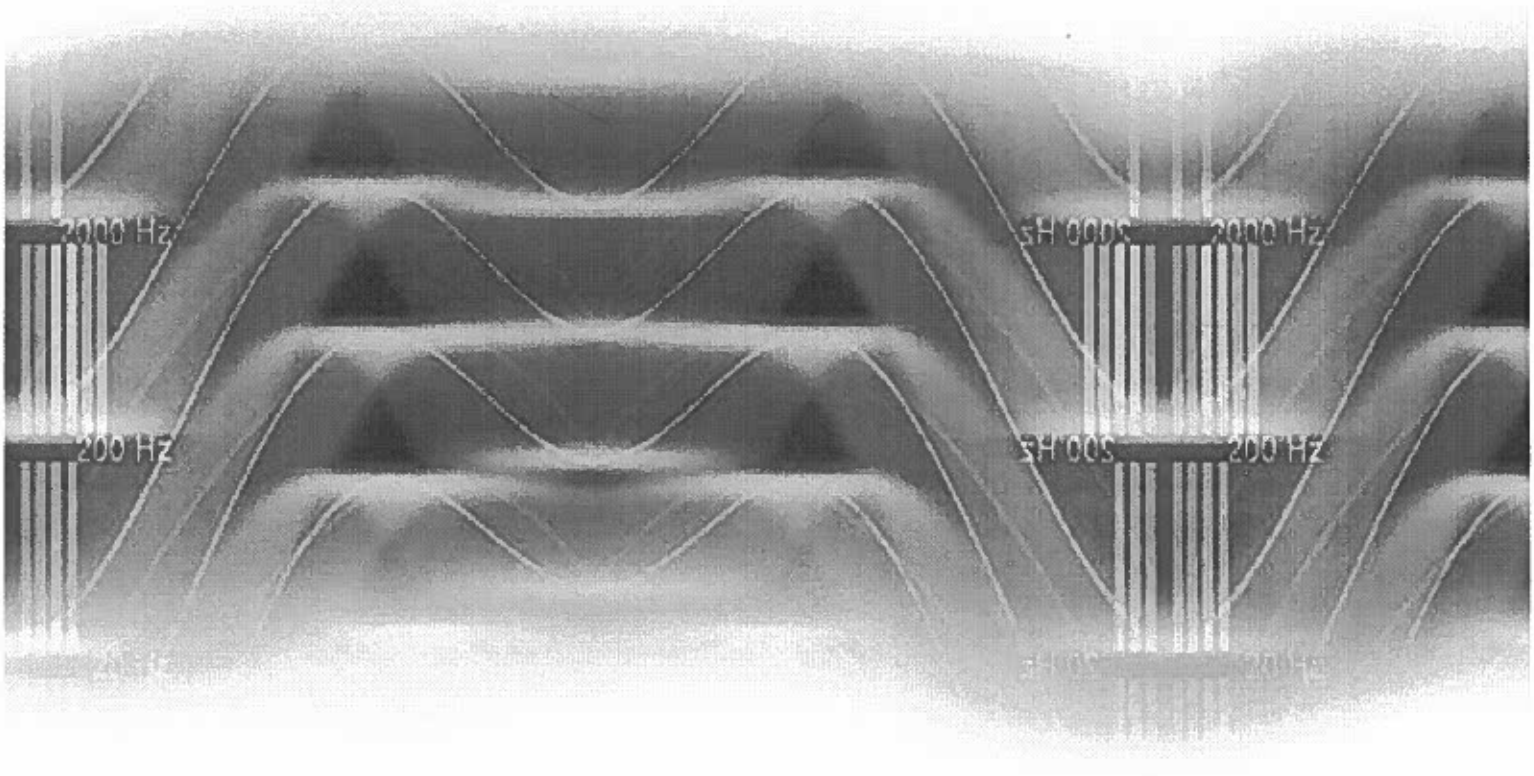
Planning Noise Report for Proposed Courtyard Area Mount Pleasant, Camden

Report ref.
JW551/12162

Date
November 2012

Issued to
Willmott Dixon Housing Limited



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ACOUSTIC CONSULTANTS

1. SUMMARY

- Willmott Dixon Housing Limited are refurbishing an existing hostel building at Mount Pleasant, Camden. As part of this development, the proposals include alterations to the main courtyard area. The proposed alterations include significant layout changes and landscaping.
- As part of the planning approval process, Camden Council require an acoustic report to be prepared, to protect the occupiers of the nearest dwellings from disturbance.
- An ambient noise survey has been carried out over a continuous 24-hour period to determine existing background noise levels in the area. Average noise levels in the daytime were $L_{Aeq, 16hr}$ 60 dB. Background noise levels during the same period were $L_{A90, 16hr}$ 52 dB. The minimum background noise level ($L_{A90,15\ min}$) was 49 dB, measured at 22:21.
- This report describes the analysis carried out in determining the acoustic properties of the courtyard area; including reverberation times, predicted noise levels and the resultant sound pressure levels outside residences for assessment purposes.
- There are no specific criteria available that specify acceptable noise levels from private residential courtyards. Therefore, guidelines are proposed to protect the amenity of nearby residences, referring to British Standards for guidance.
- During normal use, noise from within the courtyard is predicted to meet the proposed guideline criteria for both relative and absolute noise levels. Predictions show that these guidelines can potentially be exceeded during the busiest times, but this would only rarely occur.
- A number of conservative assumptions are included within the analysis that ensure that 'worst case' conditions have been considered. In general, these conditions would not occur together, giving some comfort that the actual noise impact will be below that considered here.
- Accordingly, it is advised that the design and landscaping of the proposed courtyard will not give rise to unacceptable levels of noise for nearby residents.

2. INTRODUCTION

Willmott Dixon Housing Limited are refurbishing an existing hostel at Mount Pleasant, in the London Borough of Camden. The development includes alterations to the central courtyard area, including layout and landscaping changes. It is a requirement of the Local Planning Authority's consent that a noise report be submitted to comply with planning conditions attached to the permission for the development.

Accordingly, Spectrum Acoustic Consultants have been appointed by Willmott Dixon to conduct the relevant analyses and provide the necessary technical input required as part of the relevant planning condition.

3. SITE DESCRIPTION AND PROPOSALS

3.1 GENERAL DESCRIPTION OF THE DEVELOPMENT AND AREA

The existing hostel building is located at 52-54 Mount Pleasant, Camden, just off Grays Inn Road. There are residential buildings on the opposite side of the road to the South and East, and immediately adjoining the West boundary of the site.

The existing building is a rotated 'H' shape, having 2 central courtyards – one to the east and one to the west. The east courtyard is overlooked by residential buildings across the road, although a brick wall on the Mount Pleasant site boundary screens the courtyard from view from lower level residences. The courtyard to the west is directly overlooked by adjoining residences within Tiverton Mansions.

The proposals include the removal of the central block and the construction of infill blocks to the far east and far west of the site, thus creating a single, fully-enclosed central courtyard. The refurbished hostel will have 50 bedrooms in total. Existing site layout plans are given in Appendix A. The proposed site layout plans are given in Appendix B.

The long-term ambient noise climate at the site is controlled at all times by road traffic noise on surrounding roads. At night, the road traffic volume decreases, with a corresponding reduction in noise levels, although road traffic noise remains a significant characteristic of the environment at all times.

3.2 COURTYARD PROPOSALS

As described above the proposed courtyard will be enclosed on all sides. The construction of infill developments at either end of the site will provide acoustic screening to the overlooking residences to the east and west, and also increase the distance between these residences and the courtyard when compared to the existing situation. For Tiverton Mansions to the west, the screening effect will be greater for the lower residential windows where certain areas of the courtyard will become completely screened.

The landscaping proposals include a granite effect concrete cobble surface, and the use of several low level trees in tree pits, planters and benches.

The proposed landscaping drawing for the courtyard is given in Appendix C.

