Great Ormond Street Hospital Children's Cancer Centre (GOSHCCC)
Noise Impact Assessment

20/05/2022

NHS
Great Ormond Street Hospital for Children
NHS Foundation Trust

RSK Acoustics

Table of Contents

Attachments

Glossary of Acoustic Terms

Appendix A
Proposed Site Layout

Appendix B
Proposed Plant Layout

Appendix C
Measurement Location Photographs

End of Section

Introduction

1 Overview

1.1 RSK Acoustics (RSKA) has been commissioned, to undertake a Noise Impact Assessment in relation to a proposal for the development of a Children's Cancer Centre (CCC) at Great Ormond Street Hospital, London, located within the London Borough of Camden (LBC). This scope of work commissioned to RSKA by ADAS (on behalf of appointed design and build contractor John Sisk & Son (Holdings) Ltd) to inform the planning application.

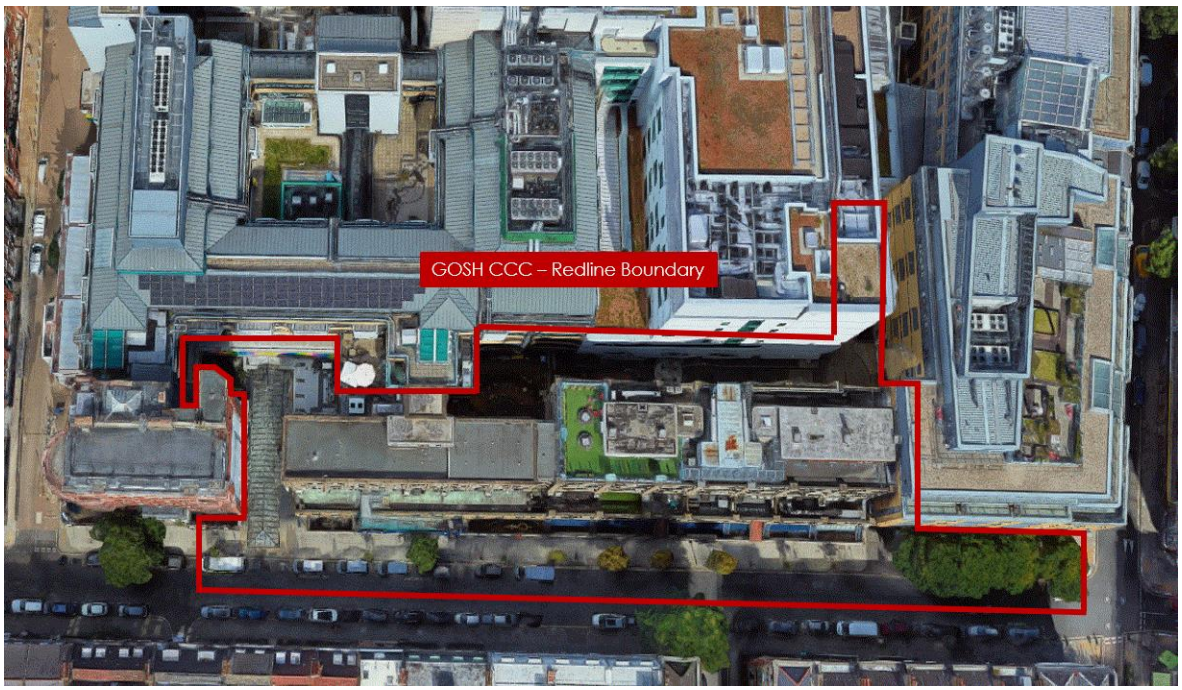


Figure 1.1 – Nearest Noise Sensitive Receptors

1.2 This planning application relates to Phase 4 of the five-phase redevelopment programme for Great Ormond Street Hospital which aims to rebuild two thirds of the hospital over a 20-year period, to upgrade and better meet forecast future healthcare needs. Phase 4 will consist of the redevelopment of the Great Ormond Street Hospital (GOSH) Frontage Building comprising:

"Demolition of the existing building and erection of a replacement 8 storey hospital building (Class C2 Use) together with 2 basement floors, roof top, balcony and ground floor landscaped amenity spaces, cycle storage, refuse storage and other ancillary and associated works pursuant to the development."

1.3 Improving outcomes for cancer is a major priority for the UK and paediatric cancer is assuming increasing importance. The proposed GOSHCCC will create a national resource for children with rare and difficult-to treat cancers. GOSH has a vision for the centre – to create facilities where our expert clinicians can improve outcomes for children through holistic, personalised and coordinated care across the child's entire cancer journey.

1.4 The majority of the site is currently occupied by the existing GOSH Frontage Building, a five-storey building (inclusive of basement) dating from the 1950s that was constructed in two separate phases. The building is currently occupied by a number of GOSH departments including Audiology Department, Clinical Research Facility (CRF), Department of Child and Adolescent Mental Health and Paediatric Psychology Department.

1.5 The western most part of the site is occupied by the main GOSH Entrance providing connections to the wider GOSH island site and by a small rear element (external staircase) of the Paul O'Gorman Building that will be demolished to facilitate the proposed development.

1.6 The site is bounded by the Paul O'Gorman Building to the west, Octav Botnar Wing to the east, the Variety Club Building and Premier Inn Clinical Building to the north and Great Ormond Street to the south.

1.7 The assessment focuses on the effects of operational noise from external fixed plant items, specifically the impact of those on the prevailing background noise level at the nearest noise sensitive receptors (NSRs). These comprise the existing hospital which includes bedrooms and residential properties along the south side of Great Ormond Street.

1.8 The method and results of the assessment are provided, as well as a summary of the applicable guidance and legislation. Based on the assumptions made and the instructions from the relevant standards, the resultant plant noise limits are presented, and indicative façade sound insulation requirements provided.

1.9 Appendix A illustrates the site and proposed layout drawings provided by SISK.

2 Objectives

2.1 This noise impact assessment has been prepared on behalf of the Applicant, Great Ormond Street Hospital for Children NHS Foundation Trust (referred to hereafter as the 'Applicant') in collaboration with the appointed design and build contractor John Sisk & Son (Holdings) Ltd (referred to hereafter as Sisk) to support an application to the London Borough of Camden (LBC) for full planning permission for the redevelopment of the Great Ormond Street Hospital (GOSH) Frontage Building and Entrance on Great Ormond Street WC1N 3JH X (referred to hereafter as the 'site'), to provide a new Children's Cancer Centre (CCC).

2.2 The aim of this noise impact assessment is to:

a. Quantify the existing acoustic environment at nearby Noise Sensitive Receptors (NSRs);

b. Predict noise contributions from the operational development of the new fixed plant items and report on any increases at the nearest NSRs; and

c. Where required, suggest any appropriate mitigation measures to source equipment to reduce the potential for disturbance at the nearest NSRs.

3 British Standard 4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

3.1 BS 4142 describes the methods for rating and assessing noise from industrial or commercial sources, including energy projects. The standard is applicable to the assessment of sound affecting residential receptors, through the determination of a specific level of an industrial or commercial noise source.

3.2 Where certain acoustic features are present at the assessment location, a character correction should be applied to the specific sound level to give the rating level to be used in the assessment. Acoustic features can include tones, impulsivity, intermittency, or a type of noise that is distinct from the existing noise environment.

