



MARCUS WORTHINGTON PROPERTIES LIMITED

PROPOSED STUDENT ACCOMMODATION DEVELOPMENT

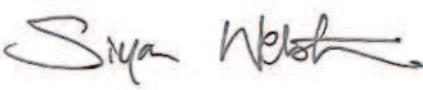
PHILHARMONIC COURT, LIVERPOOL

ENVIRONMENTAL NOISE STUDY

R0594-REP01-IE

5 SEPTEMBER 2012

REPORT DETAILS

Project	Proposed Student Accommodation Development Philharmonic Court Liverpool			
Client	Marcus Worthington Properties Limited Brockholes Pavilion Brockholes Way Claughton-on-Brock Preston PR3 0PZ			
Document Reference	R0594-REP01-IE			
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Signed				
Checked By	Simon Webster BEng (Hons) MIOA, Red Acoustics Limited			
Signed				

SUMMARY

Red Acoustics has been commissioned by Marcus Worthington Properties Limited to provide an assessment of environmental noise relating to a proposed student residential development at Philharmonic Court near Liverpool city centre. This report examines the environmental noise conditions at the site and advises on suitable facade constructions to achieve recommended internal noise criteria within habitable rooms during daytime and night-time periods.

It has been determined that suitable noise levels within study bedrooms and communal living rooms can be achieved using standard double glazed units in windows to all spaces. Study bedrooms within the Caledonia Street elevation of the building will require acoustically rated passive ventilators or a background ventilation strategy that does not rely on ventilation openings within their external walls in order to achieve suitable internal noise levels at night, subject to approval of the proposed ventilation scheme for compliance with Approved Document F - Ventilation.

Suitable plant noise limits have been specified at the nearest noise sensitive dwellings to the application site. Plant noise levels should be assessed in accordance with BS4142 and, if applicable, suitable attenuation measures should be specified by Red Acoustics as plant data become available.

CONTENTS

1.0		
INTRODUCTION		1
2.0		
DESCRIPTION OF APPLICATION SITE		2
	<i>Figure 1: Location of proposed development</i>	3
3.0		
CHARACTERISTICS OF THE PROPOSED DEVELOPMENT		4
	<i>Figure 2: Ground floor plan</i>	5
	<i>Figure 3: Caledonia Street elevation</i>	5
4.0		
ENVIRONMENTAL NOISE SURVEYS		6
	<i>Figure 4: Noise measurement positions</i>	6
	<i>Table 1: Summary of Measured Environmental Noise Levels</i>	7
5.0		
NOISE PROPAGATION MODELLING		9
	<i>Figure 5: Noise propagation model - general arrangement</i>	9
	<i>Figure 6: Noise propagation across south east elevations</i>	10
	<i>Figure 7: Noise propagation across north east elevations</i>	10
	<i>Figure 8: Noise propagation across north west elevations</i>	11
	<i>Figure 9: Predicted facade noise levels at ground floor (LAeq) - daytime</i>	12
	<i>Figure 10: Predicted facade noise levels at top floors (LAeq) - daytime</i>	12
	<i>Figure 11: Predicted facade noise levels at ground floor (LAeq) - night-time</i>	14
	<i>Figure 12: Predicted facade noise levels at top floors (LAeq) - night-time</i>	14
6.0		
NOISE MITIGATION		15

7.0

PLANT NOISE DESIGN CRITERIA **17**

Table 2: Plant Noise Limits at Nearest Dwellings 17

APPENDIX A: NOISE SURVEY DETAILS **18**

APPENDIX B: SUMMARY RESULTS **24**

Table B1: Summary of Measured Noise Levels – Daytime 24

Table B2: Summary of Measured Noise Levels – Night 25

1.0 INTRODUCTION

Red Acoustics has been commissioned by Marcus Worthington Properties Limited to provide an assessment of environmental noise relating to a proposed student accommodation development at Philharmonic Court, Liverpool. This report examines the environmental noise conditions at the site and advises on suitable facade constructions and ventilation strategies to achieve recommended noise criteria within habitable rooms during daytime and night-time periods.

Daytime and night-time noise surveys have been carried out as part of this assessment in order to quantify the existing noise climate at the application site. The measured noise levels have then been used to calibrate a computerised noise propagation model for the entire development allowing noise levels at all residential facades to be calculated. The results of this exercise have facilitated the development of suitable noise mitigation options.

The noise survey results have also been used to formulate noise limits for any plant that may be associated with the development in order to protect the amenity of neighbouring residents and other noise sensitive users.

2.0 DESCRIPTION OF APPLICATION SITE

The application site is located in the Canning area of Liverpool and is currently occupied by five 3-storey student accommodation buildings and a surface carpark.

The site is bounded to the north by Caledonia Street, a lightly trafficked road on the opposite side of which lie buildings operated by Liverpool John Moores University's Faculty of Art and Design. These buildings provide effective screening for the site against noise from the busy Myrtle Street which lies approximately 60m to the north.

The site is bounded to the east by Victorian townhouses, on the opposite side of which is Catharine Street (A5039) a busy road leading from the city centre to Toxteth. The site is bounded to the south by Victorian townhouses on the opposite side of which lies Falkner Street, a residential road with light traffic flows during daytime and at night. A gated entrance is present in the south west corner of the site providing access from Falkner Street. A small surface carpark borders western boundary of the site.