3.3 NOISE SENSITIVE RECEPTORS

Currently, the closest noise sensitive receptors are the residential windows at the rear of Tiverton Mansions, which directly overlook the adjoining courtyard. The proposed plans mean that the courtyard will be screened from most residential windows. However, the upper windows will still have a direct line of sight to the new courtyard. Nevertheless, all of these windows will have a greater distance between them and the courtyard following the proposed alterations.

The residential windows of Tiverton Mansions are highlighted on the proposed drawings given in Appendix B.

4. REQUIREMENTS AND NOISE STANDARDS

4.1 PLANNING REQUIREMENTS

This development was approved under London Borough of Camden's permission 2011/6016/P. The consent included 3 conditions relating to noise; two of which relate to mechanical plant noise and one which refers to the control of noise in open areas. A report on the issue of mechanical plant noise has been prepared as a separate document (JW527/12162). This report considers the requirements of Condition 6, which states:

6. *No development shall take place until full details of hard and soft landscaping and means of enclosure of all un-built, open areas, including the acoustic properties of these materials, have been submitted to and approved by the Council. The relevant part of the works shall not be carried out otherwise than in accordance with the details thus approved.*

4.2 GUIDELINES FOR ACCEPTABILITY

There is no specific guidance in British Standards or Planning Legislation that sets out amenity tests for noise breakout from a courtyard. Therefore an approach is proposed that seeks to protect amenity of the nearby noise sensitive receptors, referring to British Standards for guidance.

There are two general approaches to noise guidelines. The first is to compare the noise generated within the courtyard relative to the existing noise environment. This approach would adopt an assessment method similar to BS4142:1997 'Method for rating industrial noise affecting mixed residential and industrial areas'. Using this approach Spectrum consider that, provided the level of noise breakout from the courtyard is no more than 5 dB above the background L_{A90} then this is a marginal condition regarding the likelihood of complaints. This is in line with the guidance given in BS4142.

The second criterion is to consider absolute noise levels, like those set out in BS8233:1999 and World Health Organisation (WHO) documents. Section 7.6 of BS8233:1999 states that it is desirable for external noise levels at residential properties not to exceed L_{Aeq} 50 dB and that L_{Aeq} 55 dB should be regarded as the upper limit.

It should be noted that neither of these criteria strictly apply, and that they should be used only to provide an indication of the acceptability of noise impact from the courtyard.

5. BACKGROUND NOISE SURVEY

5.1 DATE, LOCATION AND EQUIPMENT

Ambient noise measurements were carried out during a site survey between 26 and 28 September 2012, consisting of automatic unattended noise measurements at a position representative of ambient noise levels in the area. This measurement location is shown in Appendix B.

Whilst the measurement location does not provide the exact noise levels incident upon the residential windows to the rear of Tiverton Mansions, the noise levels measured are representative and provide a good indication of the local ambient noise environment.

The following equipment was used during the survey:

- Bruel & Kjaer Type 2260 Sound Level Meter s/n 1772229
- Bruel & Kjaer Type 4189 Microphone s/n 2199530
- Bruel & Kjaer Type 4231 Acoustic Calibrator s/n 2229957
- Bruel & Kjaer Type UA 1404 Outdoor microphone attachment
- Bruel & Kjaer Type AO 0441 10m microphone extension cable

Before and after the survey, the sound level meter was field-calibrated in accordance with the manufacturer's guidelines. Drift was less than 0.2 dB and therefore acceptable. The meter, microphone and field calibrator is laboratory calibrated biennially in accordance with UKAS procedures or to traceable National Standards.

5.2 RESULTS

Measurements have been summarised into contiguous 5 minute periods to present the noise profile throughout the monitoring period. Noise metrics consisted of equivalent continuous (L_{Aeq}) noise levels and maximum (L_{Amax}) noise levels as well as statistical noise levels (termed Ln, where n is the percentage of time the level is exceeded during the measurement period) including L_{A90} levels (the noise level exceeded for 90% of the individual measurement period) which is taken to be the background noise level. Overall A-weighted measurements were stored for later analysis.

The results of the measurements are shown graphically in Appendix D.

The measured daytime noise level (07:00-23:00) was $L_{Aeq,\ 16hr}$ 60 dB. The background noise level over the same period was $L_{A90,\ 16hr}$ 52 dB.

The above results correspond to the periods of normal courtyard use. During this time, the lowest measured background noise level was $L_{A90,\ 15min}$ 49 dB, measured at 22:21 am on 26 September 2012. This value will be used as a 'worst case' in determining the noise impact at nearby noise-sensitive receptors.

6. PREDICTED NOISE LEVELS

6.1 DESCRIPTION OF CALCULATIONS AND MODELLING

As the courtyard is enclosed on all sides other than from above, it is a potentially reverberant space. Noise generated within the courtyard will propagate to noise sensitive receptors via a large number of different paths, both directional and reflected. Only those windows overlooking the courtyard will receive direct sound, however reflections and diffraction caused by the various building surfaces will contribute to the incident noise level at each residential facade.

Due to the complexity of the courtyard layout, calculations of noise propagation were undertaken using computer modelling software to calculate the reverberant sound pressure and incident noise level at the residential facades of Tiverton Mansions.

Calculations of reverberation time were undertaken using the numerical modelling software, 'Odeon'. Odeon is a tool for room acoustic design and analysis. It is used for the design of performance spaces like theatres, concert halls and opera halls. It uses 3 dimensional data about the space (geometry, size, orientation, room finishes, etc.) to calculate various acoustic parameters including reverberation time. In order to simulate an open courtyard, a fully absorptive roof was used in the model.

Standard noise calculation algorithms have been used carrying out this analysis, including:

- Odeon's combined ray-tracing formulae which determine reverberant noise levels.
- Distance attenuation from the noise sources (geometric spreading).
- Sound power to sound pressure conversion.

The client has advised on how the courtyard space will typically be used, and two scenarios have been considered. The first represents normal to busy use of the courtyard, and assumes the space is occupied by several people talking simultaneously in normal voices. The second scenario is a 'worst case' representative of the busiest use of the courtyard, and assumes the same people are all talking in raised voices.

Input data for different speech conditions has been taken from the '*Handbook of Noise Control*', *C. M. Harris, 2nd edition.*

Table 1 below shows the acoustic properties of the materials used in the model:

Surface Material	Absorption Coefficient, α Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Ground: granite effect concrete cobble	0.180	0.180	0.220	0.155	0.145	0.195	0.125	0.125
Walls: unglazed brick	0.030	0.030	0.030	0.030	0.040	0.000	0.070	0.070
Stairs and recesses: rough concrete	0.020	0.020	0.030	0.030	0.030	0.040	0.070	0.070
Tiverton mansions pitched roof: lead lined	0.040	0.040	0.040	0.070	0.060	0.060	0.070	0.070
Windows: standard double glazing	0.150	0.150	0.050	0.030	0.030	0.020	0.020	0.020

Table 1: Absorption coefficients of surface materials used in model. *Spectrum materials library.*

A visualisation of the Odeon model and model output is shown in Appendix E.

6.2 RESULTS

Calculations of courtyard noise breakout following the method described above show that the predicted noise levels at the most affected windows of Tiverton Mansions would be LAeq 49-53 dB, during normal use. At more distant or shielded locations, this noise level will be lower.

Using this noise level, together with the assumption that it is remains constant, provides a conservative assumption, which tends to overestimate the impact of noise at the nearest residence. In our experience, such noise levels are occasional and temporary, rather than continuous.

For the 'worst case' scenario described above, predicted noise levels are LAeq 57-61 dB.

These results are shown in the model output given in Appendix E.

7. ASSESSMENT

To assess the impact of the proposed courtyard on the surrounding noise sensitive properties the predicted noise levels have been compared with the measured background and ambient noise levels, and also absolute levels set out in Section 4.2.

As there are no widely agreed criteria, the 'acceptability tests' set out in Section 4.2 are guidelines only, and are used below to provide an indication of the acceptability of noise impact at nearby residences.

