29 July 2021
0-3563-1a

aulos ACOUSTICS

ADDENDUM

Reports and documents under previous planning applications
References included in report above

Delegated Report

Analysis sheet	Expiry Date:	27/08/2013
N/A	Consultation Expiry Date:	n/a

Officer	Application Number(s)
Tania Skelli-Yaoz	2013/4129/P
Application Address	**Drawing Numbers**
163 Iverson Road London NW6 2RB	See decision notice

PO 3/4	Area Team Signature	C&UD	Authorised Officer Signature

Proposal(s)

Details of conditions 18 (noise levels), 19 (acoustic measures), 20 (vibration), of planning permission ref: 2012/0099/P dated 12/12/2012 for the erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats (1 x one bed, 20 x two bed, 9 x three bed and 3 x studio flats) and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre buildings.

Recommendation(s):	**Approve details**
Application Type:	**Approval of Details**
Conditions or Reasons for Refusal:	**Refer to Draft Decision Notice**
Informatives:	

Consultations

Adjoining Occupiers:	No. notified	**00**	No. of responses No. electronic	**00** **00**	No. of objections	**00**
Summary of consultation responses:	n/a					
CAAC/Local groups* comments: *Please Specify	n/a					

Site Description

Former garden centre under redevelopment for housing.
Site is registered as previously contaminated.

Relevant History

2012/0099/P GRANTED subject to section 106 legal agreement on 12/12/12 for the Erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats (1 x one bed, 20 x two bed, 9 x three bed and 3 x studio flats) and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre buildings.

Other relevant:
2013/3500/P GRANTED 23/10/2013 Details of conditions 4 (window details), 7 (green wall and green roof), 8 (bird and bat habitat provision), 10 (Landscape and Habitat Management Plan), 13 (waste storage and removal) & 16 (cycle storage) of planning permission ref: 2012/0099/P, dated 12/12/2012; for the erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre buildings.

2013/3749/P GRANTED 9/8/13 Details pursuant to condition 5 (hard and soft landscaping) of planning permission granted 12/12/2012 (ref: 2012/0099/P) for erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre.

2013/4245/P GRANTED 9/8/13 Details pursuant to condition 9 (urban drainage system) of planning permission granted on 12/12/2012 (ref. 2012/0099/P) for the erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre.

2013/5321/P GRANTED 22/10/2013 Details of ground investigation and remediation relating to condition 14(a+b) of permission granted 12/12/12 (ref: 2012/0099/P) for the erection of a part four/part five storey building plus lower ground floor comprising 33 residential flats and 3 three storey townhouses, following the demolition of the existing garden centre.

Relevant policies

LDF Core Strategy and Development Policies

CS5 Managing the impact of growth and development
CS16 Improving Camden's health and well-being

DP22 Promoting sustainable design and construction
DP26 Managing the impact of development on occupiers and neighbours
DP28 Noise and vibration

Assessment

Condition 18:

Before building works commence on the site, a scheme shall be submitted to and approved in writing by the Local Planning Authority providing for the insulation of the proposed dwelling unit(s) so that externally generated noise from railway and road traffic noise, do not cause internal noise levels to exceed an indoor ambient noise levels in unoccupied rooms of 30 dB(A) LA eq (1hour) and individual noise event shall not exceed 45 dB LAmax The development shall be carried out in such a manner to ensure that the above noise levels (from railway and road traffic) are to be retained for the next 15 years.

On completion, a test on each dwelling shall be carried out to verify compliance with this condition. A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to and approved in writing by the Local Planning Authority. The Noise report shall clearly contain standards used, measurements locations, raw tabulated and graphically represented data, time, date etc.

(For the residential accommodation the design and construction criteria for development of building shall have regard to the good criteria set out in BS 8233:1999 Sound insulation and noise reduction for buildings - Code of Practice The scheme shall include full details on noise mitigation measures to be incorporated including window glazing and room ventilation provisions Where ventilation is required it should be capable of achieving the same noise reduction as the closed glazing or building structure).

Reason: To safeguard the amenities of future occupants in accordance with the requirements of policies CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

Condition 19:

Before building works commence on the site, a scheme shall be submitted to and approved in writing by the Local Planning Authority providing full details of the acoustic measures to be incorporated to ensure that the steady noise level does not exceed 50 LAeq,T dB in open spaces (including balconies) and open communal areas.

The development shall be carried out in such a manner to ensure that the above noise levels (from railway and road traffic) are to be retained (including maintenance) for the next 15 years.

On completion a test on each open communal including balconies shall be carried out to verify compliance with this condition. A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to and approved in writing by the Local Planning Authority. The Noise report shall clearly contain standards used, measurements locations, raw tabulated and graphically represented data, time, date etc.

Reason: To safeguard the amenities of future occupants in accordance with the requirements of policies CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

Condition 20:

Before building works commence on the site, a scheme shall be submitted to and approved in writing by the Local Planning Authority providing for the insulation of the proposed dwelling unit(s) so that externally generated vibration from road and railway traffic do not cause any discomfort to its occupants as measured and interpreted by BS.6472:1992 "Evaluation of human exposure to vibration in buildings [1 Hz to 80 Hz]."

The scheme shall provide adequate insulation to prevent the transmission vibration from railway and road traffic to levels that are not perceived by the occupants as measured in BS.6472:1992

"Evaluation of human exposure to vibration in buildings [1 Hz to 80 Hz]."

Reason: To safeguard the amenities of future occupants in accordance with the requirements of policies CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

Assessment:

The original submission included 2 reports:

1) Environmental Intrusive Noise & Vibration Study dated 27/6/2013 by SOL Acoustics; and

2) Internal Sound Insulation Review dated 24/6/2013 by Sol Acoustics.

These were assessed by the Environmental Health Officer and further supplementary information/clarifications, as follows, was submitted:

(a) Letter by SRL dated 3/12/2013 ref. C/30557/L02/JDH addressed to Tom Westwood
(b) Planning Report 1-475 dated 17/12/2013 by Waugh Thistleton

The Environmental Health's Officers assessment concluded that the glazing specification [Idealcombi Futura+ (8.4 lam glass / 16mm cavity / 4mm glass + 10mm glass) for both railway façade and road façade noise] meets the acoustic criteria. All bedrooms have openable windows should residents wish to open them. All proposed windows are confirmed to be the highest performing double glazed windows available.

Mechanical ventilation will be incorporated to this proposal to be installed to all dwellings to allow background ventilation to all rooms without the need to open windows. This is a fully ducted system within the ceiling void. The ducts all pass through a central heat exchanger plant thus preventing external noise entering the flat. Furthermore all ducts are installed above plasterboard ceilings with acoustic insulation immediately above the plasterboard to provide additional acoustic insulation to the flats.

A railway-side acoustic fence is provided and is confirmed to run the full length of the north boundary and fixed from within the site (not from the Network Rail side). Therefore maintenance of this will be from within the site's control through the management company who will maintain the development.

With regard to condition no. 20 the applicant has provided information for the next 15 years and also carried out vibration measurements. Their findings indicated that the ground-borne vibration levels would be such that there would be a *low probability of adverse comment* due to train movements and road traffic.

In view of these findings no specific mitigation measures such as building isolation should be deemed necessary.

In view of all the above, the information supplied by the applicant with regard the imposed planning conditions 18, 19 and 20 is acceptable.

Recommendation: Approve details.

Outstanding conditions: Condition 2 (sample panel of facing brickwork), condition 3 (screen) and 11 (wildlife habitat and biodiversity).

Under consideration: none.

Regeneration and Planning
Development Management
London Borough of Camden
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WC1H 8ND

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planning@camden.gov.uk
www.camden.gov.uk/planning

Mr Anthony Thistleton-Smith
Waugh Thistleton Architects Ltd.
74 Paul Street
London
EC2A 4NA

Application Ref: **2013/4129/P**
Please ask for: **Tania Skelli-Yaoz**
Telephone: 020 7974 **6829**

11 February 2014

Dear Sir/Madam

DECISION

Town and Country Planning Act 1990 (as amended)
Town and Country Planning (Development Management Procedure) Order 2010
Town and Country Planning (Applications) Regulations 1988

Approval of Details Granted

Address:
163 Iverson Road
London
NW6 2RB

Proposal:
Details of conditions 18 (noise levels), 19 (acoustic measures), 20 (vibration), of planning permission ref: 2012/0099/P dated 12/12/2012 for the erection of a part four and part five storey building plus lower ground floor comprising 33 residential flats (1 x one bed, 20 x two bed, 9 x three bed and 3 x studio flats) and 3 three-storey townhouses (Class C3), following the demolition of the existing garden centre buildings.

Drawing Nos: Environmental Intrusive Noise & Vibration Study dated 27/6/2013 by SOL Acoustics, Internal Sound Insulation Review dated 24/6/2013 by Sol Acoustics, Letter by SRL dated 3/12/2013 ref. C/30557/L02/JDH addressed to Tom Westwood and Planning Report 1-475 dated 17/12/2013 by Waugh Thistleton.

The Council has considered your application and decided to grant approval of details:

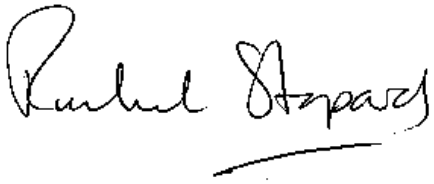
1

Director of Culture & Environment
Rachel Stopard

In dealing with the application, the Council has sought to work with the applicant in a positive and proactive way in accordance with paragraphs 186 and 187 of the National Planning Policy Framework.

Your attention is drawn to the notes attached to this notice which tell you about your Rights of Appeal and other information.

Yours faithfully



Rachel Stopard
Director of Culture & Environment

It's easy to make, pay for, track and comment on planning applications on line. Just go to www.camden.gov.uk/planning.

It is important to us to find out what our customers think about the service we provide. To help us in this respect, we would be very grateful if you could take a few moments to complete our online planning applicants' survey. We will use the information you give us to monitor and improve our services.

sol
acoustics

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Waugh Thistleton Architects Ltd
Iverson Road, London

Environmental Intrusive Noise & Vibration Study

27 June 2013

PROJECT:	Iverson Road, London Environmental Intrusive Noise & Vibration Study
CLIENT:	Waugh Thistleton Architects Ltd
DOCUMENT REFERENCE:	P1498-REP01-SJF
SIGNED:	_____ SIMON FERENCZI
CHECKED:	_____ MATTHEW FISHER
DATE:	27 June 2013

CONTENTS

SUMMARY

Sol Acoustics Ltd (Sol) has been commissioned by Waugh Thistleton Architects Ltd (WTA) to conduct an environmental noise and ground borne vibration assessment relating to the Iverson Road residential development site located in West Hampstead, London.

The purpose of this report is to determine an appropriate acoustic performance specification for glazing and building envelope elements, all as based on the pre-existing site environmental noise climate, the interpreted (Conditioned) intrusive noise requirements and currently available design drawings and specifications.

Ground borne vibration from road and rail sources has also been considered in detail (both in terms of "feelable" vibration *per se*, as well as vibration-induced noise within flats also), together with the determination of the maximum allowable daytime and night time environmental noise contribution from M&E plant, in performance specification terms.

Full details are provided within the report, including the acoustic performance specifications and suggested configurations for all glazing, trickle vent and external building envelope construction for habitable rooms, for acoustic purposes, and environmental noise limits for M&E plant also.

Ground borne vibration due to *worst current, and future case* train movements is expected to lead to structureborne vibration within the building that would lead to a 'low probability of adverse comment', all as assessed in accordance with BS6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings'*.

In order to achieve a *below* 'low probability of adverse comment' BS6472 rating as regards feelable vibration, it would be necessary to isolate the building from ground borne vibration (e.g. via the use of building isolation bearings).

Please refer to the report for further details.

1.0 INTRODUCTION

Sol Acoustics Ltd (Sol) has been commissioned by Waugh Thistleton Architects Ltd (WTA) to conduct an environmental noise and ground borne vibration assessment relating to the Iverson Road residential Development site located in West Hampstead, London.

The purpose of this report is to determine an appropriate acoustic performance specification for glazing and building envelope elements, all as based on the pre-existing site environmental noise climate, the interpreted (Conditioned) intrusive noise requirements and currently available design drawings and specifications.

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2.0 DESCRIPTION OF SITE

The proposed residential development, 163 Iverson Road, West Hampstead, London, is to comprise of a six storey (Lower Ground to 4th Floor) residential building and three storey terrace style houses.

To the north of the site lie six railway lines that carry mixed train types. The railway lines are made up of the following type of lines:

- The two lines closest to the Iverson Road development are emergency use only, 'freight diversionary lines' with maximum speed of 40mph
- The next two lines are the mainline with speeds up to 110mph
- The furthest two lines have speeds up to 90mph – with most trains stopping at the station

To the north east of the site boundary is the West Hamsptead Railway Station building, which also has associated walkways from the station to the various station platforms.

To the south of the site boundary, approximately 3 metres from the nearest future residential façade is Iverson Road (i.e. the road itself), which is a fairly busy road used as a cut through to the main roads. This carries mixed traffic including cars and some HGVs. No bus routes are believed to use Iverson Road in any capacity.

To the west of the site boundary is the commercial unit of Iverson Tyres Ltd. This commercial unit is the nearest commercial premises to the Iverson Road site; other commercial sites further to the west include the German Auotcare Centre.

Figure 1 shows an aerial photograph of the pre-Development site, indicating its approximate location relative to the surrounding buildings and roads.

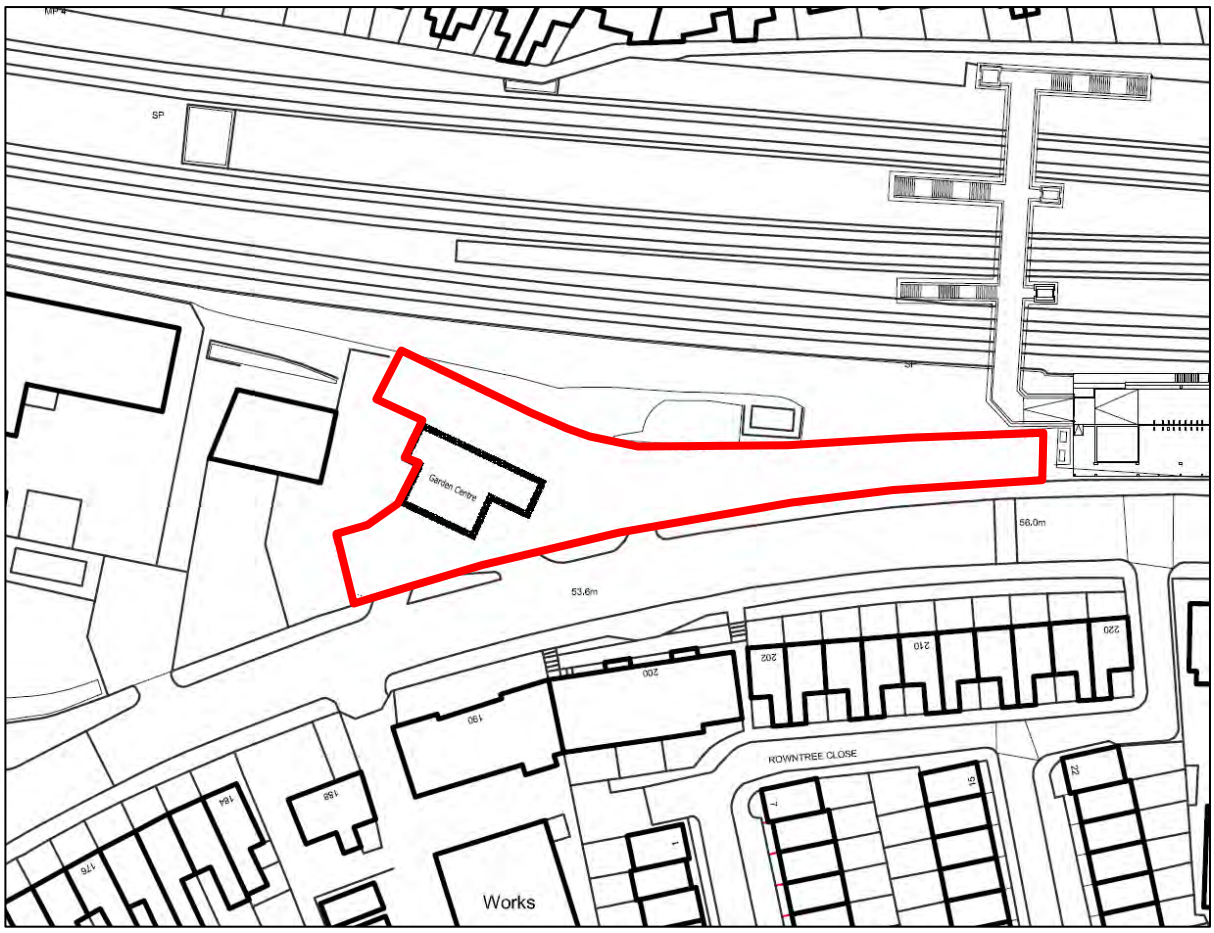


Figure 1: Site location plan and surrounding areas

3.0 DETAILS OF INVESTIGATION

In order to determine the prevailing environmental noise and vibration levels around the site, surveys of the pre-existing noise and ground borne vibration climates have been carried out over a typical weekday daytime and night time period.

Specifically, noise and vibration surveys were undertaken during the following periods, with no site construction activities occurring, including demolition or related site plant operation:

- Late afternoon and evening – 29th May 2013 (16:00 to 22:59)
- Night – 29th to 30th May 2013 (23:00 to 07:00)

The prevailing weather conditions were suitable for the purposes of environmental noise measurements throughout the various noise surveys. No rain occurred at any time and mean wind velocities were below 5m/s, albeit microphone windshields were in use at all times.

Figure 2 shows the approximate location of all noise and ground borne vibration monitoring points. As indicated, the various monitoring locations were selected to coincide with the proposed key future new build building façades.

Noise measurements made at Positions 1 and 2 were undertaken at a height of 5 metres from ground level. All other positions were undertaken at a height of 1.6 metres from ground level. (All microphone measurement heights were selected to coincide with the minimum first storey level of accommodation, per future façade and for all measurement positions, relative to ground level).

All noise monitoring locations were in so-called “free field” conditions, in acoustic terms, and thus no correction has been applied to the noise survey data directly obtained.

The majority of noise measurements were undertaken using continuous logged measurement duration of 5 minutes; measurements at Position 1 were of 1 minute duration (so as to ensure true representation of key L_{max} noise levels of railway activities), with L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} being recorded, together with unweighted octave band L_{eq}, L_{max}, L_{10} and L_{90}.

Ground borne vibration measurements were undertaken using a dedicated vibration analyser and transducer, as measured during periods of rail activity (Position V1 and V2). Long term vibration measurements were made at Position V2.

Type 1 Precision Grade sound measuring instrumentation was exclusively used for all surveys. Full details of all the instrumentation used, and corresponding traceable calibration records, are retained on file by Sol and available for inspection if required.

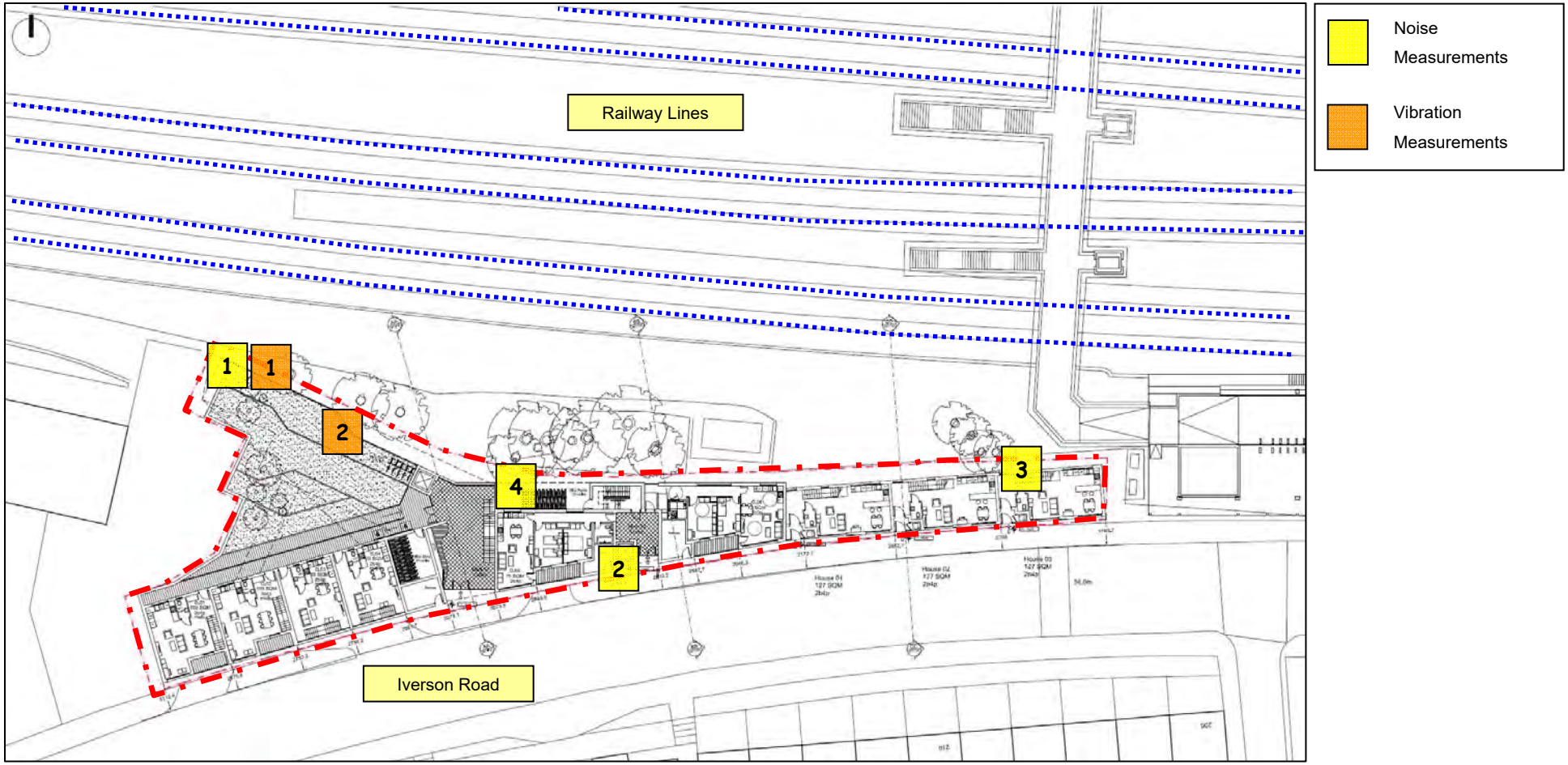


Figure 2: Noise and vibration survey monitoring locations

4.0 SUMMARY MEASURED NOISE DATA

Table 1 provides a basic summary of the average, free field noise levels measured at the various locations around the site, in L_{Aeq}, L_{A90} and L_{Amax} terms:

	Typical Measured Noise Level (Average L_{Aeq}, Range L_{Amax} and L_{A90})					
	Daytime			**Night time**		
Position	**dB, L_{Aeq}**	**dB, L_{Amax}**	**dB L_{A90}**	**dB, L_{Aeq}**	**dB, L_{Amax}**	**dB L_{A90}**
1	65	50 to 98	42 to 59	56	40 to 86	36 to 62
2	63	71 to 92	44 to 57	58	46 to 93	36 to 50
3	60	66 to 81	43 to 49	n/a	n/a	n/a
4	60	59 to 86	43 to 50	53	44 to 80	34 to 47

Table 1: Summary of typical, measured environmental noise levels, in broadband terms

Tables 2 and 3 summarise the corresponding unweighted, time-averaged (L_{eq}) daytime and night time period ambient noise levels respectively, in octave band frequency terms:

Measurement Location	**Noise Level, dB L_{Aeq}**	**Sound Pressure Level (dB) @ Octave Band Centre Frequency (Hz)**						
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**
1	66	62	62	61	62	62	55	54
2	63	69	63	58	58	60	55	52
3	60	64	59	57	56	57	52	44
4	60	65	58	56	57	56	51	49

Table 2: Summary of *daytime* time-averaged environmental noise levels, octave band terms

Measurement Location	**Noise Level, dB L_{Aeq}**	**Sound Pressure Level (dB) @ Octave Band Centre Frequency (Hz)**						
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**
1	57	57	56	56	53	53	47	42
2	59	64	57	54	53	54	52	49
3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	53	61	54	52	50	49	44	38

Table 3: Summary of *night time*, time-averaged environmental noise levels, octave band terms

5.0 FUTURE PREDICTED ROAD AND RAIL TRAFFIC FLOWS

5.1 Iverson Road – Road Traffic Data

Traffic flow data has been provided by Iceni Projects for the current (2013) and future 15 year (2028) predicted flows. Iverson Road traffic flows were calculated from surveys conducted on 14th May 2013 by Traffic Surveys UK Ltd. Future predicted traffic flows have been derived by Iceni Projects from TfL data. Additionally, NTM growth rates have been applied to 2013 data in order to replicate future year 2028 (15 years from planning). The full traffic flow data sheet is presented within the Appendices of this report.

5.1.1 Road Traffic - Calculated Future (2028) Increase

Table 4 below summarises the 18-hr AWWT traffic flow data for both current and future conditions on Iverson Road. The future (2028) increase in noise has been calculated for traffic flows on both sides of Iverson Road.

In summary and as indicated by Table 4, since the 15-year traffic flow is predicted to increase by 25% as compared to current day, the resultant effect on the corresponding resultant overall road traffic noise levels will be an increase of approximately +1dB for the daytime $L_{Aeq,\ 16\ hour}$ and night time $L_{Aeq,\ 8\ hour}$ noise levels.

Description/Specific Location	18-hr AAWT (Traffic Flow)	Increase in Noise Level (dB)
Existing 2013	4856	0.97
Iverson Road - West of Site (near Maygrove Road)		
Future 2028	6074	
Iverson Road - West of Site (near Maygrove Road)		
Existing 2013	4729	0.97
Iverson Road - East of Site (near West End Lane)		
Future 2028	5915	
Iverson Road - East of Site (near West End Lane)		

Table 4: Current / future 18-hr AAWT traffic flows with associated noise level change

5.2 Iverson Road – Railway Data

Discussions between Tom Westwood from WTA and the Construction Manager at Network Rail have highlighted that:

1) The two lines closest to Iverson Road are freight diversionary lines (max speed of 40mph)
2) The next two lines are the mainline with maximum speed up to 110mph
3) The furthest two lines have speed up to 90mph – with most trains stopping at the station

The following further specific acoustic design assumptions for the present conditions are taken from information provided in the Aulos Acoustics Noise Survey and Planning Report dated 15th December 2011.

5.2.1 Relief Lines

It is understood that these are intended to ease peak flow train movements and possibly, train relocation before and during peak times.

Confirmed data on the use of these lines is unavailable, but indications given by train operators and Network Rail personnel are that approximately 5% of peak time fast train movements out of London could use the line.

5.2.2 Freight Rail Traffic

Network Rail has confirmed that expected freight use for all lines through West Hampstead Thameslink is approximately 12 movements per day spread equally over the full period. Freight operations are “reduced” at weekends.

5.2.3 Predicted 15-Year Future Rail Usage

Mark England of Iceni Projects Limited has been in contact with Network Rail attempting to obtain information/data regarding future railway usage. At the time of reporting (June 2013) no information has been forthcoming.

In the absence of future (2028) data from Network Rail, the following assumptions regarding future usage of the railway lines affecting the Iverson Road development have been made:

1) +5% increase in the number of movements of all train types including:
    a. Freight Trains (up to 40mph) – middle two lines / nearest two lines
    b. Mainline passenger trains (up to 110mph) – middle two lines
    c. Passenger trains (up to 90mph – majority stopping at the station) – furthest lines
2) Up to 5% of mainline passenger trains (up to 110mph) to be relocated on to the nearest two lines that run past Iverson Road site.

Table 5 below summarises the calculated increase in noise levels due to the assumed 15-year increases in daily train numbers as compared to current (i.e. +5% of each type) and also relocation of 5% of the fast mainline trains onto the nearer 'relief lines':

Train Noise Increases at Position 1	**Year**	**Noise Level L_{Aeq} (dB)**
Increase due to 5% increase of all train types	2028	0.3
Increase due to 5% of mainline trains moving onto relief lines	2028	0.2
Existing 2013 daytime LAeq	2013	65.4
Calculated 2028 daytime LAeq	2028	**65.9**
Existing 2013 night time LAeq	2013	56.3
Calculated 2028 night time LAeq	2028	**56.8**

Table 5: Train noise increases due to future predictions at Position 1

6.0 INTRUSIVE NOISE AND VIBRATION CONTROL (CONDITIONS 18, 19 AND 20)

6.1 Basis of Acoustic Design

Condition 18 relates to intrusive noise to habitable rooms, and is as follows:

"…18. Before building works commence on site, a scheme shall be submitted to and approved by the LPA providing for the insulation of the proposed dwelling units so that externally generated noise from railway and road traffic, do not cause internal noise levels to exceed the ambient noise levels in unoccupied rooms (30dB[A] LA eg. [1 hour]) and individual noise event shall not exceed 45dB LAmax. The Development shall be carried out in such a manner to ensure that the above noise levels are to be retained for the next 15 years. On complete a test on each dwelling shall be carried out to verify compliance with this condition. A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to and approved in writing by the LPA. The noise report shall clearly contain standards used, measurements locations, raw tabulated and graphically represented data, time, date etc..."

Condition 19 relates to intrusive noise to amenity spaces, and is as follows:

"…19. Before building works commence on site, a scheme shall be submitted to and approved in writing by the LPA, providing full details of the acoustic measures to be incorporated to ensure that the steady noise level does not exceed 50LAeq, T dB in open spaces (including balconies) and open communal areas. The Development shall be carried out in such a manner to ensure that the above noise levels (from rail and road traffic) are to be retained and maintained for the next 15 years. On completion, a test on each open communal area including balconies shall be carried out to verify compliance with this condition. A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to and approved in writing by the LPA. The noise report shall clearly contain standards used, measurements locations, raw tabulated and graphically represented data, time, date etc...

Condition 20 relates to ground borne vibration, and is as follows:

"…20. Before building works commence on the site, a scheme shall be submitted to and approved in writing by the LPA providing for the insulation of the proposed dwelling units so that externally generated vibration from road and railway traffic doesn't cause any discomfort to its occupants as measured and interpreted by BS.6472:1992 - "Evaluation of human exposure to vibration in buildings [1Hz to 80Hz]"..."

Accordingly therefore, this report provides acoustic advice for the attainment of BS8233 defined "Good" intrusive noise standards, as defined by Table 6 below**:**

BS8233 Acoustic Design Criteria	
Unoccupied Location	**Intrusive Noise Level**
Living Rooms	Good Standard 30dB $L_{Aeq(16\text{-}hour)}$
Bedrooms	Good Standard 30dB $L_{Aeq(8\text{-}hour)}$ (45 dB L_{Amax})
Amenity Spaces	Good 50dB $L_{Aeq(16\text{-}hour)}$

Table 6: Intrusive noise design criteria

Thus, the maximum recommended daytime intrusive noise level within habitable living rooms forming part of the development is 30dB $L_{Aeq(16\ hours)}$ and the corresponding night time intrusive noise limit within bedrooms is 30 dB $L_{Aeq(8\ hours)}$.

For night time periods, the Local Authority require that *maximum* noise levels within bedrooms should not exceed 45dB L_{Amax} and that this level is not be exceeded, which is more stringent that WHO guidelines for sleep disturbance upon which the Condition is based, which actually permit up to 10-15 nightly exceedances.

Accordingly, this report provides *alternate* acoustic design advice; for both absolute "strict" Condition wording compliance (i.e. with *no* 45dB L_{Amax} exceedances during a complete overnight period which, in the opinion of Sol, would be unduly onerous), and also for WHO Guidance compliance, with up to 10-15 nightly 45dB L_{Amax} exceedances being permitted. Although in the experience of Sol, the latter standard is invariably deemed to be acceptable, this aspect must be checked with the Local Authority (by others), prior to any finalisation of the design.

Additionally, a daytime *external ambient* noise limit is applicable to the various proposed *amenity spaces* (gardens and balconies) forming part of the development; this is set at 50dB $L_{Aeq(16\ hours)}$.

By taking into account of the actual levels of ambient noise specifically measured precisely at the future site façade locations, the proposed areas of façade elements and their intended constructions (i.e. glazing and walls), and the likely acoustic characteristics of the noise sensitive receiving spaces (i.e. living rooms, bedrooms), the sound reduction required to be provided by the various building façade elements have been determined through acoustic calculation.

The window areas, room dimensions and site layout used in all our calculations are as shown by WTA drawings and details as provided to Sol during May and June 2013.

(If there are any subsequent changes to any the proposed glazing areas and/or room layouts and floor plans, for any habitable room(s), these must be evaluated acoustically).

It should be noted that during both daytime and night time noise and vibration assessments, there were no train movements observed at any time on the 'relief tracks' that lie closest to the site boundary/future façades.

6.2 Glazing and Building Envelope Recommendations

Acoustic advice is provided within this report for both continuous extract (MEV) and whole house ventilation (MVHR) options. For the continuous extract scenario, trickle vents should only provide a maximum 2500mm^2 per habitable room.

All glazing, trickle vent (where used) and external wall construction specifications must have at least the minimum acoustic performance specifications as indicated by Table 7, Table 8 and Table 9 respectively, as confirmed and corroborated by independent acoustic laboratory test data of identical constructions, particularly in the case of glazing systems.

Thermal cavities must be specified by others, albeit these must not impinge upon the minimum required acoustic performance specification requirements.

Glazing should be used in conjunction with the stated minimum requirements for external envelope construction as given in Section 6.4 of this report.

6.3 Glazing and Trickle Vent Acoustic Performance Specification Requirements

6.3.1 Railway Façades – North Façade

The following glazing and trickle acoustic specifications are applicable for all railway-facing (north façade) habitable rooms. (Where a railway-facing habitable room has windows on different facades, the following glazing configurations apply to *all* windows serving that habitable room).

Bedrooms

Glazing: Wide-cavity triple glazed system (see Table 7) for strict Condition wording compliance in L_{Amax} terms

- OR -

10mm/12mm thermal cavity/8.4mm glazing (see Table 7) for WHO sleep disturbance guidance compliance in L_{Amax} terms **(NB: 30dB $L_{Aeq(8\ hours)}$ still achieved, as is 45dB L_{Amax} except for exceedances. Up to exceedances @ c.50dB L_{Amax} for future condition, including assumed diversionary line use)**

Trickle vent option: High specification trickle vent (see Table 8)

Living Rooms

Glazing: 10mm/12mm thermal cavity/8.4mm glazing (see Table 7)
Trickle vent option: High specification trickle vent (see Table 8)

6.3.2 Iverson Road Façade – South Facade

The following glazing and trickle acoustic specifications are applicable for all south façade habitable rooms:

Bedrooms

Glazing: Wide-cavity triple glazed system (see Table 7) for strict Condition wording compliance in L_{Amax} terms

- OR -

10mm/12mm thermal cavity/8.4mm glazing (see Table 7) for WHO sleep disturbance guidance compliance in L_{Amax} terms **(NB: 30dB $L_{Aeq(8\ hours)}$ still achieved, as is 45dB L_{Amax} except for exceedances. Up to exceedances @ c.50dB L_{Amax} for future condition, including assumed diversionary line use)**

Trickle vent option: High specification trickle vent (see Table 8)

Living Rooms

Glazing: 10mm/12mm thermal cavity/8.4mm glazing (see Table 7)
Trickle vent option: High specification trickle vent (see Table 8)

Table 7 shows the minimum acoustic performance specification requirements for each type and configuration of glazing referred to above; these must be achieved for the entire window and frame construction in each case, as a complete unit (and be as corroborated via independent acoustic laboratory test data):

Glazing Configuration	**Minimum Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)**						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
Wide-cavity triple glazed system	31	35	46	46	46	56	65
10mm / 12mm / 8.4mm	23	27	30	39	43	43	50

Table 7: Minimum recommended sound reduction index of glazing

All trickle ventilators, where used, must achieve at least the minimum acoustic performance specification performances as indicated by Table 8:

Trickle Vent Specification	**Minimum Element-Normalised Level Difference - $D_{n,e}$ (dB) @ Octave Band Centre Frequency (Hz)**						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
High specification trickle vent *2500mm^2 max. per habitable room (e.g. Greenwood Airvac MA3051)*	40	46	46	49	56	66	64

Table 8: Minimum required sound reduction index of trickle vents

It must be noted that the acoustic performance stated by manufacturers for various trickle vents will be related to the free area of the vent that has been acoustically tested in a laboratory.