3.3 The assessment of the impact from a commercial or industrial sound can be carried out as follows:

- A difference of around +10 dB or more, between the rating and background noise levels, is likely to be an indication of a significant adverse impact, depending on the context;
- A difference of around +5 dB is likely to be an indication of adverse impact depending on the context; and
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact depending on the context.

3.4 As indicated above, the significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. BS 4142 states than 'an effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context'.

3.5 Where the initial estimate of the impact needs to be modified due to the context, the standard recognises that aspects such as the absolute level of sound or the character and level of the residual sound compared to the character and level of the specific sound shall be considered.

4 British Standard 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'

4.1 BS 8233 establishes internal ambient noise levels for dwellings based upon occupancy patterns which are derived from World Health Organisation (WHO) guidelines for community noise. These are summarised in Table 4.1 below:

Activity	Location	0700h – 2300h	2300h – 0700h
Resting	Living room	35 dB $L_{Aeq,16h}$	---
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	---
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

Table 4.1 – Summary of Internal Ambient Noise Level Criteria for Dwellings

4.2 BS 8233 also summarises the typical noise levels in non-domestic buildings as shown in Table 4.2 below:

Activity	Location	Design range dB $L_{Aeq,T}$
Speech or telephone communications	Department store, cafeteria, canteen, kitchen	50 – 55
	Concourse, corridor, circulation space	45 – 55
Study and work requiring concentration	Library, gallery, museum	40 – 50
	Staff/meeting room, training room	35 – 45
	Executive office	35 – 45
Listening	Place of worship, counselling, meditation, relaxation	30 – 35

Table 4.2 – Summary of Typical Noise Levels in Non-domestic Buildings

5 WHO Environmental Noise Guidelines for the European Region (2018)

5.1 Noise is an important public health issue. It has negative impacts on human health and well-being and is a growing concern. The WHO Regional Office for Europe has developed guidelines, based on the growing understanding of these health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various

sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of noise. The guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

6 British Standard 7445-1, -2, -3 'Description and Measurement of Environmental Noise. Guide to Quantities and Procedures'

6.1 The three-part standard BS 7445 provides the framework within which environmental noise should be quantified. Part 1 (2003) provides a guide to quantities and procedures and Part 2 (1991) provides a guide to the acquisition of data pertinent to land use. Part 3 (1991) provides a guide to the application of noise limits.

6.2 BS 7445 also refers to a further standard, BS EN 61672, which prescribes the equipment necessary for such measurements. Whilst BS 7445 does not prescribe the meteorological conditions under which noise measurements should or should not be taken, it does (part 2, paragraph 5.4.3.3) recommend that in order:

"…to facilitate the comparison of results (measurements of noise from different sources), it may be necessary to carry out measurements under selected meteorological conditions which are reproducible and correspond to quite stable propagation conditions."

6.3 These conditions include:

- Wind speed not exceeding 5 m/s (measured at a height of 3 to 11 m above the ground)
- No strong temperature inversions near the ground
- No heavy precipitation.

7 International Standard ISO 9613-2: 1996

7.1 International Standard: ISO 9613-2: 1996(E): "Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation" enables the prediction of noise levels in the community from sources of known sound emission.

The noise prediction method described in this part of the standard is general and is suitable for a wide range of engineering applications where the noise level outdoors is of interest. The noise source(s) may be moving or stationary and the method considers the following major mechanisms of noise attenuation:

- Geometrical divergence (also known as distance loss or geometric damping)
- Atmospheric absorption
- Ground effect
- Reflection from surfaces
- Screening by obstacles.

7.2 The method predicts noise levels under metrological conditions favourable to noise propagation from the sound source to the receptor, such as downwind propagation, or equivalently, propagation under a moderate ground-based temperature inversion as commonly occurs at night.

8 The London Plan (March 2021)

Noise

8.1 Policy D14 states:

"In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development proposals should manage noise by 1) avoiding significant adverse noise impacts on health and quality of life

2) reflecting the Agent of Change principle as set out in Policy D13 Agent of Change

3) mitigating and minimising the existing and potential adverse impacts of noise on, from, within, as a result of, or in the vicinity of new development without placing unreasonable restrictions on existing noise-generating uses

4) improving and enhancing the acoustic environment and promoting appropriate soundscapes

5) separating new noise-sensitive development from major noise sources (such as road, rail, air transport and some types of industrial use) through the use of distance, screening, layout, orientation, uses and materials – in preference to sole reliance on sound insulation

6) where it is not possible to achieve separation of noise-sensitive development and noise sources without undue impact on other sustainable development objectives, then any potential adverse effects should be controlled and mitigated through applying good acoustic design principles

7) promoting new technologies and improved practices to reduce noise at source, and on the transmission path from source to receiver.

Boroughs, and others with relevant responsibilities, should identify and nominate new Quiet Areas and protect existing Quiet Areas."

9 Camden Local Plan 2017

Policy A4 Noise and vibration

9.1 Policy A4 states:

"The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

a. development likely to generate unacceptable noise and vibration impacts; or

b. development sensitive to noise in locations which experience high levels of noise unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity.

We will also seek to minimise the impact on local amenity from deliveries and from the demolition and construction phases of development."

Plant and other noise generating equipment

9.2 Paragraphs 6.99 to 6.101 state:

"Planning conditions will be imposed to require that plant and equipment which may be a source of noise is kept working efficiently and within the required noise limits and time restrictions. Air conditioning will only be permitted where it is demonstrated that there is a clear need for it after other measures have been considered (Policy CC2 Adapting to climate change). Conditions may also be imposed to ensure that attenuation measures are kept in place and are effective throughout the life of the development.

Emergency equipment such as generators which are only to be used for short periods of time will be required to meet the noise criteria of no more than 10dB above the background level (L90 15 minutes). During standby periods, emergency equipment will be required to meet the usual criteria for plant and machinery. Conditions to this effect may be imposed in instances where emergency equipment forms part of the application.

Security alarms cause significant disruption to local amenity and wellbeing. Whilst security alarms would generally not require planning permission, we would strongly encourage developers and householders to install silent alarms or alarms with a maximum of a 20-minute cut out."

10 Camden Planning Guidance: Amenity (January 2021)

Noise and vibration thresholds

10.1 Paragraph 6.8 states:

"When assessing acoustic reports, the Council will consider the reported measurements against the noise thresholds set out in Appendix 3 of the Local Plan. The thresholds are expressed as 'effect levels', which sets out a hierarchy of expected changes in behaviour and impact on health and wellbeing in response to increasing noise levels (measured in decibels - dB). The 'effect levels' are summarised below and explained in detail in National Planning Practice Guidance (NPPG). The table detailing each 'effect level' from NPPG is also set out in Appendix 1 to this guidance for ease of reference.

- *No observed effect level (NOEL) – the level below which no effect can be detected on health and quality of life.*
- *Lowest observable adverse effect level (LOAEL) – the level above which changes in behaviour (e.g., closing windows for periods of the day) and adverse effects on health (e.g. sleep disturbance) and quality of life can be detected.*
- *Significant observed adverse effect level (SOAEL) – the level above which adverse effects on health and quality of life occur. This could include psychological stress, regular sleep deprivation and loss of appetite."*

Plant and other noise generating equipment

10.2 Paragraphs 6.27 to 6.29 state:

"Developments proposing plant, ventilation, air extraction or conditioning equipment and flues will need to provide the system's technical specifications to the Council accompanying any acoustic report. 'BS4142 Method for rating Industrial and Commercial Sound' contains guidance and standards which should also be considered within the acoustic report.