Noise from within the proposed courtyard has been predicted to be 49-53 dB(A) at the overlooking windows of Tiverton Mansions, during normal use of the courtyard.

In terms of absolute levels, this is within the recommended upper limit of LAeq 55 dB given in BS8233:1999. When looking at the noise level relative to background, the predicted level is also within the recommended guideline of no more than 5 dB above the minimum measured background noise level.

Results are also provided in Section 6 for a 'worst case' scenario, where the people in the courtyard are talking with raised voices simultaneously. In this instance the guideline criteria are exceeded. Even so, the predicted noise levels of 57-61 dB are similar to the measured average daytime noise level of LAeq, 16hr 60 dB. Therefore, whilst this level of noise from the courtyard will be audible at the residences, it will be no noisier than the existing ambient noise levels in the area. This is regarded as a true worst case and not a fair representation of normal use. Given that this would occur only rarely, it is considered to be an acceptably low impact on amenity.

The above assessments assume that there are several people in the courtyard, all talking at once, at a time when the background noise level is at its lowest. It is unlikely that these two situations would regularly coincide. Accordingly, the level of noise breakout from the courtyard will typically be lower than predicted, with a resultant reduction in the likelihood of disturbance. It is my view that this is an acceptably low noise impact.

8. DISCUSSION

The above analysis and results shown in Appendix E indicate that acceptable noise conditions will be achieved at this development for the great majority of the time.

It must be borne in mind that, in carrying out this assessment, a number of conservative assumptions about noise emission from the courtyard room have been included. These are:

- Noise generated in the courtyard is modelled as occurring continuously at the predicted levels whereas such noise levels due to speech are occasional and temporary.
- The predicted noise levels have been compared with the lowest L_{A90} noise levels, i.e. those that occur early in the morning or late at night when activity in the surrounding area is low. Therefore, the noisiest courtyard activity and the quietest ambient condition are compared. During the rest of the time ambient noise levels are higher and the impact will be less.
- The assessment is based on external noise levels, not internal levels. Noise levels inside residences, where people could be disturbed, will be much lower due to the sound insulation of the building envelope.
- The landscape drawing given in Appendix C shows that planters, trees and benches have been used where possible, which have not been included in the simulations. These items will provide additional absorption and diffusion which will result in a reduced level of noise at the residences.
- All noise sources modelled are omnidirectional. The drawings indicate that the positioning and orientation of benches will be such that will encourage occupants of the courtyard not to face the nearest residential windows. In addition, the closest bench to the assessment location is well screened and facing away from the residences. Directivity effects will reduce noise levels.

However, even taking these conservative assumptions into account the guideline criteria are met, and noise from the proposed courtyard is deemed to be acceptable for the majority of the time.

In comparison to the existing courtyard(s), the proposed design is a larger space; therefore reverberant sound will be reduced due to increased attenuation with distance. Diffraction within the courtyard is also improved by the proposed irregular shape. For residential buildings to the east and west, the distance to the courtyard will increase due to the infill buildings.

9. CONCLUSION

Willmott Dixon Housing Limited are refurbishing an existing hostel development at Mount Pleasant, in the London Borough of Camden. The development includes considerable alterations to the central courtyard area.

A planning condition within Camden Council's permission for the development includes the approval of acoustic properties of the courtyard, in order to demonstrate that the control of noise within this space has been given thorough consideration.

There are no specific criteria available for assessing amenity based on noise generated within a courtyard. An approach has been proposed, referring to British Standards for guidance. A survey was carried out to determine the ambient background noise levels in the area.

Comparison of the noise levels predicted within the courtyard with the relevant background noise level shows that noise generated within the courtyard meets the recommended guideline criteria, and is also within the guideline upper limit, under normal operation.

The assessment shows that there are potentially times where the recommended guideline criteria are not met, however during this time the predicted noise levels from the courtyard are not noticeably higher than the existing average ambient noise levels in the area. Also, this is a true worst case and is rarely likely to occur.

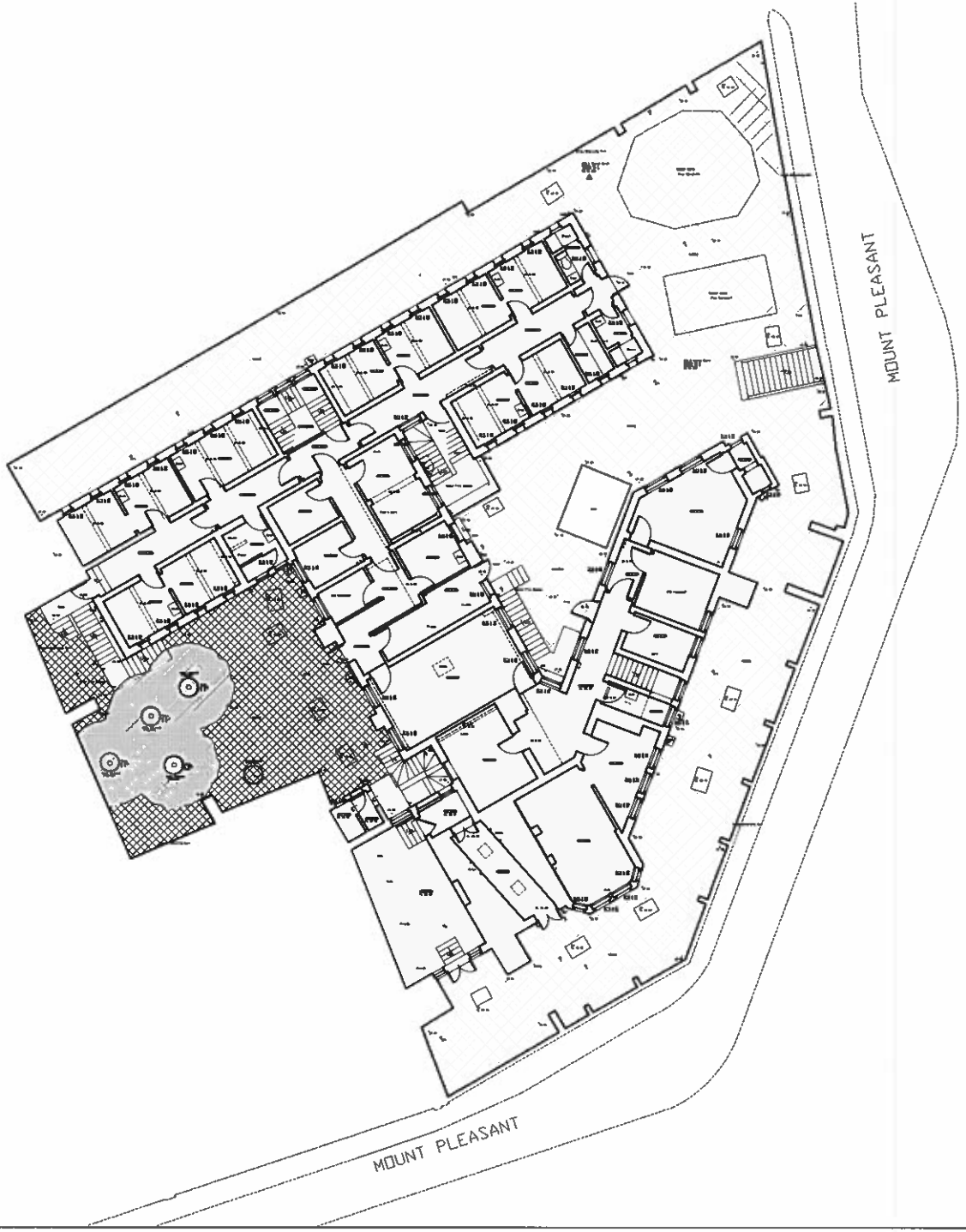
Specific features have been incorporated into the design in order to provide additional acoustic absorption and diffraction within the courtyard in the form of trees, planters, benches and balconies.

Accordingly, the noise impact associated with the proposed development will be in accordance with the requirements of the planning permission and, in my view, will not result in any significant or unreasonable loss of amenity to nearby residences.

