BUROHAPPOLD ENGINEERING

TfL Landholdings at Northwood

Acoustic Planning Report

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Glossary

Term	Definition
Ambient noise	The totally encompassing noise in a given situation at a given time; it is usually composed of noise from many sources, near and far (defined in BS 4142).
$L_{Aeq,T}$	Equivalent continuous sound pressure level (A-weighted) over a period of time, T.
$L_{A90,T}$	Sound pressure level (A-weighted) exceeded for 90% of the measurement period. Referred to as background noise level over a period of time, T.
$L_{AMAX,T}$	The maximum sound pressure level measured during the measurement period, T.
Time weighting	One of the standard averaging times (Fast, Slow, Instantaneous) used for the measurement of RMS sound pressure level in sound level meters.
VDV	Vibration Dose Values ($m/s^{1.75}$).
PPV	The maximum instantaneous velocity of a particle at a point during a given time interval (mm/s).

1 Introduction

1.1 Application proposal

Hybrid planning application for comprehensive redevelopment of the site comprising full planning permission involving demolition of existing buildings to provide 93 residential units (C3) and associated car parking, 1,440 sq.m of new retail floorspace (A1-A5), a new operational station (Sui Generis) with step free access and associated car parking for the station; new bus interchange, and a new piazza. Outline planning consent is included for up to 34 residential units, car parking (all matters reserved apart from access), and refurbishment works to existing retail units along Station Approach.

1.2 Site description

The site is located on the junction of Green Lane (B469) and Eastbury Road within the London Borough of Hillingdon (LBH). The site comprises land north and south of Green Lane including part of the highway. The area of land north of Green Lane comprises a parade of single storey retail units located over the railway bridge with a two storey adjoining unit on the Corner of Eastbury Road. The northern part of the site is bounded by the Eastbury Surgery to the north; Green Lane to the south; Eastbury Road to the east and the retail units on the bridge to the west. The site is 1.91 ha. The majority of the site lies south of Green Lane, in Northwood and comprises the existing underground station and a mix of A-Class uses, residential flats, a light industrial use, dental practice and area of surface car parking. The southern part of the site is bounded by Green Lane to the north; the London Underground (LU) compound to the south; the railway line to the east; and the rear boundaries of the Northwood Central Club, St John's United Reformed Church and residential properties fronting Hallowell Road to the west.

1.3 TFL's objectives:

TFL recognise there is an opportunity to deliver comprehensive place-making through redevelopment of their landholdings for the benefit of Northwood which would meet aspirations to deliver the following objectives:

- deliver a high quality design for Northwood;
- step-free access as part of a new Underground Station;
- improve accessibility for all users around the station;
- improve the interchange at this transport hub between underground trains, buses, vehicle users, pedestrians and cyclists;
- provide a new public space in the form of a piazza;
- provide a dedicated area for drop off/ pick up and taxis;
- provide a mix and range of housing types to meet different needs; and
- provide new commercial uses which will improve and contribute towards the vitality and viability of the existing centre.

1.4 Report objectives

This report addresses the following:

- noise and vibration criteria relevant to the development and in accordance with LBH requirements and relevant noise and vibration standards;

- methodology and results of a noise and vibration survey undertaken at the site of the proposed development;
- environmental noise modelling prediction results of the development;
- specification of noise limits for new fixed plant introduced to the site; and
- construction noise and vibration best practices and mitigation methods.

The scope of this report has been agreed with LBH and has been prepared to demonstrate how the proposed development will comply with LBH requirements and all relevant noise and vibration standards.

2 Guidance and Criteria

2.1 Introduction

Noise and vibration guidance and criteria has been obtained from the LBH *Noise Supplementary Planning Document (2006)*. Several standards have been updated since the issue of the LBH SPD (including BS 8233, BS 4142) and PPG24 has been withdrawn. Therefore, the following guidance and standards are of relevance to the proposed development:

- LBH Noise SPD[1];
- BS 8233: 2014 Sound Insulation and Noise Reduction for Buildings - Code of Practice[2];
- BS 6472: 2008 Guide to the Evaluation of human Exposure to Vibration in Buildings[3];
- BS 4142: 2014 Methods for rating and assessing industrial and commercial sound[4];
- BS 5228-1: 2009 +A1 2014 Construction Noise [5] and BS 5228-2: 2009 Construction Vibration[6];
- World Health Organisation Guidelines for Community Noise[7];
- Department of Transport/Welsh Office, (1998): Calculation of Road Traffic Noise[8];
- Highways Agency, (August 2008); Design Manual for Road and Bridges Volume 11 Section 3 Part 7-Traffic
- Noise and Vibration[9];
- Control of Pollution Act[10]; and
- BS 7445: 2003 Description and measurement of environmental noise. Guide to quantities and procedures[11].

2.2 Noise and vibration criteria

2.2.1 LBH residential noise criteria

Table 2 and Table 3 of the LBH Noise SPD provides guideline values for noise in residential developments and is presented below. The values have been referenced from BS 8233: 2014 and the World Health Organisation (1999) Guidelines for Community Noise.

Table 2.1: Table 2 of LBH Noise SPD.

Time	Specific environment	Recommended Noise Level (dB)
Daytime (07:00-23:.00)	Outdoor living area	As low as practicable, and < 50 $L_{Aeq,T}$ (free field)
	Indoor living areas	< 35 $L_{Aeq,T}$
	Executive Offices/Meeting Rooms	35-40 $L_{Aeq,T}$
Night-time (23:00-07:00)	Outside bedroom windows	< 45 $L_{Aeq,T}$ (façade) < 60 $L_{AMAX,FAST}$ (façade)
	Inside bedrooms	< 30 $L_{Aeq,T}$ < 45 $L_{AMAX,FAST}$

2.2.2 British Standard 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice

BS 8233:2014 provides guidance for the control of noise in and around buildings. The standard provides internal noise level criteria for various rooms with different noise sensitivities and privacy requirements. Table 4 of BS 8233 provides indoor ambient noise levels for dwellings. Table 2 of LBH Noise SPD reflects the levels set out with Table 4 of BS 8233.

2.2.3 British Standard 6472-1:2008 Guide to the Evaluation of human Exposure to Vibration in Buildings

BS 6472-1: 2008 provides guidance on the prediction of the human response to vibration in buildings. The vibration dose value (VDV) is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop. It also provides recommended frequency weighted vibration spectra above which adverse comments are likely to occur in residential buildings. Details of the calculation procedure of VDV are provided in Section 3.5 of BS 6472. Table 1 of BS 6472 is presented in Table 2.2 below. The VDV values given in this table will be used to assess the probability of adverse comment at the proposed development.

Table 2.2: VDV levels as taken from Table 1 of BS 6472.

Place and time	Low probability of adverse comment ($m \cdot s^{-1.75}$ [1])	Adverse comment possible ($m \cdot s^{-1.75}$)	Adverse comment probable ($m \cdot s^{-1.75}$ [2])
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

1) Below these ranges adverse comment is not expected; 2) Above these ranges adverse comment is very likely.

2.2.4 BS 4142 (2014) Methods for rating and assessing industrial and commercial sound

BS 4142:2014 provides methods for rating and assessing sound of an industrial and/or commercial nature, which includes sound from industrial and manufacturing processes, fixed services plant, sound generated by the loading/unloading of goods and sound from mobile plant/vehicles associated with industrial/commercial premises (e.g. fork-lift trucks).

The standard utilises various descriptors to assess complaints, the impact of sound associated with proposed industrial/commercial activities on existing noise-sensitive receivers, or the impact and likely suitability of siting new noise-sensitive receptors in the vicinity of existing industrial/commercial noise sources.

The standard is specifically precluded from being used to determine likely internal sound levels arising from external noise, or from the assessment of various sound sources for which other (more relevant) guidance exists, including music/entertainment noise, person noise and construction noise.

The magnitude of impact is assessed by subtracting the measured background sound level at a location representative of the nearest noise-sensitive receiver, from the 'rating level' (the specific sound source to be introduced into the locality, corrected for acoustically distinguishing characteristics which may make it more subjectively prominent).