There are however likely to be instances where the Council will consider that a BS4142 assessment alone is not sufficient to provide all the information necessary. Plant such as electrical substations for example, may meet BS4142 standards, but are also known to emit low frequency noise, which also needs to be considered. Developers are therefore encouraged to discuss proposals of this nature with the Council's Noise team before preparing their acoustic report - Email: RegulatoryServices@camden.gov.uk.

Plant, ventilation, air extraction or conditioning equipment and flues can cause disturbance to residential properties. The Council would therefore welcome the use of long-term maintenance agreements to ensure that equipment maintains acceptable noise levels over its lifetime and the use of timers to limit any unnecessary operation of the equipment."

Development Location

11 Existing Site and Surroundings

11.1 The proposed site is located on land occupied by the existing Great Ormond Street Hospital Frontage Building. The surrounding land use is predominantly a mix of residential and commercial uses with an interconnecting urban road network.

11.2 The site and surrounding area are largely flat with no significant elevation change. The dominant noise source is road traffic on Great Ormond Street with additional noise from the surrounding road network and occasional vehicular emergency sirens associated with hospital operations.

11.3 The nearest noise sensitive receptors (NSRs) are situated to the north of the Frontage Building (The Variety Club Building VCB which include occupation by hospital beds) and along Great Ormond Street, to the south of GOSH (residential and commercial properties).

11.4 The nearest NSRs identified for assessment purposes are considered those at the closest distance to the development site. As a row of residential properties exists along Great Ormond Street, the nearest property to the development site within that row has been adopted for any calculations for distance to the plant items. In addition, the closest hospital bedroom to the application site has also been assessment (located within the Variety Club Building).

Baseline Noise Survey

12 Survey Measurement Details

12.1 To establish the existing baseline noise environment representative of the nearest NSRs and to determine future operational noise impacts, RSKA has undertaken an unattended baseline noise survey at two locations considered representative of the nearest NSRs to the development site. The survey was undertaken in accordance with the relevant British Standards and guidance.

12.2 The baseline noise survey was conducted over a five-day period between 20 August 2021 in and 25 August 2021 in order to quantify the existing noise levels throughout daytime and night-time periods. Monitoring locations and their rationale are outlined below:

- UL1 – sound level meter positioned on a flat roof of one of the buildings at GOSH at 3rd floor level (approx.).
- UL2 – sound level meter positioned on the flat roof of the Frontage Building at GOSH at 4th floor level (approx.).

12.3 A map of the baseline noise monitoring locations is shown in Figure 12.1 and site photographs of the sound level meters in position are shown in Appendix B:

Figure 12.1 – Baseline monitoring locations

13 Survey Observations

13.1 Subjective audible observations during the daytime installation and demobilisation of the unattended noise equipment were noted:

- Pedestrians – voices
- Visitors to hospital – voices / children shouting
- Ambulance and Taxi drop off and collection - engines / door slams / voices
- Hospital staff with trolleys / deliveries
- Road traffic – dominant
- Vehicle horns / reversing beacons / emergency sirens (occasionally and throughout)
- Various plant items audible but not dominant
- Aeroplanes and helicopters passing overhead.

14 Survey Equipment

14.1 Noise monitoring was undertaken using the following equipment, detailed in Table 14.1:

Equipment	Type	Serial Number	Calibration date
Class 1 sound level meter	Rion NL-52	01043374	19 April 2021
Class 1 sound level meter	Rion NL-52	00197783	19 April 2021
Acoustic calibrator	Rion NC-74	34425552	06 June 2021

Table 14.1 – Monitoring equipment

14.2 All measurements were undertaken with the microphone positioned away from reflecting surfaces and at a height of 1.5 m above the ground to the requirements of BS 7445.

14.3 The calibration of each sound level meter was checked before and after the measurements, using the acoustic calibrator at 94 dB at 1 kHz; no significant calibration drift was noted (+/- 0.3 dB).

14.4 The sound level meters used conform to the Class 1 requirements of BS EN 61672-1: 2013 *'Electroacoustics. Sound level meter, Specifications'*. The calibrator used conforms to the

requirements of BS EN 60942: 2003 *'Electroacoustics, Sound calibrators'*. The equipment used has a calibration history that is traceable to a certified calibration institution.

15 Weather Conditions

15.1 Weather conditions during the unattended measurement period were obtained from Wunderground (www.wunderground.com), using the weather station closest to the measuring locations (with available historical data), which was judged to be at London City airport (EGLC). This weather data is summarised in Table 15.1; conditions were considered conducive to environmental noise monitoring.

Date	Temperature High (ºC)	Temperature Low (ºC)	Wind Speed High (ms)	Wind direction	Accumulated precipitation (mm)
20.08.21	21	15	5	W	0.0
21.08.21	21	16	4	E	0.0
22.08.21	21	16	6	W	0.0
23.08.21	21	14	4	N	0.0
24.08.21	22	13	7	E	0.0
25.08.21	22	14	6	N	0.0

Table 15.1 – Summarised weather data during monitoring period

16 Long Term Measurements

16.1 The baseline noise survey was conducted over a five-day period between 20 and 25 August 2021 to quantify the existing noise levels throughout daytime and night-time periods.

16.2 Analysis of the dataset accounting for the 16-hour daytime period (07:00 – 23:00) and 8-hour night-time period (23:00 – 07:00) is provided to quantify the noise fluctuations at those positions during a representative period.

16.3 A summary of the measured noise levels at position UL1 and UL2 are presented in Table 16.1 and Table 16.2.

		Measured Noise Levels [b]			
Date	**Time period (T)**	**Average $L_{Aeq,T}$ dB**	**$L_{AFmax,T}$ dB**	**Average $L_{A90,T}$ dB**	**Average $L_{A10,T}$ dB**
20.08.21 [a]	14:00 – 23:00	58	81	57	59
20.08.21	23:00 – 07:00	58	66	57	58
21.08.21	07:00 – 23:00	60	81	57	59
21.08.21	23:00 – 07:00	58	72	57	59
22.08.21	07:00 – 23:00	59	77	58	59
22.08.21	23:00 – 07:00	57	64	57	58
23.08.21	07:00 – 23:00	59	89	57	60
23.08.21	23:00 – 07:00	57	62	57	58
24.08.21	07:00 – 23:00	59	75	57	59
24.08.21	23:00 – 07:00	57	72	56	58

(a) Measurements not taken throughout full 16hr period
(b) $L_{Aeq,T}$ values are the logarithmic average of $L_{Aeq,15min}$ samples, and the $L_{A10,T}$ and $L_{A90,T}$ are the arithmetic average of the $L_{A10,15min}$ and $L_{A90,15min}$ samples