Report Code: E/PRA/EH

APPENDIX A

Existing site layout plans



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CLIENT London Borough of Camden

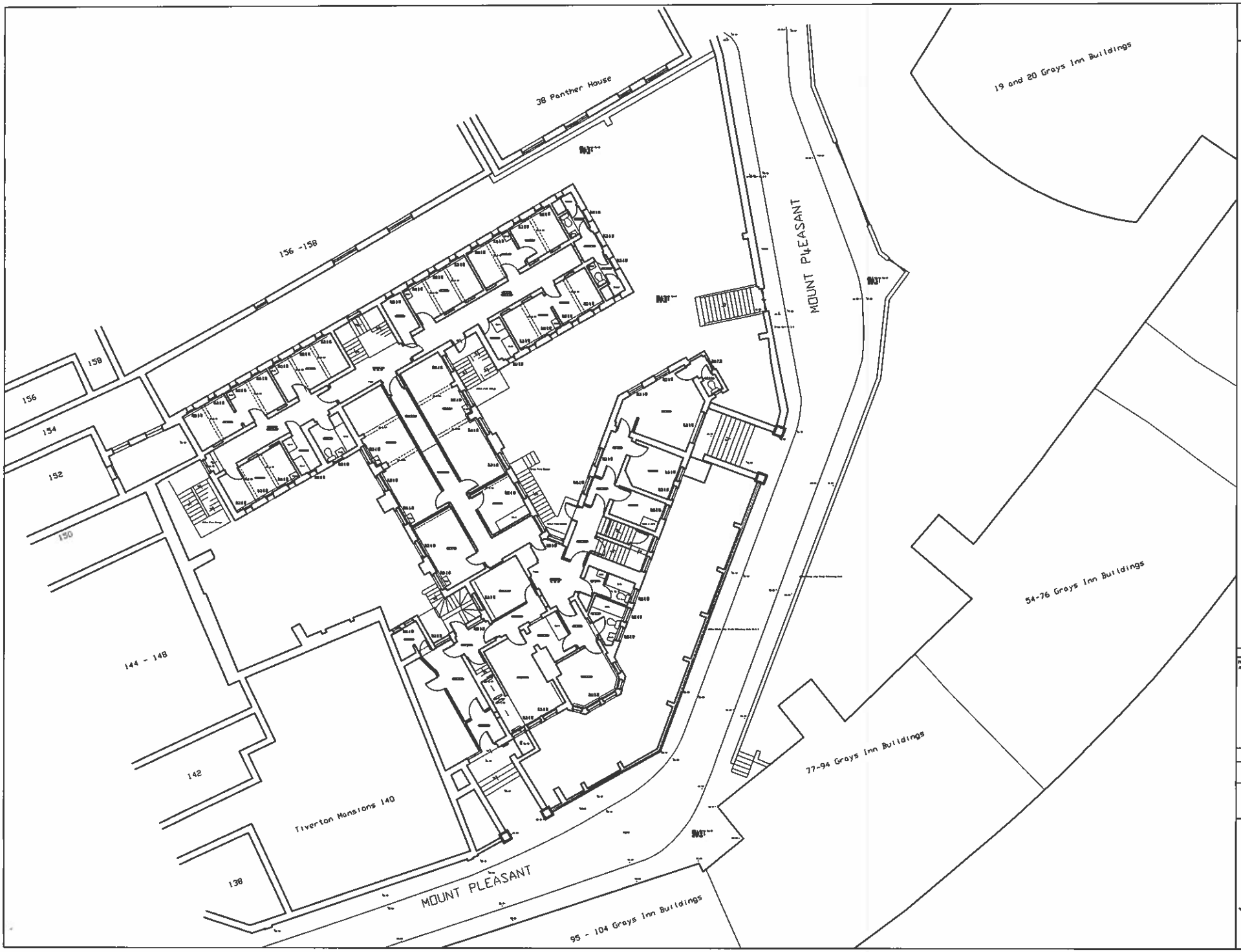
SCALE 1/100 @ A1 DATE 10 11

DRAWN JB CHECKED PB

ISSUED FOR PLANNING

EXISTING LOWER GROUND FLOOR PLAN

DRAWING NO 099_L_01X REV A



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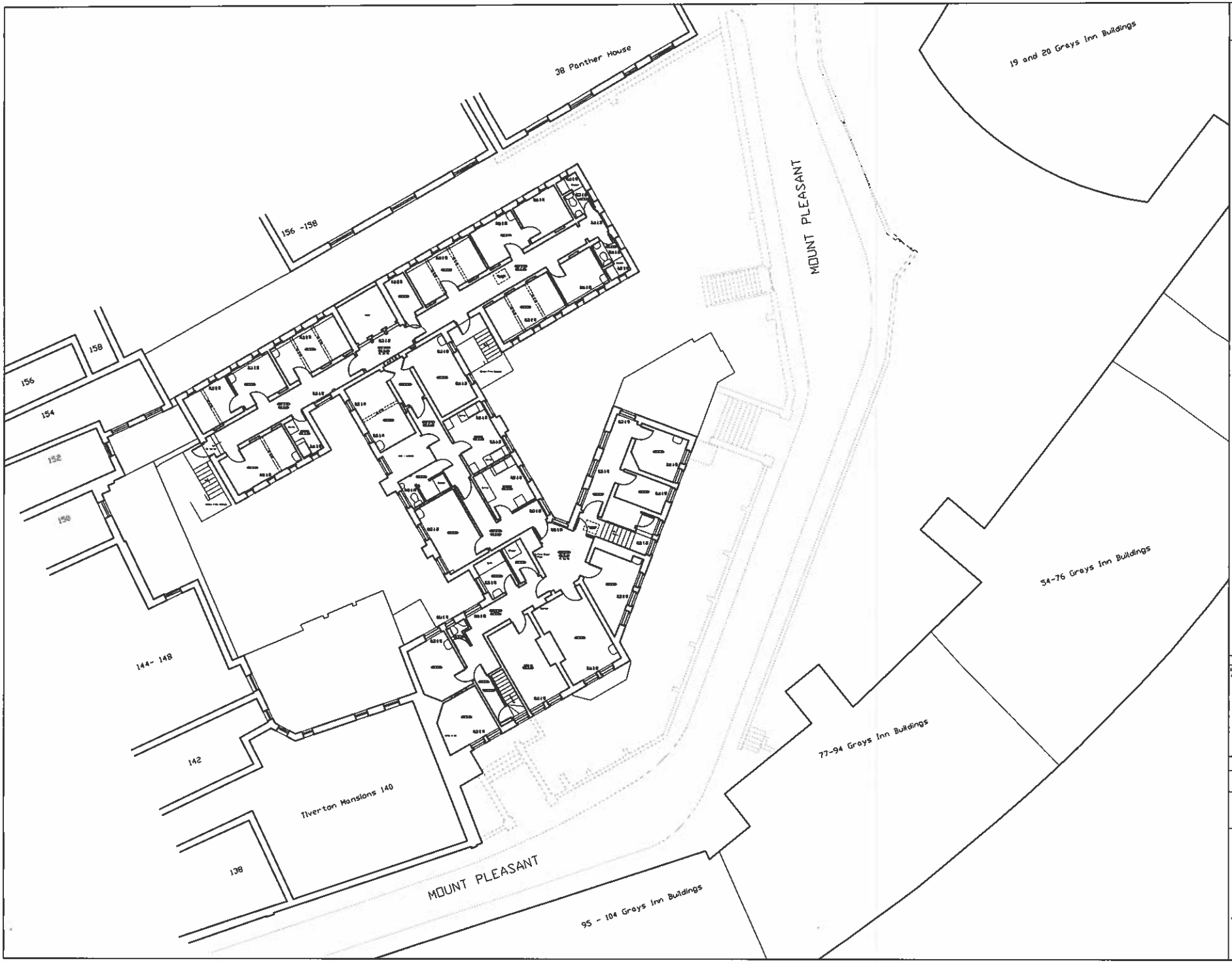
scale 1/100 @ A1 date 10 11