If a greater free area of vent is to be installed than that actually tested, then the acoustic performance will be less than that stated in the literature and/or acoustic laboratory report – this must be taken account of when selecting trickle ventilator types and their required sizes.

6.4 Building Envelope Acoustic Requirements

The following *minimum* external wall constructional specifications will be required in acoustic terms, which Sol understands are as already proposed for this development:

Wall Type A1 – External Brick (≈385mm)

- 102.5 mm facing brick skin w.flush light mortar or slurried finish TBC on 50mm cavity w.wall ties @ 450 centers on Breather membrane on 80mm Celotez GA4000 or similar approved insulation to achieve u-value of 0.2 m²K/W, taped and sealed to manufacturers recommendations or equivalent approved on 100mm CLT (100 180mm to S.E Specification) on 25mm service void using BG GypLyner on 2 x 12.5mm BG SoundBloc plasterboard or similar approved with 3mm plaster.
- ***25mm service void must be filled with mineral wool***

Wall Type A2 – External Timber (≈375mm)

- 22mm timber cladding by Kebony or similar approved on 50mm ventilated cavity w. battens at recommended c/c on Vapour permeable membrane by Tyvek or similar approved 150mm Rockwool Duo Slab or similar mineral wool insulation to achieve u-value of 0.2 m²K/W, laid to manufacturers recommendations or on 100mm CLT (100-180mm to S.E Specification) on 25mm service void using BG GypLyner on 2 x 12.5mm BG SoundBloc plasterboard or similar approved with 3mm plaster skim.
- ***25mm service void must be filled with mineral wool***

Table 9 shows the minimum required acoustic performance requirements for the external building envelope, in terms of sound reduction indices:

Wall Construction Type	Sound Reduction Index (dB) @ Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
Wall Type A1 External Brick (≈385mm)	33	43	43	61	≥75	≥75	≥75
Wall Type A2 External Timber (≈375mm)	26	33	40	52	60	67	75

Table 9: Minimum commercial unit building envelope acoustic performance requirements

6.4 Noise Control to Amenity Spaces (Gardens and Balconies)

Condition 19 states that the external, ambient noise limit applicable to the various proposed amenity spaces (gardens and balconies) forming part of the development is 50dB $L_{Aeq(16\ hours)}$.

6.4.1 Gardens

The current, existing measured daytime ambient noise level at Position 1 was 65.4dB $L_{Aeq(16\text{-}hour)}$. With assumed future (2028) increases in train traffic and activities on railway lines to the north of the site boundary, this is expected to rise to 65.9dB $L_{Aeq(16\text{-}hour)}$., as previously discussed.

The use of a close boarded, gap-free, 2.4 metre height completely imperforate and continuous perimeter fence along the entire northern site boundary and garden boundary also, could potentially provide c.10dB attenuation within the amenity spaces, albeit the resultant c.55dB $L_{Aeq(16\text{-}hour)}$ ambient noise level within the screened gardens would still be above the Conditioned noise level. However, it is suggested that this should be accepted, since no further practicable acoustic mitigation measures are available and this is the best practice.

6.4.2 Balconies

Similarly, most of the proposed balconies are to be located on the Iverson Road façade of the building (i.e. southern façade); The daytime ambient noise level along this façade is represented by Position 2 noise data, which currently gives 65dB $L_{Aeq(16\text{-}hour)}$. With the future (2028) road traffic flow noise increase of +0.97dB, this gives a future predicted balcony noise level of 66dB $L_{Aeq(16\text{-}hour)}$.

In order to comply with the Conditioned balcony noise level, the only available mitigation measure would be the complete glass (or other) enclosure, including roof, of the entire balcony space. It is assumed that such a measure would be deemed impractical (and in any event undesirable; ventilation would be required to the enclosed balcony space which would also be liable to be affected by solar heating etc.).

Aside from complete enclosure of the balconies, more conventional (i.e. nominal, practicable) noise mitigation measures are typically used, such as the combined use of acoustically absorptive materials on balcony soffits (e.g. slotted timber with acoustic media) and 1.2 metre height partial, gap-free glazed balcony screens. Albeit, it should be noted that such measures typically provide c.1-3 dB reduction in L_{Aeq} terms.

In consideration of balcony ambient noise levels generally, it should of course be borne in mind that these are *not* habitable spaces; residents have a choice as to whether or not they are used, at any given time.

7.0 GROUND BORNE VIBRATION

7.1 'Feelable' Vibration

BS 6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings'* provides guidance on typically acceptable limits for perceived, 'feelable' vibration, such that annoyance is likely to be avoided. In particular, Section 6 of the Standard requires the vibration exposure to be determined for both for daytime and night time periods, in terms of the 'vibration dose value', VDV (or 'estimated vibration dose value', eVDV). The VDV/eVDV takes into account both the *magnitude* of the vibration and the *duration* of the exposure.

Table 10 shows an excerpt from the Standard, namely (e)VDV values which result in various probabilities and degrees of adverse comment, or otherwise, within residential buildings:

	Low Probability of Adverse Comment $ms^{-1.75}$	**Adverse Comment Possible** $ms^{-1.75}$	**Adverse Comment Probable** $ms^{-1.75}$
Daytime (07:00-23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Night Time (23:00-07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.6

Table 10: Probability of adverse comments within residential buildings

Thus, according to the Standard, the point at which there becomes a "low probability of adverse comment" occurs for an eVDV (16 hours) value of 0.2 in the case of daytime periods and an eVDV (8 hour) of 0.1 in the terms of night time periods. These daytime and night time (e)VDV thresholds are widely regarded as appropriate, albeit stringent, design criteria for residential developments such as this, in terms of perceptible vibration within any of the dwellings arising from external (or plant) vibration sources.

Manned surveys of the existing vibration levels at site locations representative of key future residential façades and structural columns were undertaken, as previously described. Namely, Position V1, representative of the future structural columns of the building, and Position V2, representative of the future rear façade of the building.

The measurement transducers were adhered to paving slabs in order to measure the ground borne vibration levels induced by train movements. The measurements have been conducted in accordance with the guidance given in 'Measurement and Assessment of Groundborne Noise and Vibration' published by The Association of Noise Consultants (ANC).

These determined the actual levels of ground borne vibration prevailing around the site. From these measurements, the eVDV has been calculated.

Table 11 shows the *current measured* and 15-year future predicted eVDV for each measurement location assessed, as indicated by Figure 2:

Measurement Location	Daytime eVDV ($ms^{-1.75}$)	Night Time eVDV ($ms^{-1.75}$)
Current day Vibration Positions V1 and V2 (at location of future structural columns and future building foundations)	0.20	0.10
15-year future predicted (2028) Vibration Positions V1 and V2 (at location of future structural columns and future building foundations)	0.22	0.10-0.12

Table 11: Predicted eVDV levels within habitable rooms at key façade locations

The assessed eVDV values indicate that groundborne vibration levels would be such that there would be a *low probability of adverse comment* due to train movements. This result is in accord with the subjective assessment on site that the great majority of train movements did not induce vibration that was feelable at the proposed development site.

7.2 Predicted Noise Induced within Bedrooms by Ground Borne Vibration

Ground borne vibration, when of a sufficiently high level, can generate audible structureborne noise within a building, which could cause adverse comment. Accordingly, the data obtained from ground borne vibration measurements have also been used to predict the potential levels of structureborne noise within the buildings of the proposed development.

The potential levels of structureborne noise within rooms have been calculated in accordance with Annex C of BS EN ISO 140: Part 4 – Acoustics – Measurement of sound insulation in buildings and of building elements.

The results of the assessment shows that night time noise *maxima* levels ranging between 12dB L_{Amax} to 36dB L_{Amax} would be expected within the bedrooms of the proposed Iverson Road residential dwellings closest to the railway lines, specifically due to structureborne vibration caused by existing train movements.

Given the potential use in the future of the currently unused rail lines that are in closer proximity to the proposed Development, internal noise levels within bedrooms of up to 42dB L_{Amax} would be expected.

These predicted ground borne vibration induced noise maxima are compliant with the recommendations of BS8233: 1999 and associated WHO guidance for sleep disturbance.

Thus, it is the conclusion of the ground borne vibration studies undertaken that the pre-existing and potential levels of ground borne vibration occurring at any site location due to movements of road traffic and rail movements are not unduly high and accordingly, no specific mitigation measures such as building isolation should be deemed necessary.

8.0 ENVIRONMENTAL NOISE LIMITS FOR M&E PLANT (CONDITION 21)

Condition 21 states the following:

"…21. (i) Any plant machinery, plant or equipment including air ventilation equipment ("machinery) installed or operated in connection with the carrying out of this permission shall be so enclosed and/or attenuated and or sited that the noise generated by the operation of the machinery shall not increase the preexisting [Daytime - 7am - 11pm] background noise levels during day time expressed as LA90 [1 hour] [day 7am-11pm] and night [11pm-7am] at any adjoining noise sensitive locations or premises in separate occupation above that prevailing when the machinery is not operating.

(ii)The Development shall be carried out in such a manner to ensure that the above noise levels are permanently retained thereafter. Noise measurements for the purpose of this condition shall be pursuant to BS 4142:1997.

(iii)On commissioning the machinery and prior to the building being occupied, a noise survey shall be carried out ascertain the above noise levels from the machinery are being met. A noise report shall be submitted to and approved in writing by the LPA. The noise report shall clearly contain a map/plan showing all measurement locations, tabulated and graphically raw data, calculations/façade corrections/assumptions made, time and date etc..."

It is normal practice to limit the total, aggregate *environmental* noise from all M&E plant, when operating simultaneously, to an ambient noise level (in $L_{Aeq,T}$ terms) equating to the lowest, pre-existing daytime or night time background noise level at any residential property façade, in L_{A90} terms, less a further 5dB.

The lowest recorded daytime and night time background noise levels at the proposed Development façades were 42dB L_{A90} in the day for Position 1 and 34dB L_{A90} at night, at Position 4.

Thus, in order to minimise the environmental noise impact of the development, mechanical services plant should be selected and suitably attenuated so as to limit the environmental noise at any residential property facades to the following daytime and night time limits:

Location	**Maximum Building Services Plant Noise Level dB L_{Aeq}**	
	Daytime (07:00hrs to 23:00hrs)	**Night time (23:00hrs to 07:00hrs)**
Any residential façade within, or adjacent to the proposed Development	37	29

Table 12: Environmental noise limits for building services plant

The above maximum allowable daytime and night time M&E plant environmental noise level limits must be forwarded to the M&E Engineer to allow selection of suitable plant and any required noise mitigation measures, such as attenuators, when full details of the entire proposed M&E scheme are known.

It must also be noted that the M&E plant noise limits identified above are applicable to *all* plant serving all areas of the development, when operating simultaneously. The allowable individual contribution from all plant items and atmospheric terminations such as louvres and cowls must be determined based on these overall noise limits, and will be lower.

APPENDIX A
NOISE SURVEY DETAILS AND SUMMARY RESULTS

LOCATION

163 Iverson Road, West Hampstead, London

DATES AND TIMES

Wednesday 29th May 2013	16:00 hrs to 23:59 hrs
Thursday 30th May 2013	00:00 hrs to 07:00 hrs

PERSONNEL PRESENT DURING MEASUREMENTS

Darren Clucas – Sol Acoustics Ltd

Mirza Nabeel Mubarak – Sol Acoustics Ltd

INSTRUMENTATION

Norsonic Type 118 IEC 60651 Type 1 Integrating-Averaging Sound Level Meter (serial no. 28260)
Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 29917)

Norsonic Type 118 IEC 60651 Type 1 Integrating-Averaging Sound Level Meter (serial no. 28957)
Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 31041)

Norsonic Type 118 IEC 60651 Type 1 Integrating-Averaging Sound Level Meter (serial no. 31498)
Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 31971)

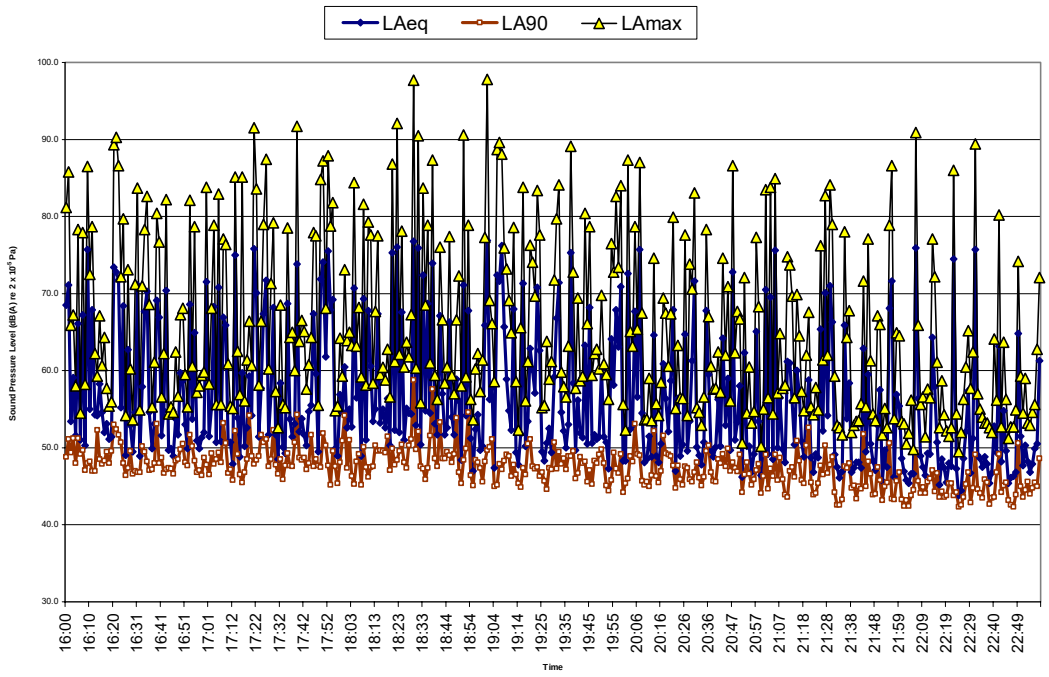
Norsonic Type 140 IEC 61672 Type 1 Precision Sound Analyser (serial no. 1403193)
Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 27878)

METHODOLOGY

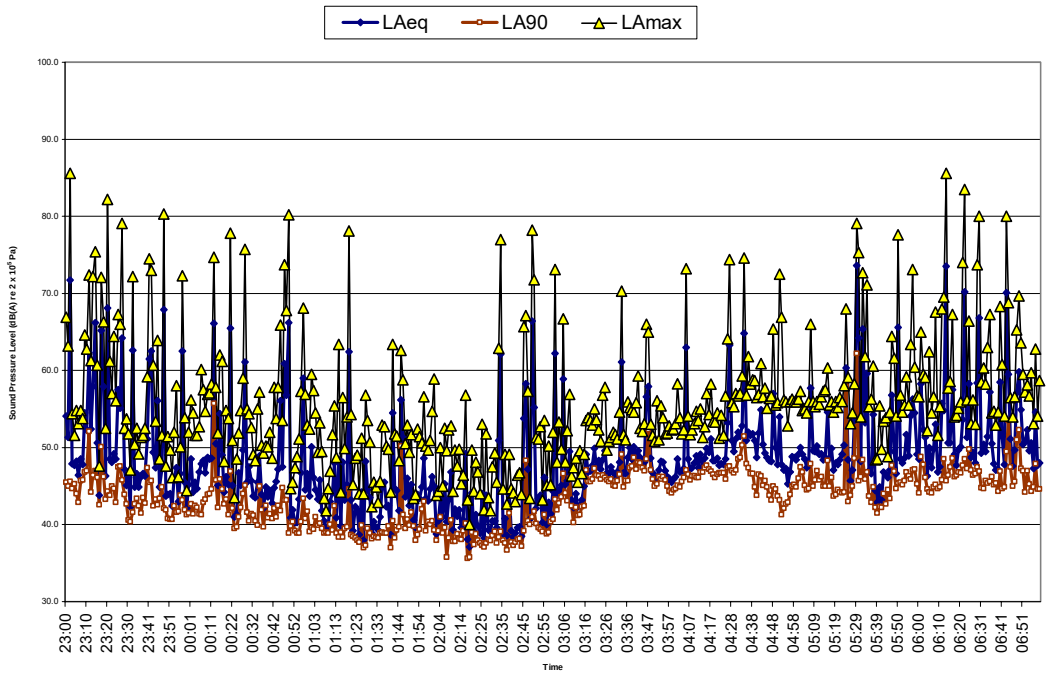
Before and after the measurements the Norsonic Type 118 was check calibrated to an accuracy of ±0.3dB using the Norsonic Type 1251 Calibrator. The calibrator produces a sound pressure level of 114 dB re $2x10^{-5}$ Pa @ 1kHz.

MEASUREMENT RESULTS

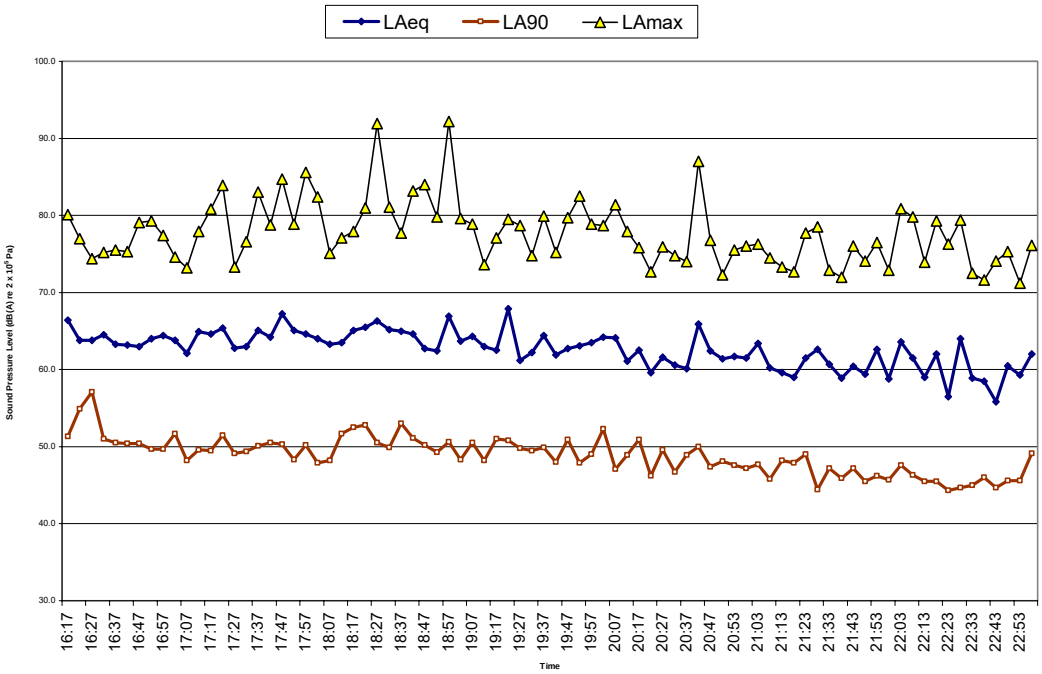
Graphs A1 to A9 summarise the results obtained from the noise surveys.



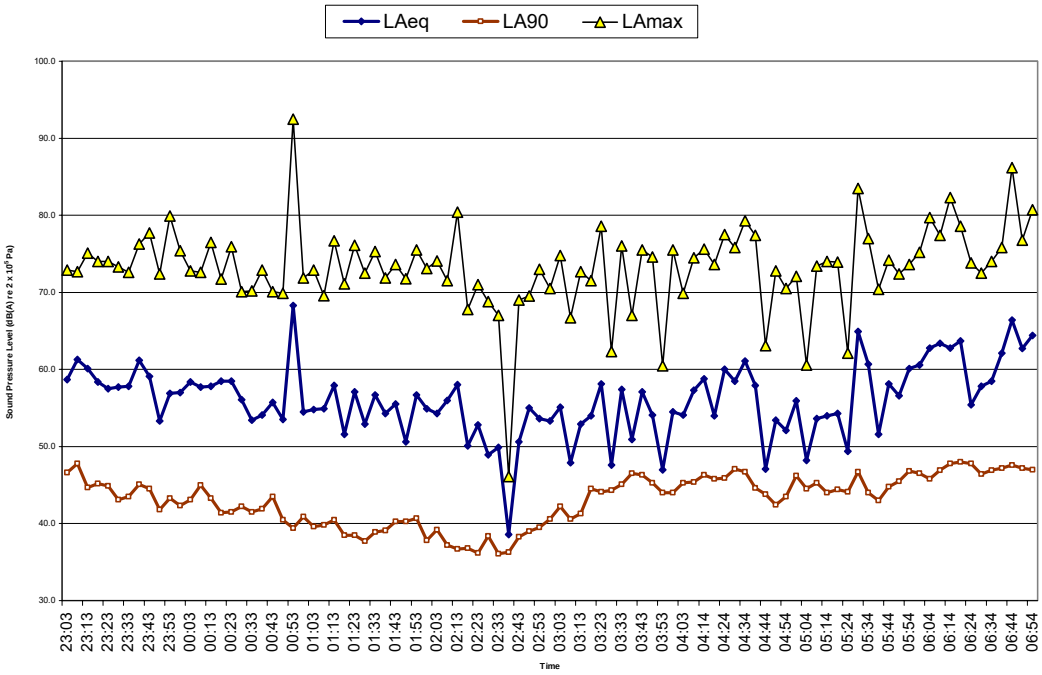
Graph A1: Daytime noise summary – 29th May 2013 - Position 1



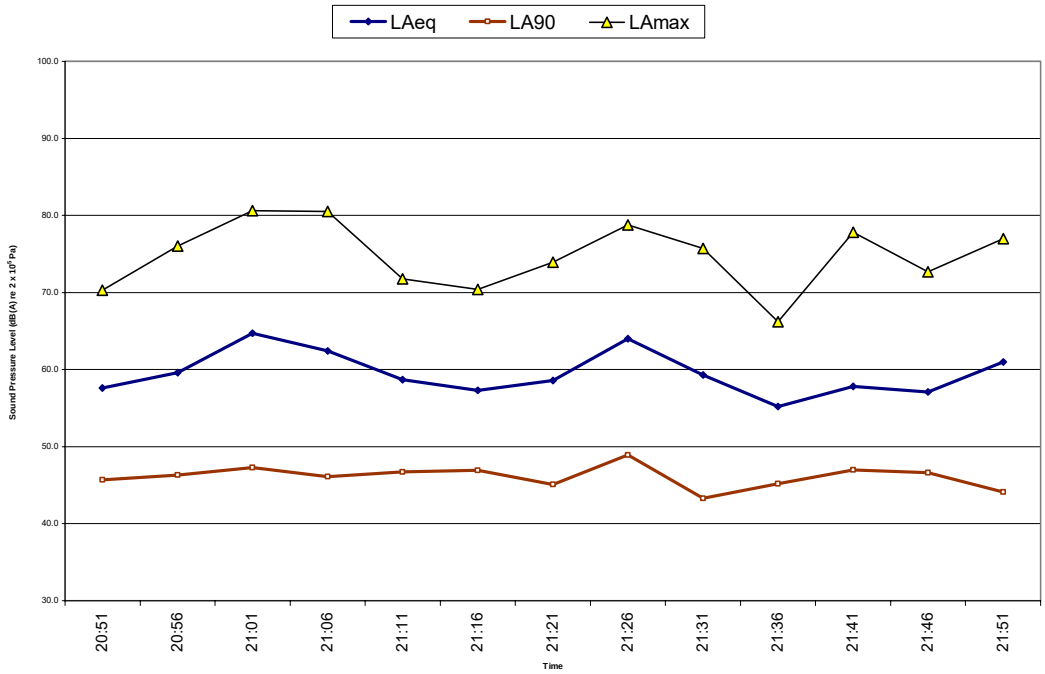
Graph A2: Night time noise summary – 29th to 30th May 2013 - Position 1



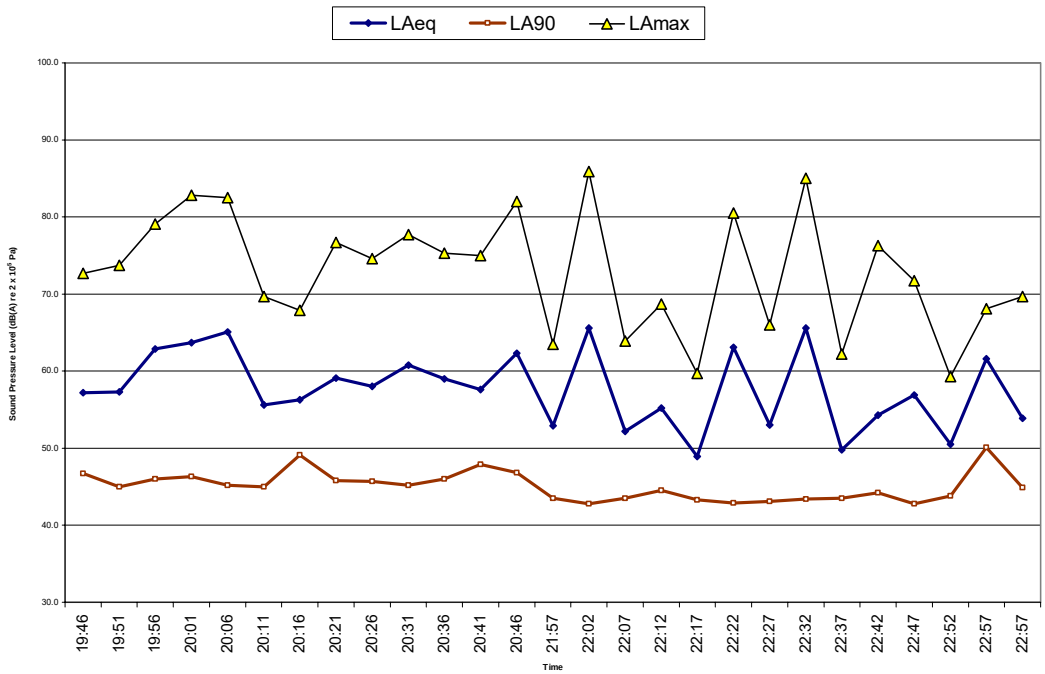
Graph A3: Daytime noise summary – 29th May 2013 - Position 2



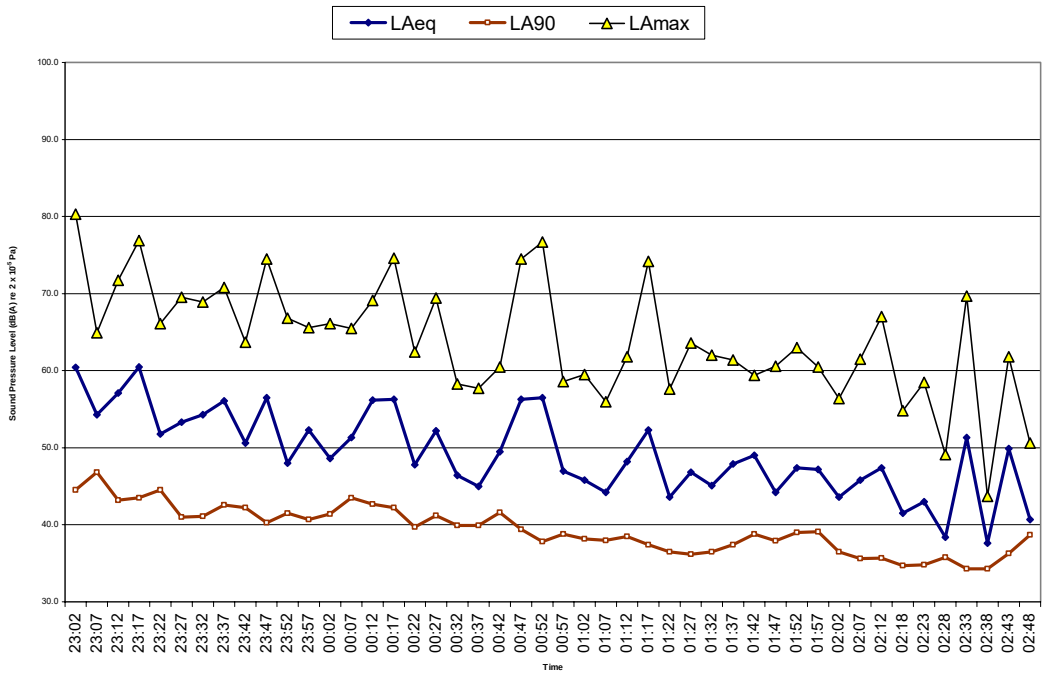
Graph A4: Night time noise summary – 29th to 30th May 2013 - Position 2



Graph A5: Daytime noise summary – 29th May 2013 - Position 3



Graph A6: Daytime noise summary – 29th May 2013 - Position 4



Graph A7: Night time noise summary – 29th to 30th May 2013 - Position 4

APPENDIX B
OBSERVED TRAIN MOVEMENTS USED FOR VIBRATION COMPARISON
(REAR OF 163 IVERSON ROAD, LONDON)

Store	Type	Direction	Station Notes
S001	*Background*		
S002	Intercity	W	Through
S003	Regular	W	Arriving
S004	Regular	W	Departing
S005	Regular	E	Arriving
S006	Regular	E	Departing
S007	Intercity	E	Through
S008	Intercity	W	Through
S009	Regular	E	Arriving
S010	Intercity	W	Through
S011	Intercity	E	Through
S012	Regular x2	W E	Departing Arriving
S013	*void*		
S014	Intercity	E	Through
S015	Intercity	W	Through
S016	Regular	E	Arriving
S017	Intercity	E	Through
S018	Regular	W	Departing
S019	Regular	W	Through
S020	Regular	E	Arriving
S021	Regular	E	Through
S022	Regular	W	Through

Table B1: Observed train movements at the rear of 163 Iverson Road, London – 29th May to 30th May 2013

Iverson Road, West Hampstead - 18hr and 24hr Traffic Data

24 Hour Traffic Data

	Posted Speed	Existing Baseline						Future Baseline 2028					
	Limit	24-hr AADT			Peak-period			24-hr AADT			Peak-hour		
Road Link	mph	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%
Iverson Road - West of Site (near Maygrove Road)	20	5396	173	3.21	996	32	3.21	6750	217	3.21	1246	40	3.21
Iverson Road - East of Site (near West End Lane)	20	5255	184	3.51	970	34	3.51	6574	230	3.51	1213	43	3.51
		Factor =	5.418	x				Growth Rate =		1.250859			

18 Hour Traffic Data

	Posted Speed	Existing Baseline						Future Baseline 2028					
	Limit	18-hr AAWT			Peak-period			18-hr AAWT			Peak-hour		
Road Link	mph	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%
Iverson Road - West of Site (near Maygrove Road)	20	4856	156	3.21	996	32	3.21	6074	195	3.21	1246	40	3.21
Iverson Road - East of Site (near West End Lane)	20	4729	166	3.51	970	34	3.51	5915	207	3.51	1213	43	3.51
		Factor =	4.875	x				Growth Rate =		1.250859			

Nightime Traffic Data

	Posted Speed	Existing Baseline						Future Baseline 2028					
	Limit	Nightime			Peak-period			Nightime			Peak-hour		
Road Link	mph	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%	Total vehic	Total HGV	HGV%
Iverson Road - West of Site (near Maygrove Road)	20	541	17	0	0	0	0	676	22	0	0	0	0
Iverson Road - East of Site (near West End Lane)	20	527	18	0	0	0	0	659	23	0	0	0	0

* Please note that nightime HGV movements are highly unlikely due to restrictions

Iceni Projects Notes

0700-1000 peak period used for factoring
18-hour AAWT from 06:00 to 24:00
Nightime traffic 24:00 to 06:00
Vehicle traffic expressed as 2-way volumes
Calculation factor to 18hrs derived from TfL Data
Calculation factor to 24hrs derived from TfL Data
Survey Flows of 14.5.13 provided by Traffic Surveys UK Ltd
NTM Growth Rates applied to replicate future year of 2028 (15 years from planning)

Table B2: Iceni Projects road traffic data

sol
acoustics

Albion Wharf, Albion Street, Manchester, M1 5LN

tel 0161 923 4844
fax 0161 923 4833
email info@solacoustics.co.uk

Waugh Thistleton Architects

Iverson Road, West Hampstead, London

Internal Sound Insulation Review

24 June 2013

PROJECT:	Iverson Road, West Hampstead, London Internal Sound Insulation Review
CLIENT:	Waugh Thistleton Architects
DOCUMENT REFERENCE:	P1498-REP02-SJF
SIGNED:	_____ SIMON FERENCZI
CHECKED:	_____ MATTHEW FISHER
DATE:	24 June 2013

CONTENTS

SUMMARY

Sol Acoustics Ltd (Sol) has been commissioned by Waugh Thistleton Architects Ltd (WTA) to conduct an outline internal sound insulation acoustic review of the current build intent relating to the Iverson Road residential development site located in West Hampstead, London.

The purpose of this report is to review the current, proposed details of the various building element constructional specifications (i.e. party walls, party floors, internal walls, dry lining to core walls, SVP bulkheads and proposed external doors), in outline terms.

Full details are provided within the report, including the outline advice concerning the ability of the current proposed scheme to attain the necessary airborne and impact sound insulation values between the various units. Where any shortfall(s) and/or potential opportunities for cost savings are identified, full information has been provided.

Additionally, generic acoustic design guidance regarding Section 7 of Approved Document E has also been given.

1.0 INTRODUCTION

Sol Acoustics Ltd (Sol) has been commissioned by Waugh Thistleton Architects Ltd (WTA) to conduct an outline internal sound insulation acoustic review of the current build intent relating to the Iverson Road residential development site located in West Hampstead, London.

The purpose of this report is to review the current, proposed details of the various building element constructional specifications (i.e. party walls, party floors, internal walls, dry lining core walls, SVP bulkheads and proposed external doors), in outline terms.

Full details are provided within the report, including the outline advice concerning the ability of the current proposed scheme to attain the necessary airborne and impact sound insulation values between the various units. Where any shortfall(s) and/or potential opportunities for cost savings are identified, full information has been provided.

Additionally, generic acoustic design guidance regarding Section 7 of Approved Document E has been given.

2.0 ACOUSTIC PERFORMANCE REQUIREMENTS

The statutory, numerical performance requirements of Approved Document E of the Building Regulations (ADE), relating to airborne sound insulation, must be achieved prior to completion of the development.

Table 1 lists the ADE acoustic performance requirements (for airborne and impact sound insulation) of constructions providing a separating function:

Additionally, Table 2 lists the *more stringent* airborne and impact sound insulation requirements of the Code for Sustainable Homes (CfSH), as detailed in Sustainable Homes 2009 Guidance Section HEA 2 – Sound Insulation.