Typically, the greater the difference between the background and rating level, the greater the magnitude of impact, although BS 4142 emphasises that this is highly context-specific.

As a guideline, BS 4142 states that:

- a difference (between the background and rating level) of around +10 dB or more is likely to be indicative of significant adverse impact, depending on context;
- a difference (between the background and rating level) of around +5 dB or more is likely to be indicative of adverse impact, depending on context;
- the lower the rating level relative to the background level, the less likely it is that the specific sound will have an adverse impact; and
- where the rating level does not exceed the background level, this is an indication that the specific sound will have a low impact, depending on context.

It should be noted that BS 4142:2014 draws a clear distinction between the detailed and flexible assessment methods contained within, and the more limited versions contained in the previous (1997) edition.

Above all, BS 4142:2014 requires qualified engineering consultants and technical planning professionals (e.g. Environmental Health Officers) to use a combination of quantitative assessment techniques and rational qualitative judgements to come to a sensible and reasonable conclusion.

Definitions

BS 4142 uses several specific terms to define the various levels used in assessments, as follows:

- specific sound – the commercial / industrial noise source under consideration;
- residual sound – the sound level at the noise-sensitive receivers in the absence of the specific sound;
- ambient sound – the sound level at the noise-sensitive receivers in the presence of the specific sound (i.e. ambient = residual + specific);
- background level – the sound pressure level which is exceeded by the residual sound for 90% of the measurement period; and
- rating level – the specific sound, corrected for acoustically distinguishing characteristics.

Background level

BS 4142 emphasises that the background level ($L_{A90,T}$) is in fact a range of levels, not one absolute value. Whilst stating that the measurements of background sound should be normally not less than 15 mins, the focus is on obtaining a level for use in assessment that is representative of typical conditions at the noise-sensitive receivers.

An example methodology by which this typical value may be obtained is provided in BS 4142. In this example, monitoring of $L_{A90,15mins}$ is undertaken during periods which represent when the specific noise will be operational. After obtaining a sequence of representative contiguous or disaggregated results, it is then proposed that the modal value is representative of the 'typical' background level.

Specific sound

BS 4142 requires that the specific sound ($L_{Aeq,Tr}$) is obtained over a reference period of 1 hour (daytime) and 15 mins (at night). Ideally, measurements would be taken of the ambient sound and residual sound at the assessment location, with these measurements used to accurately calculate the specific sound (ambient – residual = specific).

Where the source (specific sound) is not yet operational, it is permissible to measure the specific sound elsewhere (or to use known manufacturers' or library data) and then model the impact of this against the known background level.

Rating level

Once the specific sound level has been determined, this must be corrected in terms of the need to consider the subjective prominence of the impact of the sound at noise-sensitive receivers, and the extent to which acoustically distinctive characteristics will attract attention.

BS 4142 states that it is normally possible to carry out a subjective assessment of characteristics, based on the following correction guidelines:

- tonality: +2 dB for a 'just perceptible' tone, +4 dB for 'clearly perceptible', and rising to +6 dB for 'highly perceptible' tones;
- impulsivity (rapidity of change and overall chance in level): +3 dB for 'just perceptible' impulsivity, +6 dB for 'clearly perceptible', rising to +9 dB for 'highly perceptible' impulsivity; and
- intermittency: if the on/off-time of the specific sound is readily distinctive at the noise-sensitive receivers, +3 dB.

It should be noted that where one feature is clearly perceived as dominant, it may be applicable to correct for that feature only. Where multiple features are likely to affect perception and response, each should be added arithmetically.

2.2.5 Road traffic noise criteria

Relative changes in road traffic noise levels along the surrounding roads have been calculated using methodologies derived from the Calculation of Noise from Road Traffic (CRTN), and potential impacts have been assessed according the Design Manual for Roads and Bridges (DMRB) significance criteria for traffic noise.

The (DRMB) sets out methods for assessing the traffic noise level and details the magnitude of impact with respect to noise changes.

Traffic flows on surrounding roads typically increase when a new development is introduced to the area. This leads to an increase in the traffic noise level over the long term and may potentially have an impact on nearby noise sensitive locations.

A long-term increase of 3 dB is considered perceptible by most people. The magnitude of impacts for long-term traffic noise is presented in the Table 2.3 below and has been taken from Table 3.1 of DMRB Volume 11, Section 3, Part 7.

Table 2.3: Magnitude of long-term noise impacts from traffic noise

Noise Change from Existing Traffic Levels (dB)	Magnitude of Impact
0	No Change
1 to 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
>10	Major

2.2.6 British Standard 5228-1 2009+A1 2014 Construction Noise

The criteria for the significance of construction noise upon noise sensitive receptors (NSR) are derived from Annex E of BS 5228-1. This criteria is based on the total construction noise level which is a combination of the pre-existing ambient noise level plus construction noise.

The significance of construction noise can be determined using the ABC method which sets an appropriate Assessment Category which is derived from the pre-existing ambient noise level. If the combined construction noise and ambient noise level exceeds the Assessment Category value, then a significant effect is deemed to occur.

Table 2.4 shows an example of the threshold of significant effect at dwellings when the total noise level, rounded to the nearest decibel, exceeds the listed value. The table can be used as follows: for the appropriate period (night, evening/weekends or day), the ambient noise level is determined and rounded to the nearest 5 dB. This is then compared with the total noise level, including construction. If the total noise level exceeds the appropriate category value, then a significant effect is deemed to occur.

Table 2.4: Threshold of significant effect at dwellings.

Evaluation Period	Assessment Category (dB L_{Aeq})		
	A	B	C
Night-time (23:00-07:00)	45	50	55
Evening and Weekends*	55	60	65
Daytime (07:00-19:00)	65	70	75
* 19:00-23:00 weekdays, 13:00 - 23:00 Saturdays and 07:00 - 23:00 Sundays.			
Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.			
Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as Category A values.			
Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than Category A values.			
The Category (A, B or C) is to be determined separately for each time period and the lowest noise category is then used throughout the 24-hour cycle, e.g. a site which is category A by day and category B or C in the evening and night will be treated as category A for day, evening and night.			

Table 2.5 provides the magnitude of impact associated with the combined noise and the assessment category in Table 2.3.

Table 2.5: Construction noise significance.

Total Construction Noise Level	Magnitude of Impact
< Assessment Category	No Change
1 to 3 dB > Assessment Category	Negligible
3 to 5 dB > Assessment Category	Minor

Total Construction Noise Level	Magnitude of Impact
5 to 10 dB > Assessment Category	Moderate
+10 dB > Assessment Category	Major

2.2.7 British Standard 5228-2 2009 Construction Vibration

Guidance on the human response to vibration is presented in Annex B, Table B.1 of BS 5228-2. These levels have been reproduced in Table 2.6 below along with the magnitude of impact.

Table 2.6: Guidance on effects of vibration levels on humans as taken from Table B.1 of BS 5228-2: 2009.

Vibration Level (PPV)	Effect	Magnitude of Impact
0.14 mm·s^{-1}	Vibration might be just perceptible in the most sensitive situation for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Negligible
0.3 mm·s^{-1}	Vibration might be just perceptible in residential environments.	Minor
1.0 mm·s^{-1}	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Moderate
10.0 mm·s^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure level.	Major

Guidance on vibration effects on buildings can be found in Annex B, Table B.2 of BS 5228-2. These levels have been reproduced in the Table 2.7 below.

Table 2.7: Transient vibration guide values for cosmetic damage as taken from Table B.2 of BS 5228-2: 2009.

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
2	Unreinforced or light framed structure Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
NOTE 1 Values referred to are at the base of the building.			

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
NOTE 2 For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.			

3 Environmental Noise and Vibration Survey

3.1 Site location

The site is located on the junction of Green Lane (B469) and Eastbury Road within the LBH.