Table 16.1 – Noise measurement results – UL1

		Measured Noise Levels [b]			
Date	**Time period (T)**	**Average $L_{Aeq,T\ dB}$**	**$L_{AFmax,T\ dB}$**	**Average $L_{A90,T\ dB}$**	**Average $L_{A10,T\ dB}$**
20.08.21 [a]	15:00 – 23:00	55	82	53	57
20.08.21	23:00 – 07:00	53	76	52	54
21.08.21	07:00 – 23:00	58	81	53	57
21.08.21	23:00 – 07:00	54	75	52	54
22.08.21	07:00 – 23:00	55	82	53	57
22.08.21	23:00 – 07:00	54	82	52	54
23.08.21	07:00 – 23:00	59	96	54	60
23.08.21	23:00 – 07:00	54	79	52	54
24.08.21	07:00 – 23:00	58	86	54	59
24.08.21	23:00 – 07:00	54	79	52	54

(a) Measurements not taken throughout full 16hr period
(b) $L_{Aeq,T}$ values are the logarithmic average of $L_{Aeq,15min}$ samples, and the $L_{A10,T}$ and $L_{A90,T}$ are the arithmetic average of the $L_{A10,15min}$ and $L_{A90,15min}$ samples

Table 16.2 – Noise measurement results – UL2

17 Measurement Summary

17.1 The representative background noise levels are presented below, derived from the arithmetic average of the $L_{AF90,15mins}$ measurements at each location. The presented background noise levels refer to daytime and night-time levels as they correspond to the potential operational times of the proposed development.

a. Measurement location UL1 – Daytime 57 dB $L_{AF90,1hr.}$; Night-time 57 dB $L_{AF90,15mins}$.

b. Measurement location UL2 – Daytime 53 dB $L_{AF90,1hr.}$; Night-time 52 dB $L_{AF90,15mins}$.

18 Fixed Plant Noise

18.1 In accordance with the methodology contained within BS 4142, limiting rating noise levels (L_{Ar}) at the surrounding noise sensitive premises have been provided based upon the measured noise levels from the baseline survey.

Assumptions

18.2 The assessment is based on certain assumptions regarding the plant to be installed. It is assumed that:

a. The ground between the source and the receivers is acoustically hard;

b. The worst-case distance from the source (plant item/termination) to the receptor is taken, i.e., from the closest edge of the roof of each building;

c. The source height is taken to be 1 meter above the roof level, i.e., no screening is applied between source and receptor;

d. There are two reflective planes close to the source, giving a realistic worst-case source directivity correction (the plant room is considered to be a fully enclosed room and the plant deck enclosure is considered to be enclosed on four sides);

e. The plant noise will contain none of the characteristic features described in Section 3, i.e., receiving no penalties;

f. Plant will operate during both the daytime and night-time periods.

Assessment basis

18.3 Following the assumptions made in Section 18.2 the calculations used to determine the required limiting sound power levels at the nearby noise sensitive receptors were carried out in general accordance with ISO 9613-2: 1996 and include the following factors:

a. Source directivity

b. Distance correction

c. Screening correction (if applicable)

d. Façade reflection correction.

18.4 Details regarding the building heights and horizontal distances were taken from the drawings shown in Appendix A.

Project Criteria

19 Plant Noise Criteria

19.1 Based on the relevant legislation and guidance and the results of the noise survey, as well as the guidelines provided by BS 4142, the plant noise criteria for the nearby noise sensitive receptors are presented in Table 19.1.

19.2 The assessment of the impact from the fixed plant has been carried out using the criterion in BS 4142 where the rating level does not exceed the background sound level. This provides an indication of the specific sound source having a low impact and has been used to provide a robust assessment of any proposed fixed plant items.

19.3 Criteria are provided for daytime and night-time. Night-time reflects the worst case. The background noise level from monitoring position UL2 has been used as representative for the NSRs on the south side of Great Ormond Street.

	Daytime dB L_{Ar}	**Night-time dB L_{Ar}**
Limit for plant	53	52

Table 19.1 – Plant noise level criteria

19.4 Depending on the noise characteristics of the plant such as prominent tones or impulsive sounds, penalties should be applied according to BS 4142. For prominent tones, the penalty ranges from 0 to +6 dB while for impulsive sounds, the penalty ranges from 0 to 9 dB.

20 Uncertainty

20.1 Uncertainty has been limited where possible through the monitoring methodology and conservative assessment approach. It is considered unlikely that the uncertainty would adversely impact the assessment outcomes.

20.2 The following measures have been taken to reduce uncertainty:

- Use of monitoring equipment in accordance with section 5 of BS 4142: 2014+A1: 2019, using Class 1 instrumentation;

- Measurement procedures followed in accordance with section 6 of BS 4142: 2014+A1: 2019 with all precautions taken to minimise interference;

- Undertaking measurements over representative midweek day, night and weekend day and night-time periods to quantity the background noise environment across all weekly time periods;

- Specific sound levels have been calculated to the requirements of ISO 9613-2:1996 which is the widely accepted procedure for the calculation of sound propagation, including favourable wind conditions from source to receiver;

- Understanding the characterisation and the complexity of the sound source and the level of variability in sound emissions from the source by assessing different operational scenarios; and

- Checking the implementation of all calculation methods for errors.

21 Fixed Plant Noise

Apportioned plant noise limits

21.1 The plant at basement and roof level has been assessed based on an assumed reverberant sound pressure level of L_{Aeq} 85 dB within the plant room (resulting in a relatively low predicted external noise contribution through the plant room structural envelope). On this basis, the total overall plant noise limit has been apportioned to external plant, with noise from the plant room limited to the total noise limit -10 dB, i.e., effectively negligible.

21.2 The following apportioned fixed plant noise limits are proposed at the NSRs on the south side of Great Ormond Street:

		Limiting rating noise level at receptor, L_{ArT} (dB)	
Source	**Receiver**	**Day**	**Night**
Level 00 Plant room	Properties on south side of Great Ormond Street	43	42
Level 09 External plant		53	52

Table 21.1 – Proposed plant noise limits at receptors - apportioned

Fixed plant noise

21.3 Following the general assumptions made in Section 18 and specific points above, calculations have been carried out to assess the limiting source sound power levels such that the proposed noise limits at the nearby noise sensitive receptors are likely to be met.

21.4 The following criteria, shown in Table 21.2 overleaf, have been used to calculate the plant noise impact at the nearest NSRs on the south side of Great Ormond Street.

	NSRs on south side of Great Ormond Street	
	Plant room	**External plant**
Source L_w (day)	75	89
Source L_w (night)	75	88
Distance to receptor (m)	25	30
Distance attenuation (dB)	-31	-32
Screening losses (dB)	0	0
Source directivity (Q)	4	4
Source directivity correction (dB)	6	6
Façade reflection correction (dB)	0	0
SPL per plant group (dB) (day)	39	52
Limiting specific sound pressure level at receptor (dB)	43	53
SPL per plant group (dB) (night)	39	51
Limiting specific sound pressure level at receptor (dB)	42	52

Table 21.2 – Proposed plant noise – assessment criteria

21.5 Based on the above criteria, the resultant plant noise limits are provided in Table 21.3 below:

	Source noise limit, L_w (dB)	
Item	**Day (07:00 – 23:00)**	**Night (23:00 – 07:00)**
Externally located plant[1]	89	88
Plant room radiated via southern facade (Total L_w of plant within plant room)	75 (103)	75 (103)

1 For externally located plant, the limit is provided for all plant items combined. In order to determine indicative limits for single items of plant, the following formula should be used:

L_W single = L_W total + 10logn

Where L_W single is the limiting source sound power level for a single item, L_W total is the limiting source sound power level for all items from Table 18.3, and n is the total number of plant items.

