19–21 High Holborn, London

Acoustic Planning Report

November 2015

Waterman Infrastructure & Environment Limited
Pickfords Wharf, Clink Street, London, SE1 9DG, United Kingdom
www.watermangroup.com

19–21 High Holborn, London

Acoustic Planning Report

Client Name: The Honourable Society of Gray's Inn
Document Reference: EED15512-100-R-2-2-2
Project Number: EED15512

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
First	May 2015	Simon Harper Acoustic Consultant	Mark Maclagan Technical Director	Mark Maclagan Technical Director
Second	November 2015	Rob Ashby Graduate Acoustic Consultant	Mark Maclagan Technical Director	Mark Maclagan Technical Director

Disclaimer

This report has been prepared by Waterman Infrastructure & Environment Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.

Content

Tables

Appendices

EXECUTIVE SUMMARY

A noise assessment has been undertaken to assess the potential noise impacts of buildings services plant associated with the proposed development of 19–21 High Holborn, London.

A baseline environmental noise survey has been conducted over a typical 24 hour weekday period to establish existing noise levels in the area surrounding the proposed Development.

Limiting noise criteria for new mechanical services plant have been set based upon the results of the baseline noise survey and in accordance with the London Borough of Camden's (LBC) policy on noise (DP28). This policy requires an emission level ($L_{Aeq,T}$) from all plant and machinery of at least 5dB below the external background noise level ($L_{A90,T}$) to be met 1m from the external façade of the nearest noise-sensitive properties during the daytime, evening and night-time periods. Where there is determined to be tonal or intermittent content emitting from plant then a +5dB acoustic feature correction must be applied to the limiting criteria (i.e. the plant noise limits shall be reduced by 5dB).

Calculations have been undertaken based on the proposed externally mounted plant complement, namely 1.no Nuaire extract fan, 1.no Swegen AHU and Heat Pump and 8.no Mitsubishi PURY 500 YLM condensers for cooling. The results of the assessment demonstrate that the rating noise level from fixed plant will be 10dB or more below the existing background noise, and as such will have a negligible effect on nearby sensitive receptors. This satisfies the requirements of LBCs Local Development Framework Policy

1 Introduction

1.1 The Brief

This noise assessment has been prepared by Waterman Infrastructure and Environment Ltd (hereafter "Waterman EED") on behalf of The Honourable Society of Gray's Inn (hereafter "the Applicant") in support of their application to obtain full planning permission for the redevelopment of 19–21 High Holborn, London, WC1V 6BS (hereafter referred to as the 'Site') for office and retail use.

Proposals involve the refurbishment of 19-21 High Holborn, London to provide a seven storey building (ground plus six floors) comprising retail at basement and ground floor levels, and office on upper floors.

Building services plant will be housed in the basement to the rear of the building. This report considers noise impact from the operation of fixed building services plant associated with the proposed development on existing noise-sensitive receptors.

As part of this examination the following activities have been undertaken:

- Baseline environmental noise survey to establish existing noise levels in the area potentially at risk of exposure to noise from the plant, which are representative of nearby noise-sensitive properties to the site;
- Prediction of cumulative plant noise at the nearest noise-sensitive premises to the site against the requirements of the London Borough of Camden (LBC); and
- Recommendations for the control of plant noise and vibration, where necessary.

A glossary of the acoustic terminology used in this report is presented in Appendix A.

1.2 Site Description

The application Site (National Grid Reference 531036, 181635) lies within the administrative boundary of the London Borough of Camden (LBC) in central London in a high density urban area comprising a mix of retail, commercial and residential uses. The property is situated between 14–18 High Holborn (east) and 22–23 High Holborn (west) with High Holborn (A40) running adjacent to the front of the buildings south façade. Gray's Inn Gate situated to the west of Site located on High Holborn gives access to South Square which leads to the Gray's Inn Gardens. The paddock which runs adjacent to the north of 19–21 High Holborn gives access on Gray's Inn Road (A5200).

The noise climate of the area is dominated by constant local and distant road traffic noise along the surrounding local road network. Contributory noise from heating, ventilation and air conditioning (HVAC) plant serving surrounding buildings, passing aircraft and from human activities in the area were evident and also influence the local noise climate, to some extent.

A review of the land uses immediately surrounding the Site has identified noise sensitive receptors in proximity to the Site, which could be impacted by operation of the Proposed Development. The identified sensitive receptors are illustrated as Figure 1 and described in Table 1.

Table 1: Sensitive Receptors

Sensitive Receptor	Sensitive Receptor/ Land Use
SRA	1 South Square (Offices) 14m from the application site boundary.
SRB	14 – 18 High Holborn (Offices) 4m from the application site boundary.
SRC	319 - 330 High Holborn (Retail and Offices) 20m from the application site boundary.

2 Noise Assessment Criteria

2.1 Local Planning Policy

Camden Local Development Framework, Camden Core Strategy, 2010-2025 Adopted, November 2010

The local planning authority of LBC has certain legal responsibilities to prepare documents that control and regulate the use of land. The Local Development Framework (LDF) Core Strategy was formally adopted by the Council in November 2010[1], replacing the Unitary Development Plan (UDP) as the main collection of planning policy documents for the Council. This is a strategic document that establishes the land use and planning framework for the borough and is the primary reference for all planning decisions.

Camden Local Development Framework, Camden Development Policies, Adopted, November 2010

The Adopted Core Strategy acknowledges the key policy (Development Policy (DP) 28 – Noise and Vibration) relevant to noise issues within the Camden Development Policies document[2], which form part of the Council's LDF. This document sets out detailed planning criteria that LBC use to determine applications for planning permission in the borough in contributing towards delivering the Council's Core Strategy.

Disturbance from noise and vibration is recognised as a particularly important issue in the borough on amenity and health and therefore quality of life due to Camden's high density and mixed-use nature. Policy DP28 specifically relates to noise and vibration and contributes to implementing a number of Core Strategy policies, including CS5 – *Managing the impact of growth and development*, CS9 – *Achieving a successful Central London*, CS11 – *Promoting sustainable and efficient travel* and CS16 – *Improving Camden's health and well-being*.