It is understood that for this project, a 5dB enhancement above 'basic' Approved Document E requirements are required, namely 50dB $D_{nT,w}$ + C_{tr} and 57dB $L_{nT,w}$ for airborne and impact sound insulation respectively:

	Airborne sound insulation $D_{nT,w} + C_{tr}$ dB (Minimum values)	**Impact sound insulation $L_{nT,w}$ dB (Minimum values)**
Purpose built dwelling - houses and flats		
Walls	45	-
Floors and stairs	45	62

Table 1: Building Regulations 2000 Approved Document E: Purpose built dwelling-houses and flats - performance standards for separating walls, separating floors, and stairs that have a separating function

Credits	**Improvement on Approved Document E airborne sound insulation requirements $D_{nT,w} + C_{tr}$**	**Improvement on Approved Document E impact sound insulation requirements $L_{nT,w}$**
1	+3	-3
3	**+5**	**-5**
4	+8	-8

Table 2: HEA 2 Credit Summary – Improvement on Approved Document E

3.0 PARTY WALLS

As identified in Section 2 of this report, the minimum required weighted standardised level difference between dwellings at Iverson Road, via party walls, when measured on site, must be at least 50dB $D_{nT,w}$ + C_{tr} for airborne sound insulation, in order to achieve the minimum required acoustic performance standards cited by CfSH, in this instance.

It is understood that the current proposed party wall construction is as follows:

Party Wall Type B1 (350mm)

- 2 x 12.5mm plasterboard with 3mm plaster skim
- 25 mm service void using British Gypsum GypLyner
- 100 mm Cross Laminated Timber (CLT)
- 40 mm mineral wool (Isover Acoustic Partition roll or similar)
- 100 mm CLT
- 25 mm service void using British Gypsum GypLyner
- 2 x 12.5 mm plasterboard with 3mm plaster skim

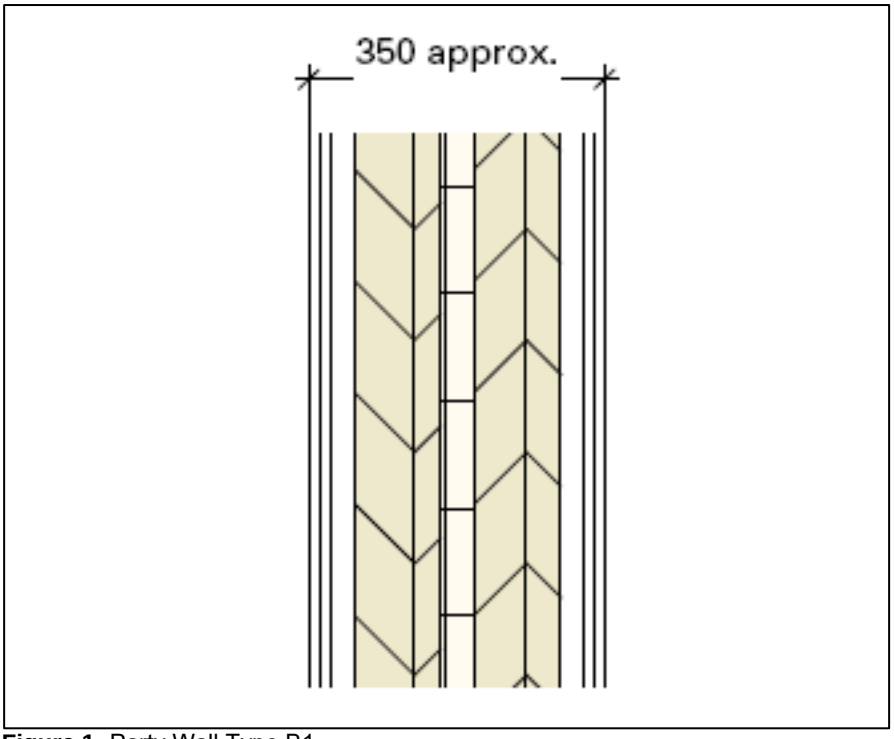


Figure 1: Party Wall Type B1

3.1 Outline Acoustic Advice

Party Wall Type B1

The currently proposed separating Party Wall Type B1 specification, as described above, is capable of achieving the 50dB $D_{nT,w}$ + C_{tr} performance required by CfSH, without further remedial enhancements. Others must advise on the thermal and fire requirements of the party wall.

By reference to the results of on-site sound insulation testing conducted by others, it is known that an alternative party wall construction, described below, when combined with the attendant external wall and party floor constructions (as also detailed below), is capable of achieving a sound insulation performance on site of at least 50dB $D_{nT,w}$ + $C_{tr.}$

Party wall construction:

- 2 x 15mm SoundBloc plasterboard
- 50 mm independent MF studwork, fully filled with mineral wool
- 128 mm KLH wall panel (CLT)
- 50 mm independent MF studwork, fully filled with mineral wool
- 2 x 15 mm SoundBloc plasterboard

External wall construction (for clarity, external cladding and insulation is omitted):

- 128 mm KLH wall panel (CLT)
- 2 x 15 mm SoundBloc plasterboard

Party floor construction:

- 55 mm Gyvlon screed
- Isover RD 25 acoustic insulation
- 146 mm KLH floor panel
- 110 mm MF suspended ceiling
- 50 mm mineral wool insulation inside ceiling cavity
- 1 x 15 mm SoundBloc plasterboard

Others would need to advise on structural, fire and thermal performance issues if the alternative constructions outlined above are considered for use on the project under discussion.

4.0 PARTY FLOORS

As identified in Section 2 of this report, the weighted standardised level difference between dwellings at Iverson Road via party floors, when measured on site, must be at least 50dB $D_{nT,w}$ + C_{tr} for airborne sound insulation and 57dB L_{nTw} for impact sound insulation, to achieve the minimum acoustic performance requirements cited by CfSH.

It is understood that the current proposed party floor construction is as follows:

Party Floor Type F2

- 15 mm surface finish
- 55 mm sand/cement screed with under-floor heading by WMS or similar
- 5 mm Yelofon edging strip to perimeter
- 25 mm Resilient layer of Isover Sound Deadening Floor Slab
- 160 mm CLT
- GypLyner universal ceiling providing minimum 75 mm clear ceiling void
- 50 mm Isover Acoustic Partition Roll (APR 1200) in the cavity
- 12.5 mm plasterboard with 3mm plaster skim

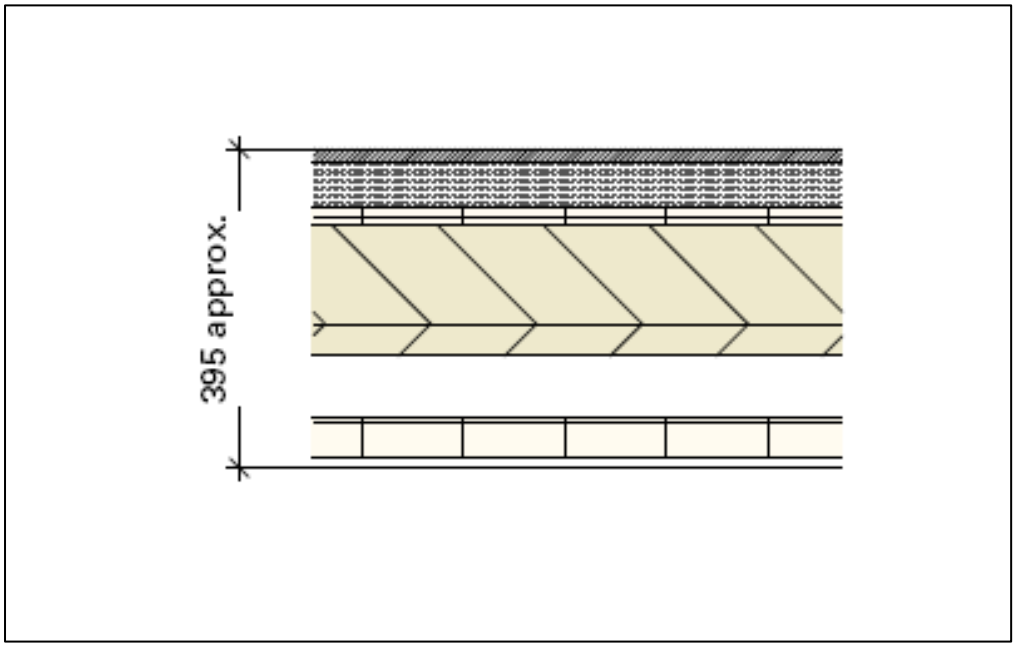


Figure 2: Party Floor Type F2

4.1 Outline Acoustic Advice

Party Floor Type F2

The proposed separating floor specification, as described above, is ***not*** **believed to be capable** of achieving the 50dB $D_{nT,w}$ + C_{tr} airborne and 57dB L_{nTw} impact performances required by CfSH.

The following changes to the described build up should be made:

- 1 x 12.5 mm plasterboard should be **upgraded to 1 x 15mm SoundBloc**

5.0 CORE WALLS

It is understood that the current proposed core wall construction is as follows:

Separating Wall between Apartments and Cores

- 2 x 12.5 mm plasterboard with 3mm plaster skim
- 25 mm service void using BG GypLyner
- 100 mm CLT
- 40 mm void
- 140 mm CLT (to stair side)
- 25 mm service void using BG GypLyner
- 2 x 12.5 mm plasterboard with 3mm plaster skim

5.1 Outline Acoustic Advice

5.1.1 Lift Cores

The proposed separating wall specification, as described above, is capable of achieving the performances required by ADE.

5.1.2 Stair Cores

The proposed separating wall specification, as described above, is capable of achieving the performances required by ADE.

6.0 INTERNAL WALLS WITHIN DWELLINGS

Approved Document E requires that internal walls between a bedroom (or a bathroom) and other rooms within dwellings that do not contain a door achieve a Weighted Sound Reduction Index of 40dB R_w.

On site acoustic testing of internal walls is not required, however, and furthermore, internal walls that contain a door between the rooms are not required to achieve any specific acoustic performance.

It is understood that the current proposed internal wall construction is a Gypwall Classic system – system reference A206001 and A206033. It is understood that this system will be upgraded to 60-90 minutes fire resistance where required:

Gypwall Classic A206001

- 1 x 12.5mm wallboard
- 48mm 'C' Stud
- 1 x 12.5mm wallboard

Gypwall Classic A206033

- 1 x 12.5mm wallboard
- 48mm 'C' Stud
- 25mm Isover APR 1200 in the Stud zone
- 1 x 12.5mm wallboard

6.1 Outline Acoustic Advice

Gypwall Classic A206001

The proposed internal wall specification, as described above, achieves a sound insulation performance of 34dB Rw and is ***not*** **capable of achieving** the 40dB Rw performance required by Approved Document E.

This wall type **may only** be used if it contains a door, as the 40dB Rw performance is not required for internal walls that contain a door.

Gypwall Classic A206033

The proposed internal wall specification, as described above, achieves the 40dB Rw performance required by ADE.

7.0 SOIL & VENT PIPES AND RAINWATER PIPES

Approved Document E of the Building Regulations requires that all pipework that passes through party floors must be separated from habitable rooms (e.g. living rooms, bedrooms) by boards that have a minimum mass of 15kg/m^2.

This requirement can be achieved by two layers of 12.5mm thick wallboard. The encasement must be lined internally with 25mm thick unfaced (i.e. not foil-faced) mineral wool (minimum density 10kg/m^3). The encasement could be lined on three sides with the mineral wool or alternatively the pipe could be lagged with the mineral wool, although others must advise if this could cause condensation problems.

In order to achieve the vertical sound insulation requirements of ADE, it is also recommended that this encasement be applied within bathrooms and kitchens.

It is important to ensure the stud framework supporting the plasterboard is not in direct contact with the pipework.

.

8.0 SOCKET OUTLETS IN PARTY WALLS

It is recommended that a putty pad be fitted into the back-box of sockets within party walls. A suitable intumescent mouldable putty pad for use with plastic or metal back-boxes would be the Hilti CP 617 Intumescent Acoustic Putty Pad. Contact details for Hilti are as follows:

- Hilti (Gt. Britain) Limited, 1 Trafford Wharf Road, Trafford Park, Manchester, M17 1BY, tel 0800 886 100, www.hilti.co.uk

Additionally, socket outlets should ideally be staggered and not located back-to-back on each side of the party wall.

9.0 MAIN APARTMENT ENTRANCE DOORS

Approved Document E of the Building Regulations requires that main doors between flats and common areas have *'good perimeter sealing (including the threshold where practical) and a minimum mass per unit area of 25 kg/m^2 or a minimum sound reduction index of 29dB R_w'.*

It is likely to be more cost effective to provide acoustic seals to a standard fire door (assuming that the mass of the door complies with the above), rather than provide a doorset with a specific acoustic rating.

A suitable combined smoke/fire and acoustic seal for the head and jambs of doors is the LP2004AS by Lorient. This is a twin-blade seal and must be installed such that one of the blades is continuous past the door ironmongery. A suitable threshold seal is the IS8010 automatic recessed seal by Lorient. Contact details for Lorient are as follows:

Lorient Polyproducts Ltd, Fairfax Road, Heathfield Industrial Estate, Newton Abbott, Devon, TQ12 6UD, tel 01626 834252, fax 01626 833166, www.lorientgoup.com

10.0 ABSORPTION IN ACOUSTICALLY SENSITIVE AREAS AND COMMON PARTS

Section 7 of Approved Document E

The stated Requirement E3 is as follows:

'The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable'.

Requirement E3 only applies to corridors, stairwells, hallways and entrance halls which give access to a flat or room for residential purposes.

Appraisal Methods

Section 7 of Approved Document E gives guidance on providing 'reasonable' conditions in common parts:

Entrance Halls, Corridors and Hallways

Two possible assessment methods are described in Section 7. "Method A" recommends the covering of an area equal to or greater than then the floor area with an acoustically absorptive material of specified acoustic properties. Typically, this would be achieved by installed an acoustically absorptive ceiling over the full ceiling area; it is recommended that the "Method A" prescribed advice is followed, in all cases.

"Method B" recommends that in corridors, a minimum of 0.25m^2 total absorption area per cubic metre of the total volume is provided. This recommendation applies to frequencies between 250 Hz and 4kHz inclusively.

Stairwells

For stairwells or a stair enclosure, the methodology required is to calculate the combined area of the stair treads, the upper surface of the intermediate landings, the upper surface of the landings (excluding ground floor) and the ceiling area on the top floor.

Either:

- Cover at least an area equal to this calculated area with a Class D absorber, or
- Cover an area equal to at least 50 % of this calculated area with a Class C absorber or better (this is normally the preferred, more cost effective route).

In all cases, the absorptive material should be equally distributed between all floor levels. It will normally be convenient to cover the underside of intermediate landings, the underside of the other landings, and the ceiling area on the top floor.

Email: tom@waughthistleton.com

3 December 2013

C/30557/L02/JDH

Tom Westwood
Waugh Thistleton
74 Paul Street
London
EC2A 4NA

Dear Tom

163 Iverson Road – Review of Facade Specification

Further to our review of the Sol acoustic report done for the Iverson Road project (our report C/30557/L01/JDH dated 25 November 2013) and our subsequent meeting with Environmental Health at Camden Council, I have addressed below the items raised in our meeting and I hope that the information is to the satisfaction of the Environmental Health department.

1. Glazing Specifications to Control External Noise Break-in

The EHO requested that we present the highest performing glazing that is practicable for use on the Iverson Road building. Five glazing types have been proposed and these represent the highest sound insulation performances that the manufactures are able to offer for this project:

- Idealcombi Futura+ [8.4mm laminated glass / 20mm cavity / 10mm glass]
- Idealcombi Futura+ [8.4 lam glass / 16mm cavity / 4mm glass + 10mm glass]
- Reynaers CS 68 ac_3813 Gasket [12.8 lam glass / 20mm cavity / 8.8mm lam glass]
- Olsen IV 92 ALU 2+1 SOiD [build-up unknown]
- Rationel Aldus [6mm glass / 18mm cavity / 8.4mm lam glass]

The table below shows the internal maximum noise level (L_{AFmax}) that would be achieved in a typical bedroom using each type of window for each of the maximum noise levels measured during the 8 hour night time surveys done by Sol (details in their report ref P1498-REP01-SJF dated 27 June 2013).

Note that some internal levels in the table below may in some cases be higher for a corresponding lower external level. This is due to the frequency content of the particular maximum noise level recorded.

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Registered Name and Address:
SRL Technical Services Ltd
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Little Waldingfield
Sudbury
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CO10 0TH
Registered Number: 907694 England

Table 1 – Internal Maximum noise Levels on Railway Facade

Position 1 (Railway)		Internal L_{AFmax} with Glazing Unit, dB				
External L_{AFmax}, dB	No. Maxs recorded over 8 hour night‡	idealcombi futura+ 8.4-20-10	idealcombi futura+ 8.4-16-4+10	Reynaers CS 68 ac_3813 12.8-20-8.8	Olsen IV 92 ALU 2+1 SOiD	Rationel Aldus 6-18-8.4
86	2	48	43	45	49	50
84	1	44	41	43	44	47
82	1	47	43	45	48	49
80	4	46	41	43	49	49
79	2	45	40	42	47	47
78*	4	43	40	41	44	45

Table 2 - Internal Maximum noise Levels on Iverson Road Facade

Position 2 (Road)		Internal L_{AFmax} with Glazing Unit, dB				
External L_{AFmax}, dB	No. Maxs recorded over 8 hour night‡	idealcombi futura+ 8.4-20-10	idealcombi futura+ 8.4-16-4+10	Reynaers CS 68 ac_3813 12.8-20-8.8	Olsen IV 92 ALU 2+1 SOiD	Rationel Aldus 6-18-8.4
93†	1	50	47	49	50	55
86	1	48	45	46	49	51
84	1	48	45	46	51	50
82	1	50	48	48	51	52
81	1	43	40	41	46	46
80	3	43	41	42	46	46
79*	3	42	40	40	44	45

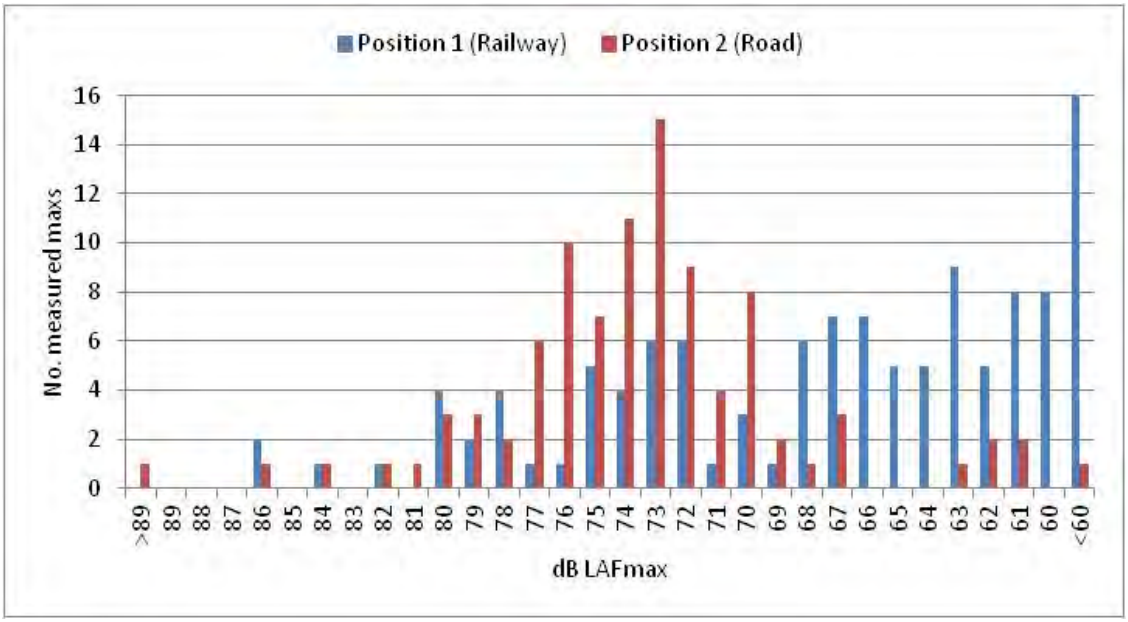
†The spectrum of this maximum shows more energy at higher frequencies and it is likely to be due to a siren on an emergency vehicle and as such is not considered typical.

*This is the level SRL have proposed to use as the typical maximum level, based on the WHO guidance that 10-15 occurrences of 45dB L_{AFmax} in bedrooms is acceptable.

‡Total number of L_{AFmax} levels recorded over 8 hour night: Position 1 – 469, Position 2 – 95.

The distribution of the maximum noise levels recorded is shown in the graph below for information.

Figure 1 – Maximum Levels from Sol Noise Survey (night time)



2. Railway-side Acoustic Fence

The Sol report specifies a “close-boarded, gap-free, 2.4m height... perimeter fence along the entire northern boundary and garden boundary...”

A concern was raised by the EHO that while the barrier would reduce railway noise levels in the garden areas, the barrier may increase the noise level at the facade of the building above the level of the top of the barrier.

This is not the case. A barrier will offer a reduction in noise level within its “Shadow Zone” and can also provide some reduction in level within its “Illuminated Zone” (see diagram in Appendix A). Outside of these zones, the barrier will have no effect on the sound propagating from the source.

Note that Chart 6(a)(ii) of Calculation of Railway Noise (HMSO) shows that for the illuminated zone, where the path difference is greater than 0.4m, the correction is zero. This is the case for the facade areas of the first floor and above of the Iverson Road building which the barrier will have no effect upon.

We have calculated the approximate reduction in railway noise that would be experienced in the gardens based on the barrier proposed by Sol, assuming the following:

- Source height: approx 3m
- Barrier height: 2.4m
- Receiver height: 1.5m
- Source-to-barrier distance: 24m (mid way between the 4 railway lines)
- Barrier-to-receiver distance: approx 5m

The gardens would be in the “shadow zone” and the barrier correction would be approximately 8dB. Based on a daytime noise level of 65.9dB $L_{Aeq,16hour}$, at Position 1 of the Sol report, the level in the gardens would be approximately 58dB $L_{Aeq,16hour}$.

3. Maximum Noise Level Measurement Periods

Details of the noise survey can be found in the Sol report and the maximum noise levels measured are also presented in our previous letter.

Sol measured in 1 minute periods at Position 1, overlooking the railway and in 5 minute periods at Position 2 overlooking Iverson Road. The data therefore presents the single highest noise level (L_{AFmax}) measured during the 1 or 5 minute period. It is noted that a better representation of the noise would have been a full time trace which would allow every occurrence over a given level to be seen in any time period.

However because a whole 8 hour night time period has been measured, we consider that there is a sufficient number of L_{AFmax} levels recorded to represent the type of events and the noise levels that typically occur.

It is clear that the highest maximum levels recorded, shown in Tables 1 and 2 above, are a small percentage of the total number of maximum levels and the distribution of maxima in Figure 1 shows that the vast majority are significantly lower.

The total number of *maxima* throughout the night may in reality be slightly higher than the data presents but the number of *events* that cause the maxima is likely to be well represented by the data and is therefore a reasonable indicator of the number of times that sleep disturbance may occur in an 8 hour period.

For example a train passing which produces a maximum level of 86dB L_{AFmax} may also produce slightly lower maxima during the duration of its passing by, but it is the *event* of the train passing and producing a high maximum that may cause sleep disturbance, not necessarily the number of maxima that occurred within the period of that event.

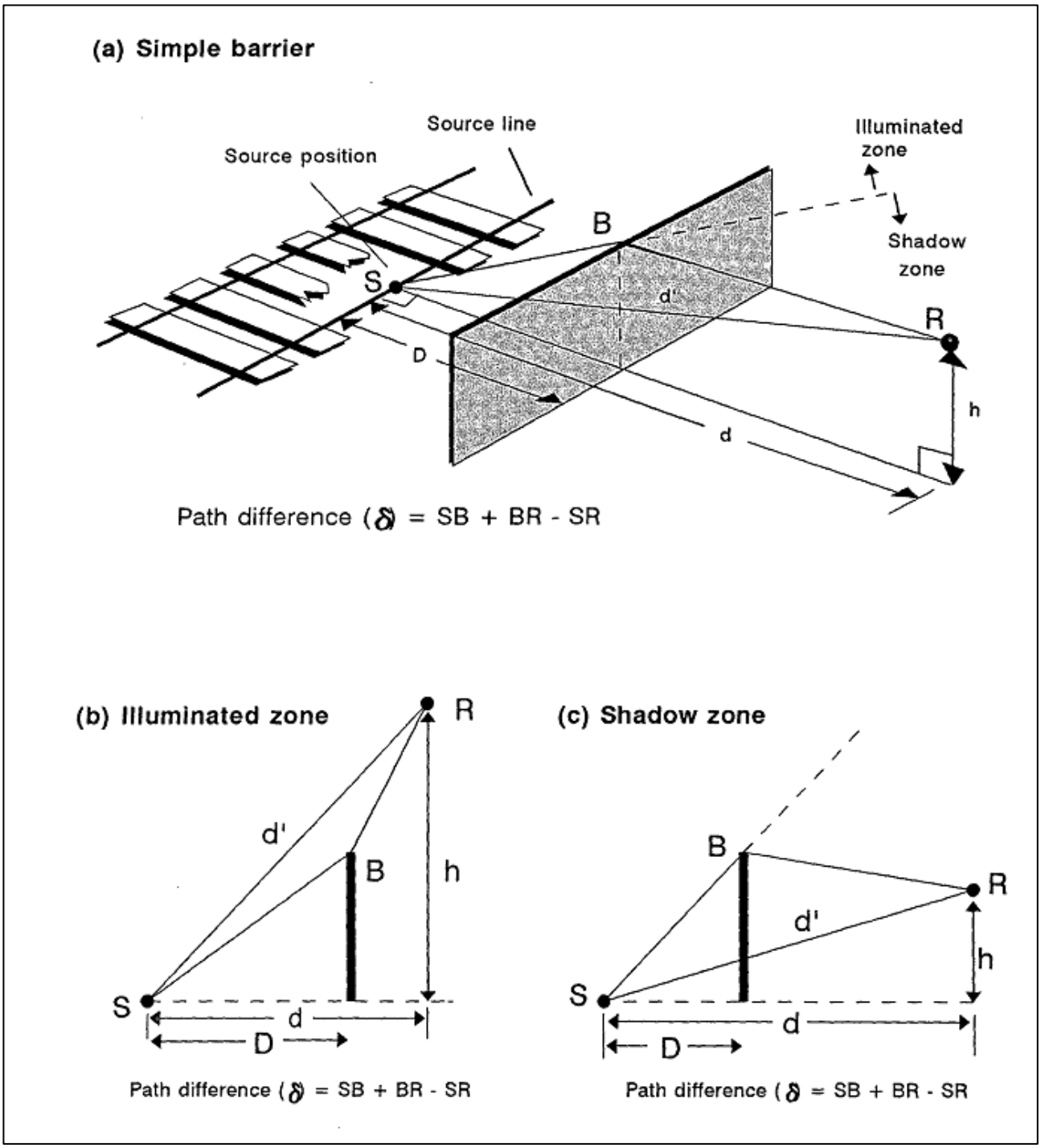
Of course, two or more distinct events may occur within the 1 minute or 5 minute measurement period and only the single highest level is recorded, but at night it is unlikely that multiple “events” would occur in the same measurement period regularly and therefore the data from the Sol report is considered a good representation of the number of potential sleep disturbance events over the night.

I trust the above is clear. Please contact me if you have any queries.

Yours sincerely

Jonathan Howson
For and on behalf of
SRL Technical Services Limited
Tel: 0161 929 5585
Email: jhowson@srltsl.com

Appendix A – Diagram showing barrier corrections taken from Calculation of Rail Noise 1995



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Planning Report

Project 163 Iverson Road

No 1-475

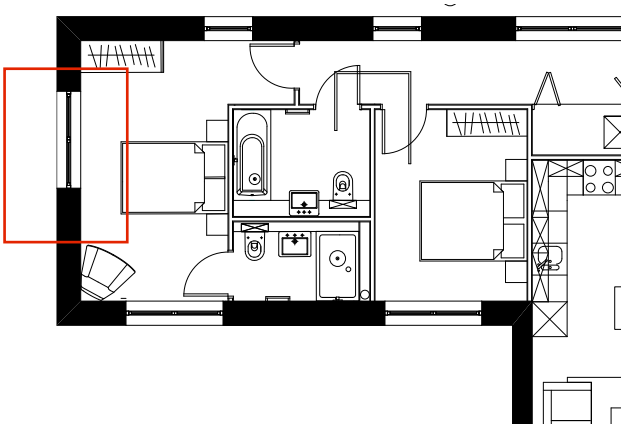
Date 17/12/2013

LPA Ref: 2013/6014/PRE & 2013/4129/P

Re. Tree house windows - to be read in conjunction with acoustic update C/30557/L02/JDH

The windows at the far end of the treehouse element of the scheme were originally designed as large openings however, as has been previously discussed with Camden officers, it is not possible to meet acoustic criteria with windows of this size. It is therefore proposed to reduce the maximum possible size that still meets the acoustic requirements

Previously submitted view of windows



Plan showing location of windows.

The windows, opening onto bedrooms, have been designed to follow the guidance in the latest Acoustic report from SRL C/30557/L02/JDH - 163 Iverson Road - Review of Facade Specification, which is issued with this report.

SRL have confirmed that the currently proposed sizes of these windows cannot be increased. This is conformed in an email which is attached to this report and quoted below:

> *" in order to achieve the internal LAFmax levels which have been presented to the EHO at Camden (namely those in Table 1 of our letter C/30557/L02/JDH), in bedrooms of the Treehouse apartments, the glazing areas cannot be increased over the currently proposed areas (3.75m^2 and 0.86m^2 overlooking the railway)"*

N.B. the windows indicated are the end window (at 3.75m^2) and the side window (at 0.86m^2)

Thus we can amend the shape and arrangement of the windows but not increase the overall open area.

Working within these constraints we have developed three options in addition to that earlier proposed, which redistribute the area of glazing to this façade. These can be found on the following pages.

Option 1

Windows separated into four portrait windows.

Option 2

Four portrait windows evenly spaced.

Option 3

Stretched longer windows.

Originally submitted

Single opening

Noise Assessment Report

159 – 161 Iverson Road, West Hampstead

Ocotober 2014

REPORT REF: NA/IR/20140925-RK

NRG Consulting— Studio 7, Third Floor, 138-148 Cambridge Heath Road London, E1 5QJ

T:0207 998 6481

CONTENTS:

DOCUMENT CONTROL SHEET:

Rev.	Issue Purpose	Author	Signature	Checked	Signature	Date
A	For Initial Comment	Robert Kimber		Paul Canessa		25/09/2014
B	Client Revisions	Paul Canessa		Ryan Thrower		01/10/2014

Executive Summary

This document presents the assessment criteria of noise and vibration related Planning Conditions given in the permission for application 2013/7505/P dated 21 February 2014. Assessment for Planning Condition 6 relating to internal noise levels and Planning Condition 15 relating to external noise levels is presented.

The assessment shows the proposed scheme of sound insulation is sufficient to satisfy the requirements of Planning Condition 6.

The assessment for Planning Condition 15 shows that best practicable means have been employed to give provision for protection against external noise levels. Without possibility of further feasible attenuation measures it is recommended that noise levels higher than the requirements of Planning Condition 15 are accepted for both communal and private external amenity spaces.

As agreed with the case officer, the assessment for condition 14 will occur on the actual piles supporting the building – due in Oct/Nov 2014

Introduction

This report has been produced to assess the Consented Development at Iverson Road in accordance with the requirements of Planning Conditions 6a, and 15a of decision for application 2013/7505/P dated 21 February 2014. The development is two buildings ranging between one and six stories, comprising 19 residential units (Class C3), and 164sqm of employment floor space (Class B1c).

Within this document is a reproduction of the Planning Condition wording, summary of environmental noise data used and details of relevant construction proposals. Reference is made to manufacturer laboratory test data for similar systems is used to inform a statistical energy model of the build ups. The proposals are rated in terms of their apparent sound reduction index and likely in situ performance or resultant level difference.

The environmental noise survey data used in the assessments are from the reports 13P282 JT R1260-188A A[i] and P1498-REP01-SJF[ii]. The latter was submitted to Camden Planning Authority in support of the Planning Application for the adjacent site 163 Iverson Road; data has been reviewed and used to inform the assessment of 159 -161 Iverson Road due to the lack of accurate environmental noise data charactering Iverson Road in the former report. The environmental noise levels presented in the report for 163 Iverson Road agree with the broad L_{den} dB noise levels indicated by the DEFRA Noise Map[iii] .

Assessment Criteria

Planning Condition 6

The exact wording of Planning Condition 6 has been reproduced below for ease of reference.

a) Before building works commence on the site, a sound insulation scheme shall be submitted to and approved by the Local Planning Authority providing for the insulation of the proposed dwelling unit(s) so that externally generated noise from railway and road traffic do not cause internal noise levels to exceed an indoor ambient noise levels in unoccupied rooms of 30 dB(A) L_{Aeq} (1hour) and individual noise events shall not exceed 45 dB LAmax The development shall be carried out in accordance with the approved scheme and in such a manner to ensure that the above noise levels (from railway and road traffic) are maintained thereafter.

b) On completion of development, a test on each dwelling shall be carried out to verify compliance with this condition. A report shall be produced containing all raw data and showing how calculations have been made. The development shall not be occupied until a copy of the report has been submitted to and approved in writing by the Local Planning Authority. The report shall set out standards used, measurements locations, raw tabulated and graphically represented data, time, date etc.

The assessment in the following section address requirement a) of the above. It is assumed that the noise level limits apply to all habitable rooms, during both day time and night time periods. The LAmax dB parameter quantifies transient events when applied to transportation noise, such as a passing motorbike, release of pneumatic pressure on an HGV. As the highest LAmax dB noise level incident at a road traffic kerb has significant variation from individual events, the LAmax dB noise level typically not exceeded more than 10 to 15 times in a night is usually considered as suggested to be a suitable criteria by WHO Guidelines[iv].

Planning Condition 15

The exact wording of Planning Condition 12 has been reproduced below for ease of reference.

a) Before building works commence on the site, a scheme shall be submitted to and approved by the Local Planning Authority providing full details of the acoustic measures to be incorporated to ensure that the steady noise level does not exceed 50 LAeq,T dB in open spaces (including balconies) and open communal areas.
The development shall be carried out in such a manner to ensure that the above noise levels (from railway and road traffic) are to be retained (including maintenance) for the next 15 years.

b) Prior to occupation a survey of each open communal amenity area including balconies shall be carried out to verify compliance with condition 15(a). A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to the Local Planning Authority for its approval in writing. The report shall include details of standards used, measurements locations, raw tabulated and graphically represented data, time, date etc.

The following section address the requirement of Planning Condition 15a.

Planning Condition 8

The exact wording of Planning Condition 8 has been reproduced below for ease of reference.

Prior to commencement on the relevant part of the development details of all internal/external plant, including an acoustic report which demonstrates that the equipment will comply with the requirements of condition 22 shall be submitted to and approved in writing by the local planning authority. The development shall be carried out in accordance the details thus approved and shall thereafter be maintained in effective order to the reasonable satisfaction of the Council.

