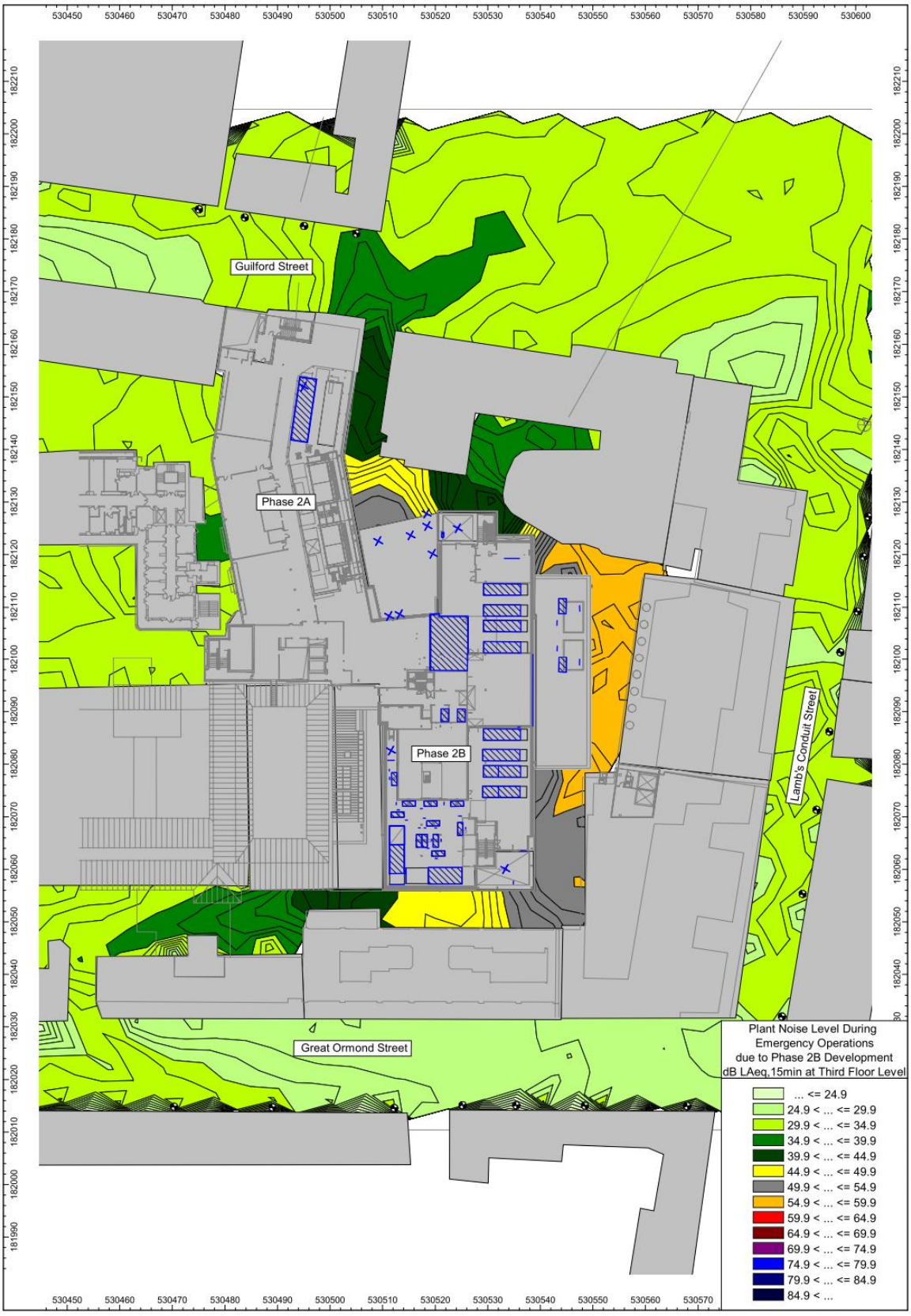


Figure G-2: Noise level contour: Plant noise level during emergency operational conditions



Appendix H – Limitations of this Report

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The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. Opinions included therein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations WSP UK Limited reserve the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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