Policy DP28 states that:

The Council will seek to ensure that noise and vibration is controlled and managed and will not grant planning permission for:

a) development likely to generate noise pollution; or

b) development sensitive to noise in locations with noise pollution, unless appropriate attenuation measures are provided.

Furthermore, DP28 states that '*Development that exceeds Camden's Noise and Vibration Thresholds will not be permitted.*' The threshold values for plant and machinery to which applications are assessed are outlined in Table 2.

Table 2: Noise Level 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 to a sensitive façade	Day, evening and night	0000-2400	5dB(A) $<L_{A90}$
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) $<L_{A90}$

[1] LBC (2010). Camden Local Development Framework, Camden Core Strategy, 2010-2025 Adopted, November, 2010.
[2] LBC (2010). Camden Local Development Framework, Camden Development Policies, Adopted, November 2010.

Noise Description and Location of Measurement	Period	Time	Noise level
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <L_{A90}
Noise at 1 metre external to sensitive façade where L_{A90}>60dB	Day, evening and night	0000-2400	55dBL_{Aeq}

Finally, DP 28 states:

"*The Council will only grant permission for plant or machinery if it can be operated without causing harm to amenity and does not exceed our noise thresholds.*

The Council will seek to minimise the impact on local amenity from the demolition and construction phases of development. Where these phases are likely to cause harm, conditions and planning obligations may be used to minimise the impact."

Camden Planning Guidance 6 – Amenity, 2011

Camden's LDF also contains a number of other documents, notably, Supplementary Planning Documents (SPD), which give detailed guidance on how the Council's planning strategy and policies will be implemented for specific topics, areas or sites. Although they do not form part of the statutory development plan for Camden, and do not therefore have the same weight in decision making, they play an important role in providing additional "material consideration" in the Council's planning decisions.

Camden Planning Guidance 6: Amenity (CPG6)[3] is a formal SPD, which supports policy DP28, providing guidance on how to control and manage noise so that growth and development is sustainably managed and harmful effects on the amenity of existing and future occupiers and to nearby properties is avoided.

Chapter 4 '*Noise and Vibration*' of CPG 6 states that LBC's commitments are to:

"… ensure that noise and vibration is controlled and managed to:

- *Limit the impact of existing noise and vibration sources on new development; and*
- *Limit noise and vibration emissions from new development."*

CPG 6 further acknowledges noise and vibration can have an effect on amenity, health and people's quality of life. In this respect, the aforementioned DP28 is referenced with regard to the control and management of noise and vibration. The document also highlights the key noise sources within LBC (namely road, rail, industrial, plant and mechanical equipment, entertainment uses and building sites), and outlines measures to minimise the effects of these sources of noise on new developments. In respect of controlling noise from development the measures range from engineering (e.g. reducing the noise emitted at the point of generation), layout (e.g. exploiting distance and screening loss between source and noise sensitive areas) and administrative (e.g. specifying an acceptable noise limit).

CPG 6 goes on to state that detailed acoustic/noise and vibration information in the form of a report will be required for developments that include installation of plant, ventilation or air conditioning equipment that

[3] LBC (2011), Camden Planning Guidance 6 - Amenity. LBC.

will create significant noise (e.g. new industry, nightclub); noise sensitive development in an area where existing noise sources are present; or will generate a significant amount of traffic.

2.2 Building Services Plant Noise

The significance of building services noise impacts depends upon a number of factors including the absolute noise level, the nature of the noise, the time and duration at which the noise occurs, whether the noise is temporary, intermittent or permanent, whether the impact is as a result of a new source, or whether it is a change to an existing source and/or the sensitivity of the receptor.

At this stage in the development, it is understood that fixed building services plant items which may be installed as a part of the scheme may include five number boilers for heating with associated 1.no Nuaire extract fan and 1.no Swegen AHU and Heat Pump and 8.no Mitsubishi PURY 500 YLM condensers for cooling.

When assessing the noise impacts of fixed mechanical plant, the guidance provided within BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' has been used. The standard sets out a methodology whereby the likelihood of complaints as a result of an industrial noise source can be assessed. The measured or predicted noise level from the source in question, known as the 'specific noise' level ($L_{Aeq,T}$), is compared immediately outside of the dwellings is compared with 'background noise' level ($L_{A90,T}$) that exists in the absence of the source in question. Where the noise contains a 'distinguishable discreet continuous note (whine, hiss, screech, hum etc.)' or if there are 'distinct impulses in the noise (bangs, clinks, clatters or thumps)', or if 'the noise is irregular enough to attract attention' then an acoustic feature correction of between +5dB and +9dB is added to the specific noise level (correcting for the influence from any residual noise) to obtain the 'rating noise' level ($L_{Ar,Tr}$).

The significance of noise impacts is assessed by subtracting the background noise level from the rating noise level. The greater the difference between the rating and background noise level the greater the significance of the impacts. The standard also requires that consideration is given to the absolute noise level and the potential for the noise level to cause annoyance/interference with everyday activities.

For the daytime, this assessment is carried out over a one hour reference period and over a fifteen minute period during the night. Day and night are not defined in the Standard but it states that night should cover the times when the general adult population are preparing for sleep or actually sleeping. For the purpose of this assessment it has been assumed that the day and night periods reflect those stated in BS 8233, i.e. daytime is 07:00–23:00 and night 23:00-07:00.

Based on the environmental noise survey data detailed in the following section (Section 4) and in accordance with LBC plant noise policy (DP 28), maximum plant emission levels have been set in controlling fixed building services plant to an acceptable level and are detailed in Section 6 of this report. Noise limits apply at a position 1m from the façade of the nearest noise sensitive properties and include the total contribution of noise from all plant items associated with the proposed plant scheme that may run during any particular period.

3 Baseline Environmental Noise Survey

A continuous 48-hour unattended baseline environmental noise survey was carried out from Wednesday 29th April to Friday 1st May 2015, thereby covering the hours of operation of fixed plant and allowing characterisation of the existing noise climate.