It is interpreted that the "relevant part" of the development is the installation of any such building services plant that may emit noise levels in its operation. As details of the building services plant have not yet been determined the requirement of Planning Condition 8 is not addressed in this report

Planning Condition 14

The exact wording of Planning Condition 14 has been reproduced below for ease of reference.

a) Before building works commence on the site, a scheme shall be submitted to and approved in writing by the Local Planning Authority providing for adequate insulation of the proposed dwellings to prevent the transmission of vibration from road and railway traffic causing any discomfort to its occupants as measured and interpreted by BS.6472:1992 "Evaluation of human exposure to vibration in buildings [1 Hz to 80 Hz]."

b) The survey, as cited in acoustic report ref: 13P282 JT R1 260 - 188AA shall be carried out.

It is interpreted that "Before building works commence on the site" does not include demolition of existing buildings and enabling ground works. The vibration survey methodology in acoustic report ref: 13P282 JT R1 260 - 188AA is cited:

1. Measurement of ground-borne vibration in accordance with BS6472 at commencement of enabling groundwork's on site at two monitoring locations

2. Analysis and assessment of ground-borne vibration in accordance with BS6472 and LB Camden criteria to determine if perceptible vibration is acceptable in residential units at all floors.
3. Where assessment shows control of ground-borne vibration is required to comply with requirements of BS6472 and LB Camden criteria, develop a control scheme to include building isolation and separation of structure, fabric and services from ground. Submit report of vibration control scheme to LB Camden for review and approval.
4. Implement control scheme in full as agreed during construction.

Item 1 would need to take place on implementation or at least when enabling works on site allow the digging of test pits or setting of test piles.

Item 2 and 3 would need to occur at the earliest stage possible due to the cost and design implications of such control measures on structural and architectural requirements.

Item 4 would need to be an integral element of the construction process and not seen as an adjunct to it.

It is not economically feasible to bore "test" piles, all piling operations have to be completed when the piling rig is on site in one phase. A pit to the same depth of piles would not be safe or economic to construct. Therefore it has been agreed with London Borough of Camden Planning Case Officer for this development that the vibration survey will be conducted on the actual piles that will support the building. The survey and assessment is currently programmed for October /November 2014, hence this report contains no further address of Planning Condition 14 requirements.

Planning Condition 6 Assessment

The environmental noise survey reported in 13P282 JT R1260-188A A (Aulos Acoustics) undertaken in support of the Planning Application 2013/7505/P characterized noise levels incident near the railway boundary of the site at approximately the proposed northern façade. The noise survey did not however characterize noise levels incident at the boundary with Iverson Road. The noise levels incident at the proposed southern façade has been determined from noise survey reported in P1498-REP01-SJF (Sol Acoustics) submitted in support of a Planning Application for residential development on the neighboring site at 163 Iverson Road.

The noise survey reported in 13P282 JT R1260-188A A was conducted between Wednesday 30th October 2013 and Sunday 3rd November 2013. The survey data is considered representative of current environmental noise levels at the northern boundary. The noise survey reported in P1498-REP01-SJF was conducted between Wednesday 29th May 2013 and Thursday 30th May 2013. The free field external noise levels from both reports are summarized as shown in Table 3 below.

Table 3: Free field external noise levels as reported in 13P282 JT R1260-188A A and P1498-REP01-SJ

Position	***Period T***	***$L_{Aeq\ T}$ dB***	***L_{Amax} dB***
Railway Façade	Day 16 hour	61.0 dB	- dB
Railway Facade	Night 8 hour	53.0 dB	64.0dB
Iverson Road Façades	Day 16 hour	63.0 dB	- dB
Iverson Road Façades	Night 8 hour	58.0 dB	46 to 93 dB*

*Range of LAmax dB noise levels reported in the summary. The noise level used for this assessment has been taken from review of the Graph A4 in P1498-REP01-SJ. It is considered appropriate that the night levels of 78 dB L_{Amax} at Position 2 is used for night time noise levels and78 dB L_{Amax} for day time noise levels.

The Noise Mapping England prediction shows Lden dB noise level contours based on traffic sources. The location of the proposed façade is within the 60 dB (A) to 65 dB (A) noise band for both rail and road traffic. The summary of noise levels in Table 3 agrees with the Noise Mapping England prediction.

The spectrum of noise levels at each façade for day time and night periods has been determined from the data presented in reports 13P282 JT R1260-188A A and P1498-REP01-SJ. The spectral levels have been uniformly adjusted to meet the overall levels considered for assessment, according to the more appropriate night time L_{Amax} dB noise levels and are shown in Table 4 below.

Table 4: Noise Levels used in PC12 Assessment

Position	***Period T***	***Noise Level dB(A)***	***63 Hz***	***125 Hz***	***250 Hz***	***500 Hz***	***1000 Hz***	***2000 Hz***	***4000 Hz***	***8000 Hz***
Railway Façade	Day $L_{eq\ 16hr}$ dB	61	-	58.3	57.6	57.7	57.2	52.3	48.8	46.7
Railway Facade	Night $L_{eq\ 8hr}$ dB	53	-	50	49.1	48.5	46.2	41.6	46	47.2
Railway Facade	Typical Night L_{max} dB	64	-	60.7	57.9	58.2	55.5	52	58.2	59.3
Iverson Road Façades	Day $L_{eq\ 16hr}$ dB	65	69	63	58	58	60	55	52	-
Iverson Road Façades	Night $L_{eq\ 8hr}$ dB	55	64	57	54	53	54	52	49	-
Iverson Road Façades	Typical Night L_{max} dB	78	-	78.1	74.1	73.1	71.1	69.1	70.3	71.4

To predict internal noise levels with closed windows and either acoustically attenuated passive ventilation and mechanical extract or mechanical supply and extract ventilation, the sound insulation performances of the building envelope has been estimated. The calculation of internal noise levels has been based on a derivation from the empirically derived methodology set out in BS 12354 -3[v] and that in BS 8233: 2014[vi]. Estimated sound insulation of building elements and other calculation inputs are outlined below based on information provided. These outlines do not constitute a design specification.

The external wall construction throughout is considered to be of the form:

- 40 mm Stone rainscreen cladding
- 25mm Frame system
- 50mm Kingspan Kooltherm K8 Cavity Board
- 50mm Steel C Stud

2 x15mm Plasterboard + skim
Predicted apparent weighted sound reduction index: R'_w 57 dB (-4 Ctr)

The acoustic performance requirement for the windows varies depending on the location and orientation. The window types are listed below in Table 5. The glazing selection is from Saint Gobain laboratory test data, the performance is for the glass however the frame selected has to be acoustically suitable for the rating. The trickle ventilator acoustic performance data is from laboratory tests of the RW Simon Duco range.

Table 5: Glazing and Ventilation Acoustic Performance

Facing	*Level*	*Room*	*Glazing Rw + Ctr dB*	*Glazing Configuration*	*Ventilation Dnew dB*	
West	All Floors	Living	Rw 34, -4Ctr dB	4 (20) 6	Dnew 41 dB	Corto 10
West	All Floors	Bed	Rw 34, -4Ctr dB	4 (20) 6	Dnew 44 dB	Medio 10
Railway	All Floors	Bed	Rw 39, -3Ctr dB	10 (12) 12	Dnew 44 dB	Medio 10
East	All Floors	Living	Rw 34, -4Ctr dB	4 (20) 6	Dnew 41 dB	Corto 10
East	All Floors	Bed	Rw 39, -3Ctr dB	10 (12) 12	Dnew 44 dB	Medio 10
Iverson	All Floors	Living	Rw 45, -4Ctr dB	12 (20) 8.8 Silence	Dnew 47 dB	Alto 10
Iverson	All Floors	Bed	Rw 45, -4Ctr dB	12 (20) 8.8 Silence	Dnew 47 dB	Alto 10

The Dnew dB value of the product selected must be adjusted according to the number of ventilators fitted.
Dnew dB shall be increased by: 10 Iog10 S / S_{ref}
where S is the total vent area and S_{ref} is the vent reference area (in m^2) at which the $D_{n,\,e,\,w}$ dB value was measured.

To put it simply, each double in free area required increase the Dnew dB requirement by 3 dB; so if two trickle vents are required, these should each be rated $D_{n,e,w}$ 36 dB to achieve an overall performance of $D_{n,e,w}$ 33 dB. The number of ventilators required should be calculated in accordance with Approved Document F, using details of the ventilator free area, mechanical extract duty, and occupancy levels.

The room furnishings will have an effect on noise levels measured in the built development. Reverberant sound energy will add to the energy transmitted through the façade elements. It is often assumed that a domestic living room or bedroom has a reverberation time of 0.5 seconds. An estimate of the furnished but unoccupied rooms has been made, including essential items such as a bed in bedrooms, kitchen cupboards in the kitchen and a sofa in the living room. It is acknowledged that the commissioning tests are required by the Planning Condition to be conducted prior to occupation and will therefore not have beds or sofas. The measured values will be normalized to a reverberation time of 0.5 seconds to account for such differences.

The calculation of internal noise levels has been based on a derivation from the empirically derived methodology set out in BS 12354 -3[vii] and that in BS8233: 2014. The results of calculation for day time internal $L_{Aeq,\ 16\ hr}$ dB noise levels are set out in Table 7 below, based on mechanical extract with supply via trickle ventilators.

Table 7: Predicted Internal $L_{Aeq\ 16hr}$ dB, $L_{Aeq\ 8hr}$ dB and L_{Amax} dB Noise Levels

Façade Facing	**Floor Level**	**Room**	**Period T**	**Internal $L_{Aeq,\ T}$ dB**	**Internal L_{Amax} dB**	**Noise Level Limit**	**Margin**
West	All Floors	Living	Day 16 hour	29	-	L_{Aeq} 30 dB	1 dB
West	All Floors	Living	Night 8 hour	21	-	L_{Aeq} 30 dB	9 dB

West	All Floors	Bed	Day 16 hour	27	-	L_{Aeq} 30 dB	3 dB
West	All Floors	Bed	Night 8 hour	18	29	L_{Aeq} 30 dB and L_{Amax} 45 dB	L_{Aeq} 12 dB and L_{Amax} 16 dB
Railway	All Floors	Bed	Day 16 hour	30	-	L_{Aeq} 30 dB	0 dB
Railway	All Floors	Bed	Night 8 hour	21	31	L_{Aeq} 30 dB and L_{Amax} 45 dB	L_{Aeq} 9 dB and L_{Amax} 14 dB
East	All Floors	Living	Day 16 hour	29	-	L_{Aeq} 30 dB	1 dB
East	All Floors	Living	Night 8 hour	21	-	L_{Aeq} 30 dB	9 dB
East	All Floors	Bed	Day 16 hour	27	-	L_{Aeq} 30 dB	3 dB
East	All Floors	Bed	Night 8 hour	18	29	L_{Aeq} 30 dB and L_{Amax} 45 dB	L_{Aeq} 12 dB and L_{Amax} 16 dB
Iverson Road	All Floors	Living	Day 16 hour	30	-	L_{Aeq} 30 dB	0 dB
Iverson Road	All Floors	Living	Night 8 hour	24	-	L_{Aeq} 30 dB	6 dB
Iverson Road	All Floors	Bed	Day 16 hour	30	-	L_{Aeq} 30 dB	0 dB
Iverson Road	All Floors	Bed	Night 8 hour	24	42	L_{Aeq} 30 dB and L_{Amax} 45 dB	L_{Aeq} 6 dB and L_{Amax} 3 dB

The analysis has shown that with the proposed construction forms all internal accommodation spaces can be constructed so that noise levels are within the Planning Condition 6 noise level requirements.

Mechanical extract or mechanical supply and extract systems are to be selected to that the combined environmental and services noise levels do not normally exceed L_{Aeq} 30 dB.

Planning Condition 15 Assessment

External noise levels reported at ground level in P1498-REP01-SJ were 65.4dB L_{Aeq} (16-hour). Where an acoustic barrier is installed at 2.4 meter height attenuation of 10dB may be given whilst in the barrier shadow zone. Such barrier is unlikely to provide 10 dB (A) attenuation at distance of more than 5m from the barrier. A larger barrier of approximately 5m would provide noise levels of less than 50 dB (A) up to 10m away. However, such a barrier would not be feasible due to visual implications. It is suggested that noise levels up to 55 dB (A) such be accepted due to impracticality of greater attenuation.

The proposed balconies on the Iverson Road façade will be exposed to noise levels of 65dB L_{Aeq}(16-hour). In order to attenuate external noise levels to less than 50 dB (A), the balconies would need to be fitted with a complete enclosure, and fitted with acoustically attenuated ventilation.

An alternative would be to provide 2m high toughened glass screens, and fit the walls and ceiling of the balcony with acoustically absorbent material. Such an arrangement would likely provide similar attenuation to an open window, approximately 10 dB (A), although in situ the level difference is more likely to be 6 to 8 dB(A) as it is unlikely sufficient absorption material can be fitted. External noise levels are therefore likely to be in the region of 57 to 59 dB (A) with this arrangement.

In consideration of balcony ambient noise levels generally, it should of course be borne in mind that these are not habitable spaces; residents have a choice as to whether or not they are used, at any given time.

Conclusion

NRG Consulting has carried out an assessment of the Consented Development at 159 – 161 Iverson Road, in accordance with the criteria of Condition 6 and 15 of permission dated dated 21 February 2014 of Application 2013/7505/P. The environmental noise levels used in assessment for Planning Condition 6 have been determined from reports 13P282 JT R1260-188A A[viii] and P1498-REP01-SJF[ix]. Sound insulation values for the proposed external wall, glazing and ventilation elements has been estimated from manufacturer data and calculation.

The assessment shown that all of the bedrooms and living rooms will achieve noise levels not greater than the requirements of Planning Condition 6.

The installation of an acoustic barrier between the development boundary and ground floor external amenity area will provide some protection from noise of rail traffic movements. Without possibility of further feasible attenuation measures it is recommended that noise levels higher than the requirements of Planning Condition 15 are accepted.

In view of all the above, the information presented with regard to the imposed Planning Conditions 6 and 15 is considered acceptable, in our opinion.

References

[i] Environmental Noise Assessment Report, Aulos Acoustics, November 2013
[ii] Environmental Intrusive Noise & Vibration Study, Sol Acoustics June 2013
[iii] Noise Mapping England, http://services.defra.gov.uk/wps/portal/noise/maps Accessed 23/09/2014
[iv] Guidelines for Community Noise, World Health Organisation, April 1999
[v] BS 12354 -3: 2003 Building acoustic - Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound
[vi] BS 8233: 2014 - Guidance on sound insulation and noise reduction for buildings. BSI February 2014
[vii] BS 12354 -3: 2003 Building acoustic - Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound
[viii] Environmental Noise Assessment Report, Aulos Acoustics, November 2013
[ix] Environmental Intrusive Noise & Vibration Study, Sol Acoustics June 2013

REPORT TITLE:

159-161 Iverson Road, NW6 2HE: Noise Assessment relating to Planning Conditions 6 &15

CLIENT DETAILS:

Formation Design and Build

DATE:

25th April 2016

REPORT REFERENCE:

PC-15-0257-RP1-REV-C

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Contents

1. Introduction

Pace Consult Limited has been commissioned by Formation Design and Build to undertake ambient noise assessment at 159 -161 Iverson Road, West Hampstead NW6 2HE

This report assesses internal and external ambient noise levels, with the primary goal to allow planning conditions 6b and 15b to be discharged as applicable. It has been prepared in accordance with the relevant national standards and guidelines including British Standard BS8233: 2014, 'Guidance on sound insulation and noise reduction for buildings' and also WHO document 'Guidelines for Community Noise 1999'

The site is shown in figure 1 and 2 to the rear of this report.

2. Assessment Methodology

2.1 Perception

Noise is defined as unwanted sound. Human ears are able to respond to sound over the frequency range of about 20 Hz to 20 kHz and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, and is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates to the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear. To help understand the range of noise levels which may be encountered, an indication of the level of some common sounds on the dB(A) scale is given in the table below.

Table 1: Common Sounds on the dB(A) Scale

dB(A)	Description
140	Threshold of pain
120	Jet take off at 50 metres
100	Maximum noise levels on an underground platform
80	Kerbside of a busy urban street
60	Busy general office
40	Residential area at night
20	Background in a TV and recording studio
0	Threshold of hearing

Furthermore, the perception of noise may be determined by a number of other factors, both acoustic and non-acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In addition, the time of day and other acoustic features such as tonality may be important, as may the disposition of the affected individual receptor.

Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that corresponds to the response of the human ear is the A-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90}, etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) of a steady source is generally regarded as the minimum difference needed to perceive a change.

2.2 BS8233:2014 Guidance on sound insulation and noise reduction in buildings

This standard gives guidance on desirable acoustic criteria and limits which are appropriate for domestic rooms for living and sleeping as outlined in table 4 of BS8233:

Table 4 **Indoor ambient noise levels for dwellings**

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	—
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	—
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

This document also provides the following notes regarding instances when the above levels may not be achieved:

NOTE 3 These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

NOTE 4 Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values.

Collectively, Table 4 and note 7 from BS8233 provide a 'good' to 'reasonable' design range for indoor ambient noise levels.

In addition to be the above, BS8233 also provides desirable limits for external amenity space:

Design criteria for external noise

For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

2.3 Planning Conditions

As part of the proposed development, Camden Planning Authority have imposed planning conditions 6b & 15b which are included below. It is understood the sound insulation scheme (6a-15a) has been provided by others.

Planning Condition 6:

a) *"Before building works commence on the site, a sound insulation scheme shall be submitted to and approved by the Local Planning Authority providing for the insulation of the proposed dwelling unit(s) so that the externally generated noise levels in unoccupied rooms of 30dB$_{LAeq}$ (1 Hour) and individual noise events shall not exceed 45dB L_{Amax}….."*

b) *"On completion of development, a test on each dwelling shall be carried out to verify compliance with this condition (6a). A report shall be produced containing all raw data and showing how calculation have been made. The development shall not be occupied until a copy of the report has been submitted to and approved in writing by the Local Planning Authority.*

Planning Condition 15:

a) *"Before building works commence on the site, a scheme shall be submitted to and approved by the Local Planning Authority providing full details of the acoustic measures to be incorporated to ensure that the steady noise level does not exceed 50dB $L_{Aeq\ T}$ in open spaces (including balconies) and open communal areas. The development shall be carried out in such a manner to ensure that the above noise levels (from railway and road traffic) are to be retained (including maintenance) for the next 15 years."*

b) *"Prior to occupation a survey of each open communal amenity area including balconies shall be carried out to verify compliance with condition 15(a). A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to the Local Planning Authority for its approval in writing. The report shall include details of standards used, measurements locations, raw tabulated and graphically represented data, date, time etc."*

Regarding planning condition no.6, it is assumed the target level of 30dB$_{LAeq}$ (1 Hour) relates to bedroom type rooms for the night time hours 23:00 - 07:00, in keeping with table no.4 of BS8233. It is also understood a deviation from the above planning requirements is permitted, in that noise level measurements on each façade is acceptable to demonstrate reasonable internal ambient noise levels within habitable rooms.

Dealing with the L_{max} levels, the current version of BS8233 lacks definitive guidance on what can cause sleep disturbance for the end user in terms of number of external events. Therefore, direction has been taken the World Health Organisation (WHO) document 'Guidelines for Community Noise- April 1999', where the following is stated:

> *'For good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10-15 times per night…..'*

3. Noise Survey Details

3.1 Survey Information

A noise survey was carried out on site between 20th-21st & 23rd - 25th January 2016. Additional measurements were undertaken 19th-22nd April within the North and West façade of Block B. The sound level meters were positioned 1.5 m above ground level (tripod mounted), and within bedroom type rooms, all trickle ventilators were open during the survey. The noise levels measured are representative of the existing noise climate at the facades of nearest sensitive receptors.

External levels were also measured in the open communal area between Block A & B within level 1 and on the Iverson road side façade within outdoor private balcony space.

Measurements were taken in accordance with the principles of BS 7445:2003 Parts 1 (2003) & 2-3(1991), 'Description and Measurement of Environmental Noise'.

Measurements were made with calibrated precision grade sound level meters which achieve the requirements of BS EN 61672: 2003. The sound level meters were calibrated before and after each survey. No significant drift was noted between the two reference checks

The noise parameters L_{Aeq}, L_{A90} and $L_{Amax(fast)}$ have been monitored and the relevant values obtained for daytime, evening and night periods. Measurements were taken in third octave bands, but noise limits later in this report are to be set as single figure 'A' weighted values rather than octave or third octave levels. The measurement positions (MP) are shown in figure 1.

3.2 Equipment Details

- Svan971 Precision grade sound level meter. Serial number: 34927 (Calibration due: October 2017).
- Svan 971 Precision grade sound level meter. Serial number: 34931 (Calibration due: October 2017).
- Svan971 Precision grade sound level meter. Serial number: 34937 (Calibration due: October 2017)
- Norsonic 1251 class 1 calibrator. Serial number 31326 (Calibration due: October 2016)
- Environmental wind shields.

3.3 Weather

In order to evaluate the weather conditions two weather check measurements were undertaken on site. During the weather checks, it was noted that the climatic conditions were stable during the whole survey period. There was around 50% cloud cover during the survey.

Table 2 : Weather conditions

Time	Location	^{o}C	Wind speed m/s	Relative Humidity %
13:30 (23/01/16)	MP1	7.9	0.5	51.4
08:40 (25/01/16)	MP2	8.7	0.8	55.2

The weather conditions were measured using a Pocket weather tracker KESTREL 4500.

4. Summary of Noise Level Measurements

Please see below a summary of noise measurements recorded at the various monitoring locations measured across the site within bedroom spaces. The acoustic parameter L_{Amax} dB, is displayed as the 90th percentile for the measurement period, which is deemed to provide a robust assessment.

4.1 Results

The tables below show the measured indoor ambient noise levels.

Table 3: MP1 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90th Percentile)
Night (23:00-7:00)	25	44

Table 4: MP2 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90th Percentile)
Night: 19/04/2016 (23:00-7:00)	23	42

Table 5: MP3 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90th Percentile)
Night: 20/04/2016 (23:00-7:00)	30	45

Table 6: MP4 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90^{th} Percentile)
Night:19/04/2016 (23:00-7:00)	24	44

The tables below show the measured external ambient noise levels.

Table 7: MP5 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90^{th} Percentile)
Daytime (7:00-23:00)	63	N/A

Table 8: MP6 Noise Measurements		
Time	$L_{Aeq,T}$ dB (Log Average)	L_{Amax} dB (90^{th} Percentile)
Daytime (7:00-23:00)	52	N/A

4.2 Uncertainty

All possible efforts to reduce uncertainty in this assessment have been taken. There will always be an element of uncertainty in the noise measurements and calculations.

The following steps were taken to reduce the level of uncertainty within the sound level measurements:

- The sound level meters were immediately calibrated before and after the survey, the difference between the initial calibration value, and the final calibration check on completion of measurements did not exceed ± 0.5 dB
- The external noise measurements were undertaken during favourable weather conditions.

5. Discussion

Internal night measurements undertaken in January and April 2016 within sample bedrooms, show planning condition 6b compliance.

Measured external levels in open spaces are in exceedance of 50dB $L_{Aeq,T.}$ This is particularly evident at the road side façade (MP5). The following text should be noted from report ref: NA/IR/20140925-RK, completed by NRG Consulting, dated October 2014:

> "*The assessment for Planning Condition 15 shows that best practicable means have been employed to give provision for protection against external levels. Without possibility of further feasible attenuation measures it is recommended that noise levels higher than the requirements of Planning Condition 15 are accepted for both communal and private external amenity spaces."*

Regarding external ambient daytime noise levels, it should be kept in mind that 'Best Practical Means' where possible, has already been utilised in the development. An example being the communal garden, which enjoys noise attenuation provided by the development itself from both road and rail noise. Historically, case law has demonstrated that persons living in urban areas would be assumed to be accepting of a certain amount smell or noise (Colls 'v' Home and Colonial Stores (1904)). It is also at the choice of the individual as to whether they decide to utilise such a space.

6. Conclusions

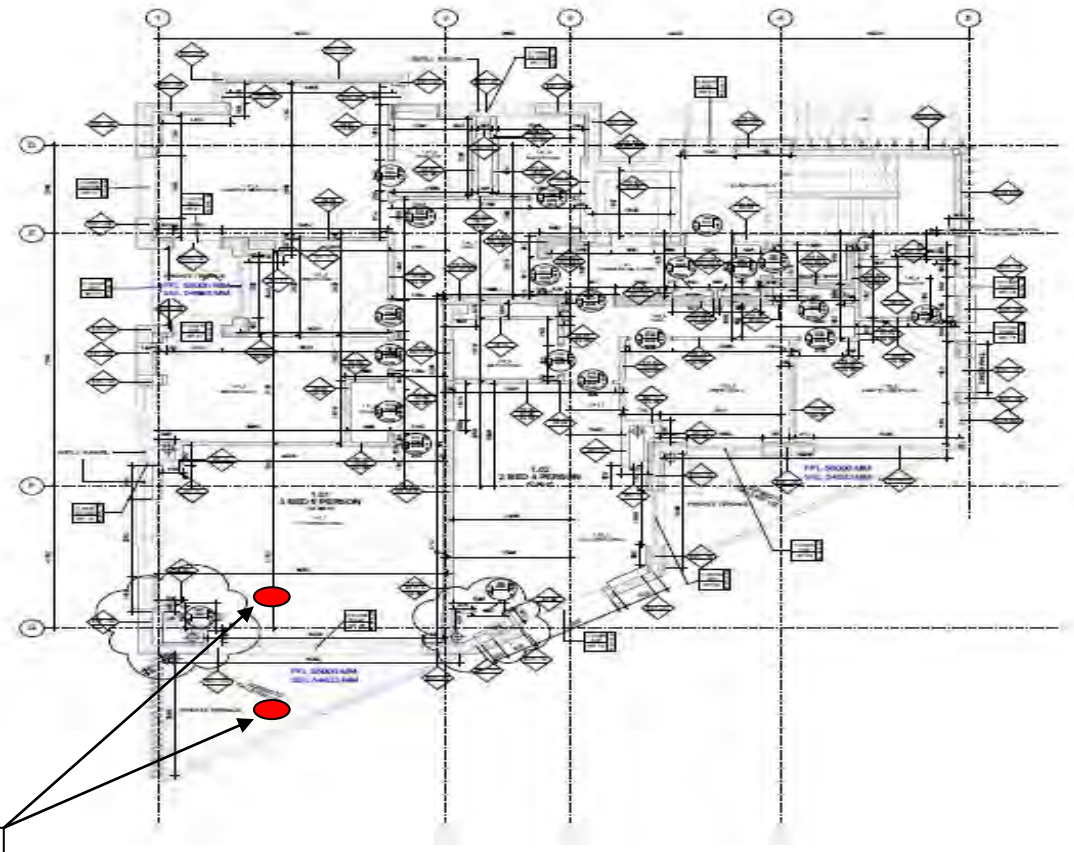
Noise levels have been assessed at 159-161 Iverson Road, West Hampstead NW6 2HE in accordance with relevant guidelines.

Internal noise levels show complete compliance with planning condition no.6.

External ambient levels are in exceedance of 50dB $L_{Aeq,T.}$ (16 hour). However, as previously stated Best Practical Means have already employed in the project.

It is therefore concluded that both Planning Condition 6 and 15 should now be fully discharged.

Figure 1 – Site Layout (Block A):



MP1 & MP5:

2.01 Bedroom & Balcony

Figure 2: Site Layout (Block B)

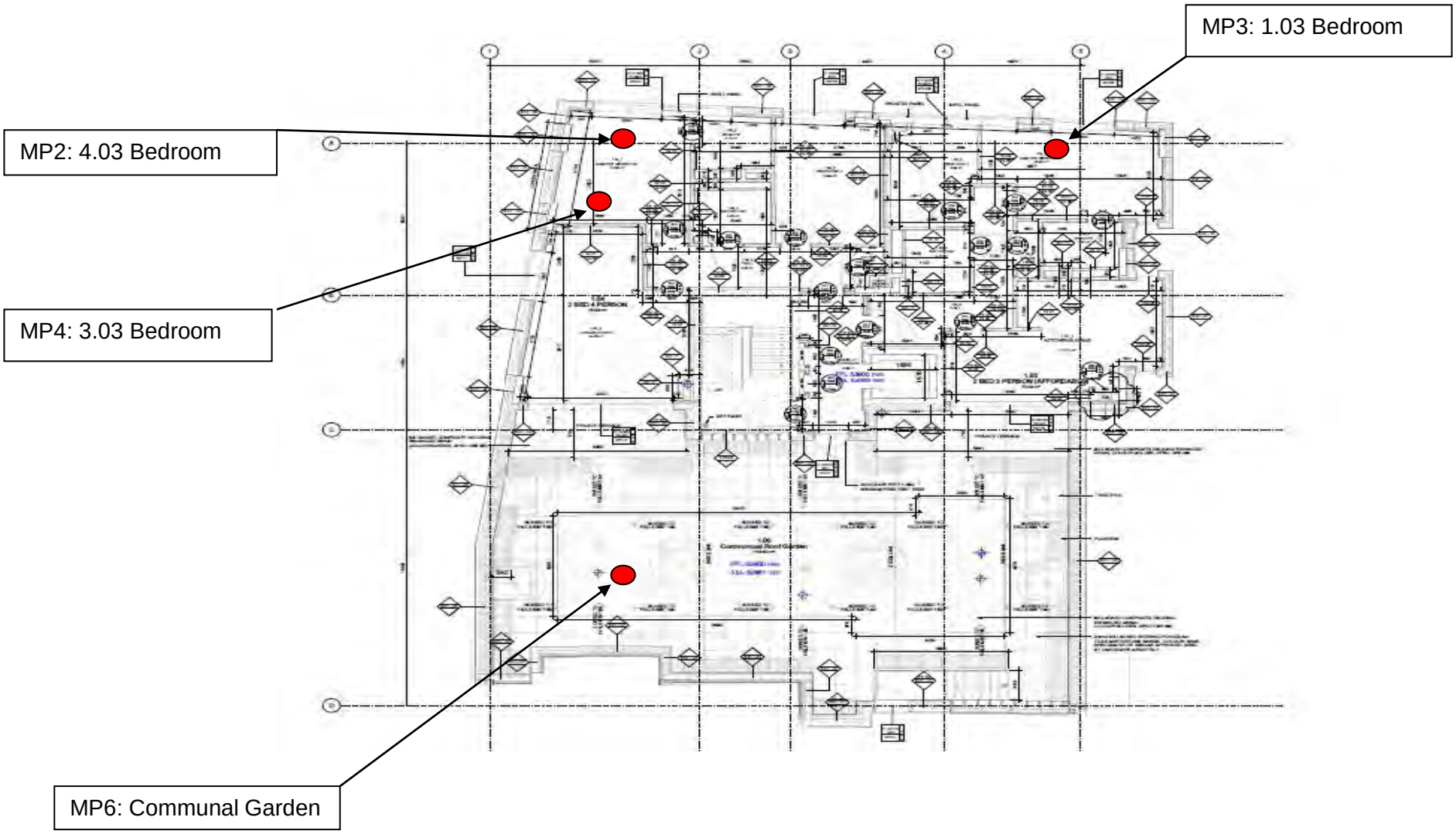


Figure 3: Summary Internal Noise Data (MP2)

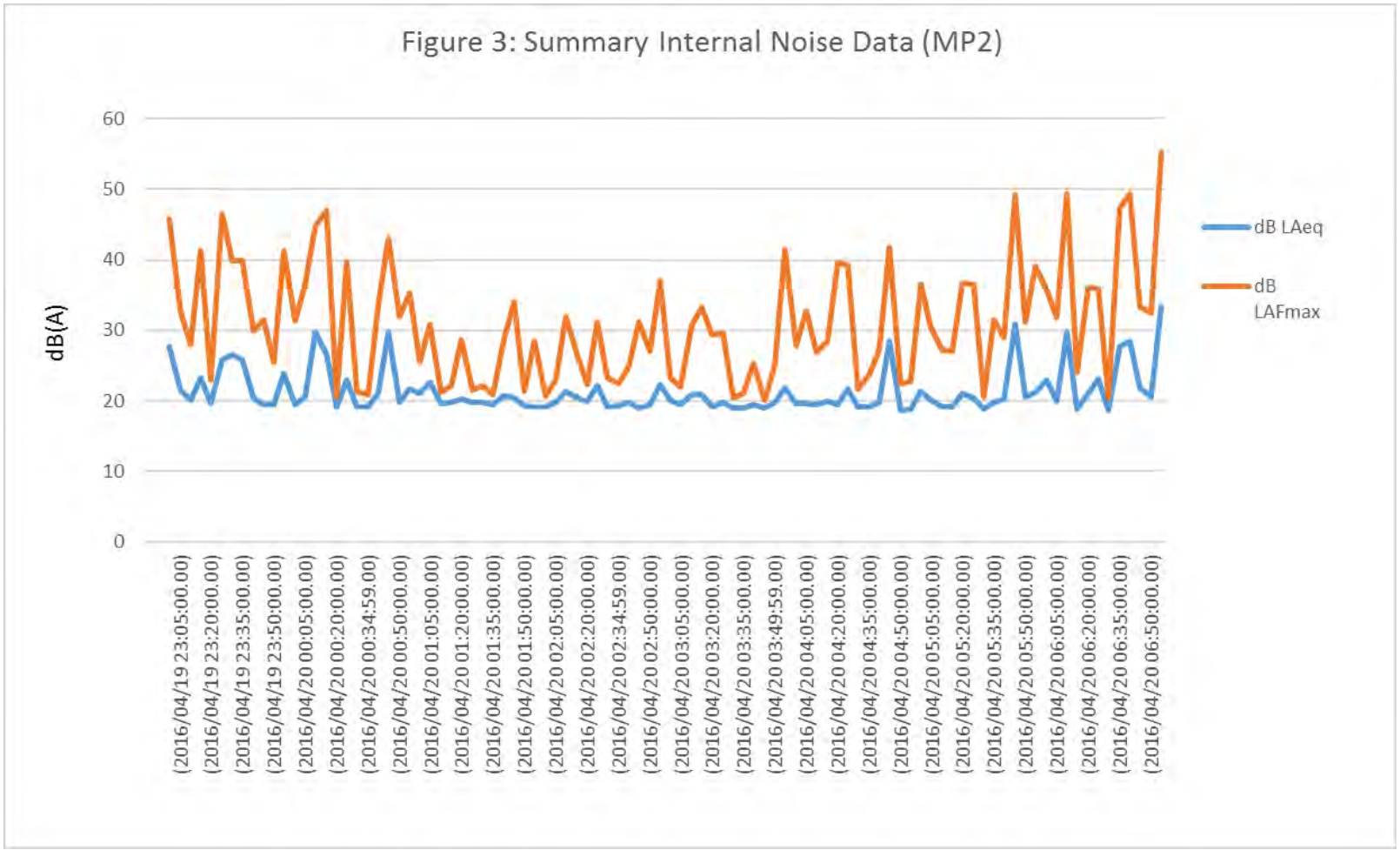
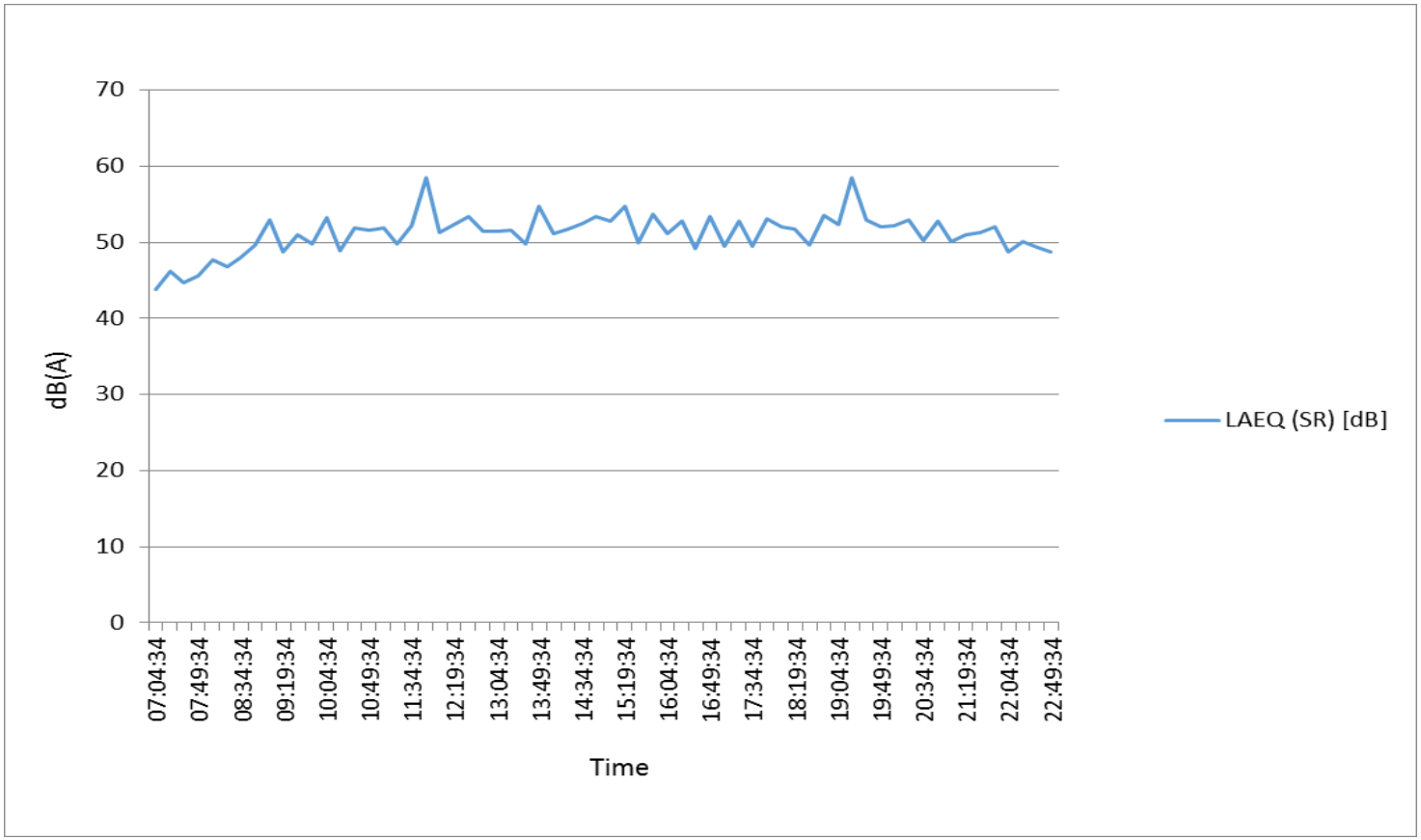


Figure 4: Summary External Noise Data (MP6)



Appendix 1 – ANC Accreditation

ANC

THE ASSOCIATION OF NOISE CONSULTANTS

Pace Consult Ltd

has been elected by the Company to

Full Membership

of the Association

Date of Election December 2009

Signed

President

(Company limited by guarantee registered in England No. 5289002)

This Certificate remains the property of the Association, returnable on demand

aulos
ACOUSTICS

163 Iverson Road, West Hampstead

Environmental Noise & Vibration Report

Thursday, 15 December 2011

James Tomalin

163 Iverson Road, West Hampstead

Environmental Noise & Vibration Report

contents

163 Iverson Road, West Hampstead

Environmental Noise & Vibration Report

contents

document control

Document Reference	Revision	Title & Revision Comment	Checked	Approved	Date
1160 JT R556-52		Environmental Noise & Vibration Report	JT	JT	15.12.11

163 Iverson Road, West Hampstead

Environmental Noise & Vibration Report

Introduction

Aulos Acoustics has been appointed by Winbush Properties Ltd to undertake an investigation of environmental noise impact affecting 163 Iverson Road, West Hampstead.