drawn JD checked PB

ISSUED FOR PLANNING

EXISTING UPPER GROUND FLOOR PLAN

drawing no 099_L_02X rev A



REVISIONS:
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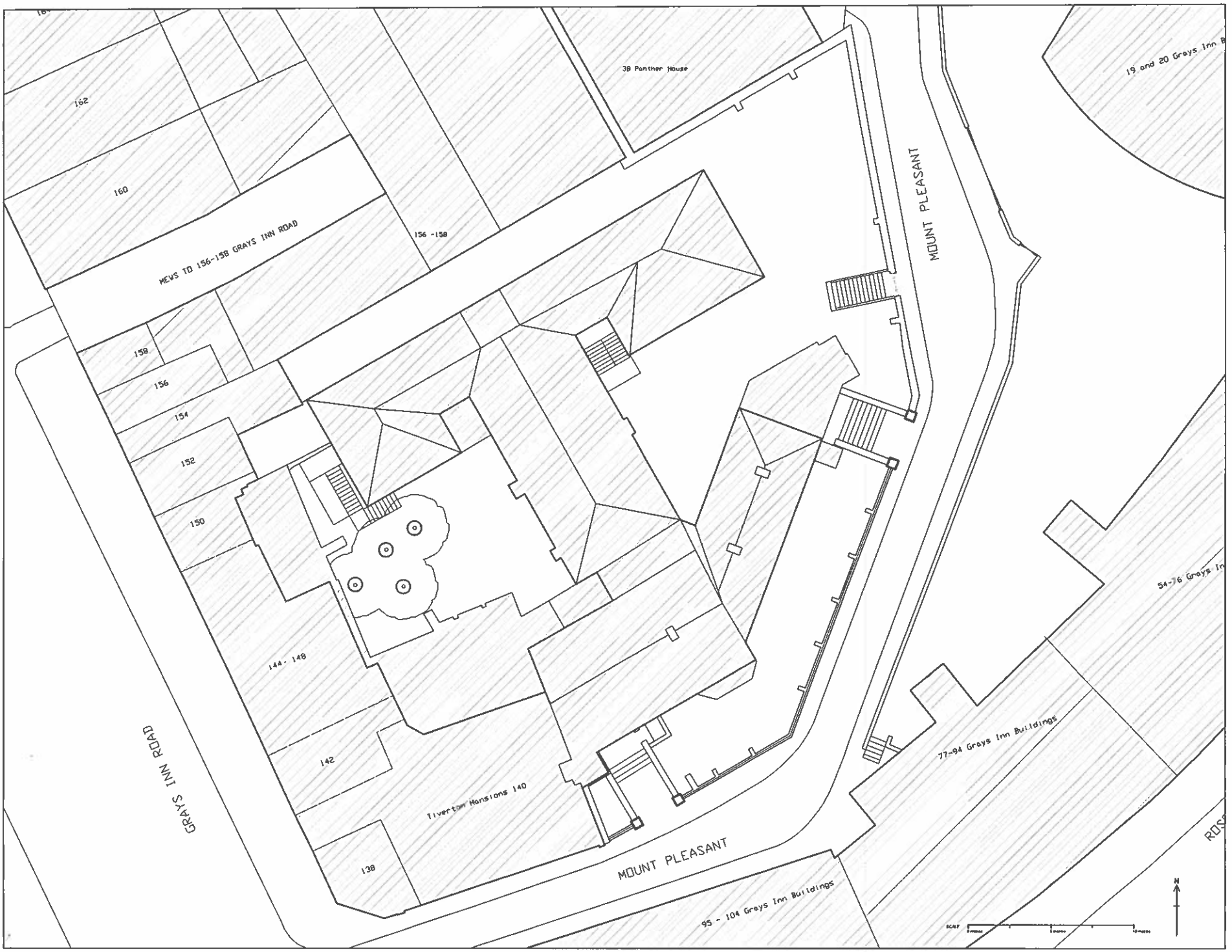
scale 1:100 @ A1 date 16 11
drawn JP checked PB

ISSUED FOR PLANNING

EXISTING FIRST FLOOR PLAN

drawing no. 099_L_03X rev. A



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ISSUED FOR PLANNING

EXISTING SITE PLAN

099_P_01X A

APPENDIX B

Proposed site layout plans and elevations

REVISIONS:
A 02.10.11 FOR FINAL CLIENT SIGN-OFF
B 20.10.11 DRAFT PLANNING SUBMISSION
C 02.11.11 FOR INFORMATION
D 10.11.11 FOR PLANNING
F 21.06.12 WEST BLOCK AMENDED
F 24.08.12 WEST BLOCK REVISED
G 13.09.12 REISSUED FOR PLANNING
H 08.11.12 building height amended

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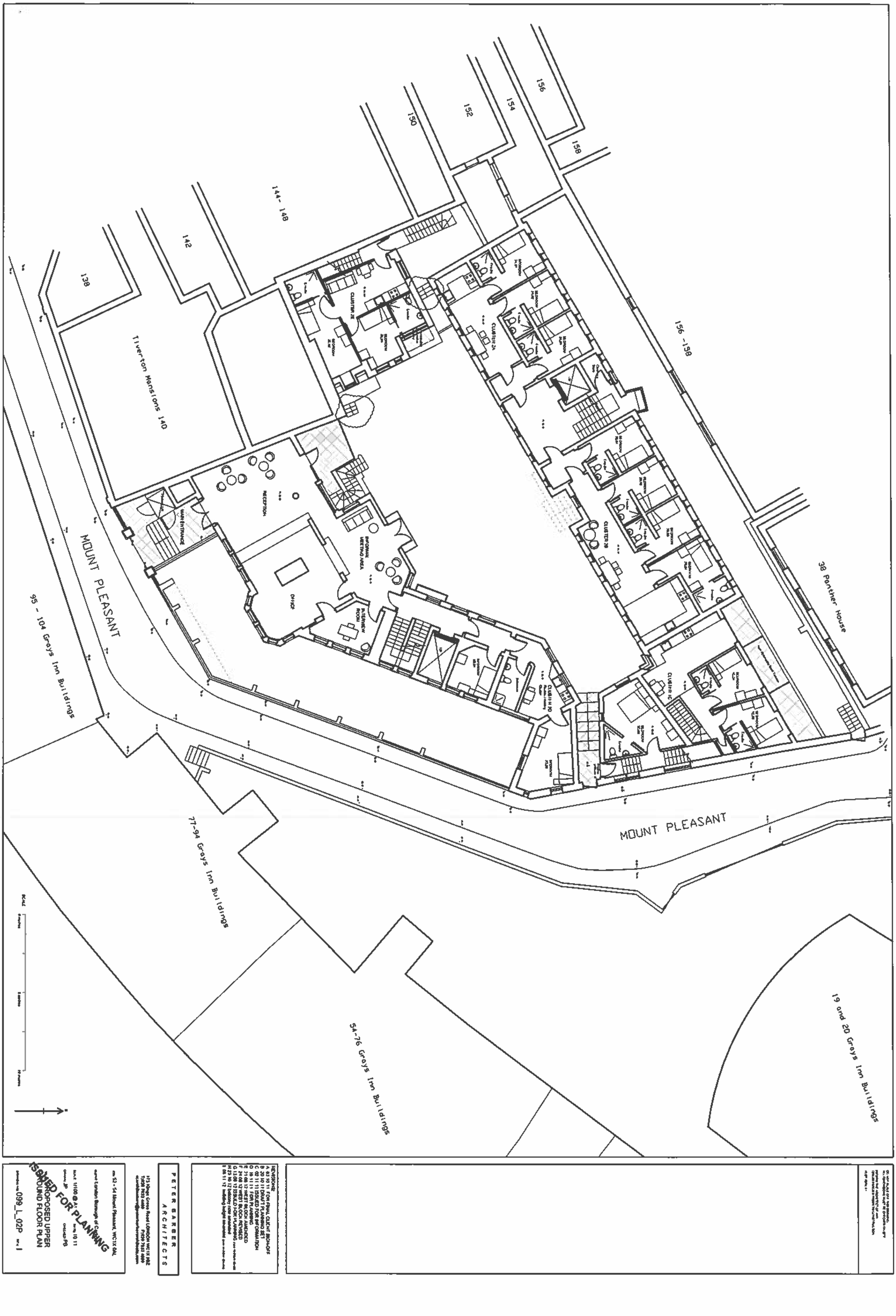
ISSUED FOR PLANNING