Table 21.3 – Limiting source noise levels for plant

22 Plant Information

22.1 BDP Acoustics has provided RSKA with a memorandum titled 'GOSH PHASE 4B: SUMMARY OF 3D ACOUSTIC NOISE MODELLING' (document ref. GOSHCCC-BDP-XX-XX-CO-YA-0008, dated 11 May 2022). The document provides a summary of the 3D acoustic noise modelling process that has been undertaken in order to review and provide advice for external plant noise emissions associated with the new GOSHCCC.

22.2 Appendix B illustrates the proposed plant layout for the Level 00 and Level 09 plant rooms, as detailed in the above document.

Level 00 Plant Room

22.3 From information provided by BDP Acoustics, it has been determined that the following plant items will be operational within the Level 00 plant room:

- 12 no. air handling units (AHUs)
    - Maximum predicted sound pressure level (SPL) @ 1 m from the development façade radiating from the plant room façade / plenum = 40 dB(A)
    - Maximum predicted SPL @ 1 m radiating from the exhaust lightwell = 60 dB (A)
    - Maximum predicted SPL @ 1 m radiating from the Level 04 Supply Intake Louvre = 51 dB (A)
- Total contribution from any additional extract fans not shown on the drawing in Appendix B should be limited to 33 dB(A) SPL, as measured @ 1 m from the façade of the nearest noise sensitive receptors Individual limits at these plant terminals will be provided once the number/location of units is known.

Level 09 Plant Room

22.4 From information provided by BDP Acoustics, it has been determined that the following plant items will be operational within the Level 09 plant room:

- 2 no. IT DACs
    - Maximum predicted SPL from each individual IT DAC @ 1 m = 54 dB(A)
- 3 no. chillers plus attenuation packs
    - Max Sound Power Level (SWL) for each of the 3 x chillers plus attenuation packs:

- 2 x 87 dB(A), 1 x 85 dB(A)
- (Assuming total unit heights plus attenuation: 3.4m)
- Limits are based on current Aermec selections plus Allaway 203 attenuation packages
- Total unit heights are limited to a level 200 mm below the top of the roof garden barrier (i.e., unit heights limited to 1.8m above L10)

- 11 no. AHUs ducted to the north façade
  - Maximum predicted SPL from each individual AHU intake terminal @ 1 m = 45 dB(A)
  - Maximum predicted SPL @ 1 m from plant room north façade via plant room façade radiation = 27 dB(A)
- 11 no. AHUs ducted to the south façade
  - Maximum predicted SPL from each individual AHU intake terminal @ 1 m = 52 dB(A)
  - Maximum predicted SPL @ 1 m from plant room south façade via plant room façade radiation = 38 dB(A)
- 3 no. emergency back-up generators
  - The 3 x emergency generators have not been included within the modelling process, as it has been agreed by BDP Acoustics that noise emissions associated with these units are to achieve a separate criterion set 10dB above the existing measured background noise level.
  - The generators are therefore required to achieve a cumulative noise emissions limit of 63 dB(A) as measured at the nearest NSRs during the daytime, when testing would be expected to occur. In order to achieve this, a limit of 65 dB(A) SPL has been set at 1 m from each individual generator component terminal for each individual generator, which would allow the separate emergency plant criteria to be met.
- Total contribution from any additional extract fans not shown on the drawing in Appendix B should be limited to 33 dB(A) SPL, as measured @ 1 m from the façade of the nearest noise sensitive receptors Individual limits at these plant terminals will be provided once the number/location of units is known.
- Solid high-mass continuous barrier to be installed to the north of the chiller compound, extending to a height of 3m above the Level 09 mezzanine chiller

compound level. Barrier is advised to be lined with Class A absorptive material on the chiller-facing side.

- Solid high-mass continuous barrier to be installed to the south, east and west of the chiller compound, extending to a height of 2m above the Level 10 roof garden level. Barrier is advised to be lined with Class A absorptive material on the chiller-facing side to reduce reflections back to existing hospital façades.

22.5 It is considered that the strategy proposed by BDP Acoustics will be acceptable in meeting the external noise emissions limits at nearby residential receptors that are imposed as planning conditions by LBC which seek plant noise to be 5 dB below background noise levels.

Conclusions

23 Recommendations

23.1 RSKA was commissioned, to undertake a plant noise assessment in relation to a proposal for the development of a Children's Cancer Centre (CCC) at Great Ormond Street Hospital, London, located within the London Borough of Camden (LBC). This scope of work commissioned to RSKA by ADAS was to inform the planning application for the proposal. As part of this, RSKA has carried out an assessment of plant noise limits.

23.2 Limiting noise levels for plant have been provided in terms of source sound power level, with provision for multiple plant items provided.

23.3 It is considered that, if the recommendations contained within this report regarding plant noise level limits are achievable, the development would be suitable with its current layout and location.

23.4 BDP Acoustics has provided RSKA with a document that provides a summary of the 3D acoustic noise modelling process that has been undertaken in order to review and provide advice for external plant noise emissions associated with the new CCC.

23.5 It is considered that the strategy proposed by BDP Acoustics will be acceptable in meeting the external noise emissions limits at nearby residential receptors imposed by planning conditions.

End of Section

Glossary of Acoustic Terms

Lp - Sound Pressure Level

The basic unit of sound measurement is the sound pressure level, which is measured on a logarithmic scale and expressed in decibels (dB). The logarithmic scale makes it easier to manage the large range of audible sound pressures, and also more closely represents the way the human ear responds to differences in sound pressure:

Lp = 20 log10 (p/po)

where p = RMS (root mean square) sound pressure; and

p0 = reference sound pressure 2 x 10-5 Pa.

Frequency Weighting Networks

Frequency weighting networks, which are generally built into sound level meters, attenuate the signal at some frequencies and amplify it at others. The A-weighting network approximately corresponds to human frequency response to sound. Sound levels measured with the A-weighting network are expressed in dB(A). Other weighting networks also exist, such as C-weighting which is nearly linear (i.e. unweighted) and other more specialised weighting networks. Variables such as Lp and Leq that can be measured using such weightings are expressed as LpA / LpC, LAeq / LCeq etc.

Time Weighting

Sound level meters use various averaging times for the measurement of RMS sound pressure level. The most commonly used are fast (0.125 s averaging time), slow (1 s averaging time) and impulse (0.035 s averaging time). Variables that are measures with time weightings are expressed as LAFmax etc.

LAeq – Equivalent Continuous Sound Pressure Level

Sound levels tend to fluctuate, and as such an 'instantaneous' measurement like sound pressure level cannot fully describe many real-world situations. A summation can be made of the measured sound energy over a certain period, and a notional steady level can be calculated which would contain the same total energy as the fluctuating sound. This notional level is termed the equivalent continuous sound level Leq. Leq can be determined over any time period, which is indicated as Leq,T where T is the time period (e.g. Leq,24h).

Lmax - Maximum Sound Pressure Level or Maximum Noise Level

This is the maximum RMS sound pressure level occurring within a specified period. The time weighting is usually specified, such as in LFmax.