The site comprises land north and south of Green Lane including part of the highway. The area of land north of Green Lane comprises a parade of single storey retail units located over the railway bridge with a two storey adjoining unit on the Corner of Eastbury Road. The northern part of the site is bounded by the Eastbury Surgery to the north; Green Lane to the south; Eastbury Road to the east and the retail units on the bridge to the west.

The site is located on the junction of Green Lane (B469) and Eastbury Road within the (LBH). The site comprises land north and south of Green Lane including part of the highway. The area of land north of Green Lane comprises a parade of single storey retail units located over the railway bridge with a two storey adjoining unit on the corner of Eastbury Road. The northern part of the site is bounded by the Eastbury Surgery to the north; Green Lane to the south; Eastbury Road to the east and the retail units on the bridge to the west. The majority of the site lies south of Green Lane, in Northwood and comprises the existing LU station and a mix of A-Class uses, residential flats, a light industrial use, dental practice and area of surface car parking. The southern part of the site is bounded by Green Lane to the north; the LU compound to the south; the railway line to the east; and the rear boundaries of the Northwood Central Club, St John's United Reformed Church and residential properties fronting Hallowell Road to the west.

3.2 Instrumentation

During the noise survey the sound level meter was programmed to log various noise parameters, including L_{Aeq}, L_{Amax}, and L_{A90} at each measurement location. The measurement periods were selected to represent typical weekday daytime noise levels while the night-time measurement was chosen to reflect the typical noise environment at the nearest noise sensitive receptor. The vibration survey was programmed to log vibration dose values (VDV (m/sec$^{1.75}$).

The noise survey was undertaken using a two Rion NL52 sound level meters (Serial # 00732075 and 00732098) and calibrated before and after the measurement using a B&K 4231 calibrator (Serial # 2342813). No significant drift (≤±0.5dB) was found to occur during the noise survey. Calibration certificates are available upon request.

The vibration survey was undertaken using a Vibrock V901-VDV (Serial # 776).

The noise and vibration survey was agreed with LBH in terms of location and duration prior to the survey.

3.3 Weather

During the first survey carried out between 23rd – 24th June, 2015 weather conditions were dry and partly cloudy with light wind speed (<2.8m/s) and temperature ranging between 11-21ºC.

The weather conditions during the noise survey on 1st-8th July, 2015 are summarized in the Table 3.1 below.

Table 3.1: Weather conditions during noise survey 1st-8th July, 2015 (values obtained from http://www.wunderground.com)

Date	Temperature Range (C)	Rain (mm)	Wind Speed (m/s)
Wednesday 1st July 2015	20-28	0	4.4
Thursday 2nd July 2015	15-26	0	2.8
Friday 3rd July 2015	10-27	10	3.0
Saturday 4th July 2015	16-26	0	3.3
Sunday 5th July 2015	11-23	0	2.5
Monday 6th July 2015	11-23	0	3.3
Tuesday 7th July 2015	14-23	0.8	4.4
Wednesday 8th July 2015	13-21	0.8	5.8

With the exception of minor rainfall on Friday 3rd July, 2015 and slightly higher wind speeds on Wednesday 8th July, 2015, the weather conditions for the noise surveys were within the limits of the environmental noise survey standard BS 7445-1:2003.

3.4 Prevailing noise and vibration climate

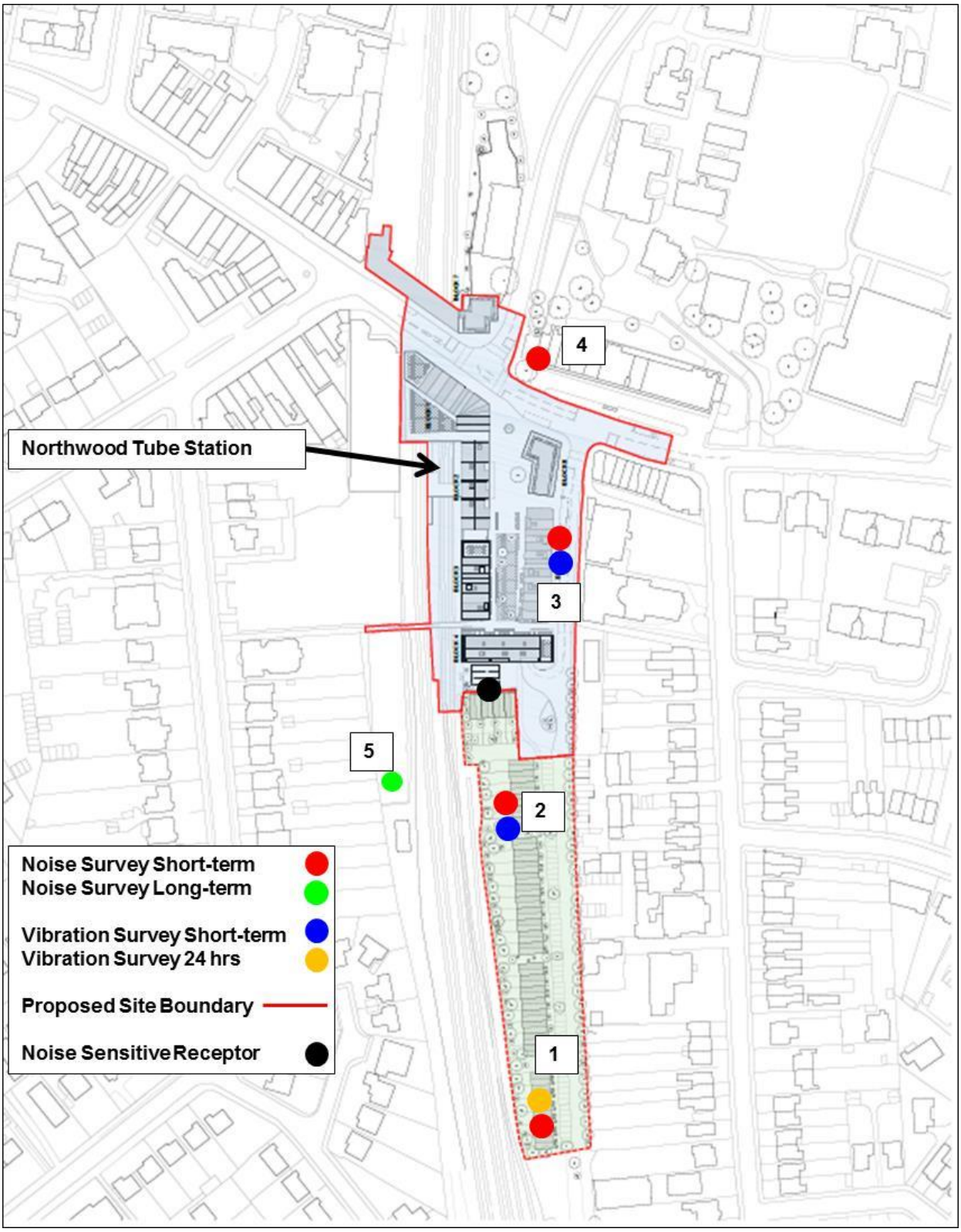
During the surveys, the dominant noise source was found to be intermittent rail movements to and from Northwood LU station and from the surrounding roads (Green Lane, Hallowell Road). Noise was also noted from vehicles entering and leaving the Northwood Station car park. Other sources of noise observed included helicopter and light aircraft flyover.

The only significant source vibration identified was found to be from the adjacent railway line.

3.5 Noise and vibration survey location

Figure 3.1 below shows the noise and vibration measurement locations and the application site boundary of the proposed development. Locations 1 to 4 were short term surveys and were carried out between 23rd – 24th June, 2015 while location 5 was carried out between 1st-8th July, 2015. For the noise surveys the noise instrumentation was placed on a tripod at 1.5 metres high for the short term noise surveys while the long term noise survey was located on a pole approximately 3.0 metres high. The vibration instrumentation was set up on a flat road surface of the car park. The noise and vibration locations were agreed with LBH and in accordance with British Standards. Photographs of the noise and vibration survey are enclosed in Appendix B.