Noise monitoring locations were selected to be representative of the noise climate on and in the vicinity of the development site. The selected monitoring locations included the fifth floor window on the south façade overlooking High Holborn and roof level at the northern façade overlooking 1 South Square. The monitoring locations are described in Table 3 and presented as Figure 1.

Table 3: Noise Monitoring Locations

Monitoring Location (Figure 1)	Description	Observations and Predominant Noise Sources
LT1	Free-field measurement at 5th floor window level facing onto High Holborn (A40).	Heavy traffic flows on High Holborn (A40) and surrounding highway network. Contributory noise from human activities in the area.
LT2	Free-field measurement at roof level facing onto 1 South Square.	Noise from road traffic movements on surrounding highway network and building services plant predominate. Contributory noise from human activities in the area and occasional vehicle movements on the cut through adjacent to south square, but to a lesser extent.

Each calibrated precision grade (Class 1) sound level meter was set-up to record over consecutive 5-minute periods the L_{eq}, L_{90}, L_{10}, and L_{max} noise indices in the A-weighting network over fast response time constant interval for the duration of the noise surveys. The indices are described in Appendix A of this report, but roughly translated they describe in turn the average, background, road traffic, and maximum noise level. Calibration certificates for the noise instrumentation are available on request.

Weather conditions, whilst not actively measured during the survey period, were monitored remotely throughout. Overall, weather conditions were conducive for the measurement of noise, it being cold but dry, with light north-easterly to easterly winds (<5ms^{-1}) prevailing.

The full results of the baseline environmental noise surveys are displayed graphically in time-history format in Appendix B, whilst a summary of the measured ambient (L_{eq}) and background (L_{90}) daytime, evening and night-time noise levels for the survey period are tabulated below in Table 4 and 5. A –3dB correction has been applied to measured noise levels at monitoring location LT1, which was located within 3m of the building façade (at 5th Floor level) to account for acoustic reflections.

Table 4: Baseline Noise Measurements

Position	Period	Duration	$L_{Aeq,T}$ dB	$L_{A10,T}$ dB	$L_{A90,T}$ dB		$L_{AFmax,5min}$ dB
			Ave[1]	Ave[2]	Min	Ave[2]	90th percentile[3]
LT1	Day	12hr	68	70	59	63	84
	Evening	4hr	67	69	59	61	84
	Night	8hr	66	68	49	57	81
LT2	Day	12hr	56	58	52	54	72
	Evening	4hr	55	56	52	53	70
	Night	8hr	53	54	49	51	64

Note 1: Logarithmic average over the daytime and night-time survey periods, Note 2: Arithmetic average over the daytime and night-time survey periods, Note 3: The 90th percentile L_{AFmax} value (equivalent to the 10th highest measured L_{AFmax} level) has been used in the assessment and is considered representative of typical L_{AFmax} levels experienced. All figures rounded to nearest whole decibel.

Table 5: Baseline Noise Measurements

Monitoring Location (Appendix A)	Period	Duration	$L_{Aeq,T}$ dB	$L_{A10,T}$ dB	$L_{A90,T}$ dB	$L_{AFmax,5min}$ dB
			Ave[1]	Ave[2]	Ave[2]	Ave[2]
ST1	Day	30mins	58	60	53	73
ST2	Day	30mins	71	74	64	84

Notes: [1] Logarithmic average over the daytime survey periods; [2] Arithmetic average over the daytime survey periods. All figures rounded to nearest whole decibel.

Measured ambient ($L_{Aeq,5min}$) and background $L_{A90,5min}$ noise levels are in line with those which would be expected for a site such as the proposed and are considered to be representative of both the noise climate at those sensitive receptors located adjacent to the site boundary (see Table 1) as well as the noise climate experienced at the façade of the proposed Development..

4 Noise Impact Assessment

4.1 Mechanical Plant Noise Limiting Criteria

Limiting criteria have been set for the closest identified sensitive receptors to the plant areas (refer to Table 1). The limiting criteria is based upon the baseline noise data summarised in the preceding section and application of LBC's plant noise policy (DP28) detailed in Section 2. Limiting criteria in terms of the maximum plant emission levels ($L_{Aeq,T}$) for fixed mechanical plant are presented below as Table 6. The criteria should be met at a location 1m from the façade of the closest noise sensitive properties.

It is important to recognise that the noise limits apply to the total contribution of noise from all plant items associated with the proposed plant scheme that may run during any particular period. Moreover, if there is determined to be tonal or intermittent content emitting from plant then a further acoustic feature correction must be applied to the limiting criteria (i.e. the plant noise limits shall be reduced) to obtain a 'rating' plant noise level.

Table 6: Plant Noise Limits at Nearest Noise Sensitive Premises

Location	Period	Minimum Measured ($L_{A90,T}$)	Plant Noise Emission Limit ($L_{Ar,T}$)[1]
SRA - 1 South Square	Daytime (0700-2300)	52	47
	Night-time (2300-0700)	49	44
SRB - 14 – 18 High Holborn	Daytime (0700-2300)	52	47
	Night-time (2300-0700)	49	44
SRC - 319 – 330 High Holborn	Daytime (0700-2300)	59	54
	Night-time (2300-0700)	49	44

Notes: [1] If there is determined to be tonal or intermittent content emitting from plant then a 5dB acoustic feature correction should be applied (i.e. the plant noise limits shall be reduced by 5dB).

4.2 Plant Noise Assessment

Calculations have been undertaken to determine the noise impact of the proposed Plant complement identified in Section 2.2, namely 1.no Nuaire extract fan and 1.no Swegen AHU and Heat Pump and 8.no Mitsubishi PURY 500 YLM condensers for cooling.