PROPOSED LOWER GROUND FLOOR PLAN

drawing no. 099_L_01P rev. H


138
142
144-148
150
152
154
156
158
Tiverton Mansions 140
156-158
38 Panther House
MOUNT PLEASANT
95 - 104 Grays Inn Buildings
MOUNT PLEASANT
77-94 Grays Inn Buildings
54-76 Grays Inn Buildings
19 and 20 Grays Inn Buildings
RECEPTION
MAIN ENTRANCE
INFORMAL MEETING AREA
OFFICE
INTERVIEW ROOM
CLUSTER 2A
CLUSTER 2B
CLUSTER 2C
CLUSTER 2D
CLUSTER 2E
REVISIONS
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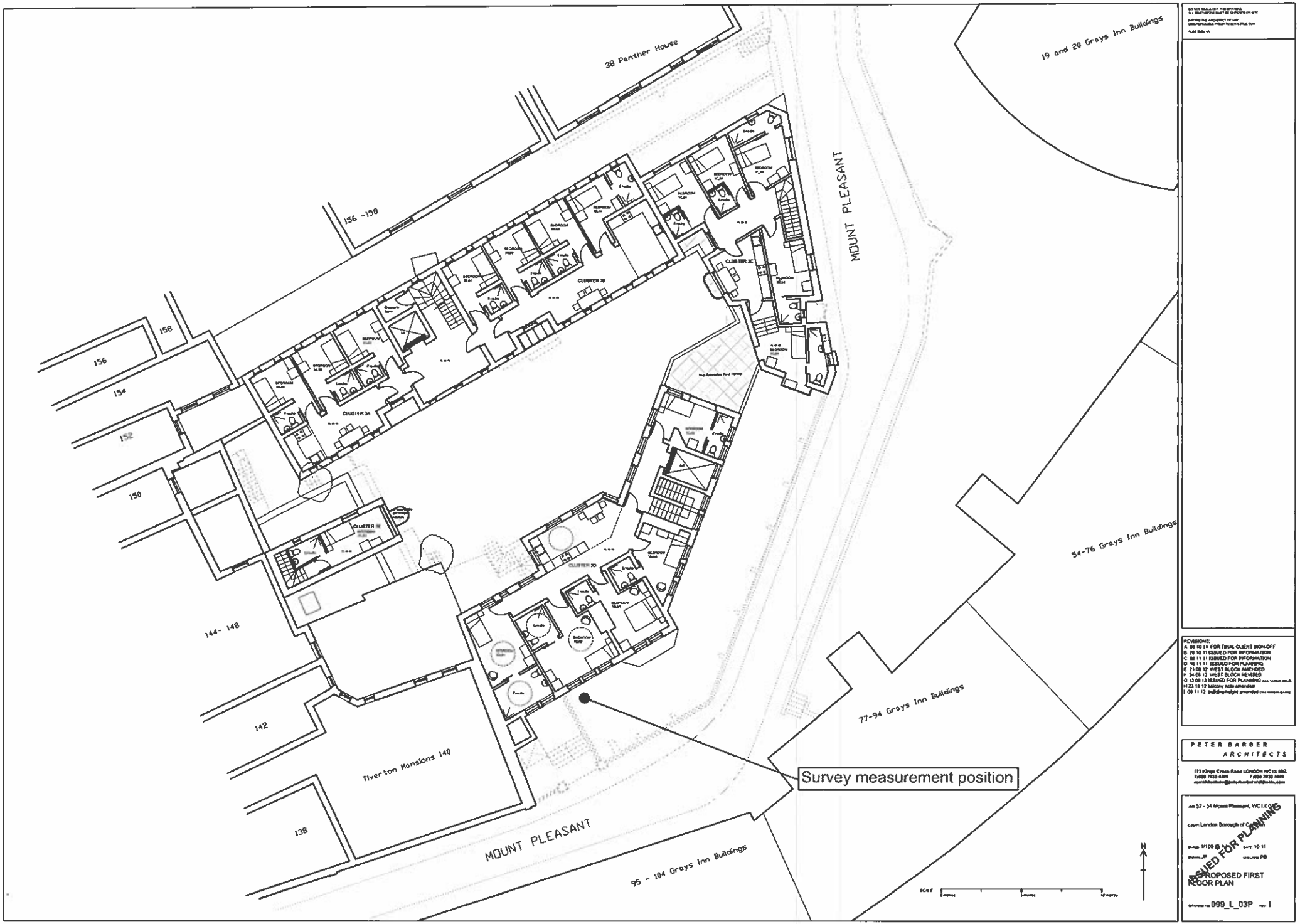
London Borough of Camden
scale 1/100 @ A1
drawn JP
date 10 11
checked PB
ISSUED FOR PLANNING
PROPOSED UPPER GROUND FLOOR PLAN
099_L_02P
rev I



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C 02 11 11 ISSUED FOR INFORMATION
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E 21 08 12 WEST BLOCK AMENDED
F 24 08 12 WEST BLOCK REVISED
G 13 09 12 ISSUED FOR PLANNING non-material amdt
H 23 10 12 balcony rails amended
I 08 11 12 building height amended cmc revision drawing

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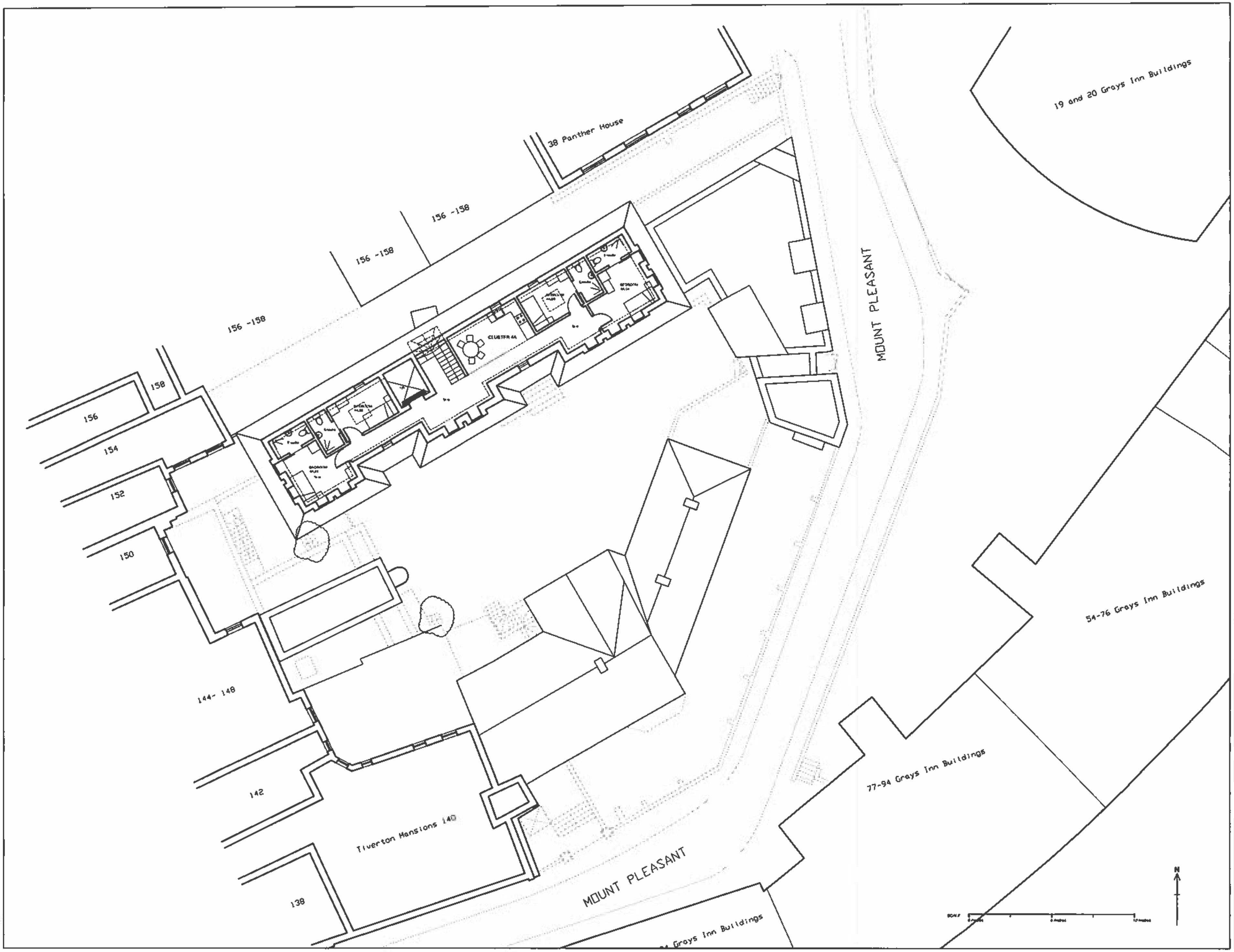
Scale 1/100 @ A1 Date 10 11