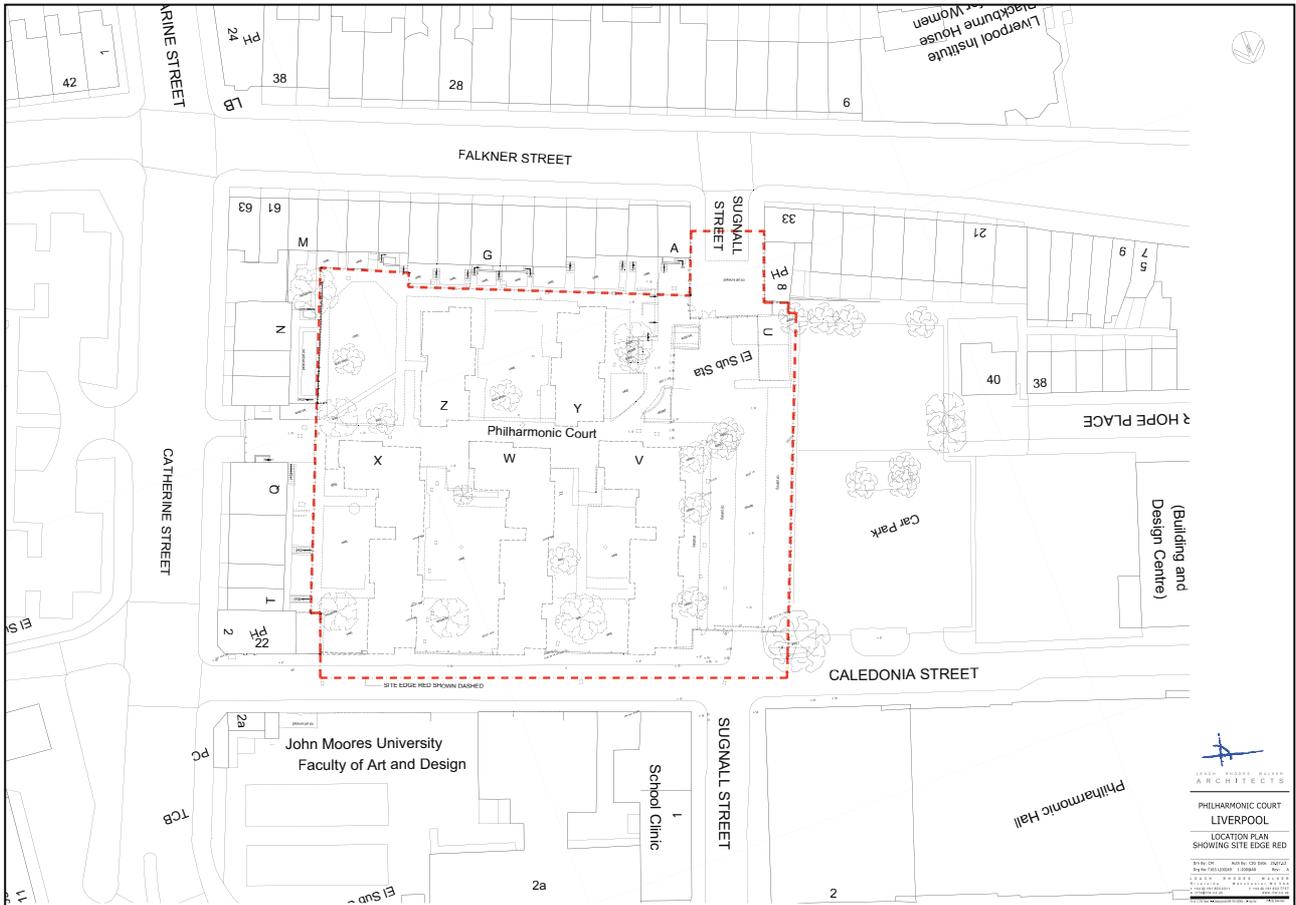
Two public houses lie close to the site. The Caledonia public house lies at the north east corner of the site at the end of the row of townhouses. The Belvedere Arms public house lies along the short access road running from Falkner Street into the south western corner of the site. Staff at the existing student accommodation of Philharmonic Court have advised that no recent complaints from students have been received regarding noise from both of these public houses.

Caledonia Street and Falkner Street are both lightly trafficked during daytime and at night. Catharine Street is well trafficked with cars, buses, taxis, LGV and HGV movements during day and night.

The Liverpool Philharmonic Hall is located diagonally opposite the site on Caledonia Street. Staff at Philharmonic court have advised that no complaints from students have been received regarding noise egress from the hall.

The location of the site in relation to the surrounding roads and buildings is shown in Figure 1.

Figure 1: Location of proposed development



3.0 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

Approval is sought for a new-build development containing 354 student bedrooms, arranged into three, four, five and six bedroom clusters. The building will replace the existing five student accommodation blocks on the site and occupy the existing car park to the rear.

The proposed development will contain two buildings, each comprising two separate blocks. The building heights will range from six storeys in the north west corner to one storey in the north east corner. The building will be arranged around a central courtyard.

A ground floor communal area, reception, offices and plantrooms will be located in the north east corner of the building together with principle pedestrian access from Caledonia Street.

New external plant items, such as air conditioning units for the offices, may be required although no plant information is currently available. As such, plant noise limits are specified within this report to ensure minimal impact on neighbouring sensitive receptors.

The proposed ground floor layout of the building is shown in Figure 2 with the Caledonia Street elevation shown in Figure 3.

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ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

Figure 2: Ground floor plan



Figure 3: Caledonia Street elevation



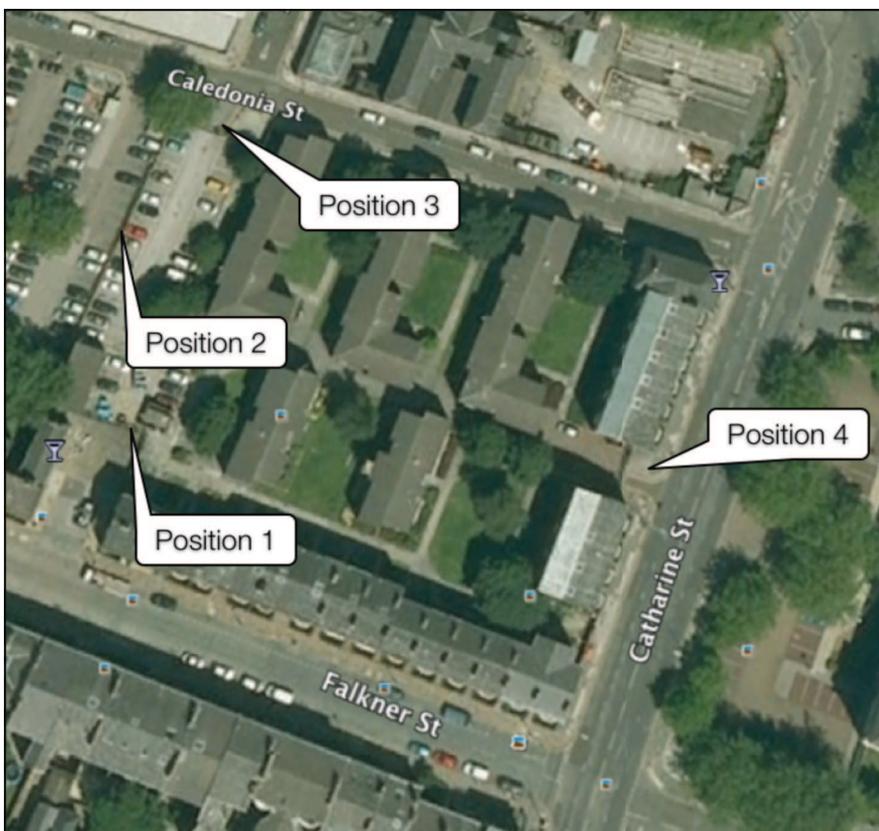
4.0 ENVIRONMENTAL NOISE SURVEYS

In order to determine the prevailing environmental noise levels at the application site, manned surveys were carried out during daytime on Wednesday 8th August 2012 and during late evening on the same day.

The measurement locations used for the surveys are identified in Figure 4. Measurements were made with the microphone positioned at a height of 1.4m above ground level at the following locations:

- Position 1 At gate in southwest corner of the application site - clear line of sight to Falkner Street.
- Position 2 Centre of western site boundary near surface car park.
- Position 3 Pavement next to car park entrance gate at northwest corner of site on Caledonia Street.
- Position 4 On pavement at current entrance to Philharmonic Court on Catharine Street. Level with front of townhouses.