In completing the calculations, corrections have been made for the attenuation of sound over distance and site specific screening effects, as appropriate. The assessment has been completed for a worst case scenario in that it has been assumed that all plant would be operating simultaneously at full duty during the quietest daytime (07:00-23:00) and night-time (23:00-07:00) period without mitigation. Similarly, the shortest distance from the receptor of interest to the nearest plant item has been taken, with angle of view to the plant and air absorption assumed negligible, such that there is no excess attenuation of noise. However, an allowance has been made for screening provided by the proposed Mansard Roof Construction.

In accordance with the guidance in Section 2.2, a -5dB correction has been applied to the rating noise limit for the all plant owing to the intermittent nature of their operation.

4.2.1 Level 4 Roof Mounted Plant

The predicted levels of noise from the proposed level 4 roof mounted plant at the nearest sensitive receptor are presented in Table 7 and are based upon manufacturer supplied acoustic data for the condenser units intended for the development. Calculation details are presented in Appendix C.

Table 7: Summary of Assessed Plant Noise Levels at the Closest Receptors

Assessment Parameter	SRA (1 South Square)	
	Daytime period (07:00-23:00)	Night-time period (23:00-07:00)
Combined sound pressure level of 8.no Condensers at 1m (Make: Mitsubishi PURY 500 YMA) where Directivity Factor (Q) = 4	72	72
Cumulative receiver plant noise level (allowing for attenuation by mansard roof)	27	27
Lowest measured background noise level ($dBL_{A90,15min}$)	52	49
Target Criterion ($L_{Ar,Tr}$ = -10dB $L_{A90,T}$)	42	39
Difference	-15	-12
Compliant with design criterion?	Yes	Yes

From review of Table 7, it can be seen that the predicted cumulative plant rating noise levels are -15 dB $L_{Ar,Tr}$ during the daytime and -12 dB $L_{Ar,Tr}$ during the night-time at 1 South Square, the closest noise sensitive premises to the level 4 plant area. The predicted cumulative receiver plant noise is less than the lowest measured daytime and night-time background levels and therefore compliant with the LBC's plant noise requirements for the scheme design.

The results also indicate that plant noise is unlikely to represent a significant impact according to the methodology outlined in BS 4142:2014, being a minimum of 12dB below the measured representative background noise level.

4.2.2 Roof Level Plant

The predicted levels of noise from the proposed roof level plant at the nearest sensitive receptor are presented in Table 8 and are based upon manufacturer supplied acoustic data for the Nuaire extract fan and the Swegen air handling unit/heat pump intended for the development. Calculation details are presented in Appendix C.

Table 8: Summary of Assessed Plant Noise Levels at the Closest Receptors

Assessment Parameter	SRA (1 South Square)	
	Daytime period (07:00-23:00)	Night-time period (23:00-07:00)
Lp at 1m of 1.no Nuaire (Extract Fan) and 1.no Swegen (AHU/ Heat Pump) where Directivity Factor (Q) = 2	62	62
Cumulative receiver plant noise level	27	27
Lowest measured background noise level ($dBL_{A90,15min}$)	52	49
Target Criterion ($L_{Ar,Tr}$ = -10dB $L_{A90,T}$)	42	39

Assessment Parameter	SRA (1 South Square)	
	Daytime period (07:00-23:00)	Night-time period (23:00-07:00)
Difference	-15	-12
Compliant with design criterion?	Yes	Yes

From review of Table 8, it can be seen that the predicted cumulative plant rating noise levels are -15 dB $L_{Ar,Tr}$ during the daytime and -12 dB $L_{Ar,Tr}$ during the night-time at 14 – 18 High Holborn, the closest noise sensitive premises to the roof level plant. The predicted cumulative receiver plant noise is less than the lowest measured daytime and night-time background levels and therefore compliant with the LBC's plant noise requirements for the scheme design.

The results also indicate that plant noise is unlikely to represent a significant impact according to the methodology outlined in BS 4142:2014, being a minimum of 12dB below the measured representative background noise level.

4.2.3 Plant Noise Assessment Summary

Based on the assessment results presented in Sections 4.2.1 to 4.2.2, no further mitigation measures are recommended over those already set out within the information received (i.e it has been assumed that silencers are positioned on the inlet / discharge of all plant items and the extract fan comes already positioned within an absorptive lined casing).

Notwithstanding this, we would recommend that the following measures are considered:

- Reasonable steps should be taken to procure the quietest yet most efficient plant for the job, with this one of the most effective ways of controlling the generation of noise;

- During the more noise-sensitive late evening and night-time period when cooling demand is less the coolers should be operated at reduced night-time set back.

The AHU and extract fan must be mounted on appropriately selected and installed anti-vibration mounts to mitigate vibration transfer into the building structure. Regard must be given, but not limited to, the mass of the plant item and the lowest forcing frequency of vibration to be isolated in ensuring a minimum 90% isolation efficiency (i.e. 10% transmissibility).

5 Summary and Conclusions

A noise assessment has been undertaken to assess the potential noise impacts of buildings services plant associated with the proposed development of 19–21 High Holborn, London.