Ln - Percentile or Statistical Levels

It is useful to calculate the level which is exceeded for a certain percent of a total period. Background noise is often defined as the A-weighted sound pressure level exceeded for 90% of the specified period T, expressed L90,T. Road traffic noise is often characterised in terms of LA10

La - Ambient Sound Level

Ambient sound level as defined in Section 3 of BS 4142:2014 is the equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time. The ambient sound level comprises the residual sound level and the specific sound.

Lr – Residual Sound Level

Residual sound level as defined in Section 3 of BS 4142:2014 is the equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval

LS – Specific Sound Level

Specific sound level is the equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval.

LAr,Tr – Rating Level

Specific sound level plus any adjustment for the characteristic features of the sound (impulsivity, tonality, intermittency), as defined in BS 4142:2014.

Tr - Reference Time Interval

The specified interval over which the specific sound level is determined.

End of Section

Appendix A: Proposed Site Layout

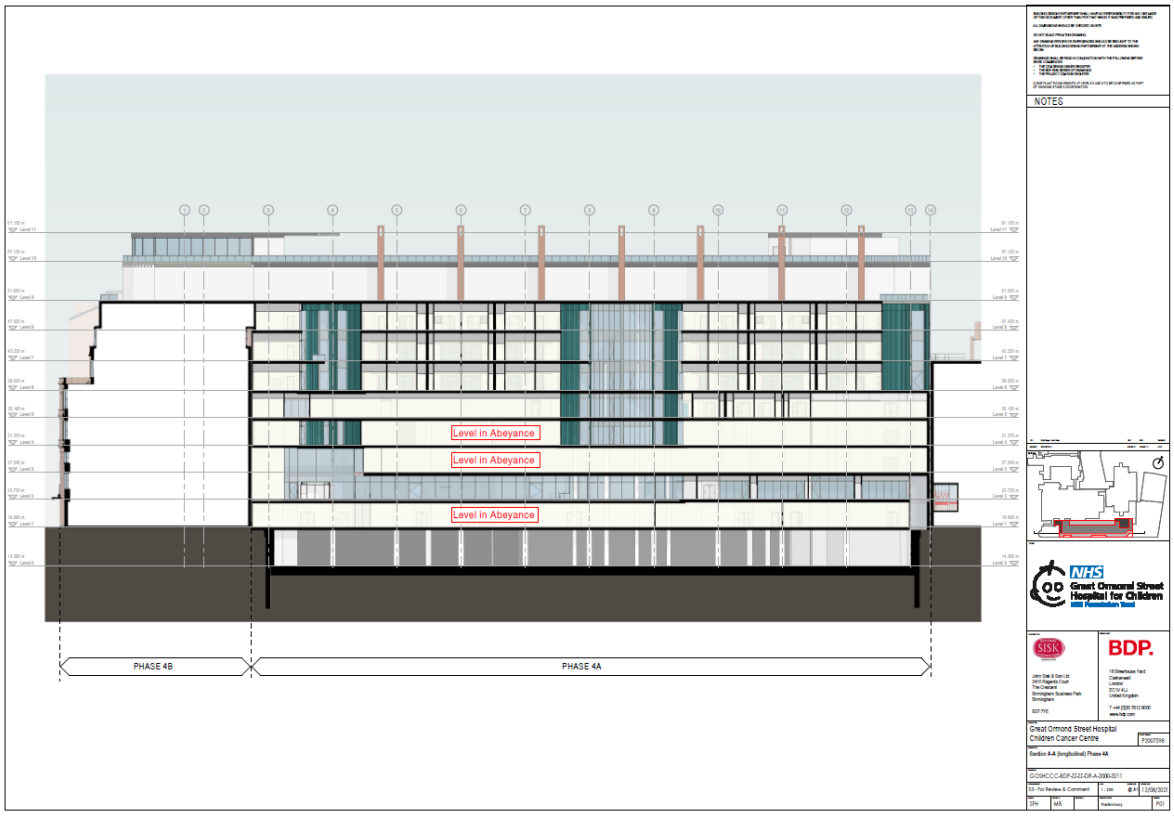


Figure A.1 – Proposed site layout – Section A-A (longitudinal) Phase 4A (drawing GOSHCCC-BDP-ZZ-ZZ-DR-A-2000-3211)

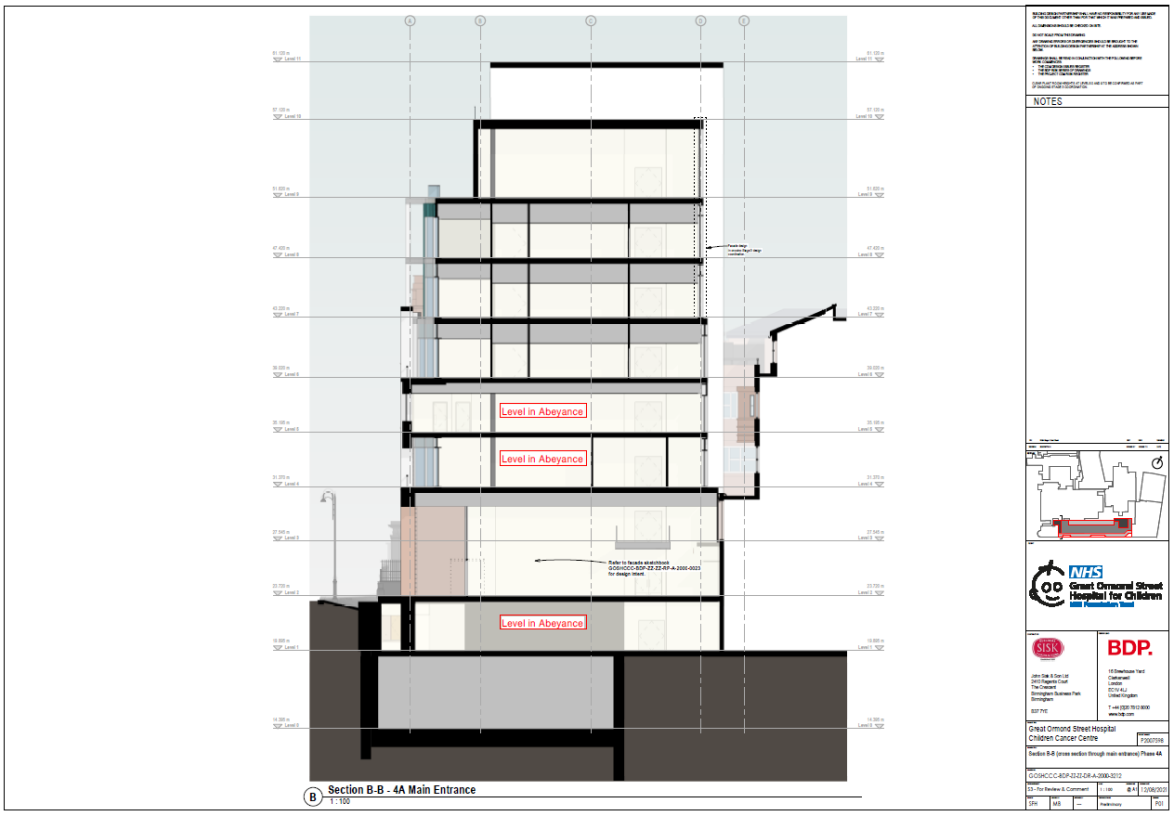


Figure A.2 – Proposed site layout – Section B-B (cross section through main entrance) Phase 4A (drawing GOSHCCC-BDP-ZZ-ZZ-DR-A-2000-3212)