The project is a proposed residential development comprising a new-build scheme. The application site is, potentially, noise-sensitive requiring an investigation of the effect of noise exposure on the proposed residential property. The principal noise sources of concern are:

- Railway traffic
- Operations and Vehicle Movements

The proposed scheme is a residential development consisting of 33 units of one, two and three bedroom apartments and three two bedroom houses. The application site is developed land adjoining a principal railway, a small commercial unit and the West Hampstead Thameslink and Midland Mainline Station.

Consequently, the future occupants may be exposed to existing noise sources. An investigation is required to determine the risk of material effects on future residential amenity.

The following reports the results and conclusions of the investigation made in accordance with local, regional, national requirements.

Information Used

The full dexter moren associates drawing package has been used in completing the investigation.

Further guidelines and standards are referenced in the report and detailed in the attached Appendix B.

No prior noise or vibration investigations have been made at the application site to the best knowledge of the author.

Planning Framework

The policy framework under which the application site needs to be assessed is defined in the following documents:

- PPG24 Planning & Noise (1)
- Camden Local Development Framework. Development Policies 2010-2025 (2)
- The London Plan (3)

Further guidance on the approach to noise across London is provided in the Sounder City The Mayor's Ambient Noise Strategy (4).

Planning Policy Guidance PPG24

Where new residential property is proposed and it may be affected by existing noise sources, an assessment in accordance with the requirements of PPG24 shall be completed normally.

The assessment process includes the categorization of the application or areas of the application site to determine which Noise Exposure Category (NEC) these fall into. NEC bands are referred to as NEC A to NEC D and are set in terms of $L_{Aeq,16hour}$ daytime, and $L_{Aeq,8hour}$ night-time noise levels free-field, 1.2 - 1.5m above ground level.

The Noise Exposure Categories for the principal transportation noise sources are as follows:

NEC		A	B	C	D	
Road						
Day	07:00-23:00h	<55	55-63	63-72	>72	$L_{Aeq,16h}$ dB
Night	23:00-07:00h	<45	45-57	57-66	>66	$L_{Aeq,8h}$ dB
Rail						
Day	07:00-23:00h	<55	55-66	66-74	>74	$L_{Aeq,16h}$ dB
Night	23:00-07:00h	<45	45-59	59-66	>66	$L_{Aeq,8h}$ dB
Air						
Day	07:00-23:00h	<57	57-66	66-72	>72	$L_{Aeq,16h}$ dB
Night	23:00-07:00h	<48	48-57	57-66	>66	$L_{Aeq,8h}$ dB

Table 1a – Recommended Noise Exposure Categories for New Dwellings

Note: In addition, sites where individual noise events regularly exceed 82dB(A) L_{max}(slow), several times in any night time hour should be treated as being in NEC C, unless the L_{eq}(8 hour) already puts the site in NEC D.

The measured and analysed noise levels are compared to the above ranges to determine which category the application site falls into. Planning policy guidance is provided in PPG24 to Local Planning Authorities for each Noise Exposure Category. These provide an objective means for investigating the potential adverse effects of noise on future residents. Minor variations in the above category boundaries are permitted.

The planning guidance for each NEC is as follows:

NEC	PPPG24 Guidance
A	Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level.
B	Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.
C	Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D	Planning permission should normally be refused.

Table 1b – Noise Exposure Category Planning Advice

PPG24 recommends the further reading and guidance is available in various documents and standards. Key among these are:

- BS8233:1999 *Sound insulation and noise reduction for buildings-Code of practice* (3)
- BS 4142:1997 *Method for rating industrial noise affecting mixed residential and industrial areas* (4)

The planning guidance, whilst ostensibly objective, does not provide a significant degree of detailed direction. Further information in the PPG24 provides only general guidance. Consequently, the application of the Noise Exposure Categories guidance has developed over time.

Aulos applies a varied approach to each NEC and within those categories due to the wide range of noise levels they address. A general guide to the approach and some of the implications in planning can be found in Appendix E.

Local Planning Policy

The current planning policies of London Borough of Camden ["LBC"] are defined in the Local Development Framework 2010-2025 (2)["LDF"]. The relevant specific policies are understood to be:

- DP28. Noise and vibration

The relevant core strategic policies are understood to be:

- CS14. Promoting high quality places and conserving our heritage
- CS16 – Improving Camden's health and well-being.

DP28 states the following:

Policy	Statement
DP28. Noise and vibration	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. Development that exceeds Camden's Noise and Vibration Thresholds will not be permitted. The Council will only grant permission for plant or machinery if it can be operated without cause 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.

Table 2 – LB Camden Planning Policy

The reasoned justification and detail of the policy section then defines a series of Noise & Vibration Thresholds on which planning decisions shall be based. These are reproduced in Appendix E.2.

Table A defines the thresholds above which noise will be refused.

Table B defines the thresholds above which noise attenuation measures are required.

At this time, the threshold values do not accord with national planning policy, as set out in PPG24, in the following manner:

a) Separate evening and daytime periods are used to divide the 16 hour day of PPG24

b) Evening values are more stringent as such large fall in evening noise may not occur for the prevailing road or rail noise source

c) All values are more stringent by virtue of a 3dB façade reflection where none applies in PPG24

In effect, LB Camden defines a refusal position where noise levels are at or below the NEC D boundary.

The criteria are those defined in the previous Local Plan and SPG relating to noise. The Camden Noise Strategy 2002 stated:

> **16.26 There are three time periods in the standard, rather than the two time periods in PPG24, because of the considerable density of the rail and road network and the wide range of tourism and entertainment facilities in the Borough. These factors combine to make the area particularly susceptible to road and rail noise during the evening period, when local residents are entitled to expect reasonable peace and quiet in their own homes.**

No time period variations are permitted under PPG24, which states in Annex 1:

> **7.** Traditionally, different indices have been used to describe noise from different sources, and limits have been set over different time periods. This has caused confusion, and this PPG follows the move towards consistency advocated in BS 7445: 1991 by expressing all noise in terms of $L_{Aeq,T}$. The recommended time periods are 07.00-23.00 and 23.00-07.00.

By contrast, the Table B values adopt an approach which at least clarifies the point where attenuation is expected, without defining a basis for the approach. These place the threshold values in NEC B, although again the different time periods skew comparison with PPG24.

Without the benefit of the national consultation process applied in developing Planning Policy Guidance / Statements, the local planning policy remains contrary to current guidance. The benefits of a consistent and comparable approach will not accrue. In comparison, few if any other London Boroughs adopt a day, evening and night approach, and the London Ambient Noise Strategy does not require or encourage such an approach at this time. Critically, neighbouring City of Westminster has a similar or greater density of transport infrastructure and "tourism and entertainment facilities" and a developed approach to noise historically. Westminster retains the PPG24 approach.

Most urban environments experience extended periods of road and railway noise. The benefits to residents of highly-developed transport infrastructure generally outweigh the potential adverse effects. Benefits include greater employment flexibility and choice, as well as wider options for leisure, entertainment and training/education.

The investigation will consider both approaches and identify the implications of the evening approach, if any.

The application site required investigation for noise and vibration exposure. The recommended method of determining the prevailing noise climate is by direct survey over an extended period.

Arrangements were made to install meters on the site to measure noise and vibration from 29 September to 6 October 2011.

Limitations

Critical to the outcome of any survey are the conditions of the main sources being considered. At the time of the survey particular restrictions apply to both the noise and vibration exposure:

- Thameslink Programme is incomplete till 2015-2018
- Restrictions apply on Thameslink operations outside peak hours till May 2012
- Nearest long siding and relief tracks of the railway have been unused for three years
- Nearest relief track will not become operationally active till Late Winter / Spring 2012
- Full, current operation of relief track and mainline not expected till well into 2012

In general, noise exposure is unlikely to be as greatly affected as vibration. The relief track is at a similar distance to the nearest mainline tracks and will experience many fewer train movements. The combination of fast trains and stopping trains on the operational lines should remain the main component of the noise climate even when Thameslink becomes fully active and the relief track is operational.

The noise survey was completed and is discussed further below.

Vibration is more likely to be determined by nearest track due to proximity, but also to the types of trains, which will be disproportionately heavy, such as some freight traffic and peak hour passenger movements.

The vibration survey was deferred and is discussed further below.

Construction works on the nearest tracks and support for the West Hampstead Thameslink station refurbishment mean that the results of the survey were affected at times by a number of extraneous noise sources including:

- Site machinery & vehicles on tracks and on Iverson Road
- Manual working and impacts on the reconditioned railway
- Mechanical and powered equipment used in and around the station

Where feasible, the effect of the works will be determined, but the following general framework applies:

- Works on permanent way are limited to 07:00-16:00 (generally) during Monday to Friday with additional Saturday morning period
- Works on station generally use same or similar hours but during the survey period were permitted to use a 24-hour weekday approach for the period of the survey

Noise Survey

An environmental noise survey was undertaken in accordance with the measurement requirements of PPG24 (1) and BS7445:2 (7).

The measurement parameters and settings used were as follows:

Symbol	Name	General Description
LAeq,T	Continuous equivalent sound pressure level	Single figure value averaging varying sound signal over period T
LpA	Sound Pressure Level	Average over each high resolution period t of sample period T
LAFmax	Maximum sound pressure level FAST	Highest 125ms sound pressure level over T
LASmax	Maximum sound pressure level SLOW	Highest 1s sound pressure level over T
LA10	Statistical Lp – level exceeded 10% of time	Typical highest noise level
LA50	Statistical Lp – level exceeded 50% of time	Median noise level
LA90	Statistical Lp – level exceeded 90% of time	Typical minimum Background noise level
A	A frequency weighting	"Equal loudness" weighting for moderate noise levels
F	FAST time weighting	A quick reaction time for measurement
S	SLOW time weighting	A slower reaction time for measurement
T	Sample time period	Five minute (5min)
t	Recording Resolution	One second (1s)

Table 3 – Survey Measurement Parameters

Intermittent audio recordings were also made using the following settings:

24 bit	30 second period	Trigger by level
48kHz	10 second delay	57dB(A) trigger level

The survey measurements began 14:00 hours on 29 September 2011 and ended at 16:00 hours on 6 October 2011.

Weather conditions were changeable over the period with high winds initially falling to within measurement parameters on 30 September except for brief periods over the following week. Rainfall was intermittent but light.

The equipment used was a Norsonic 140 with GRAS all-weather microphone. The microphone was located on the rear (north) boundary with the railway at 3m above ground level: Measurement Position M1. The Measurement Location Plan and more detailed equipment information are provided in Appendix C.

The position was selected at the point of maximum subjective noise exposure to the trains in an area of the proposed building more open to propagation.

Measurement data was downloaded and post-analysed using Norsonic Nor-Review software.

Vibration

Vibration measurements may be dominated by heavy sources close to the building foundations. The full use of the five operational tracks will not resume till May 2012 at the earliest. Bringing the relief track into full operation may take longer, based on discussions with NetworkRail (rail infrastructure) and First Capita Connect (train operating company).

For this reason, the survey was deferred following consultation with Camden Environmental Health Officers Anita Kidby and Hardesh Bhatti. The confirmatory email sent on 21 October 2011 is attached in Appendix C.3.

The clear understanding is that a deferred approach by condition is acceptable and this would include the following elements, as stated in the email:

"We would submit a "prior to construction" planning condition providing Camden Council with the ability to approve or disapprove any proposals. This would consist of the following requirements:

1. A vibration survey shall be undertaken to determine magnitude of railway vibration in accordance with LPA requirements prior to commencement of construction on site and a technical report submitted as a record
2. An assessment of vibration propagation and amplification within the proposed property shall be undertaken in accordance with LPA requirements prior to commencement of construction on site
3. Vibration mitigation and control measures shall be determined to achieve the LPA requirements of policy DP28 prior to commencement of construction on site
4. A technical report of the mitigation and control design shall be submitted to the LPA with supporting drawings to demonstrate compliance with the criteria of policy DP28 and shall be subject to examination and approval prior to commencement of construction on site beyond enabling stage [to be defined but prior to sub-structural works, piling, etc.]"

No comments, objections or amendments have been issued to in response to the email at this time.

In the interim, other sources of vibration data in the area have been sought. At present, no documents have been found which confirm clear vibration measurements. Further information is being sought from engineers on sites and development areas to the south of the application site, but no data has yet been forthcoming.

Whilst estimates of vibration from trains are to be treated with caution, initial calculations indicate a risk that minor to moderate vibration magnitudes could arise on the upper floors, particularly towards the north-west corner of the application site. At this point, the ground surface is nearest to track level and the structure of the building will be most complex.

Provision will need to be made for vibration isolation of the structure across the site with potential pile cap isolation and isolation of building fabric and services from the ground. Separate advice will be provided to the design team.

Computer Modelling

Modelling of environmental noise is being undertaken to determine the effect of full operation of the railway. Incorporation of the Thameslink, relief and future freight use will be estimated, as even the Thameslink Programme operational targets remain vague (i.e. 12 train movements per hour of eight to ten carriages on this line as a target).

Freight train use of the Midland Mainline and relief track is stated to be approximately 12 per day peak. The freight demand on the line is not significant, in comparison to many London mainline routes.

Modelling of groundborne vibration is possible, but may lack accuracy due to significant variations in track and ground conditions. Reliance is to be placed on measured data at the building position to ensure a reliable and accurate design. This in turn is reliant on full and accurate exposure to railway vibration, which will not be apparent till well into 2012.

Both environmental noise and vibration modelling will be reported separately.

Survey Results

The results of the environmental noise survey have been determined for the different periods and for the overall averages:

- Appendix D.1 Daytime periods 07:00-23:00, 07:00-19:00 and 19:00-23:00 hours
- Appendix D.2 Night-time period 23:00-07:00 hours

- Appendix D.3 Average Noise Exposure Day, Evening and Night

These detailed results are post-analysed using proprietary software. The process enables the elimination of spurious or extraneous noise sources, where these can be identified. Only a small number of such events have been removed. Equally, technical faults with source data, such as time period inconsistency, have been removed. The effect of such changes when compared against direct measurement results is ±0.5dB approximately.

Weather effects have not been omitted, meaning the 29 and 30 September include wind-affected results, where the underlying ambient noise level is likely to be higher than under optimum conditions.

Measurement results are at 2.5m high. This varies from PPG24 height requirements, but is not inconsistent with the LB Camden approach. Results are free-field unless specifically stated otherwise in the summary results.

Road Traffic Noise

The application site is largely open which leads to a significant level of railway noise on Iverson Road. The flow of vehicles there was sporadic and light on both site visits, with long periods where no or few cars passed.

Coupled with the ongoing construction noise, significant difficulty was presented for measurement.

Measurement was attempted, but was not deemed to be statistically accurate or reliable. The sample periods were too short and exclusion of other noise sources was uncertain.

Alternative positions were unavailable due to the steep gradient compared to the rest of Iverson Road.

Measured levels varied widely and erratically between LAeq,T 64dB and 76dB over selected periods, with no opportunity for accurate time-averaging or clear selection of noise sources.

It is presumed, for the basis of the assessment, the road traffic noise may require a minor degree of attenuation, but is not as significant as the railway once away from immediate road edge.

The maximum noise ranged from LAmaxSLOW 71dB to 89dB, including construction site vehicles and all other sporadic sources that could not be excluded. Most maxima on the better samples were below 81dB. These would not require attenuation under LB of Camden criteria.

In general, Iverson Road is considered to be light traffic road with sporadic flows. Individual noise events of vehicle movements or groups of vehicles are expected to determine the requirements. Maximum noise levels are considered to be more important particularly during the evening and night.

Maximum noise levels of LAmax,SLOW 71-81dB at the site boundary are considered to be within expectations for cars and light goods vehicles passing the site.

Commercial Units

There is a tyre and battery service centre to the west of the site. Close observation during both site visits indicated minimal audible activity, although there were workers inside and a large number of cars in the yard.

The one exception was an external telephone bell mounted at high level on the wall. As there were no staff members in the yard outside there seemed to be no purpose and superfluous.

It is recommended that means of removing, relocating or replacing the bell be sought, although it is only moderately loud at around LAFmax 50-55dB(A) at the yard entrance.

Environmental Noise Results

The summary of Noise Exposure Results is as follows:

Position	Day $L_{eq(16\ hour)}$	Day $L_{eq(12\ hour)}$	Evening $L_{eq(4\ hour)}$	Night $L_{eq(8\ hour)}$	
29/09	-	-	63.0	55.0	dB(A)
30/09	65.3	65.6	64.1	53.2	dB(A)
01/10	62.6	62.5	63.0	49.5	dB(A)
02/10	59.6	59.6	59.4	53.5	dB(A)
03/10	64.6	65.2	61.6	53.7	dB(A)
04/10	64.3	64.9	62.2	54.5	dB(A)
05/10	64.0	64.4	62.3	57.2	dB(A)
06/10	-	-	-	-	dB(A)
Mean	63.0	64.0	62.0	54.0	dB(A)
Log Mean	63.7	64.1	62.4	54.3	dB(A)
Façade k	+3	+3	+3	+3	dB(A)
Log Mean+k	66.7	67.1	65.4	57.3	dB(A)

Table 4a – Summary Results – Period Noise Exposure

The summary of the maximum noise level results at night are as follows:

Position	Night $L_{AFmax(8\ hour)}$	Night $L_{AFmax(8\ hour)}$ 5%	Night $L_{AFmax(8\ hour)}$ 10%	Night $L_{ASmax(8\ hour)}$	Night $L_{ASmax(8\ hour)}$ 5%	Night $L_{ASmax(8\ hour)}$ 10%	
29/09	84.5	63.5	59.7	82.2	60.9	56.8	dB(A)
30/09	80.1	61.9	57.6	78.7	59.8	55.6	dB(A)
01/10	78.4	59.3	56.0	74.2	56.3	53.7	dB(A)
02/10	86.2	62.3	58.1	84.4	58.8	55.5	dB(A)
03/10	86.2	60.7	57.1	86.7	59.3	55.5	dB(A)
04/10	95.4	60.6	56.4	89.4	59.0	55.1	dB(A)
05/10	87.5	65.4	62.8	85.2	64.3	61.4	dB(A)
06/10	-	-	-	-	-	-	dB(A)
Mean	85.0	62.0	58.0	83.0	60.0	56.0	dB(A)
Log Mean	88.8	62.4	58.9	85	60.4	57	dB(A)
Façade k	+3	+3	+3	+3	+3	+3	dB(A)
Log Mean+k	91.8	65.4	61.9	88	63.4	60	dB(A)

Table 4b – Summary Results – Noise Events

Noise Exposure Assessment

The noise exposure assessment of the application site has been completed based on both PPG24 and the LB of Camden Threshold Noise Levels.

Appendix D.3 states these assessments at the end of the summary results.

PPG24 Assessment Result

Were the standard defined Noise Exposure Category values of PPG24 to apply the following outcome would be expected:

- Daytime NEC B
- Night-time NEC B
- Maximum noise levels of individual events at night would not elevate to NEC C

Were the maximum decrease in PPG24 Noise Exposure Category boundary values to be applied then the following outcome would be expected:

- Daytime NEC B
- Night-time NEC B/C
- Maximum noise levels of individual events at night would not elevate to NEC C

Either situation would require only moderate deviation from standard acoustic design with, perhaps, some provision for acoustic ventilation of bedrooms and/or living rooms at night. The latter would be precautionary and not a significant measure.

LB of Camden

The Table A threshold value describe the levels above which planning permission would be refused.

On the basis of the survey data, the noise exposure is insufficient to require refusal of the application on noise grounds.

The Table B threshold values describe the levels above which attenuation measures would be expected by the Council.

The survey results indicate some attenuation is required for period noise exposure, but not for individual noise events at night.

Period	LAeq,T Facade	LASmax 5% Facade	Table B	Difference	Outcome
Day	67.1		65	+2	Minor attenuation required
Evening	65.4		60	+5	Moderate attenuation required
Night	57.3		55	+2	Minor attenuation required
		63.4	82	-19	Attenuation not required

Table 5 – Compare Results to LB Camden Criteria

Minor to Moderate attenuation; noise control measures; would be required during day, evening or night-periods.

Variations

Relief Line

The above assessment outcomes are based on measured data in the absence of one active minor line. The impact of the relief line is not considered to be significant as the primary use is to ease peak flow through-train movements and, possibly, train relocation before and during peak times. Confirmed data on use of these lines is unavailable, but indications given by train operators and NetworkRail personnel are that around 5% of peak time fast train movements out of London might use the line.

The effect is expected to be small but will be determined by environmental noise model.

Freight Traffic

NetworkRail has confirmed that expected freight use for all lines through West Hampstead Thameslink is approximately 12 movements per day spread equally over the full period. Freight operations are less at weekends.

The effect is expected to be small, but will be determined by environmental noise model assuming all trains are on the relief line.

Height Above Grade

The relative height of a receiver above grade or track level tends to increase noise exposure to a point. The expectation here is that noise exposure will be relatively consistent from the measurement position upwards as all tracks are visible in whole or in part.

The effect is expected to be small, but will be determined by environmental noise model assuming all trains are on the relief line.

Building view and screening reductions will be more substantial.

Overall Variations

The general level of variations from the above are expected to be minor with greater effects expected due to the orientation, arrangement and design of the building, even on the most exposed elevations.

The effect of railway noise propagation is to be determined by environmental noise model reported separately.

Allowance is to be included within the further assessment for +2dB(A) variation on $L_{Aeq,T}$ results and +4dB(A) variation on L_{ASmax} results to ensure margin exists within the planning submissions for variations.

Implications of Assessment

With allowance for variation the following outcomes are expected:

PPG24 Assessment Result

Were the standard defined Noise Exposure Category values of PPG24 to apply the following outcome would be expected:

- Daytime NEC B
- Night-time NEC B
- Maximum noise levels of individual events at night would not elevate to NEC C

Were the maximum decrease in PPG24 Noise Exposure Category boundary values to be applied then the following outcome would be expected:

- Daytime NEC B
- Night-time NEC B/C
- Maximum noise levels of individual events at night would not elevate to NEC C

LB of Camden

On the basis of the adjusted data, the noise exposure is insufficient to require refusal of the application on noise grounds under the Table A threshold values.

The Table B threshold values describe the levels above which attenuation measures would be expected by the Council.

Period	LAeq,T Facade	LASmax 5% Facade	Table B	Difference	Outcome
Day	69		65	+4	Minor – Moderate attenuation
Evening	67		60	+7	Moderate – Major attenuation
Night	59		55	+4	Minor – Moderate attenuation
		67	82	-17	Attenuation not required

Table 6 – Compare Adjusted Results to LB Camden Criteria

Overall Allowance

The acoustic design of 163 Iverson Road shall allow for attenuation to achieve the "Reasonable" to "Good" standards of BS8233:1999 *Sound insulation and noise reduction for buildings-Code of practice* (5) where feasible to do so. During daytime and evening the Living Room standards shall apply. During night-time the Bedroom standards shall apply.

Acoustic design focus on the elective use of private amenity spaces shall be on optimizing privacy between neighbours whilst minimizing noise exposure from environmental sources. These acoustic design criteria are as follows:

Inside Unoccupied Space	"Good"	"Reasonable"	Actual Design Target	
Bedroom	30	35	32 or less	LAeq,8h
Living Room	30	40	37 or less	LAeq,16h

Table 7 – Reasonable Internal Noise Design Targets

The external communal amenity spaces shall be designed to achieve noise exposure below Serious Community Annoyance levels wherever possible. If less than Moderate Community Annoyance is achievable and practical then necessary design measures shall be included.

Where applicable and feasible, lower evening acoustic design targets shall be achieved, however; the nature of most environmental transportation noise sources does not allow for such stringent targets. The over-arching aim is to protect the most people for the greater part of the day when they are more likely to be using or passing through the communal space.

Community Annoyance Outside Free Field	Moderate	Serious	Actual Design Target	
Communal Amenity Space				
– Day	50	55	55 or less	LAeq,16h
– Evening	45	50	50 or less	LAeq,4h

Table 8 – Reasonable Community Annoyance Targets

Applying the "Good" standards of BS8233 as an upper limit is considered to be precautionary and leads to excessive design allowances and cost. In essence, to ensure 30dB(A) is achieved inside the designer must also allow for a significant margin. Given the costs of construction, highly varied design is not feasible, therefore, the outcome is that a few rooms will have noise levels approaching 30dB(A), but most can experience noise levels far lower. Where internal noise levels approach 20-25dB(A), or lower, the effect on perceived sound insulation from neighbouring flats and isolation from external noise and events can have a real and adverse impact on occupants. These effects can be exacerbated where night-time noise needs to be designed to achieve the maximum noise level target, particularly where conditions insist on achieving this at all times for all events.

The design targets proposed above are those deemed most practical and effective in controlling and balancing the whole acoustic design, including both disturbance, perceived sound insulation and the isolation of people.

Individual Noise Events

The Table B Threshold Values of the LB Camden criteria indicate attenuation is not required in this instance; however, there still needs to be some degree of design to ensure conditions are reasonable and comparable.

The LB Camden criteria do not require attenuation for the low maximum noise levels measured in this case, but indicate a requirement by reference to other internal noise targets discussed elsewhere. The aim shall be to ensure a similar standard is applied to that which the Table B threshold values imply:

Description	Comparison	
LAmax,SLOW façade level outside	82dB(A)	
Attenuation	12 dB(A) open window loss	20-25dB(A) closed window loss
LAmax,SLOW inside	70dB(A)	57-62dB(A)
Equivalent LAmax,FAST	72dB(A)	59-64dB(A)

Table 9 – Implied Internal Noise Levels of LB Camden Criteria

These are the levels which research considers people find acceptable for railway noise and some other similar sources, provided louder individual noise events are relatively few. The indications from several studies described in PPG24 and elsewhere, that "several" events can occur at or above this level before an adverse effect occurs. "Several" may be approximately 6-12 in terms of measurable changes documented.

The design aim shall be to ensure the basic standard above is achieved and that the design shall aim to improve on this towards the sleep disturbance design targets of BS8233:1999. It is noted that LB of Camden do not define these as a requirement, but they remain as indicative of a reasonable internal noise climate, where practical and achievable. The BS8233:1999 target value is $L_{Amax,FAST}$ 45dB inside bedrooms.

The approach shall be to apply the upper 5-10% of individual event noise levels, rather than the 5% of all loudest events. These are typically both loud and more frequent than the loudest 5% of events, which include loud, extraneous events such as car alarms and sirens in this case.

In terms of the results in Appendix D, the night-time LAFmax5% is 62dB(A). For 180 seconds of each hour or 1440 seconds of the entire night (28,800 seconds), the noise events measured exceed this level.

Inspection of the noise levels and audio recordings indicate that night-time maxima are infrequent and brief. Importantly, there are not "several in any one hour" throughout the night.

Outline Noise Control Measures

The purpose of the outline design is not to identify specific measures for noise control, but the general principles of the proposed scheme, including position, appearance, scale and materials. Even so, the scheme includes substantial noise control measures, which accord with the guidance in BS8233:1999 and other guidance.

Current Proposed Noise Mitigation

The design includes for reasonable measures to minimize noise exposure including:

- Application site for development is not immediately adjacent to busiest sections of mainline railway as two low impact tracks provide separation
- Large proportion of rooms on screened elevations or with a restricted view of the railway
- Communal amenity area at low level where the effect of screening and topography are greatest and view of railhead is obscured
- Private amenity spaces are located away from railway or benefit from building screening in most instances
- Bedroom windows oriented away from railway in most instances
- Use of buffer spaces on Blocks 01 and 02 separate bedrooms from facade
- Other habitable rooms oriented away from railway in most instances or major window openings are facing away
- Remaining bedrooms and other habitable rooms are located at high level further from railway
- Use of building and façade features to provide for localized screening and dispersion effect from facades

Further Measures

A general review of further requirements has been undertaken. The degree of noise exposure requires more detailed consideration be given prior to construction. Specific measures recommended for inclusion at this stage are discussed below.

Block 01 Elevated Wing

The following apartments in Block 01 are those most exposed to railway noise, including noise reflected into the amenity space:

- 01.05
- 02.05
- 03.05
- 03.06
- 04.01
- 04.02

A range of attenuation measures are recommended to provide a reasonable internal noise climate, due to expected exposure to railway noise on all elevations, including:

- Provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, if desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision for improved, medium performance window sound insulation

- Provision of optimized sound insulation for other elements of building envelope, with particular focus on sound insulation of underside of floor and walls
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable

Other Block 01 Apartments

The following apartments in Block 01 are not as exposed as in the elevated north-west wing to railway noise, including noise reflected into the amenity space:

- G.01-G.04
- 01.01-01.04
- 02.10-02.04
- 03.01-03.04

Ground & Lower Ground Apartments G.01-G.04

A range of attenuation measures are recommended to provide a reasonable internal noise climate, due to expected exposure to railway noise on all elevations, including:

- Provision for improved, medium performance window sound insulation to north
- Provision for improved, medium performance window sound insulation to south along road
- Seal north window of living / kitchens if possible
- Provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, if desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision of optimized sound insulation for other elements of building envelope to north
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable

Other Apartments

A range of attenuation measures are recommended to provide a reasonable internal noise climate, due to expected exposure to railway noise on all elevations, including:

- Provision for improved, medium performance window sound insulation to north
- Seal north window of living / kitchens if possible
- Provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, if desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision of optimized sound insulation for other elements of building envelope to north
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable

Block 02 and 03

A range of attenuation measures are recommended to provide a reasonable internal noise climate, due to expected exposure to railway noise on all elevations, including:

- Provision for improved, medium performance window sound insulation to north
- Seal north window of living / kitchens if possible
- Provision for improved, medium performance window sound insulation to south along road (first storey only)
- Provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, if desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision of optimized sound insulation for other elements of building envelope to north
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable

West Ground Level Amenity

The proposed amenity space is to be landscaped. The boundary to the north and west will require further protection to provide an enhanced level of screening from the railway and buildings to the west.

- Provision for solid screening to north and west boundaries of communal amenity space to optimize attenuation from railway
- Height 1.8-2m
- Mass 15-20kg/m2
- Form: solid board or sheet material or planks jointed and sealed

Roof & Other Non-Vision Areas

Sound insulation will be provided to minimise the window and door sound insulation requirements. In general, standard construction allowances are expected to be sufficient. The exception will be the Block 01 elevated wing, where the full envelope is likely to be exposed to railway noise to a degree.

Enhanced sound insulation will be needed particularly for the walls and underside of floor slabs.

The roof will be assessed for rain impact noise with the aim of ensuring internal noise levels due to rainfall do not exceed 45-50dB(A) except under exceptional conditions.

Ventilation

The provisions of The Building Regulations are understood to encourage the use of combined ventilation systems, although the extent of such systems is debatable. Where they are required for noise control then central, whole flat systems are recommended incorporating mechanical supply and extract air service into one. The presence of trickle vents in any window or door is not recommended for NEC C and the more exposed NEC B areas – this is likely to be the case at Iverson Road in some areas. The provision of fresh air and background ventilation by separate attenuated paths or ventilators is advisable. In using any mechanical system it shall be ensured there is sufficient air leakage to provide for minimum fresh air or there are dedicated intake ducts / openings.

Most central flat systems are suitable to include heat exchangers and particulate filters to improve energy use and air quality, respectively.