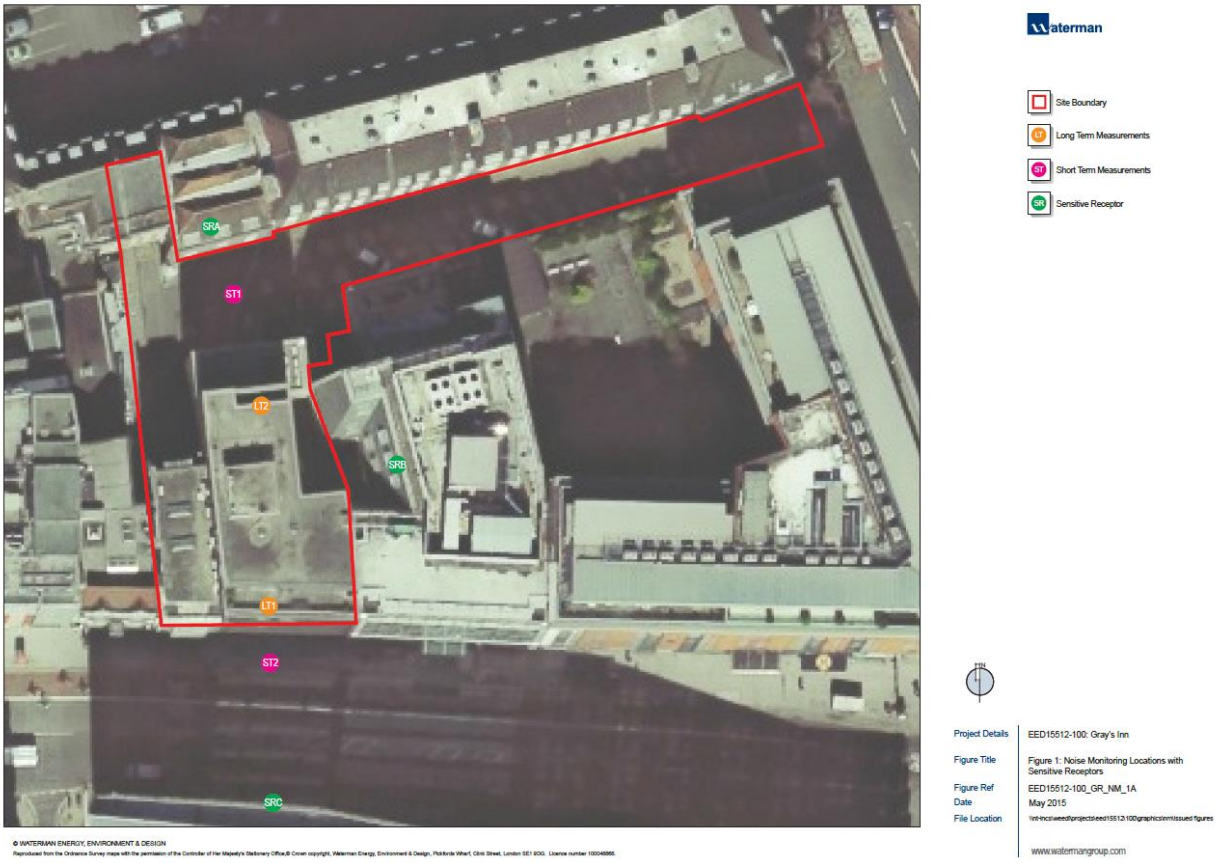
As part of this examination a baseline environmental noise survey has been conducted to establish existing noise levels in the area potentially at risk of exposure to noise from the plant, which are representative of nearby noise-sensitive properties to the site.

The external background noise levels measured have enabled appropriate environmental noise criteria to be established for proposed new mechanical services plant, in accordance with LBC's policy on noise (DP28). This requires an emission level ($L_{Aeq,T}$) from all plant and machinery of at least 5dB below the external background noise level ($L_{A90,T}$) to be met 1m from the external façade of the nearest noise-sensitive properties during the daytime, evening and night-time periods.

The results of the assessment demonstrate that the rating noise level from fixed plant will be 10dB or more below the existing background noise, and as such will have a negligible effect on nearby sensitive receptors. This satisfies the requirements of LBCs Local Development Framework Policy DP28

FIGURES

Figure 1: Location Plan of the Planning Application Boundary, Sensitive Receptors, and Measurement Locations