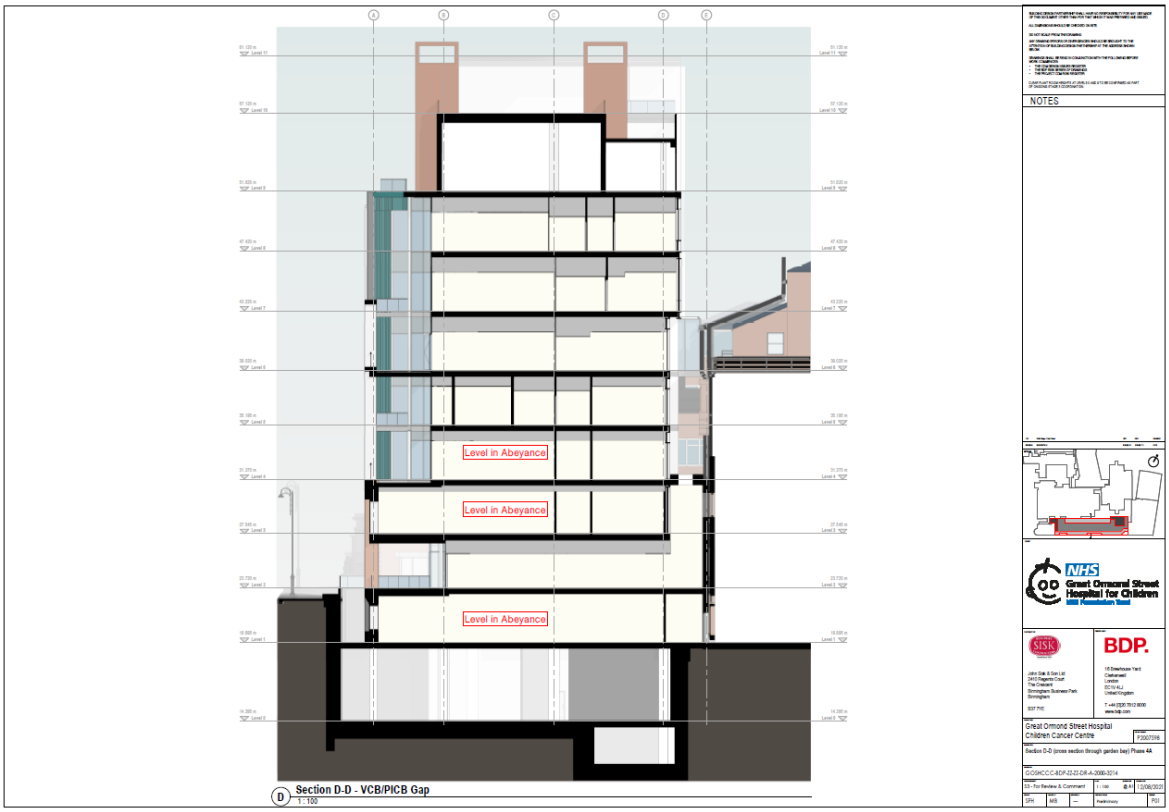


Figure A.3 – Proposed site layout – Section D-D (cross section through garden bay) Phase 4A (drawing GOSHCCC-BDP-ZZ-ZZ-DR-A-2000-3214)

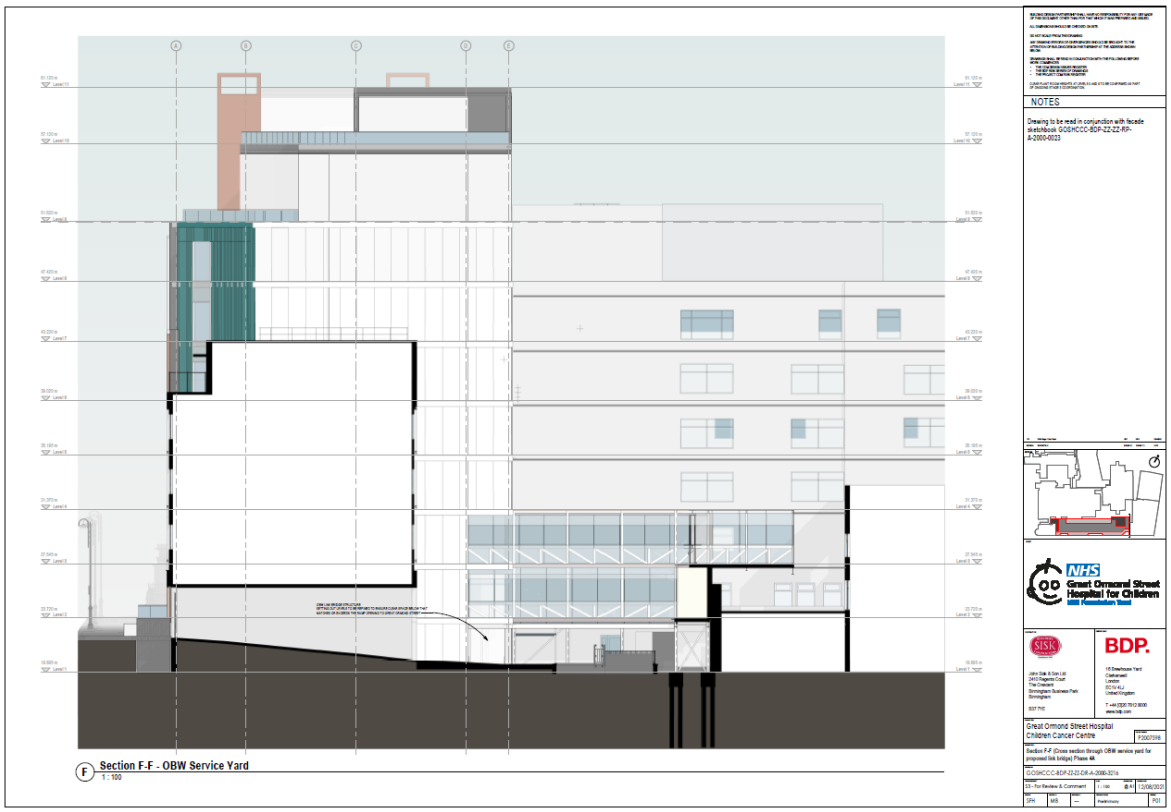


Figure A.4 – Proposed site layout – Section F-F (Cross section through OBW service yard for proposed link bridge) Phase 4A (drawing GOSHCCC-BDP-ZZ-ZZ-DR-A-2000-3216)