Figure 3-1: Noise and vibration survey locations.



3.6 Noise survey results

Results of the short term noise survey are presented in the Table 3.2 below:

Table 3.2: Short-term noise survey results.

Location	Date and Start Time	Duration (min)	$L_{Aeq,5min}$ (dB)	$L_{Amax,5min}$ (dB)	$L_{A90,5min}$ (dB)	Survey Notes
1	23/06/2015 14:15	30	58.9	87.4	35.5	Noise from rail movements and intermittent traffic entering/leaving car park.
2	23/06/2015 14:51	30	60.2	80.3	38.0	Noise from rail movements and intermittent traffic entering/leaving car park.
3	23/06/2015 15:40	30	53.9	72.7	42.6	Noise from intermittent traffic entering/leaving car park and bus turning loop.
4	23/06/2015 16:16	15	65.5	79.2	56.2	Road traffic noise from Green Lane.

Data analysis has been performed on the long-term background noise levels measured in order to determine the typical value required for a BS 4142 assessment. The results of the data analysis as a histogram of the frequency of occurrence of each data value (the noise level dB occurring most frequently during the respective time period i.e. day or night) for weekday and weekend hours are enclosed in Appendix A. Based on these histograms, L_{A90} 33 dB and L_{A90} 43 dB will be used for the night-time and daytime BS 4142 assessment respectively.

Results of the long-term noise survey are presented in Table 3.3 below. Dominant sources of noise at this location included rail movements and intermittent vehicle noise from the adjacent Waitrose car park.

Table 3.3: 7 day noise survey results for survey 1st-8th July, 2015.

Location	Weekday or Weekend	$L_{Aeq,5min}$ (dB)		$L_{Amax,5min}$ (dB)		$L_{A90,5min}$ (dB)	
		Daytime	Night-time	Daytime	Night-time	Daytime	Night-time
5	Weekday	57.7	51.8	81.0	72.0	43.0	33.0
5	Weekend	57.6	57.5	72.0	73.0	42.0	35.0

Note that daytime hours are considered 07:00 to 23:00 and night-time hours 23:00 to 07:00. Appendix A provides a plot of the day and night-time L_{Aeq}, L_{Amax} and L_{A90} for the 7 day logging period at location 5 while Appendix B shows photos of the survey locations. Note the noise results presented are assessed against guidance and LBH criteria in Section 5 of this report.

3.7 Vibration survey results

The results of both the short-term and 24 hour vibration survey are presented in Table 3.4 and Table 3.5 below, respectively. Note the vibration survey was carried out for 24 hours as this is represents a typical day of service for the LU station and the standard used for the vibration assessment, BS 6472, is based on 24 hours.

Table 3.4: Short-term vibration survey results.

Location	Date and start time	Duration (min)	Measured VDV (m/sec$^{1.75}$)		
			VDV (X)	VDV (Y)	VDV (Z)
2	23/06/2015 14:51	30	0.02	0.01	0.05
3	23/06/2015 15:40	30	0.02	0.01	0.01

Table 3.5: 24 hour vibration survey results.

Location	Date and start time	Duration	Measured VDV (m/sec$^{1.75}$)					
			VDV (X)		VDV (Y)		VDV (Z)	
			Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
1	23/06/2015 17:15	24 hrs	0.05	0.04	0.04	0.03	0.06	0.04

The results for locations 2 and 3 are short-term VDV level adjacent to the nearside railway line and the existing bus turning loop, respectively. The result at location 1 represents the long-term VDV level adjacent to the nearside railway line over 24 hours. For measurement locations 1 to 3, the VDV results are considered low and give an indication that vibration at the location of the proposed development is unlikely to adversely affect future residents.

Note the vibration results presented are assessed against guidance and LBH criteria in Section 5 of this report.

4 Baseline Noise Model

4.1 Introduction

Noise survey data presented in Section 3 of this report has been used to calibrate an environmental noise model in order to predict the future noise climate of the proposed development. The methodology and noise modelling assumptions are described followed by the resulting noise map of the proposed development. Note performance requirements for façade elements are presented in the Section 6 of this report.

4.2 Noise modelling methodology

4.2.1 CadnaA® prediction software

CadnaA® is a sophisticated noise modelling software package that predicts noise levels based on the appropriate input data e.g. location and orientation of equipment and sound power data. The software package takes into account a variety of information about the site including topography, buildings, and potential noise sources.

4.2.2 Noise modelling assumptions

The following standard assumptions have been used in the noise model and are based on similar urban environments and conditions:

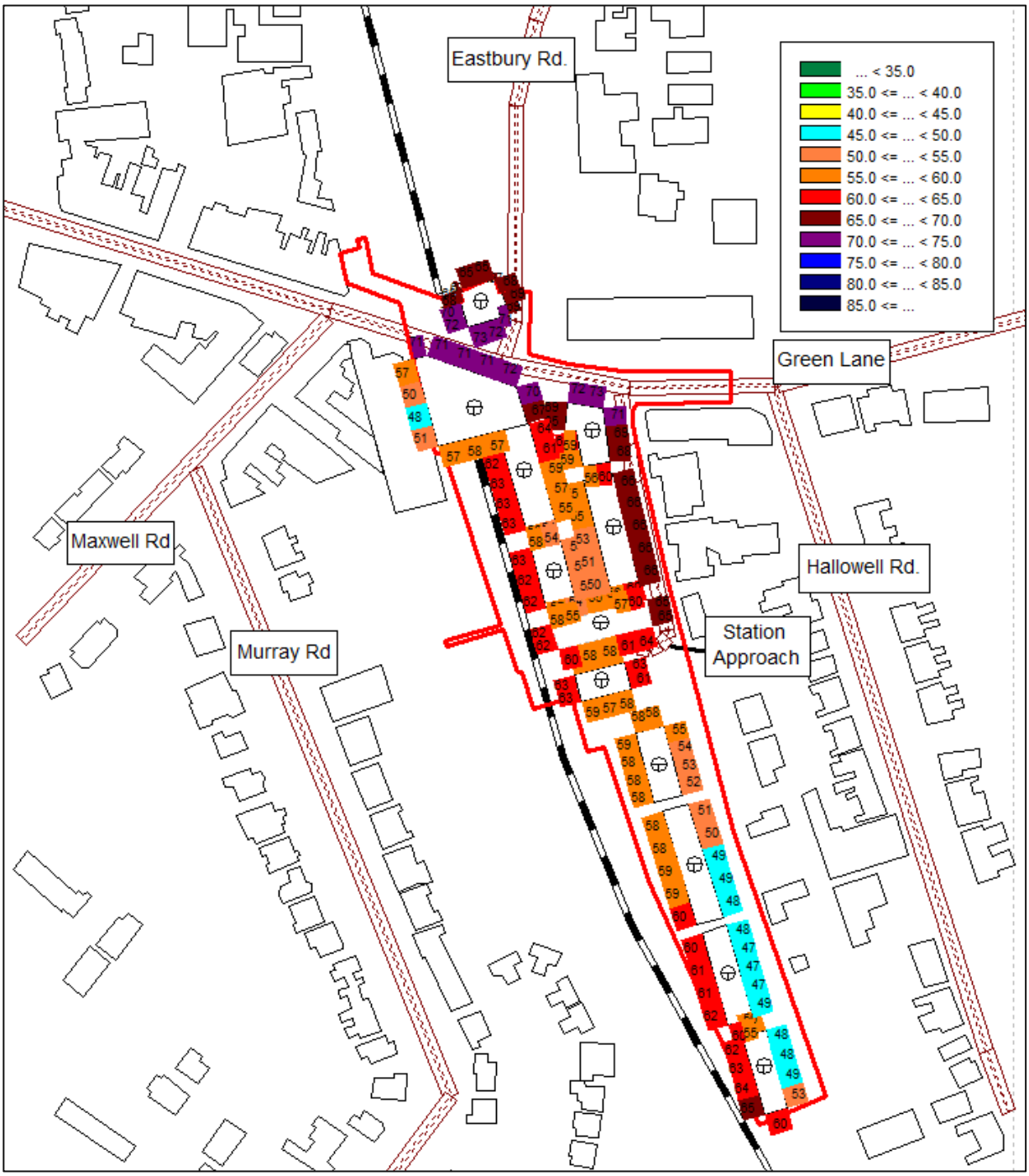
- the ground conditions have been modelled as semi-hard with a ground absorption of 0.2 as the ground conditions around the site were found to consist of a car park and roads.;
- air temperature was assumed to be 10 degrees and humidity 70%;
- it is assumed that all residential building façades are structured and therefore they have been given an absorption coefficient of 0.37; and
- two orders of reflection have been modelled.