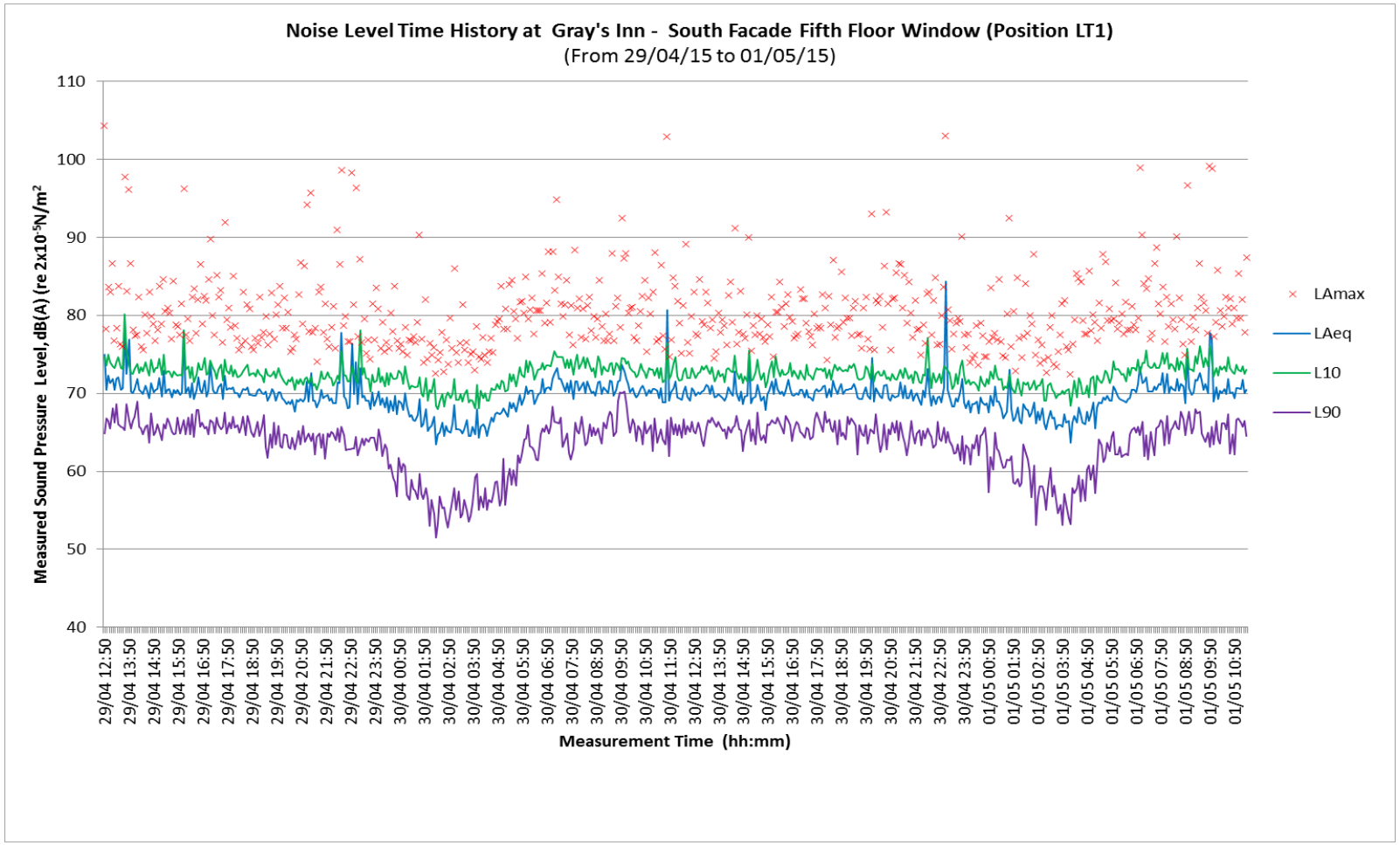
APPENDICES

Appendix A Acoustic Terminology

Ambient Noise	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Assessment Period	The period in a day over which assessments are made.
A-weighting, dB(A)	The 'A' weighting is a frequency weighting devised to take into account the fact that the human response to sound is not equally sensitive to all frequencies. The A-weighting is applied to measured or calculated sound pressure levels so that these levels correspond more closely to the subjective response of the human ear. A-weighted sound levels are denoted as dB(A).
Background Noise	Background noise is the term used to describe the noise measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety-percent of a sample period. This is represented as the L_{90} noise level (see below).
Broadband	Containing the full range of frequencies.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen. The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound that is heard. The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping. Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of decibels. The following are examples of the decibel readings of every day sounds: Four engine jet aircraft at 100m 120 dB Riveting of steel plate at 10m 105 dB Pneumatic drill at 10m 90 dB Circular wood saw at 10m 80 dB Heavy road traffic at 10m 75 dB Telephone bell at 10m 65 dB Male speech, average at 10m 50 dB Whisper at 10m 25 dB Threshold of hearing, 1000 Hz 0 dB
Façade Noise Level	A noise level measured or predicted at the façade of a building, typically at a distance of 1m, containing a contribution made up of reflections from the façade itself (+3dB).
Free-field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m away.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{Aeq,T}$ noise level	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{A90,T}$ noise level	The A-weighted noise level that is exceeded for 90% of the measurement time interval, T. The LA90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{A10,T}$ noise level	The A-weighted noise level that is exceeded for 10% of the time over the period T. The L_{A10} can be considered to be the "average maximum" noise level and is generally used to describe road traffic noise.
L_{Amax} noise level	The maximum A-weighted noise level over the time period T, and unless described otherwise, it is measured using the 'fast' sound level meter response. The L_{AFmax} is sometimes used for

	the assessment of occasional loud noises, which may have little effect on the overall L_{Aeq} noise level but will still affect the noise environment.
Rating Level ($L_{Ar,Tr}$)	The equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of sound.

Appendix B Noise Monitoring Results


Noise Level Time History at Gray's Inn - South Facade Fifth Floor Window (Position LT1)
(From 29/04/15 to 01/05/15)
Measured Sound Pressure Level, dB(A) (re 2x10-5N/m2
110
100
90
80
70
60
50
40
29/04 12:50
29/04 13:50
29/04 14:50
29/04 15:50
29/04 16:50
29/04 17:50
29/04 18:50
29/04 19:50
29/04 20:50
29/04 21:50
29/04 22:50
29/04 23:50
30/04 00:50
30/04 01:50
30/04 02:50
30/04 03:50
30/04 04:50
30/04 05:50
30/04 06:50
30/04 07:50
30/04 08:50
30/04 09:50
30/04 10:50
30/04 11:50
30/04 12:50
30/04 13:50
30/04 14:50
30/04 15:50
30/04 16:50
30/04 17:50
30/04 18:50
30/04 19:50
30/04 20:50
30/04 21:50
30/04 22:50
30/04 23:50
01/05 00:50
01/05 01:50
01/05 02:50
01/05 03:50
01/05 04:50
01/05 05:50
01/05 06:50
01/05 07:50
01/05 08:50
01/05 09:50
01/05 10:50
Measurement Time (hh:mm)
LAmax
LAeq
L10
L90