Drawn JP Checked PB

ISSUED FOR PLANNING

Title PROPOSED FIRST FLOOR PLAN

Drawing no. 099_L_03P rev. I



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B 02 11 11 ISSUED FOR INFORMATION
C 16 11 11 ISSUED FOR PLANNING
D 01 07 12 ISSUED FOR PLANNING
E 12 04 12 ISSUED FOR PLANNING
F 21 08 12 WEST BLOCK AMENDED
G 24 08 12 WEST BLOCK REVISED
H 13 09 12 ISSUED FOR PLANNING
I 06 11 12 building height amended

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1/100 @ A1 10 11

JP PB

ISSUED FOR PLANNING

PROPOSED SECOND FLOOR PLAN

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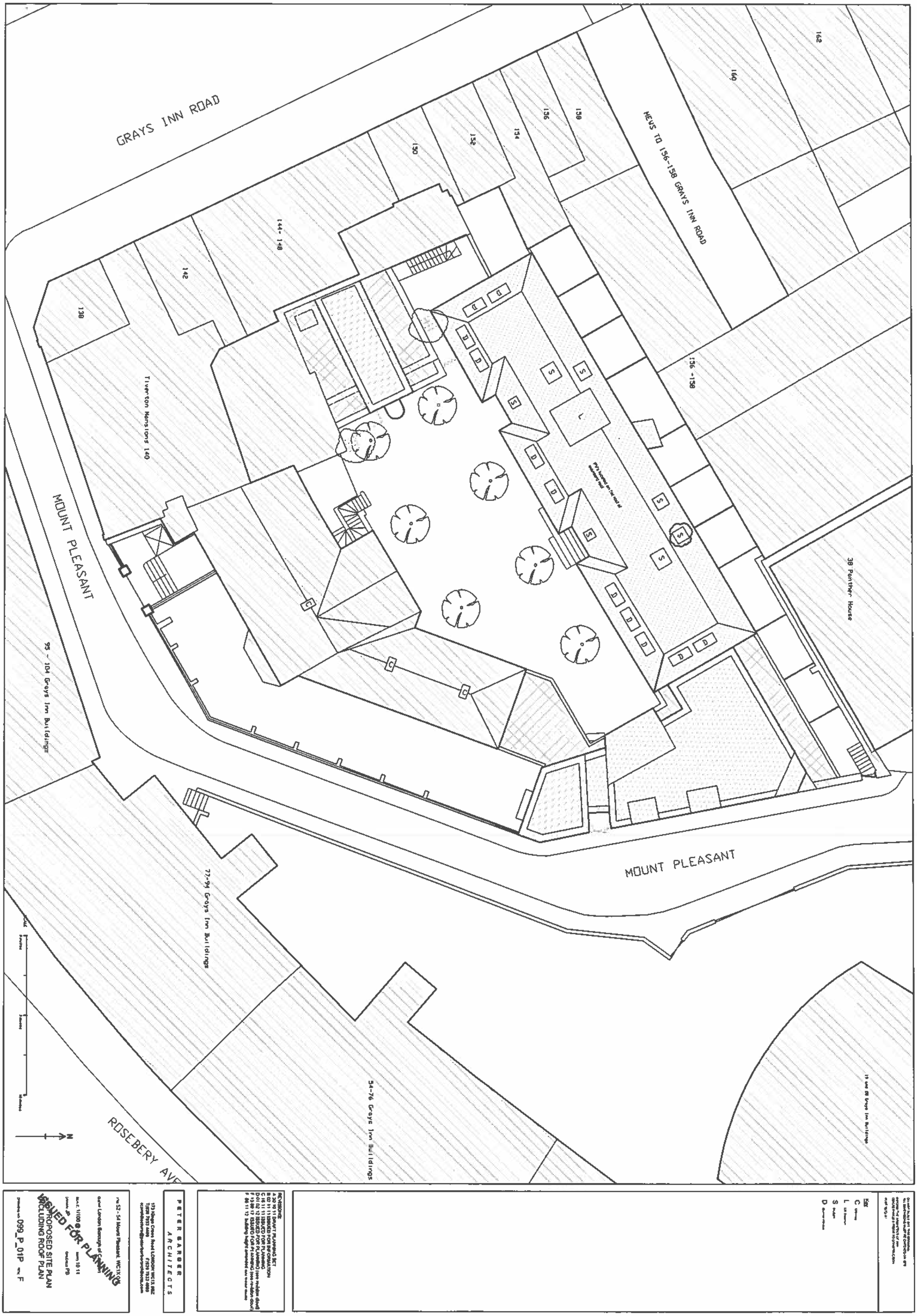

GRAYS INN ROAD
MEWS TO 156-158 GRAYS INN ROAD
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156-158
Tiverton Mansions 140
MOUNT PLEASANT
95-104 Grays Inn Buildings
38 Panther House
MOUNT PLEASANT
77-94 Grays Inn Buildings
54-76 Grays Inn Buildings
ROSEBERY AVE
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PETER BARBER ARCHITECTS
REVISIONS
ISSUED FOR PLANNING
PROPOSED SITE PLAN INCLUDING ROOF PLAN
099_P_01P
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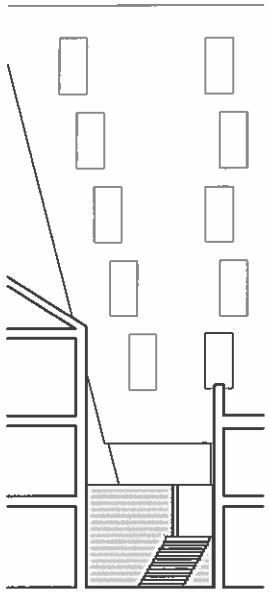
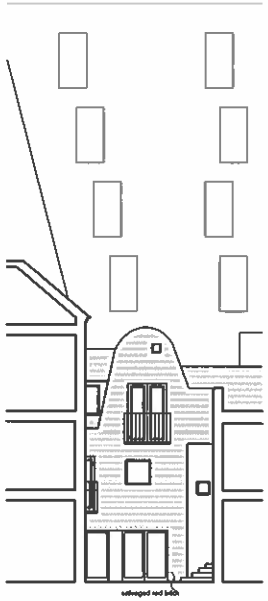