4.3 Noise source inputs and baseline noise map prediction

Noise sources identified around the proposed development include road, rail and intermittent aircraft. During the site survey aircraft noise was found to be substantially lower compared to rail and road traffic noise. As such, only roads and rail noise sources have been inputted into the noise model. Rail noise inputted into the model has been obtained from noise measurements on site. Road traffic count data has been inputted into the model using the 2020 'With Development' 18 hour (06:00-24:00) traffic counts (see Table 7.1 of this report).

Noise incident upon the façade has been predicted and is presented in Figure 4.1 below.

Figure 4-1: Proposed development predicted façade noise levels (daytime).



5 Noise and Vibration Assessment

5.1 Introduction

Based on the noise and vibration results presented in the previous section of this report, plant noise limits for new plant associated with the proposed development are specified and VDV vibration levels are assessed in accordance with BS 6472.

5.2 Plant noise limits

Noise levels measured at survey location 5 are considered representative of the general area on both sides of the railway line and is applicable to locations immediately east and west of the site boundary. The noise limits at the noise sensitive receptors during daytime and night-time hours is presented in Table 5.1 below. Note that the measured background noise levels in Table 5.1 are those obtained via statistical analysis in which represents the most frequently occurring noise level for daytime and night-time as described in Section 8 of BS 4142.

Table 5.1: Plant noise limits for the nearest noise sensitive receptors.

Location	Measured background noise at nearest receptor $L_{A90,T}$ dB(A)		Rating level noise limit at sensitive receptor $L_{r,Aeq,Tr}$ dB(A)	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
5	43	33	38	28

New plant items supporting the residential units of the development will be established as part of the detailed design. Paragraph 4.24 of the LBH Noise SPD states the following regarding plant noise:

> *"The development should be controlled such that the rating level of the noise from the proposed development determined according to BS 4142 is at least 5 dB below the background noise level $L_{A90,T}$. Ideally, the assessment of noise should give a positive indication that complaints are unlikely"*

As such, noise emissions from any new mechanical plant associated with the proposed development will aim to achieve 5 dB below the measured background levels at the noise sensitive receptor.

It is understood that new fixed plant from the proposed development including a CHP and UKPN rooms will be located below Block 4 at the lower ground floor level as shown on Fletcher Priest Architect drawing A 1323 GA 0502A. It is also understood that there will be a 1400mm structure between the plant and the residential development. The nearest noise sensitive receptor from this plant will be the residential above these rooms and to the south of the development (shown in Figure 3.1).

All new plant required by the proposed development will need to meet limits set out in the above table to accord with LBH noise criteria. This will ensure the amenity of proposed and existing neighbouring residents is protected.

5.3 Vibration assessment

Both the short-term and the 24 hour vibration survey levels that have been measured on site are compared against daytime and night-time thresholds as given in BS 6472 and their significance ascertained. Table 5.2 and Table 5.3 below present the assessment for each vibration survey location identified in Figure 3.1.

Table 5.2: BS 6472 vibration assessment – Short term survey.

Location	Maximum Measured Daytime VDV ($m/s^{1.75}$) (07:00-23:00)	BS 6472 VDV threshold ($m/s^{1.75}$)	Vibration Assessment
		Daytime	Daytime
2	0.05	0.2 to 0.4	Low probability of adverse comment
3	0.02	0.2 to 0.4	Low probability of adverse comment

Table 5.3: BS 6472 vibration assessment - 24 hour survey.

Location	Maximum Measured Daytime VDV ($m/s^{1.75}$) (07:00-23:00)	Maximum Measured Night-time VDV ($m/s^{1.75}$) (23:00-07:00)	BS 6472 VDV limit ($m/s^{1.75}$)		Vibration Assessment	
			Daytime	Night-time	Daytime	Night-time
1	0.06	0.04	0.2 to 0.4	0.1 to 0.2	Low probability of adverse comment	Low probability of adverse comment

As shown in the above tables, vibration levels come under the BS 6472 category of "Low probability of adverse comment" and therefore will not impact upon future residents of the proposed development.

6 Acoustic Performance of Façade Elements

6.1 Introduction

This section presents the performance specifications of façade elements for the proposed development. It considers the façade elements of the future residential properties as these are considered to be the most noise sensitive.

It is proposed that the detail of the façade elements will be brought forward as part of the detailed design. The prediction of façade element performance has made reference to the calculation procedure as given in BS 8233. The results of this prediction have been compared with the required internal noise levels as given in Table 2.1 above.

6.2 Prediction inputs and specification

Table 6.1 below presents the façade sound reduction index of the non-glazed elements used in the prediction.

Table 6.1: Façade opaque construction used in noise ingress prediction.

Construction	Reference	Octave Band Centre Frequency Sound Reduction Performances (dB)					Rw+Ctr (dB)
		125	250	500	1k	2k	
• 122mm brick plastered wall • Timber stud with 12.5mm plaster board • 50mm insulation	Insul software	38	35	42	49	57	43

The proposed development's most exposed façade to noise is that facing the adjacent railway line and that facing Green Lane as shown in Figure 4.1. These areas are identified as Block 1 to 7 in Fletcher Priest Architect's drawing A 1323 GA 0502. It is also understood that windows overlooking the platforms of the railway station will be fully sealed.

To assess whether natural ventilation is possible at the proposed development, the noise reduction across an open window fitted in a façade with a good sound insulation of 10 dB is assumed. As such, the maximum noise incident upon a residential façade for a living room and bedroom with an open window would equate to 35+10= L_{Aeq} 45 dB and 30+10 = L_{Aeq} 40 dB during daytime and night-time hours, respectively. Based on noise survey measurements and prediction results these limits will be exceeded for most façade locations of the proposed development. As such, using windows as natural ventilation at these locations will not meet internal noise targets for residential development and instead acoustic ventilators are required (or the use of MVHR).

The following assumptions for a typical bedroom, living room or executive office/meeting room and have been taken from BS 8223 and used in the prediction of glazing and natural ventilator requirements:

- bedroom or living room dimensions: (L) 4.25m x (W) 3.5m x (H) 2.6m;
- glazing: 1.5m^2; and
- reverberation time in rooms: 0.5 seconds.

Façade elements have been specified using noise survey data for both daytime L_{Aeq} and night-time L_{Amax}. Acoustic ventilators are presented in the following table for various façade noise exposure levels. These elements have been selected to achieve required indoor ambient noise levels during the daytime (L_{Aeq} 35 dB) and during the night-time (L_{Amax} 45 dB). Note an equivalent $D_{n,e,w}$ should be sought if these units are not chosen.

Table 6.2: Façade element acoustic requirements.

Façade Noise exposure L_{Aeq} (dB) (Figure 3.1)	**Minimum acoustic requirements for glazing (R_w+C_{tr} in dB) (Example Construction)**	**Ventilator Type (Dn,e,w (dB))**
47.0 dB to 64.0 dB	32 (6mm glass/ 6 to 20mm air gap / 6mm glass)	Titon, SF Canopy / 25mm spacer - 11mm + SF3300 Vent, $D_{n,e,w}$ 35 dB
65.0 dB to 70.0 dB	32 (10mm glass/ 6 to 20mm air gap / 6mm glass)	Passivent, Fresh TFL –dB, $D_{n,e,w}$ 44 dB
>70.0 dB	32 (10mm glass/ 6 to 20mm air gap / 6mm glass)	Advised to used MVHR

Implementation of the façade elements presented in Table 6.2 above is predicted to meet the required internal ambient noise levels described in Table 2.1 of this report.