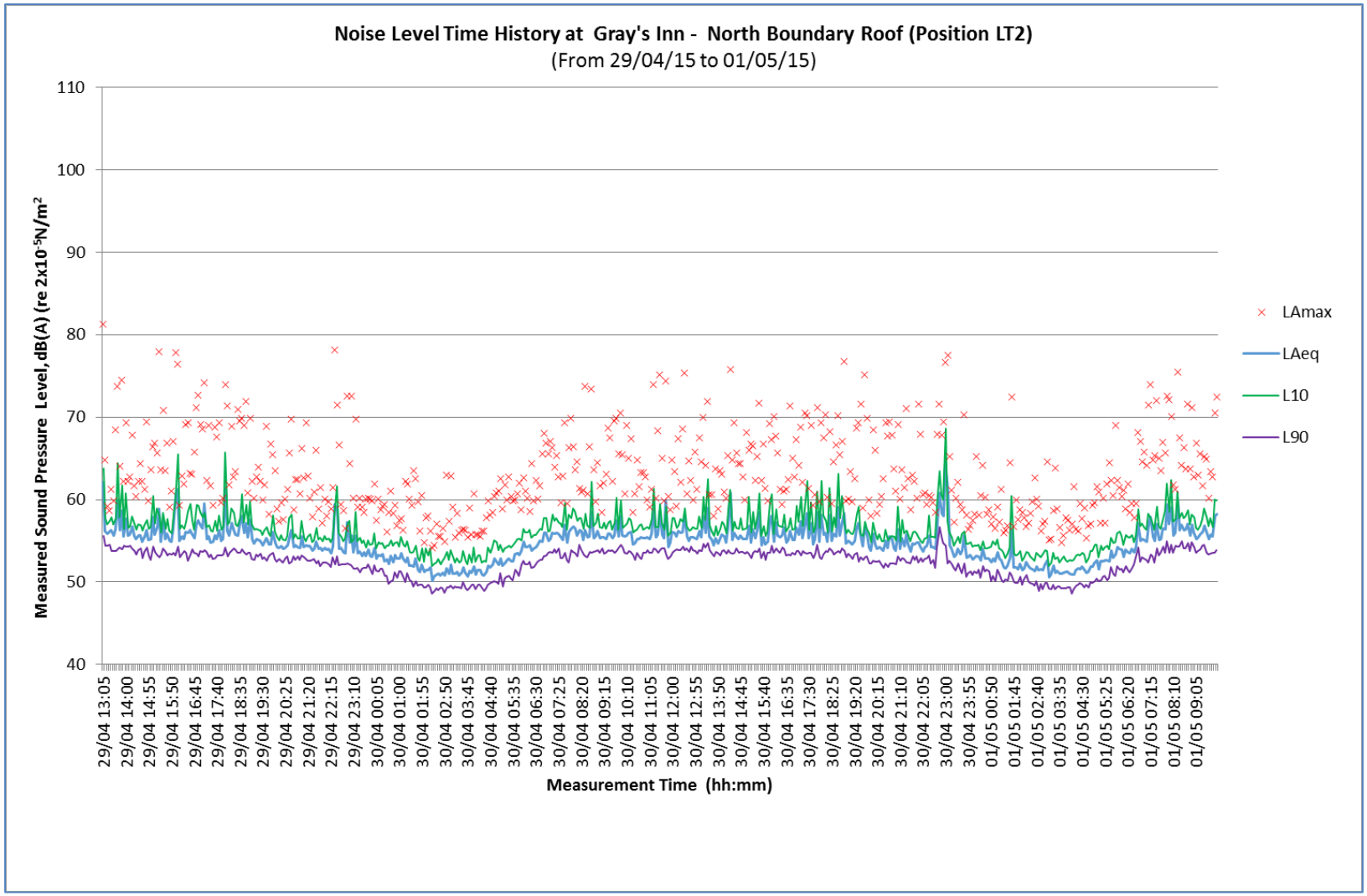

Noise Level Time History at Gray's Inn - North Boundary Roof (Position LT2)
(From 29/04/15 to 01/05/15)
Measured Sound Pressure Level, dB(A) (re 2x10-5N/m2
110
100
90
80
70
60
50
40
LAmax
LAeq
L10
L90
29/04 13:05
29/04 14:00
29/04 14:55
29/04 15:50
29/04 16:45
29/04 17:40
29/04 18:35
29/04 19:30
29/04 20:25
29/04 21:20
29/04 22:15
29/04 23:10
30/04 00:05
30/04 01:00
30/04 01:55
30/04 02:50
30/04 03:45
30/04 04:40
30/04 05:35
30/04 06:30
30/04 07:25
30/04 08:20
30/04 09:15
30/04 10:10
30/04 11:05
30/04 12:00
30/04 12:55
30/04 13:50
30/04 14:45
30/04 15:40
30/04 16:35
30/04 17:30
30/04 18:25
30/04 19:20
30/04 20:15
30/04 21:10
30/04 22:05
30/04 23:00
30/04 23:55
01/05 00:50
01/05 01:45
01/05 02:40
01/05 03:35
01/05 04:30
01/05 05:25
01/05 06:20
01/05 07:15
01/05 08:10
01/05 09:05
Measurement Time (hh:mm)

Table B1: Short Term Measurement Position ST1

Address	Start Time	Measurement Time	LAeq	LAmax	LA10	LA90
1	01/05/2015 10:15:00	00d 00:05:00.0	56.1	67.1	58.6	52.2
2	01/05/2015 10:20:00	00d 00:05:00.0	56.9	73.4	58.2	50.9
3	01/05/2015 10:25:00	00d 00:05:00.0	55.9	72	58.1	52.7
4	01/05/2015 10:30:00	00d 00:05:00.0	56.2	68.7	58.4	52.4
5	01/05/2015 10:35:00	00d 00:05:00.0	60.9	80	63	54.2
6	01/05/2015 10:40:00	00d 00:05:00.0	59.1	77.7	61.7	54.1

Table B2: Short Term Measurement Position ST2

Address	Start Time	Measurement Time	LAeq	LAmax	LA10	LA90
1	01/05/2015 10:50:00	00d 00:05:00.0	70.6	87.4	73.4	60.9
2	01/05/2015 10:55:00	00d 00:05:00.0	71.1	84.3	74.1	65.2
3	01/05/2015 11:00:00	00d 00:05:00.0	70.7	84.8	73.2	65.5
4	01/05/2015 11:05:00	00d 00:05:00.0	70.5	82.1	73.4	64.4
5	01/05/2015 11:10:00	00d 00:05:00.0	71.3	84.8	74.7	64.1
6	01/05/2015 11:15:00	00d 00:05:00.0	70.4	81.7	73.4	65.3

Appendix C Plant Noise Calculations

Table C1: Level 8 (AHU & Extract Fan Calculations) – (07:00 – 23:00) – No Mitigation