Sound Insulation

The target noise level differences from outside to inside are:

Performance	Level Difference, dB(A)
Open Windows	15
Standard Closed	20-25
Medium Closed	25-30
High Closed	30-35

Table 10 – Sound Level Difference Required

The detailed design process will determine the exact laboratory-tested performance required of the different building elements, however; the estimated performance and typical constructions expected are as follows:

External Windows & Doors	Weighted Sound Reduction Index, Rw dB	Glass Unit / Basic Construction	Frames
Standard Window	25-30	4-20-4 Argon filled	Rebated+sealed openable sections. No trickle vents. Not flush in window opening
Medium Window	30-35	10-20-6 Argon filled	As above
High Window	35-40	10-20-6 Ar +100mm cavity+6.4mm laminated secondary pane	As above
Non-vision area / walls / roofs	+7dB above highest window performance on elevation e.g. Rw 47dB where High Closed windows used	Medium density cavity masonry Lined framed and clad wall system	Staggered and sealed linings Mineral wool in primary void
Floor Slab	45	200-250mm concrete	No other finishes included

Table 11a – Typical Lab Performance & Construction – Envelope

Ventilation	Weighted Element Sound Level Difference, Dn,e,w dB	Position Openings	Type of Vent System
Trickle vents & wall vents	20-25	Elevation (where permissible)	Exclude except in NEC A areas where open windows can be used
Medium Performance	35-40 (two openings)	Elevation	Central ducted whole-flat combined extract supply unit with attenuated intake
High Performance	40-45 (two openings)	Elevation Reduce performance needed by moving to screened positions	Central ducted whole-flat combined extract supply unit with attenuated intake Additional duct attenuation
Noise Limit from Supply diffusers	30dB(A) at 1m inside	-	Under all fan speeds except very high / boost ventilation

Table 11b – Typical Lab Performance & Construction – Ventilation

Further development of the design is required and will include determination of:

- Variation of noise across the elevations
- Final building and room layout
- Composite Sound Reduction Performance of all building envelope elements

Much of the above will be informed by the results of the Environmental Noise Model to be reported separately.

Acoustic Benefits

The current site is largely open and does not provide any substantive screening of railway noise.

The proposed development forms a significant and continuous building barrier alongside the railway.

The properties on the opposite (south) side of Iverson Road are expected to benefit from a marked reduction in railway noise exposure. The following factors influence the degree of reduction:

1. Proportion of current view remaining after completion (3dB per doubling)
2. Degree of interruption to line of sight
    - Slight 5dB reduction
    - Moderate 10dB reduction
    - Major 15dB reduction

For a flat or house located opposite the centre of the Block 02 façade, substantial reductions in railway noise are likely to accrue. A 10dB reduction would be the least expected, based on current estimates. In general terms, such a difference equates to a halving of loudness.

Even at the east and west end of the property a moderate reduction of 5-8dB is expected, provided there is line of sight interruption. In general terms, such a difference equates loudness of a quarter less.

The benefits then are expected to be substantial to the occupants of residential property opposite the application site.

Conclusions

Aulos Acoustics has completed an investigation of the environmental noise exposure expected at the application site of 163 Iverson Road, West Hampstead.

A noise survey was completed to determine the noise climate affecting the proposed residential properties. The application site is widely affected by railway noise due to its proximity to the Midland Mainline operating through West Hampstead Thameslink station. Both fast and stopping trains result in frequent railway movements.

Noise exposure has been assessed against both the LB Camden criteria of development policy *DP28. Noise and vibration* and PPG24 and the outcomes are as follows:

The noise exposure is insufficient to require refusal of the application on noise grounds as levels do not exceed the Table A threshold values of DP28.

The Table B threshold values describe the levels above which attenuation measures would be expected by the Council.

The noise exposure results indicate some attenuation is required for period noise exposure, but not for individual noise events at night, as levels slightly exceed the Table A threshold values of DP28.

Period	LAeq,T Facade	LASmax 5% Facade	Table B	Difference	Outcome
Day	67.1		65	+2	Minor attenuation required
Evening	65.4		60	+5	Moderate attenuation required
Night	57.3		55	+2	Minor attenuation required
		63.4	82	-19	Attenuation not required

Table C1 – Compare Results to LB Camden Criteria

Some variation may occur due to freight, height of receivers above grade and use of the relief line (second track north of boundary). These variations are expected to result in a +2dB(A) variation on LAeq,T results and +4dB(A) variation on LASmax results.

Were the maximum decrease in PPG24 Noise Exposure Category boundary values to be applied then the following outcome would be expected:

- Daytime NEC B
- Night-time NEC B/C
- Maximum noise levels of individual events at night would not elevate to NEC C

The moderate attenuation requirement has been designed to achieve the implied reasonable internal noise levels of policy DP28 as follows:

Description	Comparison	
LAmax,SLOW façade level outside	82dB(A)	
Attenuation	12 dB(A) open window loss	20-25dB(A) closed window loss
LAmax,SLOW inside	70dB(A)	57-62dB(A)
Equivalent LAmax,FAST	72dB(A)	59-64dB(A)

Table C2 – Implied Internal Noise Levels of LB Camden Criteria

The design criteria recommended in BS8233:1999 *Sound insulation and noise reduction for buildings-Code of practice* have also been taken into account, applying the reasonable design target range.

Current Proposed Noise Mitigation

The design includes for reasonable measures to minimize noise exposure including:

- Application site for development is not immediately adjacent to busiest sections of mainline railway as two low impact tracks provide separation
- Large proportion of rooms on screened elevations or with a restricted view of the railway
- Communal amenity area at low level where the effect of screening and topography are greatest and view of railhead is obscured
- Private amenity spaces are located away from railway or benefit from building screening in most instances
- Bedroom windows oriented away from railway in most instances
- Use of buffer spaces on Blocks 01 and 02 separate bedrooms from facade
- Other habitable rooms oriented away from railway in most instances or major window openings are facing away
- Remaining bedrooms and other habitable rooms are located at high level further from railway
- Use of building and façade features to provide for localized screening and dispersion effect from facades

Further attenuation measures have been determined and recommended in the report. These include the following on the most exposed elevations:

- Provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, if desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision for improved, medium performance window sound insulation
- Provision of optimized sound insulation for other elements of building envelope, with particular focus on sound insulation of underside of floor and walls
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable
- Provision for solid screening to north and west boundaries of ground / lower ground level communal amenity space to optimize attenuation from railway

The most exposed facades containing habitable rooms include:

- Elevated Wing of Block 01
- North elevation of south-west wing of Block 01
- North elevation of Block 02 and 03
- Roadside lowest storey of all blocks on South elevation
- Western amenity space at ground level

In general, medium attenuation performance windows and ventilation system will be required for the most exposed habitable rooms. This equates to thermal double glazing with heavier glass than is standard and a central ventilation system for each flat or house.

Vibration

The railway is not currently operating at full capacity and the nearest lines are not operational at all. The effect on noise exposure is expected to be small, but vibration exposure may be determined by these nearest lines.

Consequently, an alternative approach was discussed and agreed with LB Camden which includes for:

- Full vibration survey once the lines are operating fully
- Assessment of vibration transfer in the proposed building
- Vibration control measures if required based on the DP28 threshold values

The approach would be conditioned and is discussed further in the reported and at Appendix C.3.

Benefits to Neighbours

Exposure to railway noise would be reduced at the houses and flats on the south side of Iverson Road as the building acts as a significant screen. The effect of maximum noise levels of individual train movements would be clearly and noticeably improved.

Such improvements to the noise climate of existing residents are expected to be substantial and noticeable.

The proposed development and design is capable of achieving a reasonable internal and external noise climate for future residents with moderate attenuation provided. There is expected to be material benefit to the existing residents as noise exposure to railway noise is reduced noticeably.

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ACOUSTICS

159-161 Iverson Road, London

Environmental Noise Assessment Report

31 July 2014

James Tomalin

document control

159-161 Iverson Road, London

Environmental Noise Assessment Report

Planning Application *31 July 2014*

James Tomalin

Project	Author	Contact	Type	Doc Number	Revision	Title & Revision Comment	Checked	Approved	Date
13P282	JT	J Tomalin	R	R1260-188	DRAFT+Draft 2	Environmental Noise Assessment	jt	Jt	14/11/2013
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159-161 Iverson Road, London

Environmental Noise Assessment Report

contents

159-161 Iverson Road, London

Environmental Noise Assessment Report

contents (cont..d)

159-161 Iverson Road, London

Environmental Noise Assessment Report

Introduction

Aulos Acoustics has been appointed to review the environmental noise exposure of the application site including planning and noise assessment in accordance with local planning requirements.

The proposal includes a commercial unit and residential units to be built between Iverson Road and the railway to the north, in West Hampstead, London NW6.

The development proposal comprises the replacement of the existing light industrial space (currently Iverson Tyres) and 24 residential units, comprising 19 private apartments and 5 affordable units. A four to six storey development is proposed on the site, situated at 159-161 Iverson Road West Hampstead, within the London Borough of Camden

The properties will be exposed to railway noise, road traffic noise and building services and servicing noise generated by commercial premises. The level of noise is sufficient to require environmental noise survey and assessment in accordance with local planning policy.

The investigation was undertaken on behalf of the applicant.

The following report addresses the relevant aspects of the environmental noise climate and the requirements for the control of sound, as determined by national, regional and local planning policy.

Information Used

Full reference has been made to the documents, drawings and photographs forming the planning application package.

Where direct reference is required the specific document has been identified.

LB Camden planning policy regarding noise remains is defined in the Local Development Framework 2010-2025.

The overarching national planning requirements for noise are as directed by the National Planning Policy Framework and Noise Policy Statement for England and Explanatory Note.

The London Plan and Mayor's Ambient Noise Strategy require strategic and specific consideration of noise as it affects existing and future residents.

Planning Framework

The policy framework under which the application site needs to be assessed is defined in the following documents:

National Planning Policy Framework

National planning policy regarding noise is now limited and may best be described as a general aim to improve or maintain levels of amenity, in conjunction with consideration of other pollution and a sustainable approach.

The National Planning Policy Framework makes clear reference to the Noise Policy Statement for England and Explanatory Note as the basis of current and future policy.

These allow for two important changes:-

1. The explicit inclusion of the principles of sustainable development in noise policy
2. The application and use of different bands of Observed Adverse Effect Levels (OAEL)

The Noise Policy Statement for England states:-

> The first aim of the Noise Policy Statement for England
>
> **Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.**
>
> 2.23 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development (paragraph 1.8).
>
> The second aim of the Noise Policy Statement for England
>
> **Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.**
>
> 2.24 The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development (paragraph 1.8). This does not mean that such adverse effects cannot occur.
>
> The third aim of the Noise Policy Statement for England
>
> **Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.**
>
> 2.25 This aim seeks, where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development (paragraph 1.8), recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

The NNPF / NPSE approach is, in summary, to avoid exceeding Significant OAEL values (Aim 1), to mitigate and minimise adverse effects by reasonable measures to noise between Lowest and Significant OAEL values (Aim 2) and to improve health and quality of life affected by noise (Aim 3) where possible. Wherever feasible, practical and sustainable, both current and future

noise impact should be reduced as far as may be technically feasible with the ideal goal being No Observed Effect Level.

The approach allows for higher noise levels than may have applied in the recent past, as a range of design is encouraged and adverse effects are not excluded, rather than the application of unsustainable and impractical single-value, upper limits.

NB_1: Observed adverse effect level is the sound pressure level below above which the stated magnitude of effect will be noted.

No specific criteria are defined for different noise sources and no compiled reference exists for comparison. The ongoing development and review of acoustic design standards means design criteria corresponding to each OEL are not well defined.

For the basis of comparison here for railway noise, road traffic noise and steady/continuous equipment noise, the following OEL criteria shall apply inside residential property:-

Significant OAEL	LAeq,T 45dB(A) daytime (WHO 2000, WHO Noise Criteria 12)	LAeq,T 35dB(A) night-time
Lowest OAEL	LAeq,T 35dB(A) daytime (BS8233:2014, WHO 2000 and others)	LAeq,T 30dB(A) night-time
No Observed Effect Level	LAeq,T <=35dB(A) daytime	LAeq,T <=30dB(A) night-time (BS8233:1999 Good)

Sleep and rest conditions appropriate to the time of the day for the majority of the population are the “effect” addressed.

In addition, there is a general aim to minimise the effect of individual events. The degree of such an effect is not clearly defined, but the “Lowest OAEL” may be considered to be LAmax,FAST 45dB(A). Where this level is not exceeded a significant number of times conditions will remain reasonable and sustainable for a residential community. The aim in this case is for no more than 10% of the night-time events to exceed LAmax,FAST 45dB(A) inside, although the test is not a rigid one. Interpretation is required based on the type of source and results of the noise survey. It should be noted that BS8233:2014 removes the direct relationship between residential acoustic quality and individual noise events. The effect considered in this case is the slight changes to sleep pattern without full awakening that may occur and their possible adverse effect on health.

External noise standards are better defined with community annoyance criteria applicable, where limiting the proportion of people stating they are “moderately” or “seriously”, or worse, by community noise to a reasonable value, is the “effect” in question. The equivalent criteria are:-

Significant OAEL	LAeq,T 60dB(A) daytime (Seriously annoyed, i.e. proportion seriously annoyed is significant or unreasonable above this level)
Lowest OAEL	LAeq,T 55dB(A) daytime (Moderately annoyed), i.e. proportion moderately annoyed may increase beyond reasonable standards)
No Observed Effect Level	LAeq,T 50dB(A) daytime (Slightly annoyed or Not annoyed, “desirable”....i.e. proportion moderately annoyed is small and seriously annoyed is negligible)

Regional Policy – The London Plan

At present, the regional policy remains as stated in The London Plan and Mayor's Ambient Noise Strategy, which aim to improve conditions overall.

The approach of the NPPF/NPSE is similar and more objectively defined.

Largely, local policy accords with the regional planning requirements for noise, although it is stringent in relation to the national policy and strategy.

Local Policy

London Borough of Camden (LBC) has maintained a stringent approach to noise and vibration over a considerable period of time, with highly defined criteria and approach.

Recent policy has focussed on the whether ambient noise levels outside are either too high for sensitive development or require attenuation. Such an approach is similar to that previously used by PPG24 Planning & Noise (withdrawn), although LBC policy is more refined.

The current planning policies of London Borough of Camden ["LBC"] are defined in the Local Development Framework 2010-2025 (1)["LDF"]. The relevant specific policies are understood to be:

- DP28. Noise and vibration

The relevant core strategic policies are understood to be:

- CS14. Promoting high quality places and conserving our heritage
- CS16 – Improving Camden's health and well-being.

DP28 states the following:

Policy	Statement
DP28. Noise and vibration	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. Development that exceeds Camden's Noise and Vibration Thresholds will not be permitted. The Council will only grant permission for plant or machinery if it can be operated without cause 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.

Table 1 – LB Camden Planning Policy

The reasoned justification and detail of the policy section then defines a series of Noise & Vibration Thresholds on which planning decisions shall be based. These are reproduced in Appendix E.2.

Table A defines the thresholds above which planning permission will not be granted.

Table B defines the thresholds above which noise attenuation measures are required.

These threshold values do not accord with previous national planning policy, as set out in PPG24, in the following manner:

a) Separate evening and daytime periods are used to divide the 16 hour day of PPG24

b) Evening values are more stringent as such large fall in evening noise may not occur for the prevailing road or rail noise source

c) All values are more stringent by virtue of a 3dB façade reflection where none applies in PPG24

In effect, LB Camden defines a refusal position where noise levels are at or below the former NEC D boundary. The criteria are those defined in the previous Local Plan and SPG relating to noise. The Camden Noise Strategy 2002 stated:

> **16.26 There are three time periods in the standard, rather than the two time periods in PPG24, because of the considerable density of the rail and road network and the wide range of tourism and entertainment facilities in the Borough. These factors combine to make the area particularly susceptible to road and rail noise during the evening period, when local residents are entitled to expect reasonable peace and quiet in their own homes.**

No time period variations were permitted under PPG24, which stated in Annex 1:

> **7.** Traditionally, different indices have been used to describe noise from different sources, and limits have been set over different time periods. This has caused confusion, and this PPG follows the move towards consistency advocated in BS 7445: 1991 by expressing all noise in terms of $L_{Aeq,T}$. The recommended time periods are 07.00-23.00 and 23.00-07.00.

By contrast, the Table B values adopt an approach which at least clarifies the point where attenuation is expected, without defining a basis for the approach. These place the threshold values in NEC B, although again the different periods skew comparison with PPG24.

With respect to current national requirements, the day, evening and night approach is not unreasonable and seems suitable for a dense urban environment with significant evening activity. It remains arguable whether such an approach is sustainable, however, in the context of wider policy requirements. Particularly, it is highly arguable whether the basis that "...residents are entitled to expect reasonable peace and quiet..." is valid or sustainable, given these residents live in a central urban environment and benefit from the facilities and services of such an environment.

It should be noted few, if any, other London Borough's adopt a complete evening strategy for ambient noise affecting sensitive properties. The regional or national ambient noise strategy provides no substantive support for such a blanket approach.

Further information is defined in the Camden Planning Guidance 6 Amenity ["CPG6"] under section 6 Noise & Vibration. The CPG6 is general guidance regarding design approach and demonstration of the design. It retains reference to former (withdrawn) Planning Policy Guidance PPG24. The advice is comparable to that contained in BS8233:1999 (withdrawn) and, to some extent, BS8233:2014.

Most urban and many suburban environments experience extended periods of road and/or railway noise, with residential areas tending to experience later road traffic noise peaks than employment areas due to people returning home from further afield. The benefits to residents of highly-developed transport infrastructure generally outweigh the potential adverse effects.

Benefits include greater employment flexibility and choice, as well as wider options for leisure, entertainment and training/education.

In general, these policies apply specific and onerous limits which reflect the "Lowest Observed Effect Level" and represent a good or better standard, rather than reasonable, in relation to noise ingress to bedrooms particularly.

Whilst the approach is a desirable goal, in line with Aim 3 of the Noise Policy Statement for England, the author does not consider they represent a sustainable objective as required under the NPPF and addressed by Aim 1 and Aim 2 of the NPSE.

Criteria

The criteria for assessment of noise for external noise affecting the building envelope and controlling noise ingress to residential property shall be as defined in Appendix E (Table A and B)

The criteria for assessment of mechanical equipment noise affecting residential property shall be as defined in Appendix E (Table E).

The criteria for the assessment of vibration magnitude shall be as defined in Appendix E (Table C) although, except where these are superseded by assessment requirements in British Standards.

Building Envelope Design Criteria

The criteria for design of the building envelope sound insulation (including any ventilation paths) was previously defined in BS8233:1999 for the Reasonable Design Target Range. The design aim was "Reasonable" to "Good" standards of internal noise due to environmental sources, except where individual noise events are assessed where the stated "Reasonable" maximum noise level limit would have applied.

Under the revised BS8233:2014, a single-target value is stated which equates to the Lowest Observed Adverse Effect Level based on average annual daily conditions under normal diurnal conditions.

It should be noted that BS8233:2014 states under Table 4 of *7.7.2 Internal ambient noise levels for dwellings*:-

> *"NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."*

The target levels may be considered, still, to refer to "Good" conditions and "Reasonable" conditions: a lower target and upper limit, respectively. Under the NPPF / NPSE approach, the primary aim is to avoid significant effects, which is taken to mean less than reasonable conditions and the secondary aim is to design mitigation to levels between lowest effects and significant effects, which is taken to mean reasonable to good standards. There is no indication in the NPSE, NPPF or under the principles of sustainable design that internal room quality should be better than good, although this may be desirable.

Normal diurnal conditions apply in this case.

Daytime design shall refer to Living Rooms and night-time design shall refer to Bedrooms, as these are the reasonable, primary domestic uses for the relevant periods. For the avoidance of doubt, night-time refers to the period 23.00-07.00 hours.

The highest, internal ambient noise level allowable at night in bedrooms shall be LAeq,8hour 35dB(A). The design target for the whole development shall be in accordance with BS8233:2014 at LAeq,8hour 30dB(A). The performance shall allow for design uncertainty of 2-3dB. There is no fixed, minimum ambient noise level, but the aim shall be to ensure a reasonably consistent internal environment exists within habitable rooms, which tends to require noise levels within 5-10dB of the highest noise level.

NB: no adverse effects of levels below No Observed Effect Level are addressed in the criteria, but these are real and notable at low noise level. Provision of high sound insulation building envelope must be balanced against creating an artificially quiet environment, where neighbour noise and internal services noise becomes more obtrusive and a sense of isolation may result.

Quieter ambient noise levels can be expected to increase the obtrusiveness of certain noises (such as neighbour noise and barking dogs), the adverse effects of isolation from the external environment and the audibility of internal services, such as boilers or dishwashers.

For these reasons, it is not recommended the design cause very low internal transportation or other intruding noise levels, however desirable this may seem. A general lower target of LAeq,8h 20-25dB is applied in our approach.

The exception to the lower limit is where typical individual noise events may otherwise exceed the night-time noise limit of LAmax,FAST 45dB. This target may take precedence in the design due to the known effects on sleep quality and disturbance and potential health effects of such disturbance. Typical individual noise events are generally taken to be the loudest 90th percentile of measured LAmax,FAST.

Design to maximum noise levels may result in lower ambient noise levels than would otherwise be desirable, but the design will aim to balance both ambient and maximum noise levels. It is noted BS8233:2014 no longer specifically states maximum noise level targets for residential property.

Extraneous events are excluded (e.g. emergency sirens) except where such events might form a predictable or expected noise source (e.g. if flat is opposite a fire station).

The above are in general accordance with the requirements of the National Planning Policy Framework and ambient noise strategies for England and London.

Environmental Noise Survey

An environmental noise survey was completed between 13:00 hours 30 October 2013 and 13:00 hours 3 November 2013. The installation and removal periods for the meter are excluded from these times.

The survey was conducted in accordance with the requirements of BS7445:1 for establishing environmental noise exposure.

Continuous Monitoring

The noise climate was monitored continuously over the survey period from Position M, as indicated in Figure 13P282/1.

The microphone was fixed 4.2m above local site ground level on the north boundary, in a position unaffected by façade reflection. Ground level north of the position was 2.3m below the microphone. The microphone had a full and uninterrupted view of the nearest railway and an open view of Iverson Road.

Sound pressure level parameters measured and reported are Lmax, Leq and L90. More detailed parameters were measured, but are not reported for clarity. All parameters were measured in linear and A-weighted modes and with Fast and Slow time weightings. Frequency spectra were measured in octave bands, but are not reported.

A second fixed monitoring position was not considered viable due to security concerns.

Weather Conditions

Weather conditions during the survey period were erratic. Forecast conditions were for light rain at the start of the survey and dry periods and minor rainfall thereafter till the following week. Wind speeds were predicted as low till the following week.

Actual weather resulted in heavy rainfall at times, winds above normal limitations at times and persistently damp conditions with wet roads and tracks.

Similarly, the surveyor only returned to site after delay on 6 November following rainfall on 4 and 5 November. The weather forecast was for a dry morning and afternoon, with rain beginning in the mid afternoon. Actual weather was heavy showers before arrival in the morning and persistent showers thereafter.

In normal circumstances, the survey would have been aborted in full, but time constraints did not permit a repeat survey before planning application submission.

The results of measurements at Position M are presented here for the period up till 3 November 2013. No adjustment has been made to the results for weather conditions.

Uncertainty is expected to be high, although the effect will tend to be to report higher noise levels than actually exist during normal, compliant conditions.

The earlier periods are more representative (30 October to 1 November).

Some evening and night-time fireworks will have affected results at times. Some of these are clear from the time history results, but no adjustment is made under current conditions.

The results are considered to be a worst-case representation of the noise climate and are addressed as such below.

Manual Measurement

The site was attended during 30th October and 6th November 2013.

As discussed above, it was not feasible to measure on the selected day (6/11/13) at the selected sample positions on Iverson Road and the northern boundary. Weather conditions were far from suitable.

No noise emissions were noted from the warehouse / depot buildings to the west.

No construction site noise was noted from the open site to the east (163 Iverson Road).

Road traffic noise was observed to be relatively low with light to moderate traffic moving sporadically past the site. Most vehicles were light; cars and small goods vehicles. A few medium goods vehicles passed. No large goods vehicles were noted. Some public service vehicles were noted including taxis and smaller buses.

Equipment & Calibration

The measurement equipment used was as follows:

Reference	Type	S/N	Manufacturer	Description
GRAS01				Environmental microphone
NOR118	118	31349	Norsonic	Integrating-averaging sound level meter
NREV	NorReview 4.0.102	-	Norsonic	Data analysis & reporting software
NXFR	NorXfer 4.6.0.5	-	Norsonic	Data transfer software

Table 2 – Survey Equipment

All sound level meters are precision grade and have current, traceable calibration certificates, which are available on request.

Results

The results of the environmental noise survey are detailed in Appendix C for each of the measurement positions.

Continuous Monitoring

The planning process requires demonstration of the noise exposure of an application site for residential development, based on three periods. The typical noise exposure level is defined as the mean of the continuous equivalent sound pressure level ($L_{Aeq,T}$) where the period T is each successive day, evening or night.

There is also a requirement to consider the background noise level (LA90), where this may be affected by fixed mechanical equipment or building services noise.

Appendix C.1 reports the results of the continuous measurements at Position M for the primary parameters: $L_{Aeq,T}$, $L_{Amax(FAST)}$, L_{A90}.

Appendix C.2 reports the analysis of the measured data, including the average noise exposure calculations for each day and over the whole survey period.

Appendix C.3 reports the analysis of the data for the measured and calculated maximum noise level results, including comparison to night-time results.

Analysis

The basic noise exposure analysis of the results are presented in Appendix C.4 including the assessment of:-

- daily and average noise exposure levels
- minimum background noise levels for day, evening and night

Noise Climate

The environmental noise climate is determined by regular and frequent railway traffic and by road traffic on Iverson Road to a degree. Some contribution from sporadic works by Iverson Tyres was noted.

Further contribution from the surrounding area was audible, including from the B510 west End Lane and, distantly, from other railways to the south.

Building services equipment operating in the service yard of Iverson Tyres was an audible source on Iverson Road, but not beyond 10-15m. Some activity noise within the tyre workshop was audible at times, but was not obtrusive.

Commercial servicing by goods vehicles is not a significant a source of noise. All goods vehicles seen were small and medium vehicles.

With the exception of the railway, noise exposure is not subjectively obtrusive, in general, with road speeds remaining relatively low and most larger vehicles not approaching the nearest boundaries directly. The pavement and parking on the north edge of Iverson Road form an effective buffer space between the site and the loudest vehicles, limiting direct exposure to noise.

The pattern of movement on Iverson Road is of moderate flow and sporadic, possibly with some cyclical elements due to local traffic management at and near the West End Lane junction.

The railway is relatively busy and is now understood to be operating fully following a long period of restricted activity due to engineering works and re-development of Thameslink.

The nearest tracks are understood to operate as one relief line and one management siding. Occasional trains are expected on these nearest tracks as demand requires. The through movements of trains on the relief track are expected to be few, based on previous investigations, and are likely to occur only during busy periods.

Freight is known to use all of the tracks north of the site, however, the general traffic is light in comparison to many lines. One freight train was noted on the far “Up” track (London-bound) during 30 October visit, but was not clearly audible. It is understood other routes through the Hampstead and Kilburn area can be expected to bear most of the freight traffic needs.

Background Noise Levels & Limits

The underlying background noise levels remain relatively high with the typical night-time minima being L_{90} 40dB(A). There is pre-existing building services noise audible at the site, which is normal for an urban environment.

Daytime and evening background noise is generally much higher in the core of the day, although the start and end of the full daytime period is similar. Typical minimum background noise levels over the eight days were:

Time	Min LA90,1h	
Day-Evening-Night 24-hour	33.3	dB(A)
Daytime 07:00-23:00	40.6	dB(A)
Daytime 07:00-19:00	40.6	dB(A)

Time	Min LA90,1h
Evening 19:00-23:00	41.5
Night-time 23:00-07:00	33.3

Table 3 – Minimum Background Noise Level

NB: the night-time minimum is abnormally low for the area. There is some indication engineering works or emergency railway works may have affected ambient noise levels on 1 November. Whilst this could not be confirmed, the long period of low noise level on a Saturday night and Sunday morning is representative of a substantial shutdown period. Other days of the week showed substantially higher background noise level. The minimum for other nights is LA90 38dB, which would be the design basis where operating hours of equipment / commercial space does not extend to Sunday.

The above would imply the maximum background noise level criteria due to all sources of mechanical equipment noise at 1m from the nearest residential windows would be as follows:

Time	Min LA90,1h	
Day-Evening-Night 24-hour	28	dB(A)
Daytime 07:00-23:00	36	dB(A)
Daytime 07:00-19:00	36	dB(A)
Evening 19:00-23:00	37	dB(A)
Night-time 23:00-07:00	28	dB(A)
Night-time Sunday-Friday	33	dB(A)

Table 4 – Mechanical Equipment Noise Limits

These are 5dB(A) below background noise level to ensure the LB Camden criterion is achieved.

A further 5dB(A) penalty may need to be applied in the event of acoustic features, particularly intermittency or tonal or tone-like content, as described in Appendix E.

Moderation of the above noise limits may be feasible for certain days, if operation does not occur at weekends, for example.

Ambient Noise Levels & Exposure

The ambient noise levels are moderate and normal for the central urban environment, located away from major transportation routes. These results are reported in Appendix C.

The highest noise exposure of the site would be as follows for the north boundary (Position M).

- Daytime 07.00-23.00 hours Leq,16 hours 60.5 dB(A) free-field
- Daytime 07.00-19.00hours Leq,12 hours 60.6 dB(A) free-field
- Evening 19.00-23.00 hours Leq,4 hours 60.2 dB(A) free-field
- Night-time 23.00-07.00 hours Leq,8 hours 53.3 dB(A) free-field

These are representative of noise levels for the most exposed position facing the railway.

Noise exposure is generally quieter than the above across the remainder of the site till close to Iverson Road.

As previously discussed, the above represent a worst-case due to the effects of precipitation on noise from road surfaces, particularly, and railways and of wind on measurement accuracy.

Based on previous measurement on Iverson Road and at similar locations, the expected daytime road traffic noise level may be in the range LAeq,16h 60-65dB. As the basis for design the following levels are assumed at the southern boundary within 2m of the carriageway edge:-

- Daytime 07.00-23.00 hours — Leq,16 hours 60-65 dB(A) free-field
- Daytime 07.00-19.00hours — Leq,12 hours 65 dB(A) free-field
- Evening 19.00-23.00 hours — Leq,4 hours 60 dB(A) free-field
- Night-time 23.00-07.00 hours — Leq,8 hours 55 dB(A) free-field

Maximum Noise Levels

Consideration should be given to the A-weighted maximum sound pressure levels at night. These characterize the effects of individual noise events, such as car movements. Advice has considered Fast time-weighted results to represent Human reaction as a worst case. The parameter is referred to as $L_{Amax,FAST}$.

Under PPG 24 guidance (based on extensive research into the reaction of people to such events), if the $L_{Amax,SLOW}$ exceeded 82dB several times in any night-time hour then the night-time noise exposure was deemed to be loud enough to require specific mitigation of the noise in design. Similar guidance is given in current guidance, including WHO 2000 and BS8233:2014, but the latter is not specific to residential property.

The results are reported in Appendix C.2 for the continuous monitoring LAmax,FAST and show few night-time exceedance of the 82dB limits for most nights and no period where an excess occurs more than twice in an hour.

Event noise levels at night are likely to be highest at the northern boundary, where no regular exceedance of 82dB(A) is expected.

The total period where LAmax,FAST exceeds 82dB(A) is, at most, 1 ½ minutes in any night-time period. Annoyance due to individual noise events is expected to be reasonable with or without open windows.

In general, sleep disturbance; the critical issue at night; tends to correlate with LAmax,FAST, which describes a quicker “reaction time” of the measurement equipment. Consequently, Fast time-weighted levels tend to be higher for clear noise events.

Appendix C.3 shows the LAmax,FAST results also. These are much higher during the day than at night, which is expected to be due to the nature of train and car movements in the vicinity of the site.

Typical night-time maximum noise levels at Position M are LAmax,FAST 53-64dB(A), which represents the loudest 10% of events but excludes the loudest 1%.

Night-time maxima remain critical to the design, but the number of potentially disruptive events is relatively low and the levels measured are relatively low.

The maximum noise levels at the southern boundary are expected to be up to 10dB(A) higher than the night-time ambient noise level, typically. For the purposes of design, the maximum noise level there is taken to be LAmax,FAST 65dB.

Other Noise Sources

No other significant noise sources were noted.

All servicing vehicles and commercial activity are included within the measurements and no data has been excluded for reasons of weather, extraneous peaks or otherwise.

Implications of Assessment

The Position M results reflect the noise levels expected at the residential facades well. These facades are elevated from the roadside and railway by a significant separation. Such separation allows the most obtrusive noise to be attenuated.

The Position M results are taken to represent the north elevation with a 3dB correction for uncertainty. The southern elevation shall be represented by the assumed day, evening and night-time noise levels with a -3dB correction for vertical separation and 3dB correction for uncertainty.

The flank-elevation noise exposure shall be determined by calculation, but is expected to be 3-5dB less than the north and/or south elevations. The roof is expected to experience noise exposure at least 10dB below the highest noise levels elsewhere.

Noise level will reduce with height and will be determined by calculation , but the approximate reduction will be 3dB to the sixth floor.

LB Camden Assessment

The following table provides the general assessment of site noise exposure against the criteria for planning policy DP28:-

Window	**Daytime Leq,12h 07.00-19.00 h**			**Evening Leq,4h 07.00-19.00 h**			**Night-time Leq,8h 23.00-07.00 h**		
Elevation:	**North**	**South**	**Roof**	**North**	**South**	**Roof**	**West**	**South**	
Source Noise Level	61	65	65	60	60	60	53	55	55
Uncertainty	+3	+3	+3	+3	+3	+3	+3	+3	+3
Separation	0	-3	-10	0	-3	-10	0	-3	-10
Facade	+3	+3	+3	+3	+3	+3	+3	+3	+3
Façade Noise Level	67	68	61	66	63	56	59	58	51
Table A Limit	74	72	72	74	72	72	66	66	66
Status	**Achieved**			**Achieved**			**Achieved**		
Table B Limit	65	62	62	60	57	57	55	52	52
Status	*+2dB*	*+6dB*	*Achieved*	*+6dB*	*+6dB*	*Achieved*	*+4dB*	+6dB	*Achieved*
Outcome	*Additional attenuation required for elevations*			*Additional attenuation required for elevations*			*Additional attenuation required for elevations*		

Table 5 – Review of Noise Exposure to LB Camden DP28 Requirements

Additional attenuation is expected to be required for the building envelope elevations. The roof is sufficiently separate that sound insulation over and above the normal construction performance is not expected to be necessary.

Further assessment is required.

Noise Criteria Inside

The primary noise criteria are discussed under the Planning Policy section and are reiterated below and shall apply inside residential property:-

Significant OAEL	LAeq,T 40dB(A) daytime	LAeq,T 35dB(A) night-time
Lowest OAEL	LAeq,T 35dB(A) daytime	LAeq,T 30dB(A) night-time
No Observed Effect Level	LAeq,T <=35dB(A) daytime	LAeq,T <=30dB(A) night-time

Dining rooms may have levels 5dB(A) greater than the normal living area conditions stated above.

Sleep and rest conditions appropriate to the time of the day for the majority of the population are the "effect" addressed during the night and with communication and intelligibility the main effects during the day.

It should be noted that BS8233:2014 states under Table 4 of *7.7.2 Internal ambient noise levels for dwellings*:-

> *"NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."*

NB: no adverse effects of levels below No Observed Effect Level are addressed in the criteria, but these are real and notable at low noise level. Provision of high sound insulation building envelope must be balanced against creating an artificially quiet environment, where neighbour noise and internal services noise becomes more obtrusive and a sense of isolation may result.

In addition, no observed effect will occur at night during sleep for typical levels of individual event noise of LAmax,FAST 45dB(A), where this level is not exceeded for more than 10% of the night-time events, to minimise sleep disturbance. The effect in this case is the slight changes to sleep pattern without full awakening that may occur and their possible adverse effect on health.