Figure 4: Noise measurement positions



Each noise measurement was ten minutes long in duration.

The dominant source of noise at the site is traffic on local roads. The measurement positions were therefore selected in order to assess noise contributions from Caledonia Street (and Myrtle Street to the north), Catharine Street and Falkner Street in relative isolation, thereby assisting with the development of a noise propagation model as described in Section 6.

Catharine Street is the busiest street adjacent to the site, exhibiting regular vehicle movements during daytime and at night. Caledonia Street and Falkner Street exhibit infrequent vehicle movements. Myrtle Street is one block away to the north and leads into Catherine Street, thereby exhibiting similar traffic flows. However the application site is largely screened from noise produced on Myrtle Street by the intervening University Faculty buildings. There are no other significant sources of environmental noise in the immediate area.

Full survey details and instrumentation are given in Appendix A. Appendix B contains the results obtained from the surveys.

Table 1 summarises the measured noise levels at the application site.

Table 1: Summary of Measured Environmental Noise Levels

Location	Measured Noise Levels					
	Daytime (07:00-23:00)			Night-time (23:00-07:00)		
	dB, LAeq	dB, LAmax	dB LA90	dB, LAeq	dB, LAmax	dB LA90
Position 1	55	63-72	42-51	54	66-72	42-53
Position 2	51	59-67	44-51	47	53-58	42-43
Position 3	56	68-75	50-52	52	61-75	44-47
Position 4	66	77-83	50-53	64	74-79	40-48

The results in Table 1 confirm that there is only a small variation between daytime and night-time noise climates at the site. This is due to the fact that the site is relatively well screened from busy local roads and the associated changes in noise due to daytime and night-time vehicle flows.

Daytime and night-time noise levels measured at Position 1 were influenced by the operation of a small wall mounted condenser unit outside the Belvedere Arms Public House.

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ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

No noise egress from the Caledonia and Belvedere Arms public houses was audible during the daytime and night-time surveys. During the night-time survey it was noted that four to six customers of the latter establishment were seated and talking quietly outside the premises.

The measured noise levels can be used to determine the acoustic requirements of the facades of the proposed building in order to achieve satisfactory internal noise levels within habitable rooms. Details of predicted noise propagation across the elevations of the development are given in Section 5.

5.0 NOISE PROPAGATION MODELLING

To determine the propagation of noise across the proposed development site, CadnaA 3D noise propagation software has been used to predict the ambient daytime and night-time noise levels at the building's facades based on the measured survey data and proposed site plans and elevations. The software predicts traffic noise levels in accordance with the method described within 'Calculation of Road Traffic Noise' published by the former Department of Transport and Welsh Office.

The general arrangement of the noise propagation model is shown in Figure 5.

Figure 5: Noise propagation model - general arrangement



Figures 6, 7 and 8 show the calculated distribution of noise levels across the external elevations of the proposed building and illustrate the acoustic 'hotspots' where traffic noise passes through gaps between the surrounding houses on Catharine Street and Falkner Street. The figures also confirm that the central courtyard will be subject to significantly lower noise levels than the external elevations as anticipated.