Project:	19 - 21 High Holborn, London												
Job Number:	EED15512-100												
Client:	-												
Originator / Checked / Authorised:	SH												
Date:	17/11/2015												
Issue:	1.0												
		Description	**Octave Mid-Band Frequency (Hz), dB**								**dB**	**dB(A)**	**Comments**
			63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**			
		Galloway 150mm deep Chevron Louvre	-6	-7	-9	-14	-22	-19	-19	-18			*Manu supplied acoustic data. Tel. xxx*
		Galloway 300mm deep Chevron Louvre	-8	-10	-11	-20	-27	-27	-26	-25			*Manu supplied acoustic data. Tel. xxx*
		Single leaf masonary wall	-30	-36	-37	-40	-46	-54	-57	-59			*Woods - Pg 194 - Appendix B*
Level AHU1 (Swegen)		**Description**	**Octave Mid-Band Frequency (Hz), dB**								**dB**	**dB(A)**	**Comments**
Lw Adjusting Figure	0		**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**			
No of Units	1	**AHU 1 (Supply + Exhaust Air), Lw**	76	68	61	65	50	49	46	49	77	64	*Manu supplied acoustic data. Tel. xxx*
Source Distance to NSR (m)	13	**AHU1, Lw at 1m**	76	68	61	65	50	49	46	49			
Line or Point Source Attenuation	20	**Total Units (Conformal Lw)**	76	68	61	65	50	49	46	49			
Roof/Parapet Screening Attenuation	-8	**Hemispherical Radiated SPL @ 1m**	68	60	53	57	42	41	38	41		56	
		Roof/ Parapet Screening Attenuation dB	-8	-8	-8	-8	-8	-8	-8	-8			
		Screen Attenuation	0	0	0	0	0	0	0	0			
		Distance Attenuation (dB)	-23	-23	-23	-23	-23	-23	-23	-23			
		SPL @NSR (dB)	**37**	**29**	**22**	**26**	**11**	**10**	**7**	**10**	**39**		
		SPL @NSR (dBA)	**11**	**13**	**14**	**23**	**11**	**12**	**8**	**9**		**25**	
Level 9 Toilet EF (Nuaire)		**Description**	**Octave Mid-Band Frequency (Hz), dB**								**dB**	**dB(A)**	**Comments**
Lw Adjusting Figure	0		**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**			
No of Condensers	1	**EST19C-X, Lw at 1m**	84	76	70	69	57	49	45	38	85	69	*Manu supplied acoustic data. Tel. xxx*
Source Distance to NSR (m)	16	**EST19C-X, Lw at 1m**	84	76	70	69	57	49	45	38			
Line or Point Source Attenuation	20	**Total Units (Conformal Lw)**	84	76	70	69	57	49	45	38			
Roof/Parapet Screening Attenuation	-15	**Hemispherical Radiated SPL @ 1m**	76	68	62	61	49	41	37	30		61	
		Roof/ Parapet Screening Attenuation dB	-15	-15	-15	-15	-15	-15	-15	-15			
		Screen Attenuation	0	0	0	0	0	0	0	0			
		Distance Attenuation (dB)	-24	-24	-24	-24	-24	-24	-24	-24			
		SPL @NSR (dB)	**37**	**29**	**23**	**22**	**10**	**2**	**-2**	**-9**	**38**		
		SPL @NSR (dBA)	**11**	**13**	**14**	**19**	**10**	**3**	**-1**	**-10**		**21**	

Table C2: Level 8 (AHU & Extract Fan Calculations) – (23:00 – 07:00) – No Mitigation

Project:	19 - 21 High Holborn, London
Job Number:	EED15512-100
Client:	-
Originator / Checked / Authorised:	SH
Date:	17/11/2015
Issue:	1.0

Description	Octave Mid-Band Frequency (Hz), dB								dB	dB(A)	Comments
	63	125	250	500	1k	2k	4k	8k			
Galloway 150mm deep Chevron Louvre	-6	-7	-9	-14	-22	-19	-19	-18			*Manu supplied acoustic data. Tel. xxx*
Galloway 300mm deep Chevron Louvre	-8	-10	-11	-20	-27	-27	-26	-25			*Manu supplied acoustic data. Tel. xxx*
Single leaf masonary wall	-30	-36	-37	-40	-46	-54	-57	-59			*Woods - Pg 194 - Appendix B*

Level AHU1 (Swegen)

Lw Adjusting Figure	0
No of Units	1
Source Distance to NSR (m)	13
Line or Point Source Attenuation	20
Roof Screening Attenuation	-8

Description	Octave Mid-Band Frequency (Hz), dB								dB	dB(A)	Comments
	63	125	250	500	1k	2k	4k	8k			
AHU 1 (Supply + Exhaust Air), Lw	76	68	61	65	50	49	46	49	77	64	*Manu supplied acoustic data. Tel. xxx*
AHU1, Lw at 1m	76	68	61	65	50	49	46	49			
Total Units (Conformal Lw)	76	68	61	65	50	49	46	49			
Hemispherical Radiated SPL @ 1m	68	60	53	57	42	41	38	41		56	
Roof/ Parapet Screening Attenuation dB	-8	-8	-8	-8	-8	-8	-8	-8			
Screen Attenuation	0	0	0	0	0	0	0	0			
Distance Attenuation (dB)	-23	-23	-23	-23	-23	-23	-23	-23			
SPL @NSR (dB)	37	29	22	26	11	10	7	10	39		
SPL @NSR (dBA)	11	13	14	23	11	12	8	9		25	

Level 9 Toilet EF (Nuaire)

Lw Adjusting Figure	0
No of Condensers	1
Source Distance to NSR (m)	16
Line or Point Source Attenuation	20
Roof Screening Attenuation	-15

Description	Octave Mid-Band Frequency (Hz), dB								dB	dB(A)	Comments
	63	125	250	500	1k	2k	4k	8k			
EST19C-X, Lw at 1m	84	76	70	69	57	49	45	38	85	69	*Manu supplied acoustic data. Tel. xxx*
EST19C-X, Lw at 1m	84	76	70	69	57	49	45	38			
Total Units (Conformal Lw)	84	76	70	69	57	49	45	38			
Hemispherical Radiated SPL @ 1m	76	68	62	61	49	41	37	30		61	
Roof/ Parapet Screening Attenuation dB	-15	-15	-15	-15	-15	-15	-15	-15			
Screen Attenuation	0	0	0	0	0	0	0	0			
Distance Attenuation (dB)	-24	-24	-24	-24	-24	-24	-24	-24			
SPL @NSR (dB)	37	29	23	22	10	2	-2	-9	38		
SPL @NSR (dBA)	11	13	14	19	10	3	-1	-10		21	

UK and Ireland Office Locations