On the north elevation, where railway noise determines the noise climate LAmax,FAST 45dB(A) should not be exceeded for more than 5% of the night-time events, due to the regular and similar nature of the train movements but their relative scarcity at night.

These represent a reasonable range of conditions to ensure the building design remains practical and sustainable.

Demonstration of Feasibility

Based on the general assessment methods of BS8233:2014, BS EN 12354-3:2000, the sound level difference from outside to inside is expected to be as follows:

- Partially Open Window -15dB(A)

- Closed Thermal Double Glazed Window -25dB(A)
- Closed High Mass Window -30dB(A)

The implied internal noise levels during the day and night are as follows:

Window	Daytime Leq,16h 07.00-23.00 h			Night-time Leq,8h 23.00-07.00 h		
Site:	**North**	**South**	**Roof**	**North**	**South**	**Roof**
Elevation Noise Level	67	68	61	59	58	51
Open	52	53	46	44	43	36
Closed Thermal	42	43	36	34	33	26
Closed High Mass	37	38	31	29	28	21
Key	*Not feasible*	*Not feasible*	*Feasible*			
	Excluded	*Potential for Improvement*	*Included*			

Table 4 – Feasibility of Basic Design Period Noise Levels

For illustration, the noise levels of individual events at night are taken to be Lmax,FAST 67-68dB(A) (up to 1% loudest of events) at both main elevations and with a -10B correction for the noise levels affecting the roof.

The implied internal noise levels during the day and night are as follows:

Window	*Night-time Lmax,FAST*		
Site:	***North***	***South***	***Roof***
Source Noise Level	*67*	*68*	*58*
Open	*52*	*53*	*43*
Closed Thermal	*42*	*43*	*33*
Closed High Mass	*37*	*38*	*28*
Key	*Not feasible*	*Not feasible*	*Feasible*
	Excluded	*Potential for Improvement*	*Included*

Table 5 – Feasibility of Basic Design Individual Event Noise Levels

Even if the more representative 90-95th percentile LAmax,FAST values are used the use of openable windows for bedrooms at night would not be feasible. Standard thermal double glazing would be adequate in general.

The provision of a building with open windows as the sole means of ventilation is not feasible, as the future residents would have no means of respite during the noisiest periods in moderate or high noise exposure areas.

For most circumstances, the use of windows equivalent in sound insulation to standard thermal double glazing would provide an adequate basis for noise control. Closed High Mass

double or triple glazed windows would be required on the most-affected, loudest facades or where large areas of glazing or curtain walling are needed.

Some amelioration of requirements will occur with height, but the benefits are likely to be limited and may allow only the east and west elevations to achieve a greater proportion of natural ventilation.

The control of individual event noise at night to bedrooms is expected to require such Closed High Mass double or triple glazed windows where the bedroom overlooks the railway and Iverson Road.

Again, higher areas of glazing / curtain walling would require higher, relative sound insulation performance.

The above would constrain the use of openable windows as the sole means of ventilation and is likely to preclude natural ventilation without an effective alternative.

Other means of ventilation will be required to provide future residents with an effective means of noise control during the noisiest periods, whilst maintaining appropriate fresh air and extract air provision. The options for such treatment may include high free area attenuated openings or acoustic louvres, direct mechanical room ventilators or whole-dwelling mechanical ventilators. All will require a specific attenuation performance with the latter the most straightforward for including noise control.

The current design allows for whole-flat balanced ventilation and heat recovery systems, which will be sufficient to meet the acoustic requirements provided there are no window trickle ventilators or additional unducted wall ventilation openings to outside.

Within the constraints of a modern building design, the effective control of noise intrusion is feasible during both the day and night; provided the design allows future residents to control noise ingress effectively in the most exposed areas. To achieve such a goal would require sealed thermal double glazing of high quality and high mass in conjunction with an alternative means of ventilation to openable windows or unattenuated natural ventilation.

Development & Detailed Design

Detailed design will be required both to demonstrate the effectiveness of the sound insulation scheme and to optimise the use of high performance windows, non-vision areas and ventilators.

Such full design measures are not included for assessment at this stage.

Detailed calculations would be completed at design stage to determine the performance of all elements of the building envelope.

To illustrate the implications of such calculations, reference shall be made to Appendix D. Worst case sound transmission calculations are included as calculations 13P282 C1 and C2 for the North and South Elevations of the application site, respectively.

Calculation 13P282 C1 shows that the proposed elevation design allows the reasonable to good internal noise levels to be achieved on the North Elevation, as a worst case, with relatively standard construction and dimensions. With the provision of a high standard of window / external door, the BS8233 Table 4 target value, or “good” quality, is achievable in Bedrooms at

night and all Significant Observed Adverse Effects are avoided under the NPPF / NPSE requirements.

Calculation 13P282 C2 shows that the proposed elevation design allows the reasonable to good internal noise levels to be achieved on the South Elevation, as a worst case, with relatively standard construction and dimensions. With the provision of a high standard of window / external door for both Bedrooms and Living Rooms, the BS8233 Table 4 target value, or “good” quality, is achievable in Bedrooms at night and Living Rooms during the day. All Significant Observed Adverse Effects are avoided under the NPPF / NPSE requirements.

The scheme allows for nominal acoustic ventilators, i.e. windows closed and alternative mechanical ventilation system with the exclusion of direct ventilation grilles and vents to outside.

It is recognised, though, that there are marked variations between different rooms and elevations. There are also variations in incident noise conditions, such as the degree of screening afforded by balconies. The results of this calculation provide no significant margin against these variations, although a basic degree of Uncertainty has been applied against changes in source noise level.

The results achieve the required noise targets, with a small margin for design and construction variation.

The use of higher mass thermal double or triple glazed systems would be advisable for inclusion as a general allowance at this stage. The sound insulation performance target is Rw37-40dB for windows and external doors on the North and South elevations and flank elevations. Some degree of reduction may be feasible for Living Rooms on the North elevations, where Rw 33-37dB windows / external doors may suffice.

NB: Rw = Weighted Sound Reduction Index; a laboratory-tested performance of the complete window / door system including frames, seals, glass units and other components but not the adjoining walls. Glass performance alone is not an approved means of selection.

The higher performance windows are expected to comprise glazing units with at least one 10mm or similar mass pane and one 6mm or similar mass pane. The use of laminated panes and/or gas-filled cavities is presumed, as these tend to minimise the need for deep glazing modules. A high quality unit, including frames, seals and other components, may achieve the performance more easily. Medium quality build is likely to result in a requirement to increase glazing module depth and the number of panes / laminated layers.

Walls and other non-vision components of the building envelope shall achieve a minimum Weighted Sound Reduction Index of Rw 45dB. A composite, framed, lightweight wall panel may achieve this with sufficient mass (e.g. 20kg/sq.m either side of frame) boards on inside and outside, with non-rigid, part-fill insulation and a cavity of approximately 250mm.

Traditional masonry or insulated concrete construction is expected to achieve at least the performance level and, potentially, far exceed it.

The roof shall have a similar sound insulation performance and a minimum Rw 40dB performance is recommended. In addition, the provision of a high-mass or green roof system is likely to preclude the need for additional rain noise protection. The aim should be to achieve

a mass of 150kg/sq.m or provide addition sound insulation to the roof surface and soffit to protect against rain impact noise.

On the basis such measures are included then it is expected the rooms will achieve the local and national planning policy requirements, with internal noise being below the Lowest Observed Adverse Effect Level in most cases. The proposed scheme is expected to avoid Significant Observed Adverse Effects.

No Effect Level is the most common condition with a "Good" standard of internal noise.

Both calculations are confirmation that openable windows are unlikely to be an effective means of ventilation. Any alternative ventilation system whether natural or of balanced mechanical ventilation must achieve a minimum sound insulation performance as well as meeting ventilation requirements of The Building Regulations and The Code for Sustainable Homes.

Some moderation of the requirement may be possible for the other elevations.

Detailed design development is required to optimise the sound insulation performance of the building envelope and ensure the cost-effective use of different wall, window and ventilation systems. This is particularly due to the significant variations in noise exposure expected around the buildings and with height.

Design Measures Included

The design aims to maximise separation between the noisiest sections of road and railway and the residential facades.

With noise sources on both sides of the building being of similar level, fewer options exist for changing location and outlook. The general layout places most bedroom windows on the North, West and East elevations, as well as inner elevations.

These are generally quieter or less obtrusive than the South elevation where road traffic noise is the main component of the noise climate at night.

It is deemed preferable to maintain bedrooms on the North elevation, where railway traffic is less annoying, quieter and less prolonged than road traffic. This enables the use of the Living Room frontages to remain active and more desirable spaces, as most domestic activity in these areas will not be adversely-affected or interrupted by outside noise.

A consistent standard of sound insulation is to be provided throughout the building and applied at a high quality.

All habitable spaces overlooking the noisiest routes, or with an oblique view of them, will require attenuated ventilation as an alternative to openable windows. The internal elevations may have a reduced requirement, but should be included in such a scheme. No direct ventilation openings (e.g. trickle vents) are to be provided and windows remain openable should residents require it.

The layout and orientation of the buildings is generally positive acoustically, with emphasis placed on protecting many of the most sensitive rooms from direct exposure to noise.

Noise from Commercial Uses

The proposed ground floor commercial B1 use is limited to one defined area.

Noise emissions due to activity is not expected to be an issue of concern as the use is self-contained within the building and there are limited ancillary areas, such as bin stores.

The basic airborne sound insulation between the commercial, including ancillary space, and the flats above should exceed the prevailing requirements of The Building Regulations by at least 5dB to provide for compatible neighbouring uses. The sound shall be incorporated in the property owner scheme and any operator shall add to this as required.

Where a noisy operator occupies the space, additional sound insulation may be required.

There are no specific proposals for operator at this time. It would not be practical, necessary, effective or sustainable to apply higher standards of sound insulation to address such unknown or atypical uses.

The degree of protection will extend beyond airborne sound insulation and include: impact protection of walls, columns and floors; noise-vibration control of mechanical, hydraulic and other equipment; noise-vibration control of doors and motorised openings and lifts; sound absorption control in spaces.

There may be a need for control of open doors for noisy uses, but it is noted the buildings directly opposite the site are not residential. The residential buildings are offset to a degree and separated by the full width of Iverson Road.

In general, it is expected that any use generating a noise level of greater than LAeq,1h 70-75dB will require additional sound insulation to inside and outside. All uses will require additional acoustic treatment to some degree to protect from specific activities, such as impacts and mechanical equipment.

Building Services

Noise limits will remain a requirement for all building services equipment, with a typical limit being 5dB(A) below background noise level when assessed according to BS4142:1997 to enable the installation of other equipment outside the commercial use.

Further attenuation of 5dB(A) may be required where there are acoustic features, which may attract attention, within the definition of BS4142. The noise limits for building services equipment at 1m from the nearest current and future residential windows are stated previously.

The cumulative effect of noise shall be taken into account.

Mechanical Noise & Vibration

Any mechanical building services equipment serving the development shall have noise and vibration control equipment to limit:-

- Airborne noise to the reasonable target noise levels;
- Structure-borne noise to inaudibility where practicable; and
- Vibration to imperceptible magnitudes.

The means of achieving these objectives are within current design capabilities for control equipment for, say, building services equipment.

Noise limits on equipment are as previously stated.

Outside Amenity Areas

Private amenity areas are limited to balconies which the author considers to be spaces of elective use, where the exposure to noise is an accepted circumstance.

With effective use of balcony deck and balustrade screening noise exposure while seated can be expected to be approximately LAeq,≥1h+ 55dB on the most exposed elevations. Such levels would decrease as height above ground level increased with effective treatment of projecting soffits.

Given the presence of full and Juliet balconies on the nearby and adjacent residential buildings and the common use of balconies and terraces in urban development, the future occupants' expectations should be fulfilled by the moderate noise level.

The above noise level would not be expected to represent a Significant Observed Adverse Effect in the context of an elective space in an urban area.

The remaining open or communal amenity areas are effectively screened from direct exposure to railway and road traffic noise. Daytime noise levels are expected to be below LAeq,16h 55dB and may well be below LAeq,16h 50dB in the east ground level area adjacent to the residential entrance provided a retaining wall or solid fence are retained on the northern boundary and ground level remains below the top of the embankment, as at present.

Ground-borne Vibration

No perceptible vibration was noted on site due to railway traffic at ground level or when standing on retaining masonry wall in poor condition. The latter was an unstable structure in relation to the proposed building and, so, is a reasonable indicator of low vibration magnitudes.

No perceptible vibration was noted on the adjacent consented site at 163 Iverson Road, either.

Train movements on two of the furthest four tracks were noted during the site visits, including one freight movement.

No movements occurred on the nearest relief track and siding.

There is a moderate expectation of ground-borne vibration from railway movement sufficient to be perceptible in the completed building. Due to the nature of the building sub-structure proposed, it is recommended further detailed investigation is deferred until measurements can be made at pile locations in dedicated monitoring pits or on "temporary" piles.

The same approach was used for 163 Iverson Road and involves:-

1. Measurement of ground-borne vibration in accordance with BS6472 at commencement of enabling groundworks on site at two monitoring locations

2. Analysis and assessment of ground-borne vibration in accordance with BS6472 and LB Camden criteria to determine if perceptible vibration is acceptable in residential units at all floors.
3. Where assessment shows control of ground-borne vibration is required to comply with requirements of BS6472 and LB Camden criteria, develop a control scheme to include building isolation and separation of structure, fabric and services from ground. Submit report of vibration control scheme to LB Camden for review and approval.
4. Implement control scheme in full as agreed during construction.

Item 1 would need to take place on implementation or at least when enabling works on site allow the digging of test pits or setting of test piles.

Item 2 and 3 would need to occur at the earliest stage possible due to the cost and design implications of such control measures on structural and architectural requirements.

Item 4 would need to be an integral element of the construction process and not seen as an adjunct to it.

The above approach was previously agreed in principle to enable full operation of the railway and provision of suitable test areas on site. The latter remains the critical focus in this case, although there are indications the nearest tracks are not being used as fully as anticipated or advised during investigation of 163 Iverson Road.

The footprint of the proposed scheme is located over a low quality commercial building constructed in an entirely different manner to that proposed. To obtain accurate and representative results, vibration measurements should be made at the main structural bearing positions in full contact with the ground.

This is not practical currently without moving or disrupting an operating business.

It is recommended any planning permission include conditions to ensure the vibration survey and assessment are undertaken at an early stage for approval and that any required control scheme is approved and implemented.

Future Railway Noise

The above assessment includes current railway and road traffic noise levels.

The expectation for 15-20 year growth is not substantial, particularly as the Thameslink and Midlands Mainline rolling stock is modernised and road vehicle volumes are understood to be relatively static at present.

The expectation is of a worst-case increase in road traffic noise levels of LAeq 2dB(A) and in railway traffic noise levels of 1dB(A). The former is based on original Highways Agency forecasts, but it is noted that London does not align with the national model. There is a substantially greater use of public transport modes, walking and cycling than in other parts of the UK. Consequently, there is a high likelihood that no change in road traffic noise levels will occur.

Maximum noise levels would not be expected to change to any measurable degree, although road vehicles will continue the trend towards quieter models and engines (e.g. higher proportion of electric cars, smaller engine capacity, etc.).

A 2dB(A) change in the noise exposure used in the above assessment would be notable, but the internal ambient noise climate would be expected to remain of “good” quality and no Significant Effects would arise.

Benefits to Neighbours

The proposed scheme provides a further barrier screening effect in conjunction with the consented scheme at 163 Iverson Road.

The latter scheme still allowed railway noise propagation at the western end of the site and limited the benefit attainable to existing flats further east.

The proposed scheme will effectively obscure line of sight to the railway for most if not all of the residents, in conjunction with the 163 Iverson Road scheme and the Network Rail signalling control building and other properties.

Whilst not a complete and continuous barrier, the effective noise reduction will be significant as the most open view of the railway, at the end of the embankment, will be obscured.

Overall, it is estimated that the nearest, existing residential properties on the south side of Iverson Road will benefit from reductions in train movement noise of approximately 10dB(A) from ground level up to around 8-10m above ground level. Reductions will decrease above that height, but wherever the view of the nearest mainline tracks is obscured at least 5dB reduction in train movement noise can be expected.

The greatest effect will be apparent for fast and freight trains using the relief track (the nearest track), where it is currently clearly visible as the embankment falls to the west.

Conclusions

Aulos Acoustics has completed an investigation of the environmental noise exposure expected at the application site of 159-161 Iverson Road, London.

Environmental Noise Survey

A noise survey was completed to determine the noise climate affecting the proposed residential properties. The application site is widely affected by railway noise due to its proximity to the Midland Mainline operating through West Hampstead Thameslink station. Both fast and stopping trains result in frequent railway movements.

The survey was affected by inconsistent weather conditions, including rain and wind. The results are considered to be higher than would otherwise be the case, although railway noise may not be so badly affected as road traffic noise.

As a result of the poor conditions, it was not possible to complete manual sample measurements around the site. Road traffic noise levels have been estimated on the basis of measurements at similar sites and taking into account published sources noise level progression for London.

The results have a degree of uncertainty greater than that normally expected for survey results. The contribution of the weather conditions to noise level is expected to be some 3dB (estimated).

It is recommended an environmental noise survey be repeated in more consistent conditions later to confirm noise levels and limit over-design of the building envelope sound insulation.

Noise Exposure Assessment

Noise exposure has been assessed against the LB Camden criteria of development policy *DP28. Noise and vibration* and the outcomes are as follows:

The noise exposure is insufficient to require refusal of the application on noise grounds as levels do not exceed the Table A threshold values of DP28.

The Table B threshold values describe the levels above which attenuation measures would be expected by the Council.

The noise exposure results indicate some attenuation is required to control noise exposure, although this is to a moderate degree.

Criteria

The criteria recommended in BS8233:2014 *Guidance on sound insulation and noise reduction for buildings* have also been taken into account, applying the Table 4 design targets and allowing for the stated "reasonable" conditions, where appropriate. The application of a range is in accordance with the principles of the NPPF and NPSE. The upper "reasonable" boundary of the range may be considered as the onset of Significant Observed Adverse Effects, as described in the Noise Policy Statement for England, which is referenced in the NPPF.

The design approach shall avoid internal noise levels that are either too quiet or inconsistent within a property, to limit the adverse effects of low ambient noise levels, including increased intelligibility / audibility of neighbour noise, isolation from environment and perceptions of poor sound insulation.

All criteria apply on an average annual daily basis for normal diurnal variation, which is relevant in this case.

Natural Ventilation Feasibility

A feasibility assessment has been undertaken to determine if openable windows and natural ventilation are suitable as the sole means of ventilation. It is concluded that an alternative means of full ventilation is required to provide an effective choice between open windows and noise intrusion. The exclusion of direct grilles and vents in walls, doors and windows is also confirmed as a requirement.

The current scheme would be expected to require moderate to high mass windows systems and a whole-flat balanced mechanical ventilation system, or alternative of equivalent sound insulation.

Ventilation methods are to provide normal ventilation to Building Regulations requirements (or enhanced, sustainable performance where applicable). These are not intended to provide full boost or purge ventilation, which may be required for exceptional conditions of clearing smoke, fumes, excessive moisture or heat.

Current Proposed Noise Mitigation

The design includes for reasonable measures to minimize noise exposure including:

- Application site for development is not immediately adjacent to busiest sections of mainline railway as two low impact tracks provide separation
- Large proportion of rooms on screened elevations or with a restricted view of the railway
- Provision of alternative ventilation system to openable windows
- Communal amenity area at low level where the effect of screening and topography are greatest and view of railhead is obscured
- Private amenity spaces are located away from railway or benefit from building screening in most instances
- Use of building and façade features to provide for localized screening and dispersion effect from facades

Further attenuation measures have been determined and recommended in the report. These include the following on the most exposed elevations:

- Specific provision for maintaining an alternative ventilation system to each habitable room to provide alternative to open windows, when desired by occupants
- Elimination of unattenuated background or trickle ventilation to each habitable room
- Provision for improved, medium performance window sound insulation
- Provision of increased airborne sound insulation for the B1 Use to provide substantive basis for future occupants
- Limits for building services noise emissions
- Optimise screening of balconies, rooftop amenity space and access by providing solid screen to perimeter 1.2-1.5m high to enable an obscured sound transfer path when seated, where applicable
- Provision for solid screening to north boundaries of ground level communal amenity space to optimize attenuation from railway

In general, medium attenuation (Rw 35-40dB) performance windows and ventilation system will be required for the most exposed habitable rooms. This equates to thermal double or triple glazing with heavier glass than is standard and a central ventilation system for each flat or house.

Future Noise Exposure

The future change in noise exposure levels would not be expected to alter the conclusions of the assessment or lead to Significant Observed Adverse Effects. The internal noise climate would remain in line with the better targets, or “good” quality, of BS8233:2014.

Ground-borne Vibration

No perceptible vibration was noted on site due to railway traffic at ground level or when standing on retaining masonry wall in poor condition.

The railway may not be operating fully at the nearest lines, but, critically, the site supports an operating business occupying the footprint of the proposed scheme.

The effect on noise exposure is expected to be small, but vibration exposure may be determined by these nearest lines.

Consequently, it is recommended provision is made within planning conditions, if permission is granted, for deferred survey, assessment and design of ground-borne vibration. The alternative approach was discussed and agreed with LB Camden for 163 Iverson Road consented scheme and adopted in the planning permission.

The approach to ground-borne vibration would include for:-

1. Measurement of ground-borne vibration in accordance with BS6472 at commencement of enabling groundworks on site at two monitoring locations
2. Analysis and assessment of ground-borne vibration in accordance with BS6472 and LB Camden criteria to determine if perceptible vibration is acceptable in residential units at all floors.
1. Where assessment shows control of ground-borne vibration is required to comply with requirements of BS6472 and LB Camden criteria, develop a control scheme to include building isolation and separation of structure, fabric and services from ground. Submit report of vibration control scheme to LB Camden for review and approval.
2. Implement control scheme in full as agreed during construction.

It is critical such an approach begins as soon as test sites can be prepared.

Benefits to Neighbours

Exposure to railway noise would be reduced at the houses and flats on the south side of Iverson Road as the building acts as a significant screen and completes the barrier effect of 163 Iverson Road and the Network Rail facilities.

The effect of maximum noise levels of individual train movements would be clearly and noticeably improved.

Such improvements to the noise climate of existing residents are expected to be substantial and noticeable and are strongly encouraged under local, regional and national planning policy and ambient noise policy and strategy.

These outcomes accord with Aim 3 of the NPSE and with the Mayor's Ambient Noise Strategy.

Outcome

The proposed scheme would ensure future residential amenity would be optimised.

The internal noise climate would avoid Significant Observed Adverse Effects and would be expected to result in “good” quality of acoustic comfort in most cases.

The proposal includes several design measures and key aspects, such as window sound insulation and the provision of mechanical ventilation, have been confirmed.

Criteria and noise limits for noise emissions have been confirmed.

The approach to ground-borne vibration has been considered and the approach adopted on the adjacent consented scheme is recommended.

The benefits of the property are primarily in the completion of the barrier effect between the railway and existing flats to the south and south-east of the site. These are expected to result in substantial and noticeable improvements to train movement noise levels.

The proposed development and design is capable of achieving a reasonable internal and external noise climate for future residents with moderate attenuation provided. There is expected to be material benefit to the existing residents as noise exposure to railway noise is reduced noticeably.

James Tomalin MIOA

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Term	Description	
Sound	Physical oscillation of air or other material which is normally detected by the ear as a complex, time-varying and detailed description of the environment around the listener. Interpretation and subjective filtering of sound by the brain results in comprehension, emotional response and physical reactions to sound. Sound can also be detected by touch when transmitted in a solid medium and be perceived as motion at very low frequencies (i.e. vibration).	
Noise	Generally defined as unwanted sound, which as a highly subjective description is subject to wide interpretation. Some describe noise as harsh or dissonant conditions, but such descriptions tend to be value-based and will vary from person to person.	
Ambient Noise	The noise climate heard over a period of time due to all normal sources, in the absence of extraneous or atypical sounds. Used to describe noise in the absence of the introduced sound, generally.	
Ambient Noise Level	Describes the average noise level of the ambient noise over a stated period of time, e.g. hourly noise	
	Parameter: A-weighted Continuous Equivalent Sound Pressure Level determined over the time period T. Expressed in decibels / A-weighted decibels	$L_{eq,T}$ or $L_{Aeq,T}$ dB(A) or dB
Note:	Used in the reports generically to represent both current noise climate and noise level of vehicle noise to encourage direct comparison	
Leq,T	the notionally-steady sound level having the same acoustic energy as the time varying sound pressure level over the same period	
Background Noise	The underlying noise climate in the absence of an introduced or extraneous noise. Describes the quieter periods in the noise climate.	
Background Noise Level	Describes the “average minimum” level of the background noise climate over a stated period of time	
	Parameter: A-weighted Statistical Index 90% Sound Pressure. The quietest decile of the sound pressure levels or level exceeded for 90% of the time period, T Expressed in decibels / A-weighted decibels	$L_{90,T}$ or $L_{A90,T}$ dB(A) or dB
Acoustic screening	Physical barrier to sound formed by fence, wall, building or other structure, which has the effect of reducing the sound transmitted.	
Individual Event Noise	The noise of a distinctive event with the varying noise climate, usually a transient activity, such as a vehicle pass-by, aircraft flyover or similar, rather than an isolated impulsive noise.	
Event Noise Level	Highest noise level during the event as measured under particular conditions of time-weighting	
	Parameter: A-weighted Maximum Sound Pressure Level with FAST or SLOW time weighting Expressed in decibels / A-weighted decibels	$L_{Amax,FAST}$ or $L_{Amax,F}$ $L_{Amax,SLOW}$ or $L_{Amax,S}$ dB(A) or dB
Event Frequency	The number of times an individual event of a similar type occurs in the time period under consideration. Important descriptor as the impact of Individual Event Noise is dependent on changes in both level and event frequency.	
Time Weighting	The sampling rate at which a sound level meter measures the time-varying sound pressure level: originally described how fast the needle moved on analogue meters. Ensures the measurements respond to the type of noise source accurately and are representative. FAST = 125ms sampling rate = 480 samples / minute SLOW = 1s sampling rate = 60 samples / minute	

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9. —. *Sounder City - The Mayor's Ambient Noise Strategy.* GLA. London : GLA, 2004. p. 320, Strategy. planning, strategy, sources. ISBN 1 85261 594 X.

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11. **BSI.** *BS 7445-2:1991, ISO 1996-2:1987 Description and measurement of environmental noise. Guide to the acquisition of data pertinent to land use.* London : BSI, 1991. Standard. Current UK standard. EN ISO standard is updated. BS 7445-2:1991.

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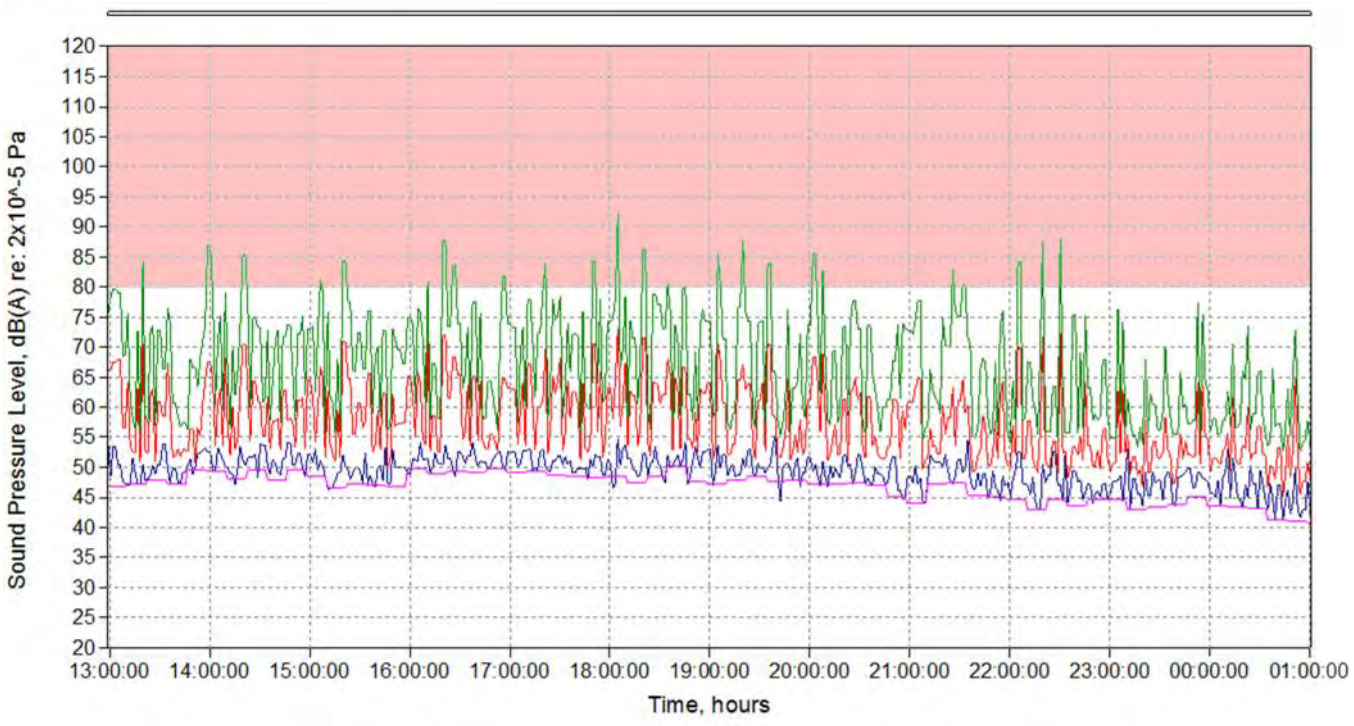
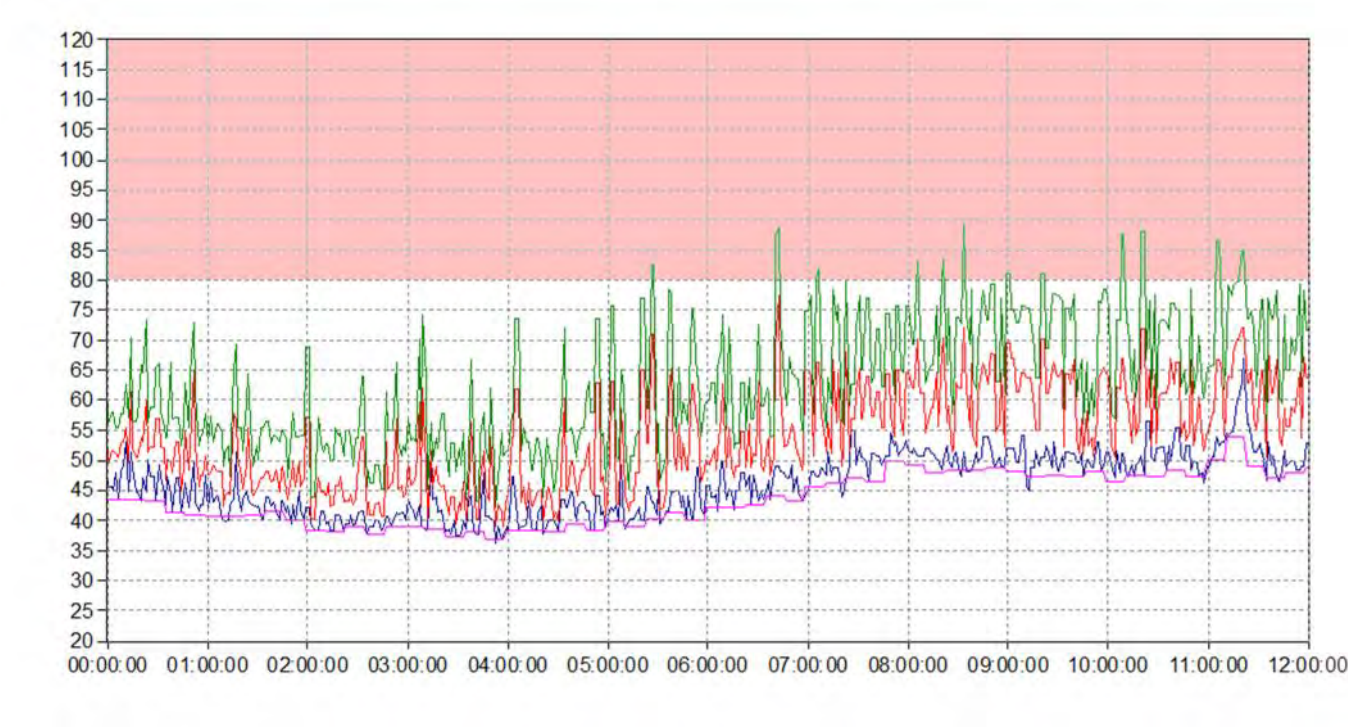
LA90, 15min
LA90,1 min
Highest LAmax,FAST 1 min
LAeq, 1 min