Figure 6: Noise propagation across south east elevations

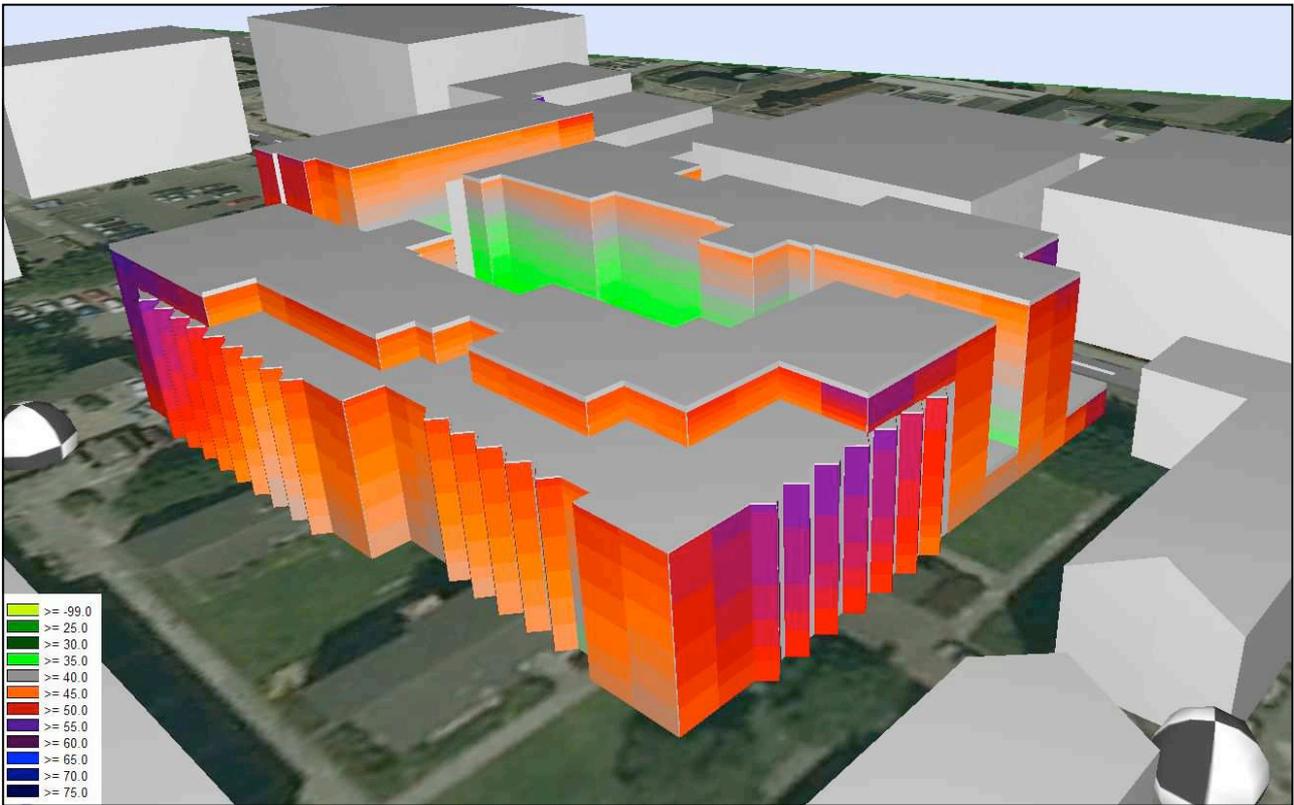


Figure 7: Noise propagation across north east elevations

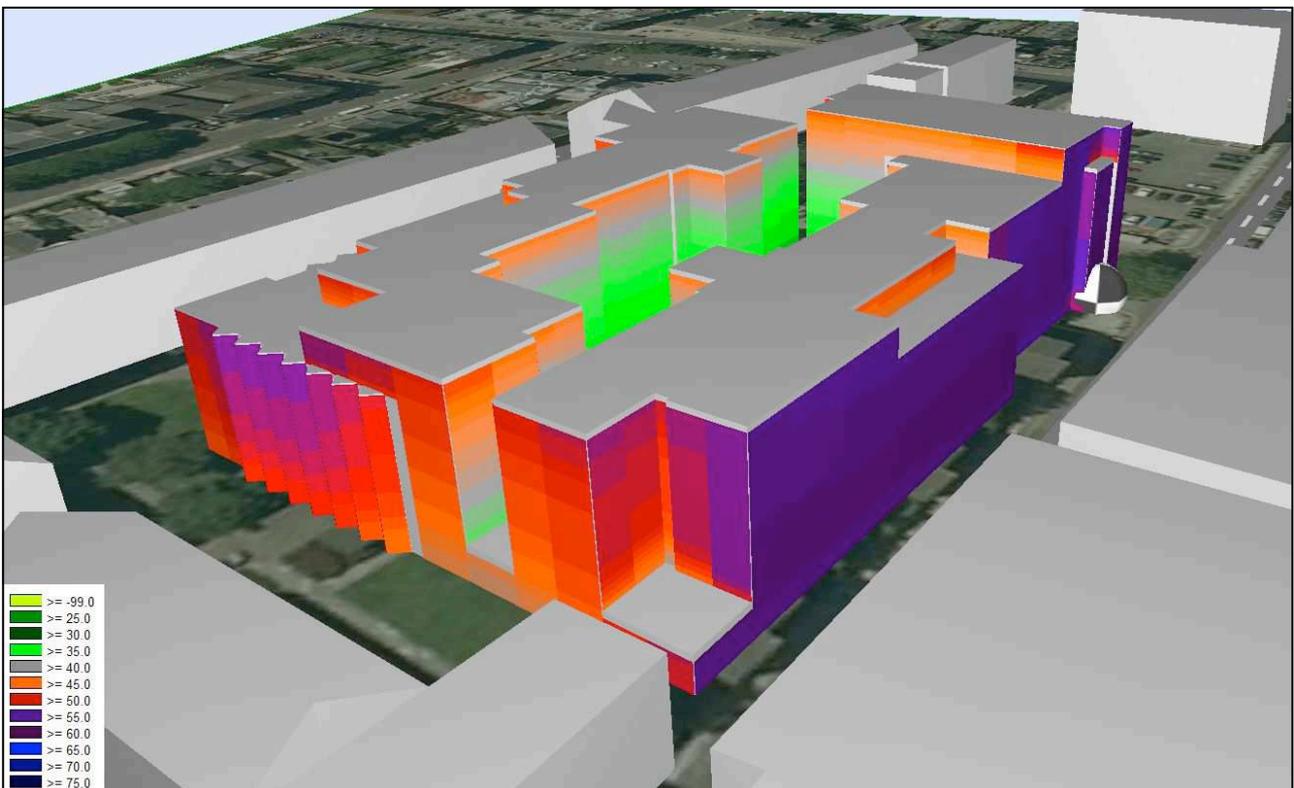
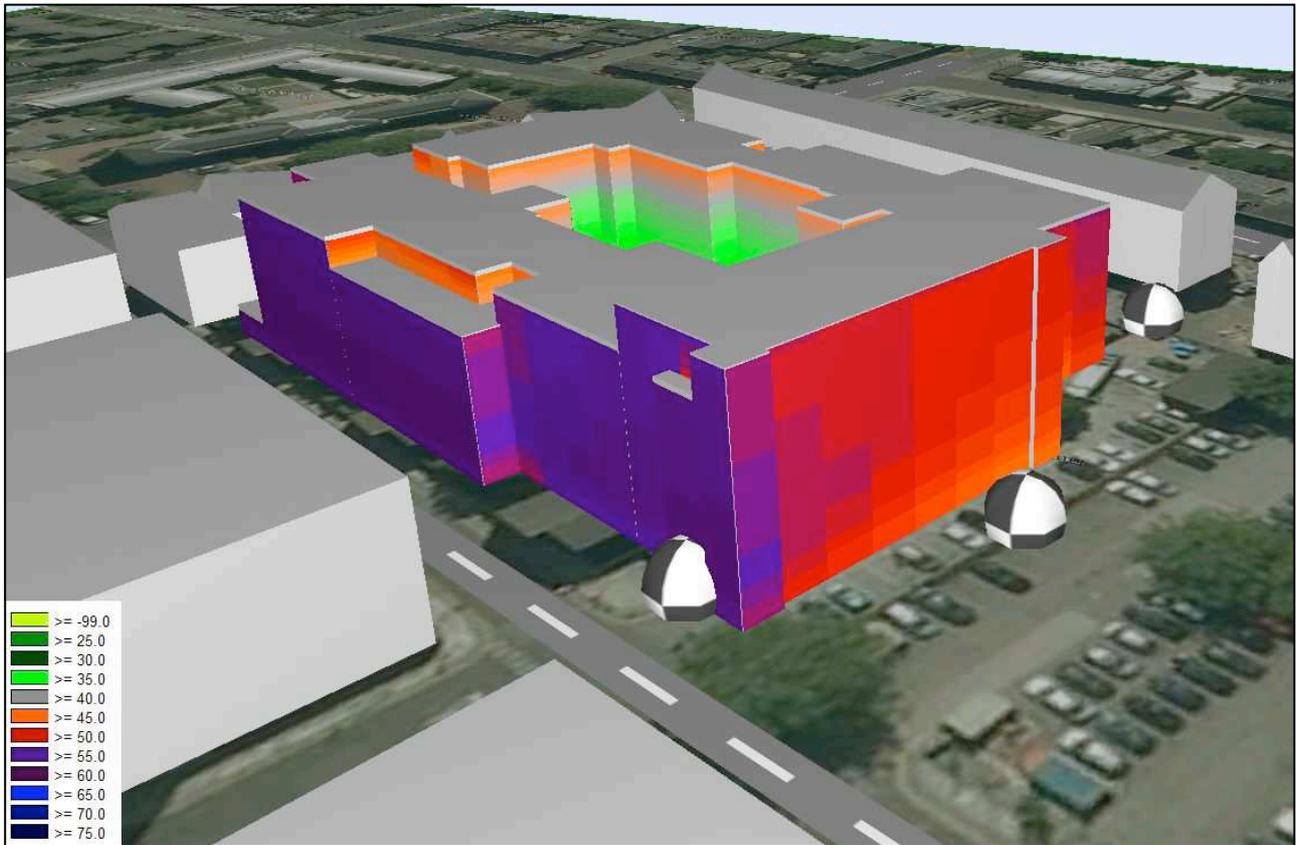


Figure 8: Noise propagation across north west elevations



Figures 9 and 10 show the predicted daytime L_{Aeq} noise levels that will impact along the facades of the proposed building at ground and top floor levels.