Mechanical Ventilation Heat Recovery (MVHR) units are typically used in residential developments at sites that are noisy. MVRHs have the benefit over acoustic ventilators in that less noise will be audible compared to acoustic ventilators. The cumulative noise emitted by MVHR units within the residential units should not exceed NR 25 dB for bedrooms and NR30 dB for living rooms.

7 Road Traffic Noise

7.1 Introduction

This Section of the report assesses the impact of road traffic changes associated with the proposed development. A traffic flow assessment of the proposed development has been carried out by Buro Happold Transport Engineers. The traffic data was collected on Thursday 10th September, 2015 and factored using ATC data collected in October 2014.

7.2 Road traffic noise assessment

Two scenarios have been investigated for the road traffic assessment: the '2015 baseline' case and the '2020 with development' case.

Using the UK standard CRTN, a noise prediction of these two scenarios has been undertaken assuming a distance of 10 metres from the road and a vehicle speed of 30 mph. Note as there are roads which are between 1000≤ Q (number of vehicles) <4000, a correction should be applied to the noise level. The correction has the effect of lowering the noise level at the prediction location. This correction has not been factored into the prediction and as such this prediction can be viewed as a worst case scenario. The impact of the road traffic changes has been assessed using DMRB significance criteria described as presented in Table 2.5.

The following table presents the road assessment for the two abovementioned scenarios.

Table 7.1: CRTN road traffic noise prediction.

Road		Existing Baseline Traffic Flow (2015)		Traffic Flow With Development (2020)		Predicted Relative Change in Traffic Noise Level (dBA)	Impact Significance
		Total Traffic Flow	Total HGV	Total Traffic Flow	Total HGV		
Green Lane (West of Maxwell Road)	Eastbound	6901	366	7689	400	0.5 dB(A)	Negligible
	Westbound	6882	289	7691	316	0.5 dB(A)	Negligible
Maxwell Road	Eastbound	2594	85	2879	93	0.5 dB(A)	Negligible
	Westbound	3166	103	3498	113	0.4 dB(A)	Negligible
Green Lane Site (West of Eastbury Road)	Eastbound	6276	362	7046	396	0.5 dB(A)	Negligible
	Westbound	7762	340	8687	372	0.5 dB(A)	Negligible
Eastbury Road	Eastbound	2141	30	2350	33	0.4 dB(A)	Negligible
	Westbound	3312	28	3633	31	0.4 dB(A)	Negligible
Station Approach	Eastbound	1106	97	1581	106	1.3 dB(A)	Negligible
	Westbound	1179	101	1658	111	1.3 dB(A)	Negligible

Road		Existing Baseline Traffic Flow (2015)		Traffic Flow With Development (2020)		Predicted Relative Change in Traffic Noise Level (dBA)	Impact Significance
		Total Traffic Flow	Total HGV	Total Traffic Flow	Total HGV		
Green Lane Site (West of Hallowell Road)	Eastbound	6460	251	7252	274	0.5 dB(A)	Negligible
	Westbound	6128	263	6878	288	0.5 dB(A)	Negligible
Hallowell Road	Eastbound	1632	30	1813	33	0.5 dB(A)	Negligible
	Westbound	1274	12	1420	13	0.5 dB(A)	Negligible
Green Lane Exit (East of Hallowell Road)	Eastbound	5867	259	6566	283	0.5 dB(A)	Negligible
	Westbound	5878	220	6587	241	0.5 dB(A)	Negligible

From Table 7.1 above, the change in noise from road traffic due to the proposed development is predicted to have negligible significance.

8 Construction Noise and Vibration

8.1 Introduction

This section presents hours of works and mitigation measures that should be implemented in order to minimize noise emissions information on the management of noise and vibration from construction sites including from which may affect existing noise sensitive receptors adjacent to the proposed development. Note that the contents of this section of the report have been agreed with LBH.

8.2 Section 60 of the Control of Pollution Act 1974[10]

Information presented on LBH's website[12] mention that the following actions will be taken should a complaint be raised due to noise from construction sites:

> *"Following complaint we will notify the person responsible in writing. Should this not resolve the matter, the Control of Pollution Act 1974 Section 60 allows the borough to issue a notice requiring compliance and is served on the person responsible for works on site. Should further complaints be received we will then arrange for spot checks to be carried out."*

Section 60 of the Control of Pollution Act provides the local planning authority (LBH) with special powers for controlling noise arising from construction and demolition works, regardless of whether a statutory nuisance has been caused or is likely to be caused. This power may be exercised either before works start or after they have started.

Section 60 of the Control of Pollution Act enables a local authority (LBH) in whose area construction works is going to be carried out, or is being carried out, to serve a notice of its requirements for the control of site noise on the party who appears to the local authority to be carrying out, or to have control over the works.

Note that the Control of Pollution Act is typically used in conjunction with other standards including BS 5228 Parts 1 and 2.

8.3 Best Practicable Means (BPM) and selection and use of equipment

There are several measures that can be undertaken by the construction contractor during construction works to reduce and minimize noise emissions. The following is a list of such measures that will aid in minimizing noise emissions from construction sites:

- provide neighbours who may be affected by particular operations at least 48 hours' notice;
- select the quietest suitable plant and equipment and keep it properly maintained and observe safe working practices;
- Ensure that all sub-contractors are told to carry out their work in compliance with agreed guidelines on noise and dust and other matters;
- for long term and complex projects, arrange for detailed liaison with the local community, through structured meetings with residents;
- avoid the need to park on the street by providing on-site parking wherever possible;
- inform the Local Authority (LHB) where your activities might be expected to cause disturbance. Care must be taken to avoid damage to neighbours property. Detailed law exists on this;
- take all reasonably practicable steps to prevent noise and dust from causing nuisance; and

- do not allow the use of radios on the site in circumstances where it could cause disturbance.

All operations should be carried out to conform to British Standard 5228 Parts 1[11] and 2[12]. On all sites at all times, the Best Practicable Means (BPM) to minimise noise and vibration should be used, and includes the following points, although this list is not exhaustive:

- employ only modern, quiet and well maintained equipment on site;
- noisier plant and equipment will be sited at basement level with a significant deck structure in place to mitigate noise;
- the use of barriers, huts, acoustic barriers and insulation should be employed wherever practicable;
- plant should be powered by mains electricity in preference over locally powered sources such as diesel generators. Where this is not possible suitable acoustic attenuation measures should be provided such as enclosures;
- vehicles and mechanical plant should be fitted with effective exhaust silencers and maintained in good and efficient working order. Relevant EC Directives/UK regulations should be complied with;
- avoid unnecessary noise, such as engines idling between operations, shouting, loud radios, or excessive revving of engines;
- all deliveries of materials, plant and machinery to site should take place within the LBH Council's recommended hours stated above, and must be properly co-ordinated to prevent parking in local streets while awaiting access to site;
- adequate planning should be made to ensure that lengthy operations, such as concrete pours can be completed within the permitted hours; and
- care should be taken when loading and unloading vehicles, dismantling scaffolding or moving materials to reduce impact noise.