Appendix B: Proposed Plant Layout

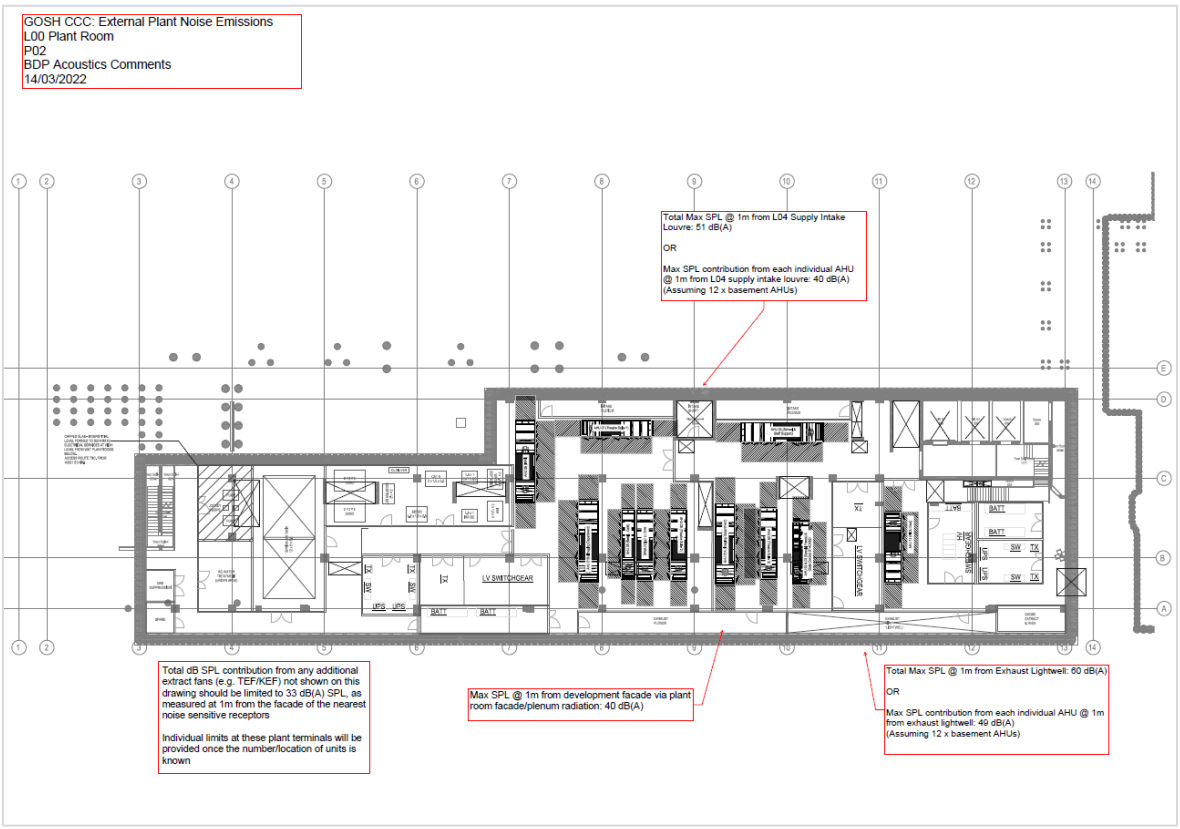


Figure B.1 – Proposed plant layout – GOSH CCC: External Plant Noise Emissions – L00 Plant Room (drawing provided by BDP Acoustics dated 14/03/2022)

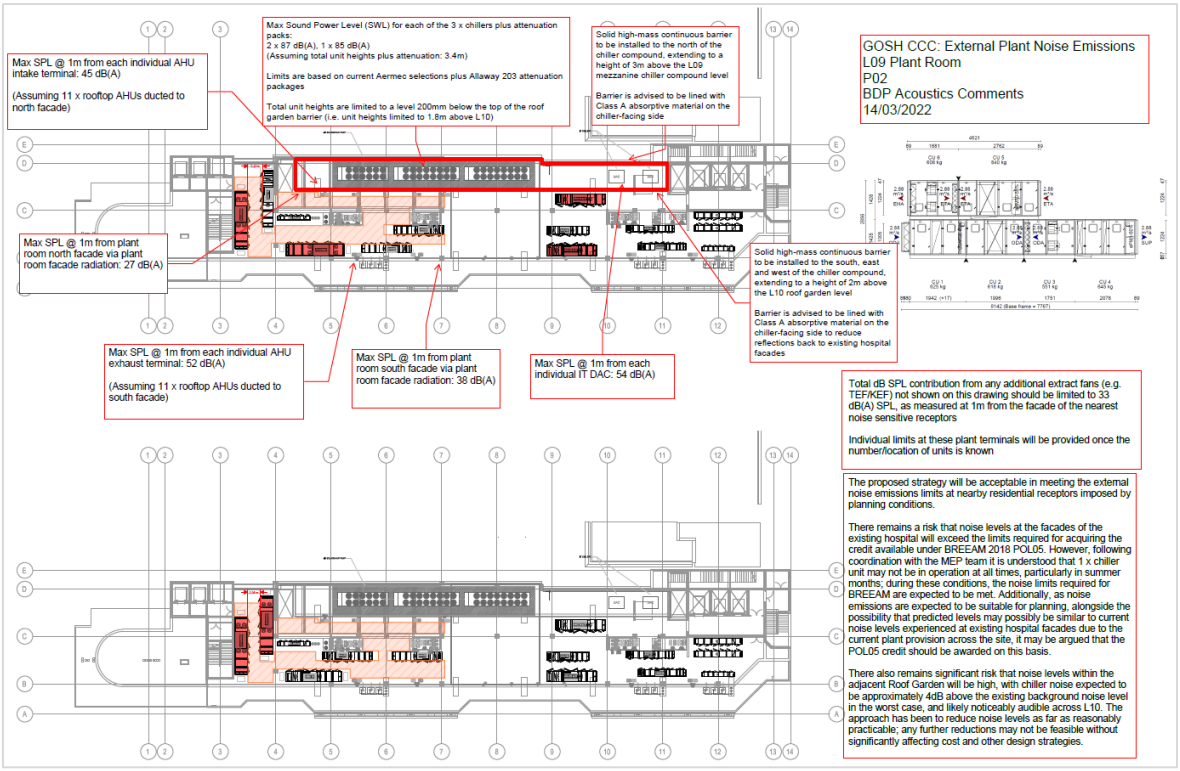
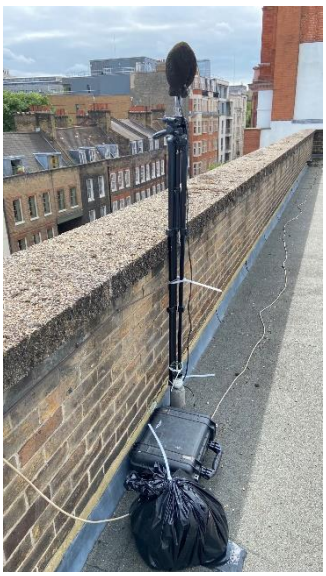


Figure B.2 – Proposed plant layout – GOSH CCC: External Plant Noise Emissions – L09 Plant Room (BDP Acoustics drawing provided by dated 14/03/2022)

Appendix C: Measurement Location Photographs

Measurement Location	Easting, Northing	Photographs
UL1	X: 530528 Y: 182054	   

Measurement Location	Easting, Northing	Photographs
UL2	X: 530507 Y: 182016	  

RSK Acoustics Limited Reg. in England and Wales No. 7102436
rskacoustics.com info@rskacoustics.com +44 (0)1932 829007

Registered Office: Spring Lodge, 172 Chester Road, Helsby, WA6 0AR
Addlestone | Bristol | Coventry | Glasgow | Helsby | Hemel | Leeds | Manchester