The figures confirm that the highest traffic noise levels will impact upon the elevation overlooking Caledonia Street. Here, ambient noise is predicted to reach up to 57dB L_{Aeq} , however in absolute terms this level is relatively modest, falling only 2dB above the upper boundary of Noise Exposure Category A as defined by the recently withdrawn Planning Policy Guidance Note 24.

Daytime traffic noise from Catharine Street will also reach up to 54dB L_{Aeq} along the east elevation of the building adjacent to the opening between the rows of adjacent townhouses. Calculated daytime noise levels along the other external elevations will be in the order of 45dB L_{Aeq} to 50dB L_{Aeq} , potentially reaching 55dB L_{Aeq} outside the upper floors in the south west corner of the building which has a direct line of sight to Falkner Street.

Daytime noise levels impacting upon rooms overlooking the central courtyard are predicted to be low due to screening from the building, ranging from 34dB L_{Aeq} at ground floor level - 43dB L_{Aeq} outside upper floor rooms.

Figure 9: Predicted facade noise levels at ground floor (L_{Aeq}) - daytime

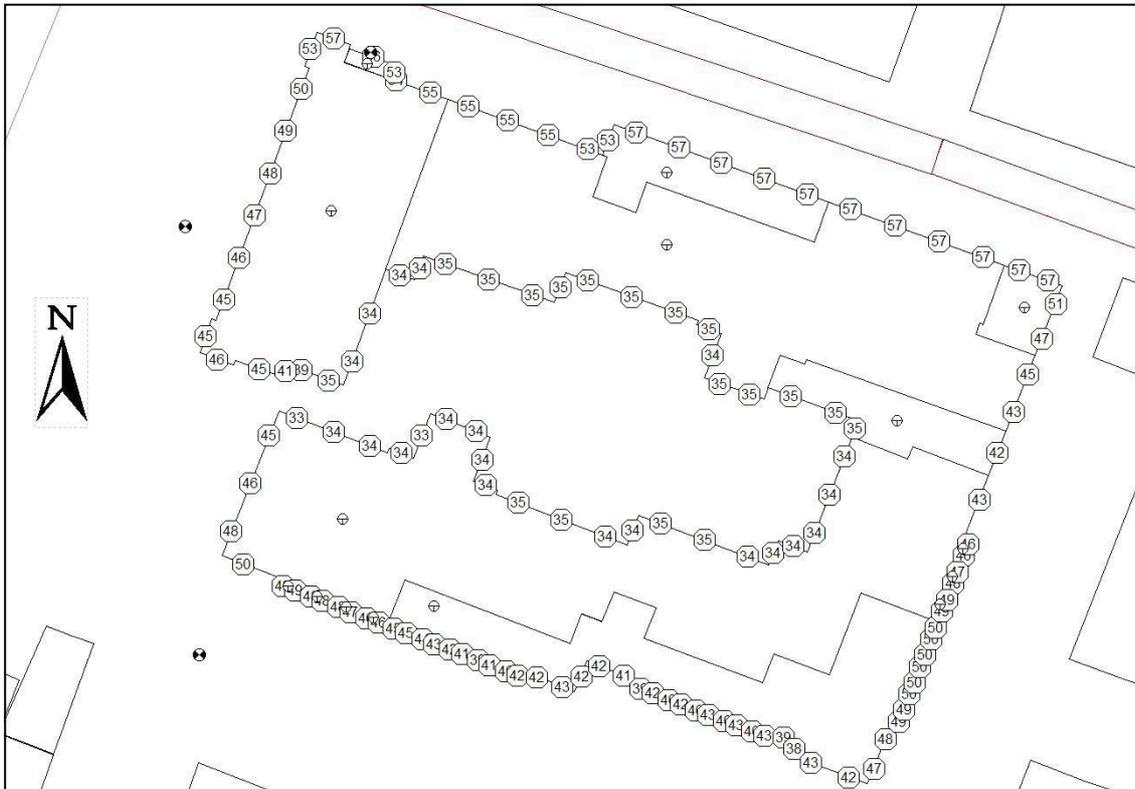
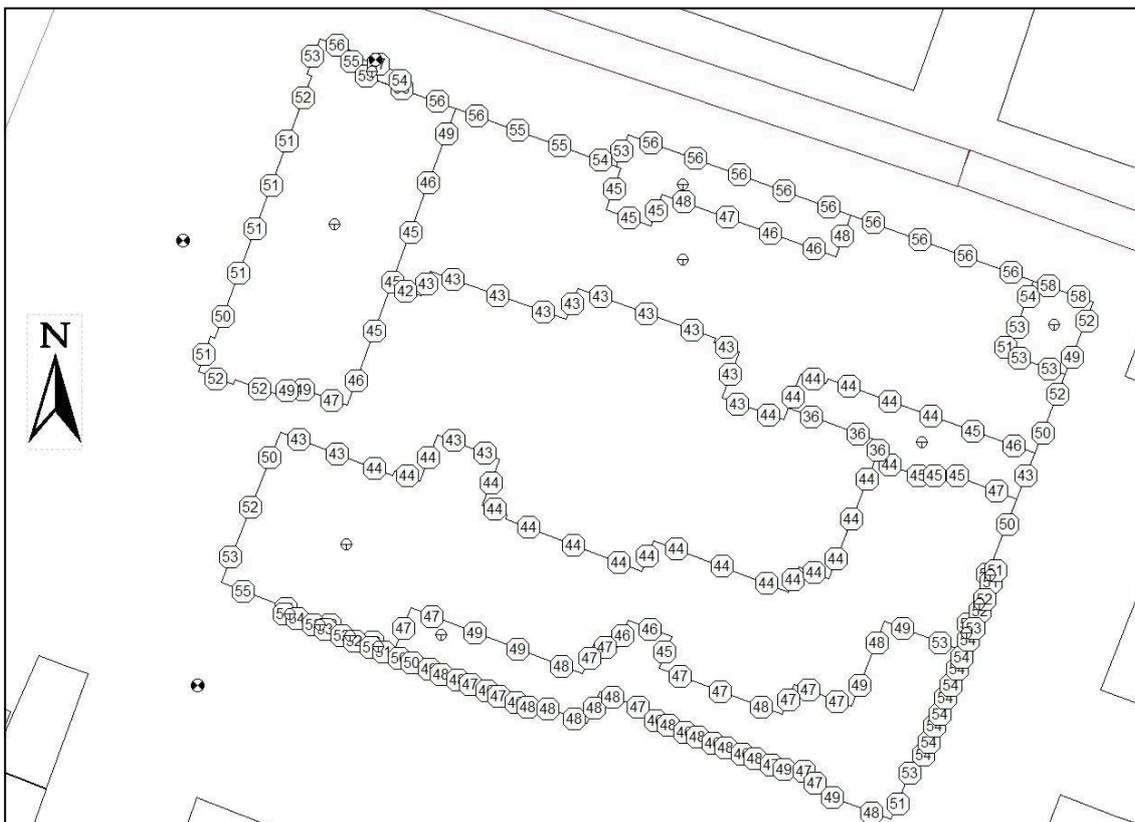


Figure 10: Predicted facade noise levels at top floors (L_{Aeq}) - daytime



MARCUS WORTHINGTON PROPERTIES LIMITED

ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

Figures 11 and 12 show the predicted L_{Aeq} noise levels that will impact along the facades of the proposed building at ground and top floor levels at night.