8.4 Noise and vibration environmental incident and complaint procedure

The following situations are examples of noise and vibration incidents and as such will be subject to the relevant controls and procedures set out within an incident plan:

- A complaint received from a member of the public or the local authority (LBH); and
- an incident or activity which results in a breach of consent conditions under section 60 of the Control of Pollution Act e.g. non-compliance with the consented working hours, non-permitted plant/equipment or non-compliance with BPM;

Complaints should be managed in accordance with a complaints procedure outlined within an Environmental Management Plan. Notification of the complaint and actions taken should be provided to the local authority (LBH) and should note the following information:

- note the time, date, identity and contact details of complainant. Note if the complaint has been referred from the local authority. Ask complainant to describe the noise and vibration emission; is it constant or intermittent, how long has it been going on for, is it worse at any time of day, does it come from an identifiable source;
- as soon as possible after receipt of a complaint undertake a site inspection. Note all noise and vibration producing activities taking place and the noise and vibration mitigation methods that are being employed. If the complaint was related to an event in the recent past, note any noise and vibration producing activities that were underway at that time, if possible. Implement any remedial action necessary;

- as soon as possible visit the area from where the complaint originated to ascertain if noise and vibration is still a problem;
- if another source of noise and vibration other than the construction work is causing the noise and vibration nuisance verify the source. Photograph the source and emissions;
- as soon as possible after the initial investigations have been completed contact the complainant to explain any problems found and remedial actions taken;
- if necessary update any relevant method statements to prevent any recurrence of problems;
- file the noise and vibration complaint form on the complaint register;
- notify the Project Manager, Community Liaison Manager, Environmental Manger and local authority as soon as practicable that a complaint has been received and what the findings of the investigation were and any remedial measures taken; and
- inform workers on site of complaint and what the findings of the investigation were and any remedial measures taken.

9 Noise and Vibration Impact Summary

A summary of the noise and vibration impact of the proposed development is presented in Table 9.1 below.

Table 9.1: Noise impact summary.

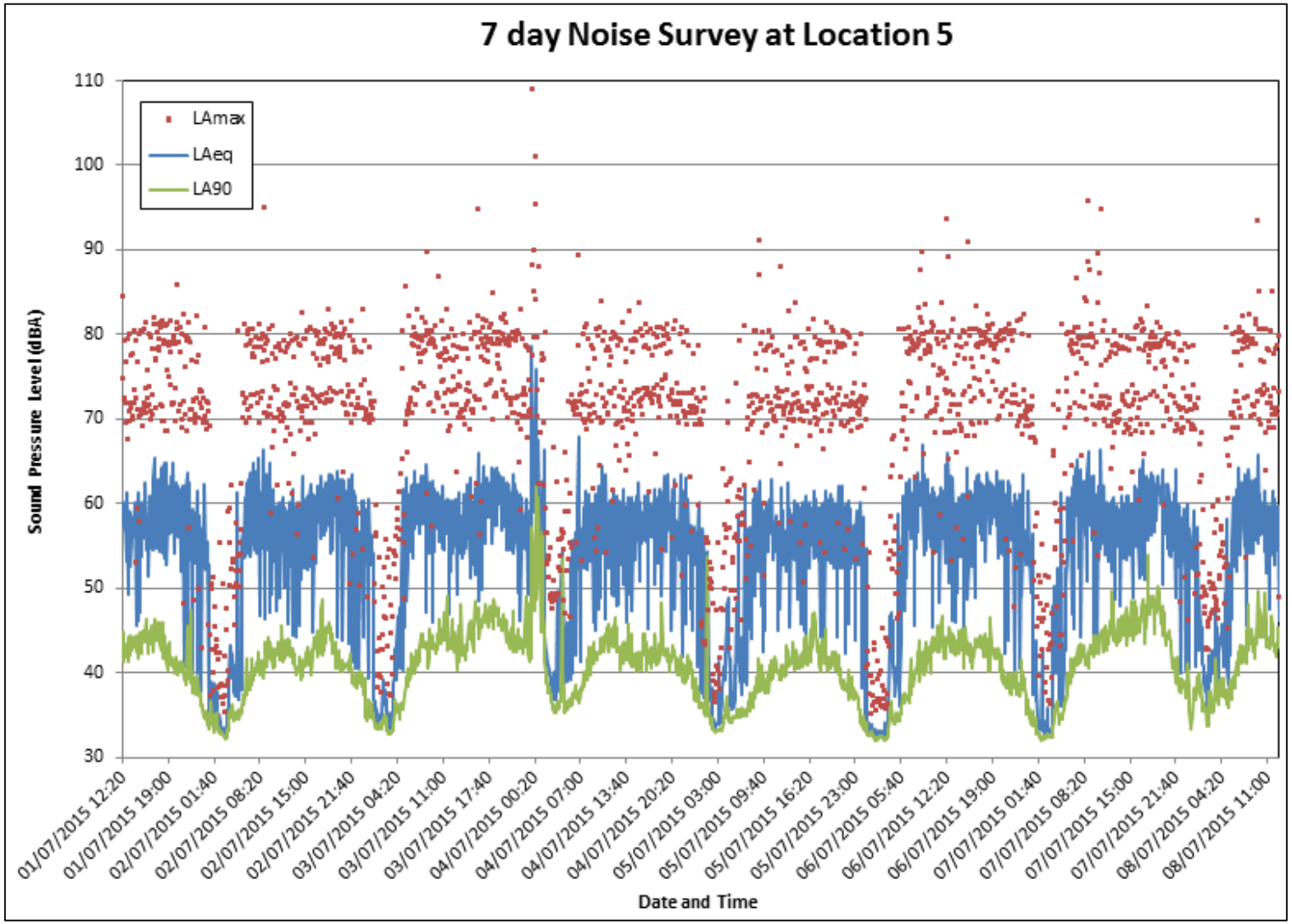
Description	Nature of Impact	Geographic Scale	Comments
Ambient Noise and Vibration Environment and Suitability of Site for Proposed Uses			
Ambient Noise	Noise from Northwood Station and local roads (Green Lane) may impact upon the new residential and commercial development.	Local	Following the use of sound insulation as given in Section 6 and orientation of noise sensitive rooms of the proposed development, the site will achieve its intended use.
Ambient Vibration	Vibration from Northwood Station railway movements.	Local	A vibration survey adjacent to the Northwood railway station has been carried out and the levels measured show that there will be a "Low probability of adverse comment" as per BS 6472.
Operational Impacts			
Noise and Vibration from Building Services Plant	Any new fixed plant introduced at the proposed development will need to be, if necessary, mitigated to meet LBH Council's noise limits at noise sensitive receptors.	Local	Using low noise plant items and/or suitable noise mitigation, noise emissions will meet criteria. No sources of vibration associated with the proposed development have been identified.
Road Traffic Impacts			
Road Traffic Noise	Increases in road traffic on surrounding roads of the development may have a negative impact while a decrease in road traffic will have a positive impact.	Local	The increase in road traffic of the local roads adjacent to the proposed development will have a negligible impact on noise.

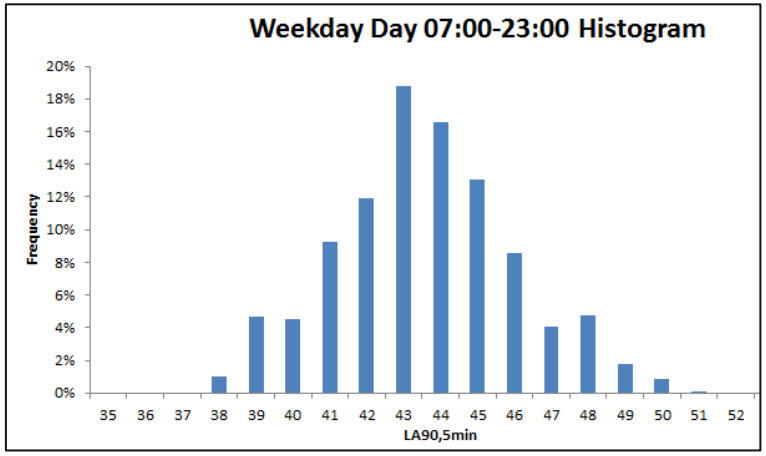
Description	Nature of Impact	Geographic Scale	Comments
Construction Impacts			
Construction Noise	Construction noise	Local	Adhering to hours of works and the guidance in BS 5228 Part 1 and LBH SPD, will ensure a negligible to minor impact to the surrounding environment.
Construction Vibration	Construction vibration	Local	Adhering to hours of works and the guidance in BS 5228 Part 2 and LBH SPD, will ensure a negligible impact due to vibration on the surrounding environment.