30 October 2013 PM



31 October 2013 AM



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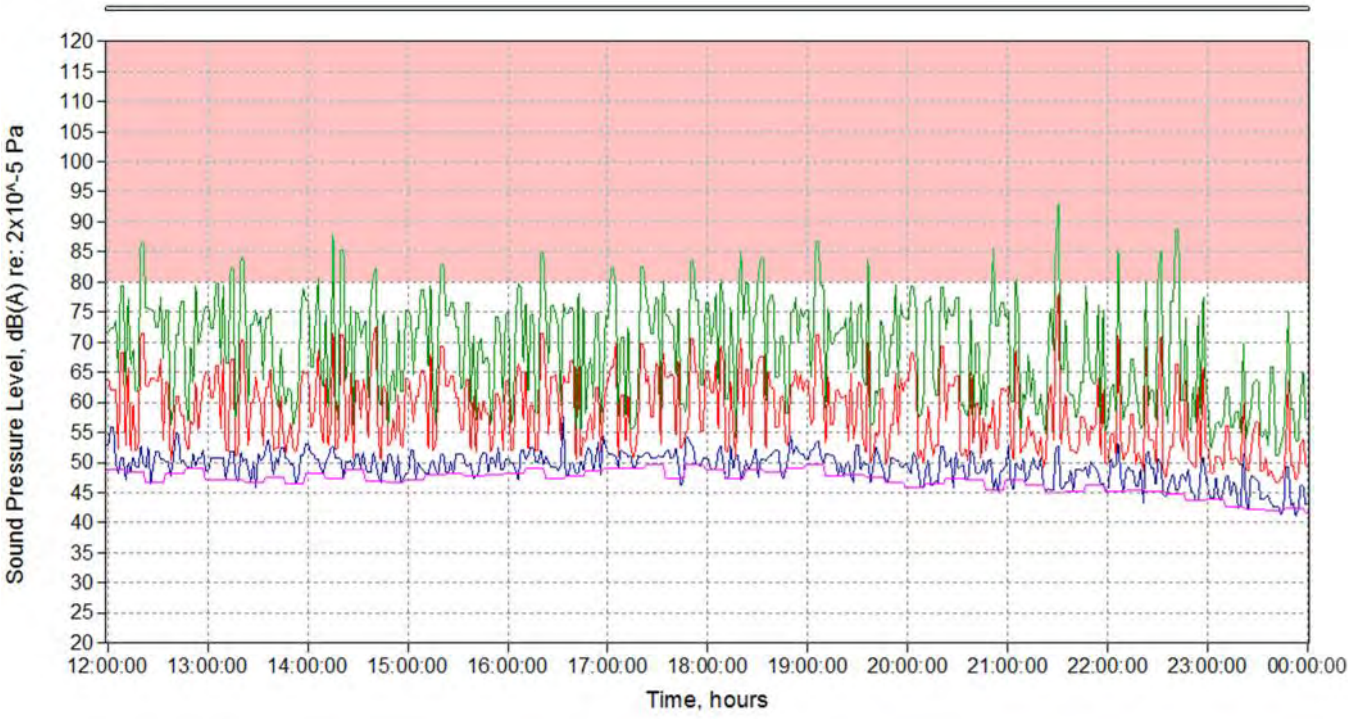
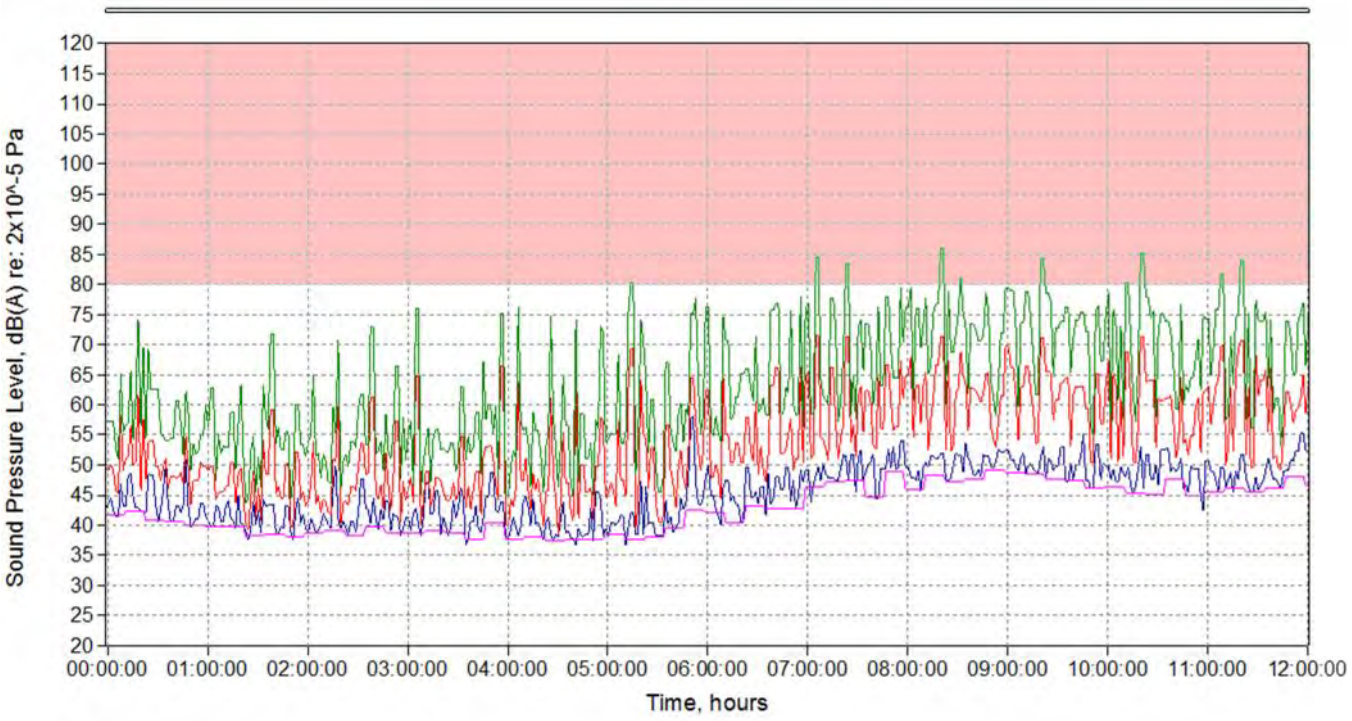


01 November 2013 AM



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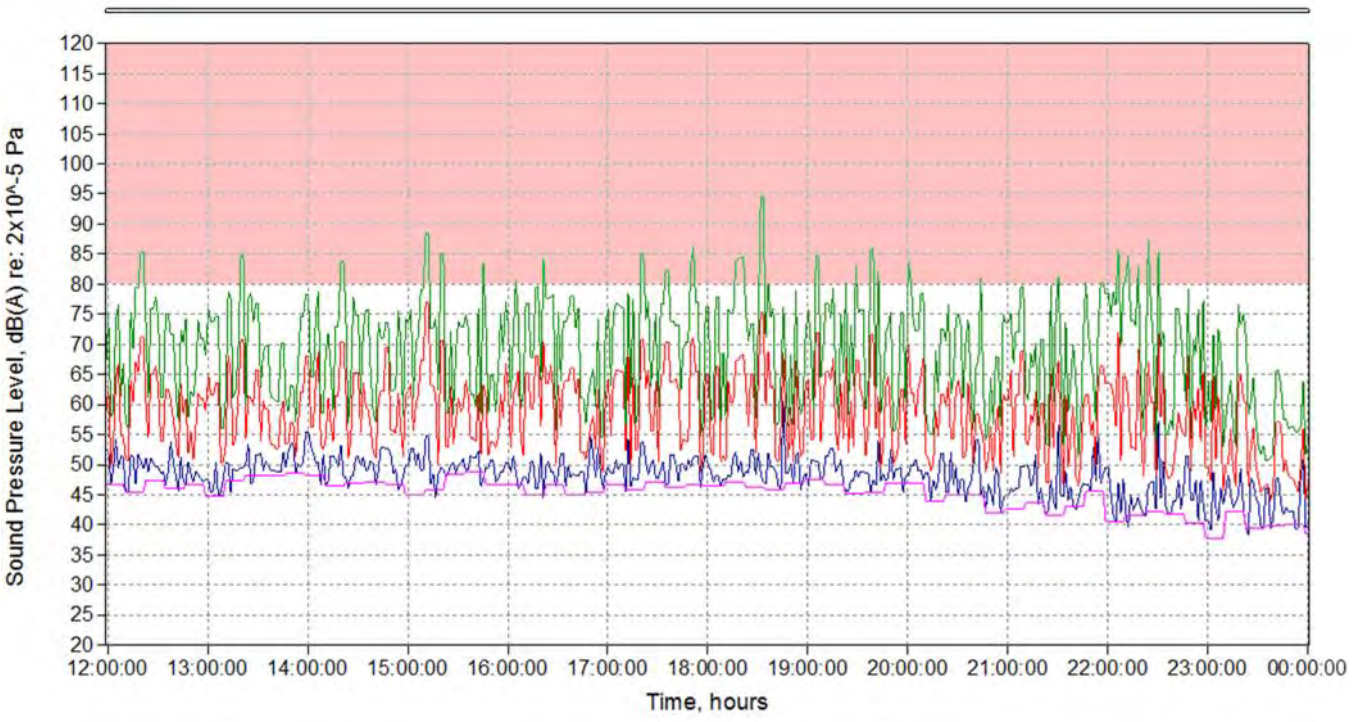
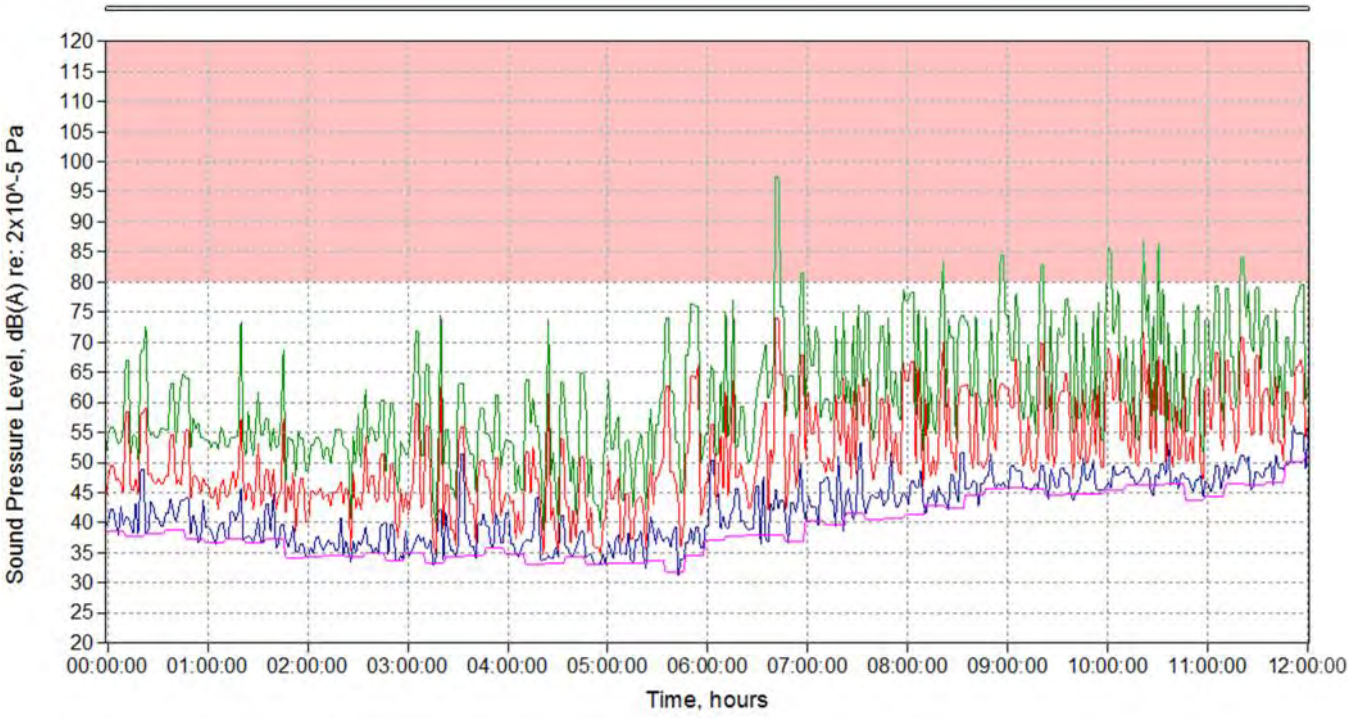


02 November 2013 AM



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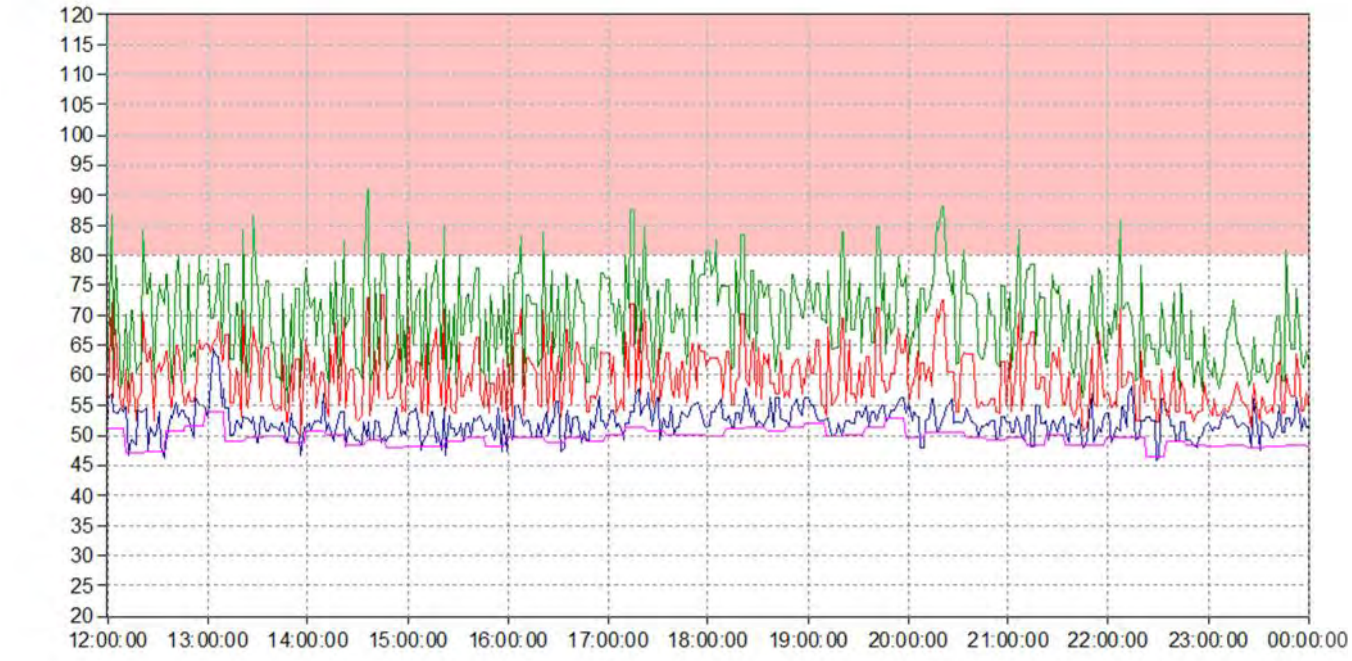

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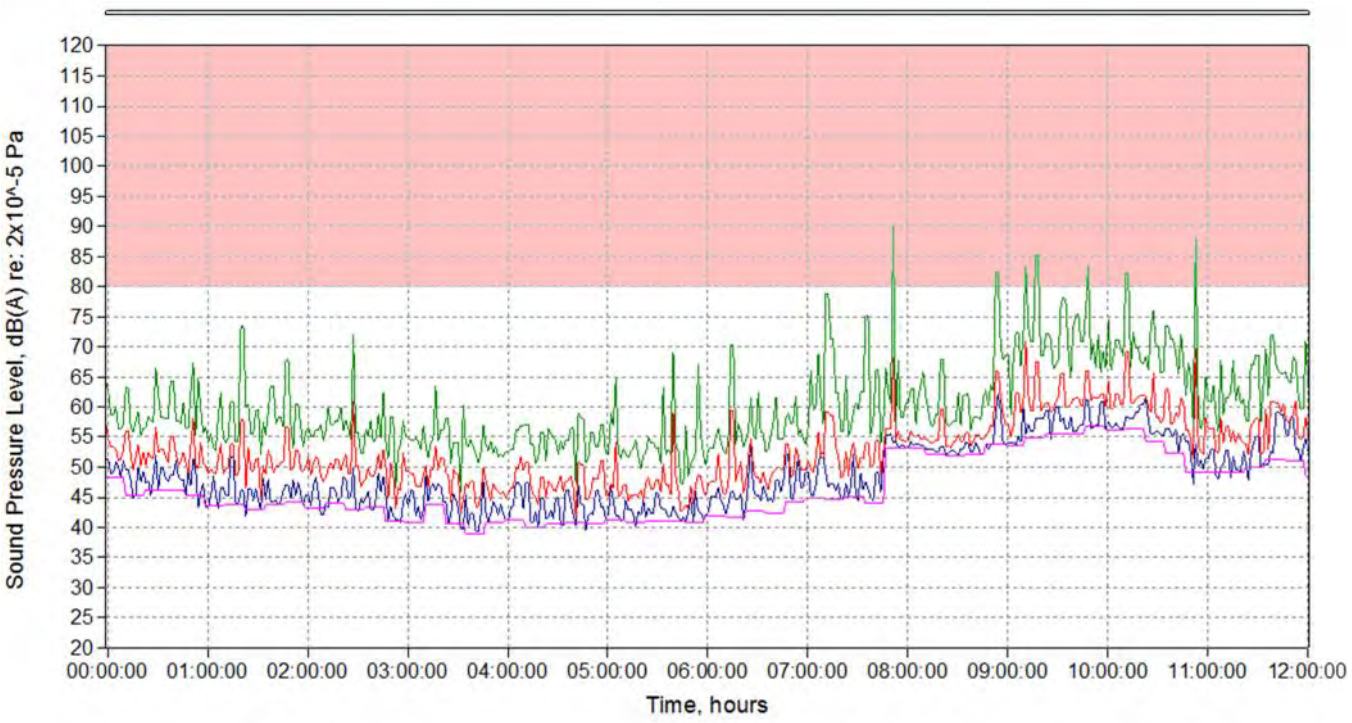

Appendix C.2 – Position M Period Analysis

Date	Period	Duration	LAeq	LA10	LA50	LA90	LAFmax	
30/10/2013	00:00-00:00	10:17:30	60	58	52	47	96	12:49:43
31/10/2013	00:00-00:00	24:00	60	58	50	42	93	21:31:28
01/11/2013	00:00-00:00	24:00	60	58	49	41	95	18:32:58
02/11/2013	00:00-00:00	24:00	59	58	51	38	98	06:42:28
03/11/2013	00:00-00:00	24:00	56	59	51	43	90	07:52:13
30/10/2013	07:00-19:00	05:17:30	61	58	52	48	96	12:49:43
31/10/2013	07:00-19:00	12:00	61	61	52	48	89	08:33:58
01/11/2013	07:00-19:00	12:00	61	59	52	47	95	18:32:58
02/11/2013	07:00-19:00	12:00	61	60	52	46	91	14:36:43
03/11/2013	07:00-19:00	12:00	59	61	55	49	90	07:52:13
30/10/2013	07:00-19:00	09:17:30	60	58	52	47	96	12:49:43
31/10/2013	07:00-19:00	16:00	61	60	52	47	93	21:31:28
01/11/2013	07:00-19:00	16:00	61	60	51	46	95	18:32:58
02/11/2013	07:00-19:00	16:00	61	60	53	47	91	14:36:43
03/11/2013	07:00-19:00	16:00	59	61	55	49	90	07:52:13
30/10/2013	07:00-19:00	04:00:00	59	57	51	46	88	22:31:43
31/10/2013	07:00-19:00	04:00:00	61	57	51	46	93	21:31:28
01/11/2013	07:00-19:00	04:00:00	61	60	49	43	87	22:25:13
02/11/2013	07:00-19:00	04:00:00	60	60	54	50	88	20:21:28
30/10/2013	07:00-19:00	08:00:00	55	53	44	39	89	06:42:58
31/10/2013	07:00-19:00	08:00:00	53	53	44	39	80	05:15:43
01/11/2013	07:00-19:00	08:00:00	53	51	41	35	98	06:42:28
02/11/2013	07:00-19:00	08:00:00	51	54	47	42	81	23:47:28

Position M – Period Averages

	Time	Period	LAeq	LA10	LA50	LA90
	00:00-00:00	24	58.9	58.2	50.4	41.2
	07:00-19:00	12	60.6	60.2	53.0	47.7
	07:00-23:00	16	60.5	60.1	52.9	47.5
	19:00-23:00	4	60.2	58.6	51.6	46.7
	23:00-07:00	8	53.3	52.7	44.8	39.3

Appendix C.3 – Position M Maximum Level Analysis

Position M - Maximum Noise Level Analysis

Date	Period	Duration	LAmax		1%	5%	10%	50%	90%	Mean
30/10/2013	00:00-00:00	10:17:30	96	12:49:43	72.9	63.2	57.9	51.7	47.1	59.4
31/10/2013	00:00-00:00	24:00	93	21:31:28	73.1	62.6	58.0	50.5	41.9	59.8
01/11/2013	00:00-00:00	24:00	95	18:32:58	73.0	63.7	57.8	49.7	41.1	59.6
02/11/2013	00:00-00:00	24:00	98	06:42:28	72.4	62.3	58.5	51.1	37.8	58.9
03/11/2013	00:00-00:00	24:00	90	07:52:13	64.6	61.3	59.1	50.8	43.0	56.6
30/10/2013	07:00-19:00	05:17:30	96	12:49:43	72.8	65.9	58.9	52.4	48.4	59.9
31/10/2013	07:00-19:00	12:00	89	08:33:58	74.1	67.1	60.7	52.3	48.2	61.3
01/11/2013	07:00-19:00	12:00	95	18:32:58	73.9	66.8	59.7	51.6	46.9	60.9
02/11/2013	07:00-19:00	12:00	91	14:36:43	73.2	65.0	59.8	52.5	46.5	60.4
03/11/2013	07:00-19:00	12:00	90	07:52:13	67.1	62.5	61.4	55.1	49.4	59.3
30/10/2013	07:00-19:00	09:17:30	96	12:49:43	73.1	63.8	58.2	51.9	47.5	59.7
31/10/2013	07:00-19:00	16:00	93	21:31:28	74.1	65.9	60.1	52.0	47.6	61.0
01/11/2013	07:00-19:00	16:00	95	18:32:58	73.9	66.4	59.9	51.2	46.0	61.0
02/11/2013	07:00-19:00	16:00	91	14:36:43	73.2	64.6	59.9	53.1	47.1	60.4
03/11/2013	07:00-19:00	16:00	90	07:52:13	67.1	62.5	61.4	55.1	49.4	59.3
30/10/2013	07:00-19:00	04:00:00	88	22:31:43	73.3	61.3	56.9	51.0	45.9	59.3
31/10/2013	07:00-19:00	04:00:00	93	21:31:28	73.5	62.4	57.3	50.8	46.0	60.0
01/11/2013	07:00-19:00	04:00:00	87	22:25:13	74.5	65.8	60.2	49.8	43.5	61.3
02/11/2013	07:00-19:00	04:00:00	88	20:21:28	73.5	63.4	60.2	54.1	49.9	60.5
30/10/2013	07:00-19:00	08:00:00	89	06:42:58	63.2	55.4	52.8	44.5	39.3	55.7
31/10/2013	07:00-19:00	08:00:00	80	05:15:43	63.9	55.2	52.5	44.1	39.1	52.8
01/11/2013	07:00-19:00	08:00:00	98	06:42:28	63.6	54.3	50.9	41.1	34.7	51.4
02/11/2013	07:00-19:00	08:00:00	81	23:47:28	59.9	55.6	54.0	47.5	41.9	51.0

Position M – Maximum Lp Averages

Night-time					Nominal averages					
Position	Period	Duration	LAmax	Time max	1%	5%	10%	50%	90%	Mean
M	23:00-07:00	08:00	88.8	06:42:58	63.2	55.4	52.8	44.5	39.3	55.7

Number of Events LAmax >82dB at Night

Date	LAmax,F	LAmax,S	
30-Oct	0.3%	0.2%	
31-Oct	0.0%	0.0%	
01-Nov	0.1%	0.1%	
02-Nov	0.0%	0.0%	
Samples	6	4	
Sample period	00:00:15	00:00:15	hh:mm:ss
Duration	00:01:30	00:01:00	hh:mm:ss

Appendix C.4 – Noise Exposure Level Analysis

Position M – Period Averages

	Time	Period	LAeq	LA10	LA50	LA90
	00:00-00:00	24	58.9	58.2	50.4	41.2
	07:00-19:00	12	60.6	60.2	53.0	47.7
	07:00-23:00	16	60.5	60.1	52.9	47.5
	19:00-23:00	4	60.2	58.6	51.6	46.7
	23:00-07:00	8	53.3	52.7	44.8	39.3

Appendix D – Sound Insulation Calculations

aulos ACOUSTICS

Job # 13P282
Project 159 Iverson Road
Elevation North **Level** First
Calculation Sound Insulation & Intru BS8233
Engineer James Tomalin

Reference			13P282 C1	11/11/13
Rev				

Frequency, Hz			dB(A)	125	250	500	1000	2000	4000	8000	dB(A)
Source Noise Levels			**Measured**	*Typical Spectrum will vary with position and height*							**Calculated**
LAeq,16hour	Daytime	L1	61.0	58.3	57.6	57.7	57.2	52.3	48.8	46.7	61.0
LAeq,8hour	Night-time	L2	53.0	50.0	49.1	48.5	46.2	41.6	46.0	47.2	53.0
LAmax,night 95%	Night-time	L3	55.0	51.7	48.9	49.2	46.5	43.0	49.2	50.3	55.0
LAmax,night 99%	Night-time	L4	64.0	60.7	57.9	58.2	55.5	52.0	58.2	59.3	64.0
Building Element Sound Insulation											
R_{ew}	Framed system	Specification Type A		30	34	38	43	46			
R_w	10-16-6 unit	Specificaton Type D		24	24	27	34	33			
	10-16-6 unit+ heavy	Specificaton Type D2		28	30	36	42	39			
	6-16-6 unit	Specificaton Type E		19	19	22	29	28			
$D_{n,e}$	Attenuated ventilator	Specification Type G		35	35	35	38	35			
R_{rr}	Projected Area	Not applicable									
Room Sound Absorption, A											
A living				16	12	14	16	17			
A bed				14	9	10	11	12			

Dimensions		Bedroom	Living Room	
Term	**Derivation**			
S_f	Façade area (including window)	10	26.25	sq.m
Sr	Roof area (exposed side)	0	0	sq.m
S_w	Window area	2	10	sq.m
S_{ew}	S_f-S_w	8	16.25	sq.m
S_{rr}	Area of ceiling	0	0	sq.m
S	S_f+S_{rr}	10	26.25	sq.m
Vn	*Number of vents serving room*	0	0	
A_0	Given in BS EN 20140-10			sq.m

Bedroom			**Ref**	**Octave Band Centre Frequency**				
				125	**250**	**500**	**1000**	**2000**
$D_{n,e}$	adjusted for number of							
t e			B					
R_{ew}		Specificaton Type D		24	24	27	34	33
t wi			C	0.00080	0.00080	0.00040	0.00008	0.00010
R_{ew}		Specification Type A		30	34	38	43	46
t ew			D	0.00080	0.00032	0.00013	0.00004	0.00002
R_{rr}								
t rr			E					
10 $\log_{10}$(B+C+D+E)			F	**-28.0**	**-29.5**	**-32.8**	**-39.2**	**-39.2**
A (furnished)				14	9	10	11	12
10 log ($^{S}/_{A}$)			G	-1.5	0.5	0.0	-0.4	-0.8
Level Difference,	**(F+G)**		**T1**	**-29.4**	**-29.1**	**-32.8**	**-39.6**	**-40.0**
Corrections?	**Allow uncertainty**			**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Living Room			**Ref**	**Octave Band Centre Frequency**				
				125	**250**	**500**	**1000**	**2000**
$D_{n,e}$	adjusted re number vents							
t e			B					
R_{ew}		Specificaton Type E		19	19	22	29	28
t wi			C	0.00480	0.00480	0.00240	0.00048	0.00060
R_{ew}		Specification Type A		30	34	38	43	46
t ew			D	0.00062	0.00025	0.00010	0.00003	0.00002
R_{rr}								
t rr			E					
10 $\log_{10}$(B+C+D+E)			F	**-22.7**	**-23.0**	**-26.0**	**-32.9**	**-32.1**
A (furnished)				16	12	14	16	17
10 log ($^{S}/_{A}$)			G	2.2	3.4	2.7	2.2	1.9
Level Difference,	**(F+G)**		**T2**	**-20.5**	**-19.6**	**-23.3**	**-30.8**	**-30.2**
Corrections?	**Allow uncertainty 3dB & separation -7dB**			**-4.0**	**-4.0**	**-4.0**	**-4.0**	**-4.0**
	Not on north elevation							

Internal Noise Levels	Target shall be Living Rooms Leq,T 40-45dBA daytime, Bedrooms Leq,T 30-35dBA & Lmax,FAST < 45dBA night-time									
Bedroom	**With ventilation**	**Ref**	**Octave Band Centre Frequency**							
			125	**250**	**500**	**1000**	**2000**	**dB(A)**		**NPSE RATING**
LAeq,16hour	Daytime	L1+T1	32	32	28	21	15	28.4	OK	No Effect Level
LAeq,8hour	Night-time	L2+T1	24	23	19	10	5	19.1	OK	No Effect Level
LAmax,night	Night-time	L3+T1	34	32	28	19	15	28.6	OK	> Lowest OAEL

Living Room	**With ventilation**	**Ref**	**Octave Band Centre Frequency**							
			125	**250**	**500**	**1000**	**2000**	**dB(A)**		
LAeq,16hour	Daytime	L1+T2	38	38	34	26	22	34.7	OK	No Effect Level
LAeq,8hour	Night-time	L2+T2	29	30	25	15	11	25.5	OK	No Effect Level
LAmax,night 99% ile	Night-time	L3+T2	40	38	35	25	22	35	OK	> Lowest OAEL

Outcome
Based on the above, with a change to windows (and external doors) of Rw35-40dB range performance the Bedrooms will attain a "Good" standard BS8233:1999 and achieve No Effect Level under Noise Policy Statement for England.
Living Rooms will be able to achieve a similar quality with the provision of Rw30-35 windows and external doors.
The internal noise climate will be consistent and above interference levels in general, although Bedrooms at night may seem very quiet particularly between railway activity.

Requirement
The above outcome requires the provision of a ducted and attenuated whole-flat balanced ventilation / ventilation & heat recovery system and exclusion of direct / open vents in windows and walls. Detailed design review will be required.

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Job # 13P282						**Reference**			13P282 C2		11/11/13
Project 159 Iverson Road						Rev					
Elevation South		**Level**	First								
Calculation Sound Insulation & Intru			BS8233								
Engineer James Tomalin											

Frequency, Hz			**dB(A)**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Source Noise Levels			**Measured**	*Typical Spectrum will vary with position and height*							**Calculated**
LAeq,16hour	Daytime	L1	65.0	67.3	64.1	62.1	60.1	57.1	49.9	49.0	65.0
LAeq,8hour	Night-time	L2	55.0	57.0	54.0	52.5	49.0	46.0	44.5	43.0	55.0
LAmax,night 95%	Night-time	L3									
LAmax,night 99%	Night-time	L4	65.0	65.1	61.1	60.1	58.1	56.1	57.3	58.4	65.0
Building Element Sound Insulation											
R_{ew}	Framed system	Specification Type A		30	34	38	43	46			
R_{ew}	10-16-6 unit	Specificaton Type D		24	24	27	34	33			
	10-16-6 unit+ heavy	Specificaton Type D2		28	30	36	42	39			
	6-16-6 unit	Specificaton Type E		19	19	22	29	28			
$D_{n,e}$	Attenuated ventilator	Specification Type G		35	35	35	38	35			
R_{rr}	Projected Area	Not applicable									
Room Sound Absorption, A											
A living				16	12	14	16	17			
A bed				14	9	10	11	12			

Dimensions		**Bedroom**	**Living Room**	
Term	**Derivation**			
S_f	Façade area (including window)	15	27.5	sq.m
Sr	Roof area (exposed side)	0	0	sq.m
S_w	Window area	5	8.4	sq.m
S_{ew}	S_f-S_w	10	19.1	sq.m
S_n	Area of ceiling	0	0	sq.m
S	S_f+S_n	15	27.5	sq.m
Vn	*Number of vents serving room*			
A_{tf}	Given in BS EN 20140-10			sq.m

Bedroom			**Ref**	**Octave Band Centre Frequency**				
				125	**250**	**500**	**1000**	**2000**
$D_{n,e}$	adjusted for number of							
t e			B					
R_w		Specificaton Type D		24	24	27	34	33
t wi			C	0.00133	0.00133	0.00067	0.00013	0.00017
R_{ew}		Specification Type A		30	34	38	43	46
t ew			D	0.00067	0.00027	0.00011	0.00003	0.00002
R_{rr}								
t rr			E					
10 $\log_{10}$(B+C+D+E)			F	**-27.0**	**-28.0**	**-31.1**	**-37.8**	**-37.4**
A (furnished)				14	9	10	11	12
10 log ($^{S}/_{A}$)			G	0.3	2.2	1.8	1.3	1.0
Level Difference,	**(F+G)**		**T1**	**-26.7**	**-25.8**	**-29.4**	**-36.4**	**-36.4**
Corrections?	**Allow uncertainty & separation**			**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Living Room			**Ref**	**Octave Band Centre Frequency**				
				125	**250**	**500**	**1000**	**2000**
$D_{n,e}$	adjusted re number vents							
t e			B					
R_w		Specificaton Type D		24	24	27	34	33
t wi			C	0.00122	0.00122	0.00061	0.00012	0.00015
R_{ew}		Specification Type A		30	34	38	43	46
t ew			D	0.00069	0.00028	0.00011	0.00003	0.00002
R_{rr}								
t rr			E					
10 $\log_{10}$(B+C+D+E)			F	**-27.2**	**-28.3**	**-31.4**	**-38.1**	**-37.7**
A (furnished)				16	12	14	16	17
10 log ($^{S}/_{A}$)			G	2.4	3.6	2.9	2.4	2.1
Level Difference,	**(F+G)**		**T2**	**-24.8**	**-24.7**	**-28.5**	**-35.7**	**-35.6**
Corrections?	**Allow uncertainty 3dB & separation -3dB**			**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Not on north elevation							

Internal Noise Levels	Target shall be Living Rooms Leq,T 40-45dBA daytime, Bedrooms Leq,T 30-35dBA & Lmax,FAST < 45dBA night-time									
Bedroom	**With ventilation**	**Ref**	**Octave Band Centre Frequency**							
			125	**250**	**500**	**1000**	**2000**	**dB(A)**		**NPSE RATING**
LAeq,16hour	Daytime	L1+T1	41	38	33	24	21	33.9	OK	No effect level
LAeq,8hour	Night-time	L2+T1	30	28	23	13	10	23.9	OK	No effect level
LAmax,night	Night-time	L3+T1	38	35	31	22	20	31.6	OK	No effect level

Living Room	**With ventilation**	**Ref**	**Octave Band Centre Frequency**							
			125	**250**	**500**	**1000**	**2000**	**dB(A)**		
LAeq,16hour	Daytime	L1+T2	40	36	31	22	19	32	OK	No effect level
LAeq,8hour	Night-time	L2+T2	30	26	21	11	8	21.9	OK	No effect level
LAmax,night	Night-time	L3+T2	38	33	29	20	18	29.8	OK	Lowest OAEL

Outcome

Based on the above, with a change to windows (and external doors) of Rw35-40dB range performance the Bedrooms will attain a "Good" standard BS8233:1999 and achieve No Effect Level under Noise Policy Statement for England.

Living Rooms will be able to achieve a similar quality with the provision of Rw35-40dB windows and external doors also.

The internal noise climate will be consistent and above interference levels in general, although Bedrooms at night may seem very quiet particularly between road activity.

Requirement

The above outcome requires the provision of a ducted and attenuated whole-flat balanced ventilation / ventilation & heat recovery system and exclusion of direct / open vents in windows and walls. Detailed design review will be required.

Figure 13P282/1 – Site Measurement Plan

Table A: Noise levels on residential sites adjoining railways and roads at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Day	0700-1900	74 dB L_{Aeq} 12h	72 dB L_{Aeq} 12h
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	74 dB L_{Aeq} 4h	72 dB L_{Aeq} 4h
Noise at 1 metre external to a sensitive façade	Night	2300-0700	66 dB L_{Aeq} 8h	66 dB L_{Aeq} 8h

Table B: Noise levels on residential streets adjoining railways and roads at and above which attenuation measures will be required

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Day	0700-1900	65 dB L_{Aeq} 12h	62 dB L_{Aeq} 12h
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	60 dB L_{Aeq} 4h	57 dB L_{Aeq} 4h
Noise at 1 metre external to a sensitive façade	Night	2300-0700	55 dB L_{Aeq} 1h	52 dB L_{Aeq} 1h
Individual noise events several times an hour	Night	2300-0700	>82 dB L_{Amax} (S time weighting)	>82 dB L_{AMAX} (S time weighting)

Table C: Vibration levels on residential sites adjoining railways and roads at which planning permission will not be granted

Vibration description and location of measurement	Period	Time	Vibration levels
Vibration inside critical areas such as a hospital operating theatre	Day, evening and night	0000-2400	0.1 VDV ms-1.75
Vibration inside dwellings	Day and evening	0700-2300	0.2 to 0.4 VDV ms-1.75
Vibration inside dwellings	Night	2300-0700	0.13 VDV ms-1.75
Vibration inside offices	Day, evening and night	0000-2400	0.4 VDV ms-1.75
Vibration inside workshops	Day, evening and night	0000-2400	0.8 VDV ms-1.75

Where dwellings may be affected by ground-borne regenerated noise internally from, for example, railways or underground trains within tunnels, noise levels within the rooms should not be greater than 35dB(A)max