The elevation overlooking Caledonia Street will experience the highest traffic noise levels at night, reaching up to 53dB L_{Aeq} outside bedroom windows. Windows within upper floors with direct line of sight to Catherine Street and Falkner Street will also be subject to traffic noise levels in the order of 52dB L_{Aeq} . The majority of other locations around the external elevations will experience average night-time noise levels below 50dB L_{Aeq} .

Ambient noise levels within the central courtyard will be low, ranging from 32dB L_{Aeq} at ground floor level to 42dB L_{Aeq} outside upper floor bedrooms.

The highest regular instantaneous noise levels impacting upon the building at night will be in the order of 75dB L_{Amax} along the Caledonia Street elevation as vehicles pass by. Along other external elevations maximum noise levels are expected to be below 70dB L_{Amax} .

6.0 NOISE MITIGATION

Acoustic Design Criteria

BS8233: 1999 'Sound Insulation and Noise Reduction for Buildings' provides appropriate broadband criteria for acceptable intrusive noise levels in dwellings, specifically bedroom and living room areas, due to 'anonymous' noise, such as road traffic. These criteria reflect those presented within guidelines published by the World Health Organisation.

The criteria for internal noise range between 30dB L_{Aeq} to 40dB L_{Aeq} for living rooms during the day (07:00 to 23:00 hours), and 30dB L_{Aeq} to 35dB L_{Aeq} for bedrooms during the night (23:00 to 07:00 hours). The upper limit is deemed to provide 'reasonable' conditions. In addition, the Standard also suggests a single maximum 45dB L_{Amax} criterion for intrusive noise events in bedrooms.

It is therefore recommended that, in order to maintain the amenity of habitable rooms in terms of environmental noise ingress, the following criteria be applied for the development based on the worst case daytime and night-time noise levels predicted by the noise propagation modelling exercise discussed in Section 5 :

Living rooms and study bedrooms during daytime (0700hrs to 2300hrs): average level no higher than 40dB L_{Aeq}

Study bedrooms and studios at night (2300hrs to 0700hrs): average level no higher than 30dB L_{Aeq}
instantaneous levels no higher than 45dB L_{Amax}

Design Recommendations

By taking into account the levels of noise measured at the application site, the modelled propagation of noise across the elevations, the proposed areas of facade elements, the likely acoustic characteristics and the volumes of receiving rooms, the sound reduction required of the most exposed building elevations has been determined.

All noise ingress calculations have been carried out in octave bands (31.5Hz to 4kHz) using the noise spectra shapes measured on site in order to provide a more robust assessment of noise ingress than simply subtracting R_{tra} sound reduction values for glazing from the predicted external noise levels. The calculation method used is as described in section 6.7.2 of BS8233:1999.

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ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

Noise ingress calculations have confirmed that compliance with the target internal noise criteria for habitable rooms can be achieved by fitting standard double glazed units (e.g. two 4mm thick panes with a thermal cavity) within all living room and bedroom windows throughout the development, however all bedrooms within the elevation overlooking Caledonia Street must also be provided with acoustically rated passive ventilators achieving a performance of at least 42dB $D_{n,e,w}$ in the open position, suitable examples of which are given below:

Window mounted: Aereco EHA with acoustic sleeve plus A-EHA external acoustic canopy
DucoMax SR Alto (15mm air gap) from R. W. Simon Ltd.

Through-wall: Passivent Fresh 80dB through wall ventilator
Greenwood Airvac MA3051 Acoustic Airbrick

Alternatively, use of a ventilation strategy that does not rely on passive ventilation openings in the external walls of bedrooms would be acoustically acceptable, for example a 'whole house' supply and extract ventilation system.

It is understood that the proposed method for providing purge ventilation will be to open windows.

The ventilation scheme as approved by others should be verified by Red Acoustics for compliance with the target noise ingress criteria.

The external wall construction has not been finalised. However, in order to avoid compromising the overall sound insulation of the facade, it is initially recommended that the sound reduction index of the external wall construction to habitable spaces should be not less than 50dB R_w . This would be practicable to achieve using an external masonry wall leaf or a lightweight Metsec type construction lined internally with two layers of high density plasterboard. All external wall constructions will be assessed by Red Acoustics during the design stage for compliance with the target noise ingress criteria.

7.0 PLANT NOISE DESIGN CRITERIA

Plant Noise Limits

In order to minimise any increase in the pre-existing background noise level and to avoid any potential disturbance, it is recommended that the total noise level (L_{Aeq}) from any new plant items should ideally not exceed a level equivalent to 10dB below the existing background noise level (L_{A90}) measured at the boundary of the nearest noise sensitive properties. The preferred target is for there to be little or no increase in the existing background noise levels due to fixed plant items.

Table 2 identifies the recommended L_{Aeq} plant noise limits which should be satisfied due to the combined noise output from all proposed new fixed plant items for strict compliance with this criteria. The limits apply to plant noise levels measured 1m from the nearest residential windows.

Table 2: Plant Noise Limits at Nearest Dwellings

	Measured Noise Levels & Target Noise Limits	
	Day Time (07:00-23:00)	Night Time (23:00-07:00)
Location	Target Noise Limit, dB L_{Aeq}	Target Noise Limit, dB L_{Aeq}
North Elevation - Caledonia Street	40	34
East Elevation - Catharine Street	40	30
South Elevation - Falkner Street	32	32
West Elevation	34	32

Plant noise levels should be assessed in accordance with BS4142 and, if applicable, suitable attenuation measures should be specified as plant data become available.

APPENDIX A: NOISE SURVEY DETAILS

Location

Philharmonic Court

Liverpool

Survey Dates

8th August 2012 - Daytime and Night-time

Weather

Daytime Dry, calm, 20°C

Night Time Dry, calm, 17°C

Personnel Present During Measurements

Ian Etchells - Red Acoustics Limited (Daytime and night-time)

Paul Clark - Red Acoustics Limited (Night time only)

Instrumentation

Norsonic Type 118 IEC 60651 Type 1 Integrating-Averaging Sound Level Meter (serial no. 31496)

Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 31040)

Norsonic Type 118 IEC 60651 Type 1 Integrating-Averaging Sound Level Meter (serial no. 30519)

Norsonic Type 1251 IEC 60942-1997 Class 1 Sound Calibrator (serial no. 33007)

Methodology

Before and after the measurements the sound level meters were check calibrated to an accuracy of $\pm 0.3\text{dB}$ using the their associated calibrators. The sound level meters were set at a height of 1.3 metres above ground level. Noise levels were recorded in 10 minute durations.