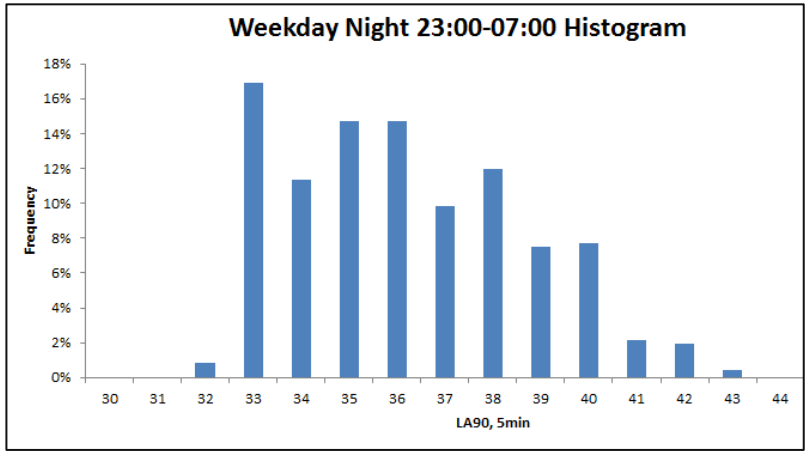
10 References

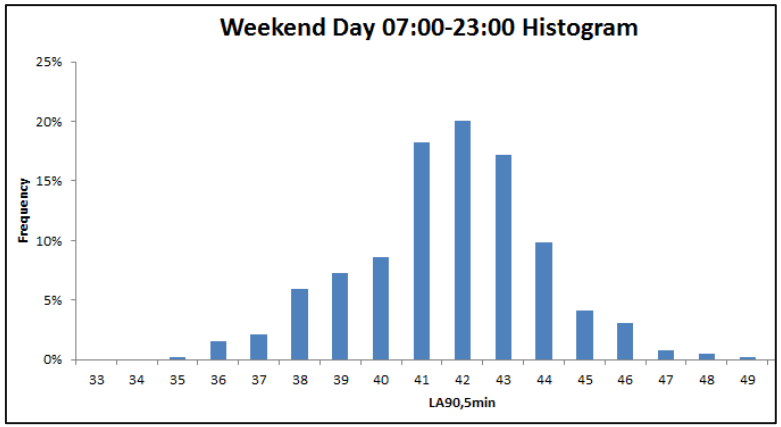
1. London Borough of Hillingdon supplementary planning document noisespdfinal2_1.pdf.
2. British Standards Institute, 8233: 2014 Guidance on sound insulation and reduction in buildings 2014, BSi London.
3. British Standards Institute, 6472: 2008 Guide to the Evaluation of human Exposure to Vibration in Buildings
4. British Standards Institute, 4142: 2014 Methods for rating and assessing industrial and commercial sound, BSi, London.
5. British Standards Institute, 5228-1: 2009 +A1 2014, Noise and Vibration Control on Construction and Open Sites, BSi, London.
6. British Standards Institute, 5228-2: 2009, Noise and Vibration Control on Construction and Open Sites, BSi, London.
7. World Health Organisation, Guidelines for Community Noise, 1999.
8. Department of Transport/Welsh Office, (1998): Calculation of Road Traffic Noise.
9. Highways Agency, (August 2008); Design Manual for Road and Bridges Volume 11 Section 3 Part 7-Traffic Noise and Vibration.
10. Control of Pollution Act, (1974); HMSO, London.
11. British Standards Institute, (2003) 7445-1 Description and measurement of environmental noise. Guide to quantities and procedures, BSi, London.
12. London Borough of Hillingdon website page http://www.hillingdon.gov.uk/article/17385/Construction-site-noise.

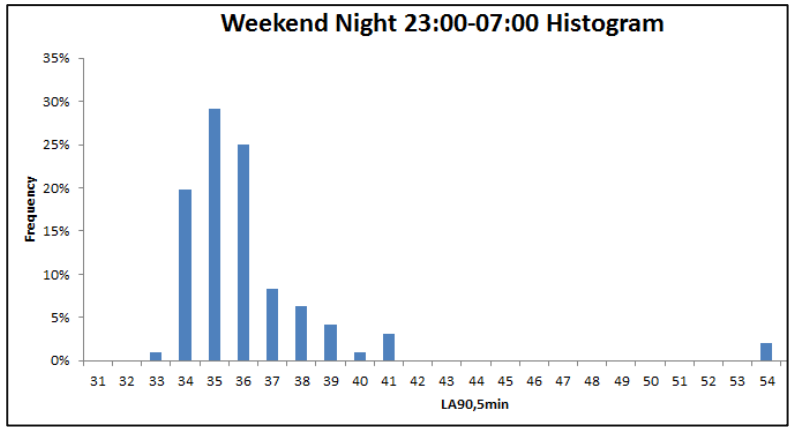
Appendix A Location 5 long term noise survey results and histograms.











24 hour VDV survey data

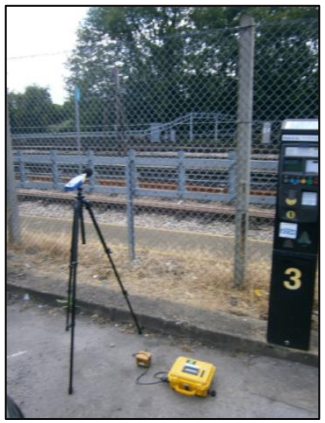
Location	Date and time	Duration (hr)	Measured VDV (m/sec1.75)		
			VDV (X)	VDV (Y)	VDV (Z)
1	23/06/2015 18:00	1	0.017	0.011	0.018
1	23/06/2015 19:00	1	0.021	0.013	0.023
1	23/06/2015 20:00	1	0.024	0.015	0.026
1	23/06/2015 21:00	1	0.026	0.017	0.028
1	23/06/2015 22:00	1	0.027	0.018	0.03
1	23/06/2015 23:00	1	0.028	0.019	0.03
1	23/06/2015 00:00	1	0.018	0.013	0.016
1	24/06/2015 01:00	1	0.021	0.015	0.019
1	24/06/2015 02:00	1	0.023	0.017	0.02
1	24/06/2015 03:00	1	0.024	0.018	0.021
1	24/06/2015 04:00	1	0.026	0.02	0.022
1	24/06/2015 05:00	1	0.027	0.02	0.023
1	24/06/2015 06:00	1	0.028	0.021	0.024
1	24/06/2015 07:00	1	0.029	0.022	0.028
1	24/06/2015 08:00	1	0.017	0.013	0.024
1	24/06/2015 09:00	1	0.02	0.015	0.029
1	24/06/2015 10:00	1	0.022	0.017	0.032
1	24/06/2015 11:00	1	0.024	0.018	0.033
1	24/06/2015 12:00	1	0.025	0.018	0.033

Location	Date and time	Duration (hr)	Measured VDV (m/sec1.75)		
			VDV (X)	VDV (Y)	VDV (Z)
1	24/06/2015 13:00	1	0.027	0.019	0.034
1	24/06/2015 14:00	1	0.028	0.02	0.035
1	24/06/2015 15:00	1	0.029	0.021	0.035
1	24/06/2015 16:00	1	0.03	0.021	0.036
1	24/06/2015 17:00	1	0.03	0.022	0.037
1	24/06/2015 18:00	1	0.031	0.022	0.037

Appendix B Noise and vibration survey photographs

Location 1

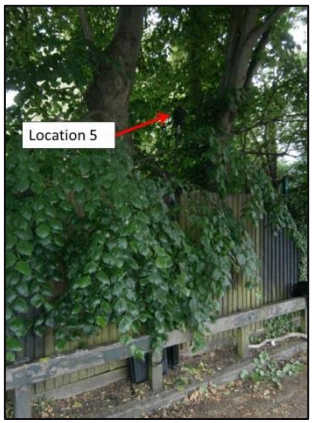
Location 2



Location 3

Location 4

Location 5



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