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ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

Calibration Certificates

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<h2 style="text-align: center;">Calibration Report</h2>		Certificate No.:10241	
Norsonic Type: 118 Serial no: 31496			
Customer:		Red Acoustics Ltd.	
Address:		Suite 3, Cottam Lane Business Centre, Cottam Lane, Preston. PR2 1JR.	
Contact Person:		Simon Webster.	
Instrument software version: V2.0.752			
Microphone :	Norsonic	Type: 1225	Serial no: 52344
Preamplifier	Norsonic	Type: 1205	Serial no: 30540
Calibrator:	Norsonic	Type: 1251	Serial no: 31040
		Sens:-26.26dB	
		Level:113.99dB	
Measured with Preamplifier		Mains adapter was included	
Interface cable was included			
This sound level meter has been calibrated as specified in BS 7580. PART 1: 1997.			
Measurement Results:			
Calibration of sound level meter - BS7580 Clause 5.4			Passed
Noise test - BS 7580 Clause 5.5.2			Passed
Level Linearity Test - BS 7580, Clause 5.5.3			Passed
Frequency weightings: A Network - BS 7580 Clause 5.5.4			Passed
Frequency weightings: C Network - BS 7580 Clause 5.5.4			Passed
Frequency weightings: Z Network - BS 7580 Clause 5.5.4			Passed
Time weightings F and S - BS7580 Clause 5.5.5			Passed
Peak response - BS7580 Clause 5.5.6			Passed
RMS accuracy - BS7580 Clause 5.5.7			Passed
Time weighting I - BS7580 Clause 5.5.8			Passed
Integrating Test : Time averaging - BS7580 Clause 5.5.9			Passed
Integrating Test : Pulse range - BS7580 Clause 5.5.10			Passed
Integrating Test : Sound exposure level - BS7580 Clause 5.5.11			Passed
Overload SPL Test - BS 7580 Clause 5.5.12			Passed
Overload Leq Test - BS 7580 Clause 5.5.12			Passed
Acoustic tests - BS 7580 Clause 5.4 and 5.6			Passed
Summation of acoustic tests - BS 7580 Clause 5.5.4			Passed
The sound level meter in the configuration tested conforms to the requirements of BS 7580 Part 1.			
Comment:			
Correct level with associated calibrator is 113.8dB(A). All results quoted are directly traceable to NPL London.			
Measurement procedure: TP02			
Environmental conditions:			
Pressure:	Temperature:	Relative humidity:	
101.304 kPa	22.9 °C	55.0 %RH	
Date of calibration: 22/11/2011			
Date of issue: 22/11/2011			
Supervisor: Darren Batten Tech IOA Engineer			
			
Michael Tickner			
Software version: 5.2e			
			 Campbell Associates www.campbell-associates.co.uk

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Calibration Report

Certificate No.:10239

Manufacturer: Norsonic
Type: 1251
Serial no: 31040

Customer: Red Acoustics Ltd
Department:
Address: Suite 3, Cottam Lane Business Centre,
 Cottam Lane, Preston. PR2 1JR.
Order No:
Contact Person: Simon Webster.

Measurement Results:

	Level: (dB)	P. Stab : (dB)	Frequency: (Hz)	F. Stab : (%)	Distortion: (% TD)
1:	113.99	0.06	1000.19	0.00	0.43
2:	113.99	0.06	1000.19	0.00	0.43
3:	113.99	0.06	1000.19	0.00	0.43
Result (Average):	113.99	0.06	1000.19	0.00	0.43
Expanded Uncertainty:	0.10	0.02	1.00	0.01	0.10
Degree of Freedom:	>100	>100	>100	>100	>100
Coverage Factor:	2.00	2.00	2.00	2.00	2.00

The stated level is relative to 20µPa.

The following correction factors have been applied during the measurement:
 Pressure:0.0005 dB/kPa Temperature:0.003 dB/°C Relative humidity: None
 Reference microphone: WSM2 - GRAS40AG-28653. Volume correction: -0.015 dB
 Records:K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2011\NOR1251_31040_M1.nmf
 Measurement procedure: CA TP-01 V7.5

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with BS multiplication IS 4702.

Calibrated in 1/2" configuration. Level adjusted from 114.17dB. Results Traceable to NPL London.

Environmental conditions:

Pressure: 101.167 ± 0.004 kPa Temperature: 23.9 ± 1.7 °C Relative humidity: 45.7 ± 4.6 %RH

Date of calibration: 22/11/2011
 Date of issue: 22/11/2011

Supervisor : Darren Batten TechIOA
 Engineer :


 Michael Tickner
 Software version: 5.2a


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Calibration Report		Certificate No.:11437		
Norsonic Type: 118 Serial no: 30519				
Customer:	Red Acoustics Ltd			
Address:	Suite 3, Cottam Lane Business Centre, Cottam Lane, Preston. PR2 1JR.			
Contact Person:	David Gray.			
Instrument software version:	V2.0.752			
Microphone :	GRAS	Type: 40AF	Serial no: 73341	Sens:-26.41dB
Preamplifier	Norsonic	Type: 1206	Serial no: 30338	
Calibrator:	Norsonic	Type: 1251	Serial no: 33007	Level:114.05dB
Wind screen	Norsonic	Type: Nor1451		
Measured with Preamplifier		Mains adapter was included		
Interface cable was included				
This sound level meter has been calibrated as specified in BS 7580. PART 1: 1997.				
Measurement Results:				
Calibration of sound level meter - BS7580 Clause 5.4			Passed	
Noise test - BS 7580 Clause 5.5.2			Passed	
Level Linearity Test - BS 7580, Clause 5.5.3			Passed	
Frequency weightings: A Network - BS 7580 Clause 5.5.4			Passed	
Frequency weightings: C Network - BS 7580 Clause 5.5.4			Passed	
Frequency weightings: Z Network - BS 7580 Clause 5.5.4			Passed	
Time weightings F and S - BS7580 Clause 5.5.5			Passed	
Peak response - BS7580 Clause 5.5.6			Passed	
RMS accuracy - BS7580 Clause 5.5.7			Passed	
Time weighting I - BS7580 Clause 5.5.8			Passed	
Integrating Test : Time averaging - BS7580 Clause 5.5.9			Passed	
Integrating Test : Pulse range - BS7580 Clause 5.5.10			Passed	
Integrating Test : Sound exposure level - BS7580 Clause 5.5.11			Passed	
Overload SPL Test - BS 7580 Clause 5.5.12			Passed	
Overload Leq Test - BS 7580 Clause 5.5.12			Passed	
Acoustic tests - BS 7580 Clause 5.4 and 5.6			Passed	
Summation of acoustic tests - BS 7580 Clause 5.5.4			Passed	
The sound level meter in the configuration tested conforms to the requirements of BS 7580 Part 1.				
Comment:				
Correct level with associated calibrator is 113.8dB(A).				
Measurement procedure: TP02				
Environmental conditions:				
Pressure:	Temperature:	Relative humidity:		
101.079 kPa	23.3 °C	49.0 %RH		
Date of calibration: 13/06/2012				
Date of issue: 13/06/2012				
Supervisor: David Egan - Laboratory Manager. Engineer				
 Michael Ticker.				
Software version: 5.2e		Campbell Associates <small>www.campbell-associates.co.uk</small>		

MARCUS WORTHINGTON PROPERTIES LIMITED

ENVIRONMENTAL NOISE STUDY - R0594-REP01-IE - 5 SEPTEMBER 2012

Calibration Report

Certificate No.:11435

Manufacturer: Norsonic
Type: 1251
Serial no: 33007

Customer: Red Acoustics Ltd
Department:
Address: Suite 3, Cottam Lane Business Centre,
 Cottam Lane, Preston. PR2 1JR.
Order No:
Contact Person: David Gray.

Measurement Results:

	Level: (dB)	P. Slab : (dB)	Frequency: (Hz)	F. Stab : (%)	Distortion: (% TD)
1:	114.05	0.06	1000.46	0.00	0.19
2:	114.05	0.01	1000.46	0.00	0.19
3:	114.05	0.01	1000.46	0.00	0.19
Result (Average):	114.05	0.03	1000.46	0.00	0.19
Expanded Uncertainty:	0.10	0.06	1.00	0.01	0.10
Degree of Freedom:	>100	4	>100	>100	>100
Coverage factor:	2.00	3.31	2.00	2.00	2.00

The stated level is relative to 20µPa.

The following correction factors have been applied during the measurement:
 Pressure:0.0005 dB/kPa Temperature:0.003 dB/°C Relative humidity: None
 Reference microphone: WSMS - B&K4192-2496459. Volume correction: -0.018 dB
 Records:K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2012\NOR1251_33007_M1.nml
 Measurement procedure: TP01 v7.9

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

Results traceable to NPL London.

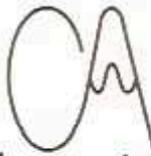
Environmental conditions:

Pressure: 101.056 ± 0.002 kPa Temperature: 23.3 ± 1.1 °C Relative humidity: 54.3 ± 2.5 %RH

Date of calibration: 13/06/2012
 Date of issue: 13/06/2012

Supervisor : Darren Batten TechIOA
 Engineer :


 Michael Tickner
 Software version: 5.2a


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APPENDIX B: SUMMARY RESULTS

Survey Results

Tables B1 and B2 summarise the results obtained from the daytime and night-time noise surveys.

Table B1: Summary of Measured Noise Levels – Daytime

Measurement Location	Start Time	L _{Aeq} dB	L _{AMax} dB	L _{A90} dB	L _{eq} (dB) @ Octave Band Centre Frequency (Hz)						
					63	125	250	500	1k	2k	4k
Position 1	10:45	52.6	66.5	44.9	61.3	55.2	51.0	49.4	48.5	43.6	39.4
	11:53	49.4	62.9	42.1	59.7	52.9	48.3	46.3	45.7	39.7	33.5
	13:05	56.9	70.4	49.4	62.9	59.0	55.2	53.8	53.3	46.9	44.0
	14:04	56.0	71.9	50.6	63.1	60.2	56.2	53.0	51.3	47.1	41.5
Position 2	10:57	49.4	64.8	44.4	64.2	53.5	52.2	45.4	43.5	40.3	34.8
	12:08	48.9	58.6	45.8	61.3	55.2	50.0	44.8	43.9	40.2	34.7
	13:20	53.2	66.8	50.9	62.3	58.3	53.2	47.8	47.9	45.6	41.6
Position 3	11:10	57.5	74.6	50.8	64.5	58.6	56.5	54.4	53.4	48.6	44.1
	11:20	55.5	68.7	49.5	63.4	56.2	53.6	52.6	51.4	47.2	41.0
	12:21	56.2	68.4	51.5	64.5	58.7	55.7	53.3	51.9	47.2	41.1
	13:32	56.2	74.3	51.7	64.8	57.3	55.7	52.3	51.9	47.6	43.5
	14:20	55.9	74.3	51.6	64.3	56.9	55.3	52.2	51.5	47.5	42.9
Position 4	11:36	65.6	80.3	52.3	71.3	63.5	63.0	62.0	62.2	57.3	50.3
	12:37	66.6	83.0	50.0	70.9	65.1	66.9	63.8	62.6	56.9	50.2
	12:47	66.9	77.1	52.7	73.5	64.8	64.8	63.4	63.6	58.0	50.6
	13:49	66.0	79.5	50.8	71.8	65.3	62.8	62.2	62.7	57.7	50.7

Table B2: Summary of Measured Noise Levels – Night

Measurement Location	Start Time	L _{Aeq} dB	L _{AMax} dB	L _{A90} dB	L _{eq} (dB) @ Octave Band Centre Frequency (Hz)						
					63	125	250	500	1k	2k	4k
Position 1	22:55	54.9	72.4	50.1	60.0	54.6	50.4	50.9	50.8	46.8	44.7
	23:23	55.3	72.3	44.3	60.6	53.9	50.9	52.6	51.9	46.3	39.8
	23:48	54.9	65.6	52.5	63.6	55.1	51.3	51.4	50.0	46.8	45.7
	00:17	52.2	68.4	42.0	56.7	53.0	48.8	48.0	48.1	43.5	42.7
	00:27	53.1	65.7	51.8	57.0	51.7	48.7	48.9	47.0	46.0	45.5
Position 2	22:56	48.1	58.4	42.6	60.1	54.4	48.6	44.1	43.6	38.8	33.7
	23:28	45.2	53.2	42.5	57.1	51.2	45.9	41.4	41.1	35.4	28.7
	23:55	47.2	56.3	42.8	57.6	52.2	46.3	41.7	43.0	39.4	32.6
	00:20	46.2	54.9	42.4	56.2	52.2	46.6	42.0	42.3	36.6	30.3
Position 3	23:10	51.4	62.1	43.9	58.7	51.3	49.7	47.9	47.9	42.6	35.7
	23:35	52.5	74.5	44.4	62.2	54.3	52.9	48.7	47.8	44.0	39.2
	00:04	51.1	63.8	43.6	62.1	53.7	51.7	47.5	47.0	41.6	35.2
	00:40	50.0	60.6	44.0	57.3	51.2	49.8	47.1	46.1	40.7	34.2
	00:50	55.0	69.4	47.1	62.3	55.2	53.1	53.5	50.0	45.9	40.0
Position 4	23:14	63.9	78.4	43.8	69.5	62.1	60.6	59.7	60.6	56.0	49.2
	23:42	62.1	76.3	39.7	65.2	59.4	59.0	57.7	59.4	53.4	45.6
	00:08	61.9	77.8	42.2	66.8	59.5	58.0	57.7	58.9	53.6	46.3
	00:35	65.4	78.5	48.2	71.2	63.8	60.8	61.3	62.2	57.1	51.8
	00:45	63.1	73.7	47.9	67.0	60.1	58.2	58.1	60.6	54.9	46.4