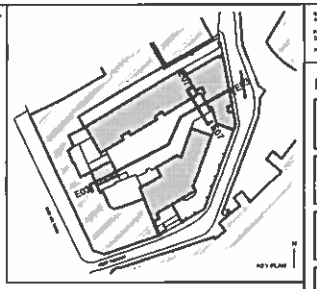
Existing ELEVATION 07
(West Elevation Facing Main Courtyard)

Existing ELEVATION 03
(North Elevation Facing Main Courtyard)



PROPOSED ELEVATION 07
(West Elevation Facing Main Courtyard)

PROPOSED ELEVATION 03
(North Elevation Facing Main Courtyard)



Existing residential windows of Tiverton Mansions

HATCH KEY

- Existing red brick
- Existing yellow brick
- New rustic pale brick
- Slates
- White acrylic render

REVISIONS:
A 20 10 11 DRAFT PLANNING SET
B 02 11 11 ISSUED FOR INFORMATION
C 18 11 11 ISSUED FOR PLANNING
D 12 04 12 ISSUED FOR PLANNING (SE CLOCH)
E 21 06 12 WEST BLOCK AMENDED
F 24 09 13 WEST BLOCK REVISED

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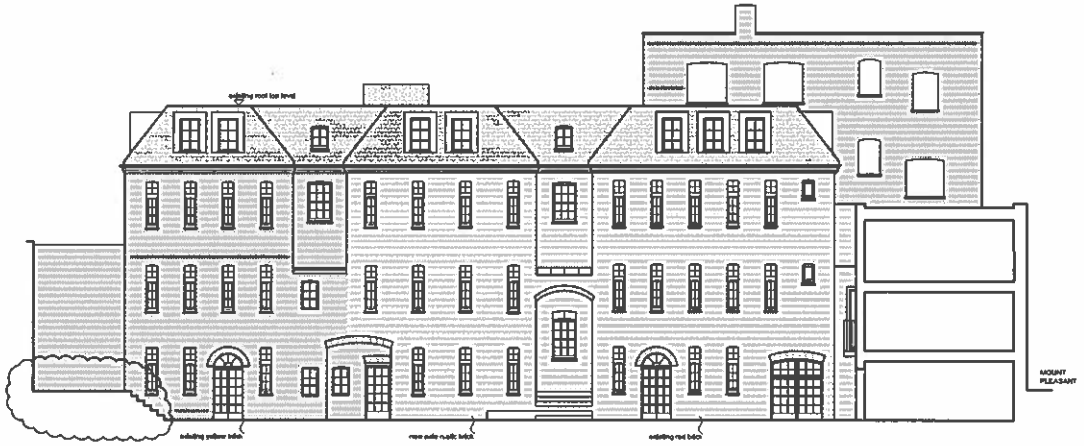
scale 1/100 @ A1 date 09 11

drawn JP checked PB

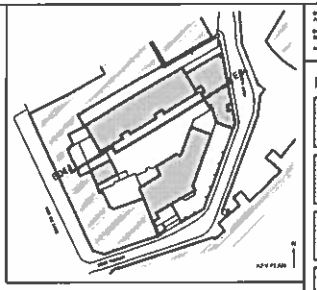
title Existing and Proposed Elevations 03 & 07 (North & West Courtyard Elevations)

drawing no 099_E_03 rev F

EXISTING ELEVATION 04
(South Elevation Facing Main Courtyard)



PROPOSED ELEVATION 04
(South Elevation Facing Main Courtyard)



HATCH KEY

- Existing red brick
- Existing yellow brick
- New rustic pale brick
- Slates
- White acrylic render

REVISIONS:

A 20.10.11 DRAFT PLANNING SET
B 02.11.11 ISSUED FOR INFORMATION
C 16.11.11 FOR PLANNING
D 21.08.12 WEST BLOCK AMENDED

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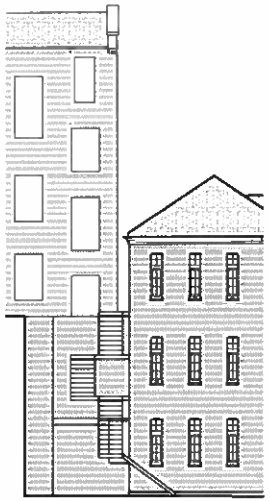
London Borough of Camden

1/100 @ A1 08.11

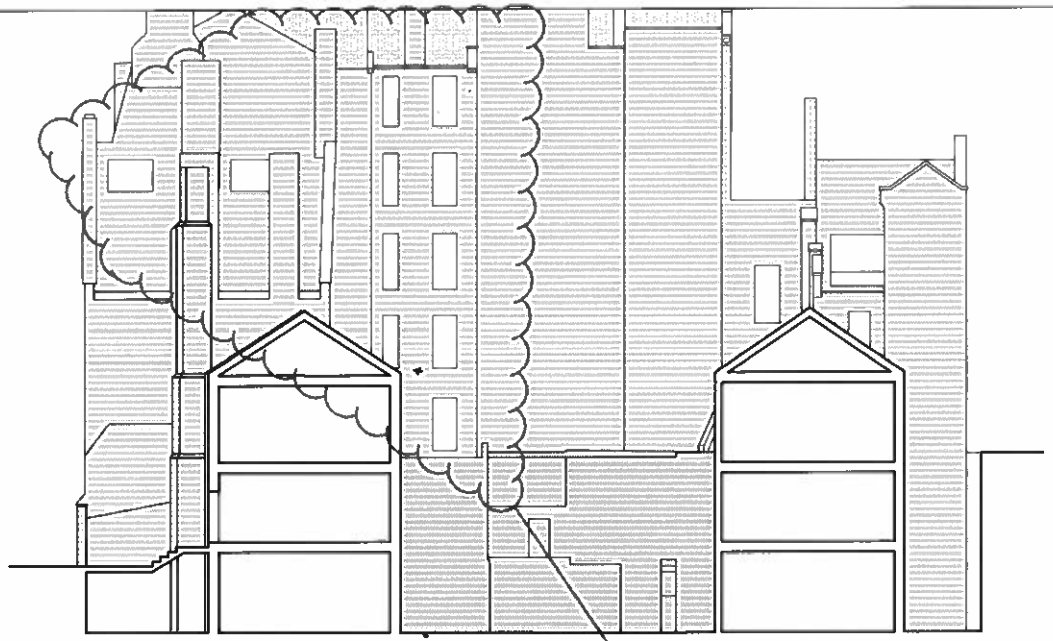
JP PB

Existing and Proposed Elevation 04 (South Elevation Facing Main Courtyard)

099_E_04 D

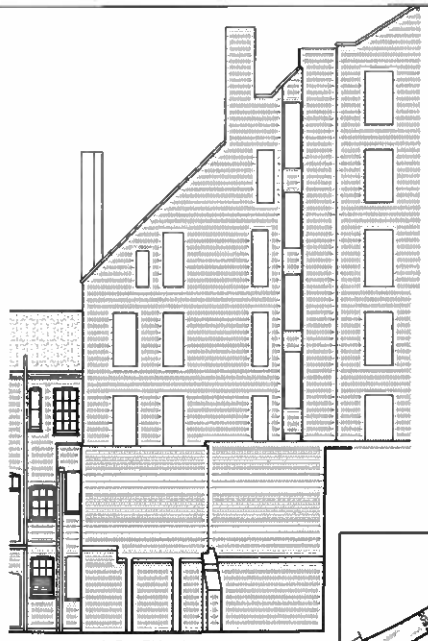


EXISTING ELEVATION 10
(South Elevation of small new build)

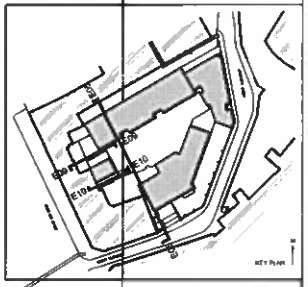


EXISTING ELEVATION 05
(East Elevation facing Main Courtyard)

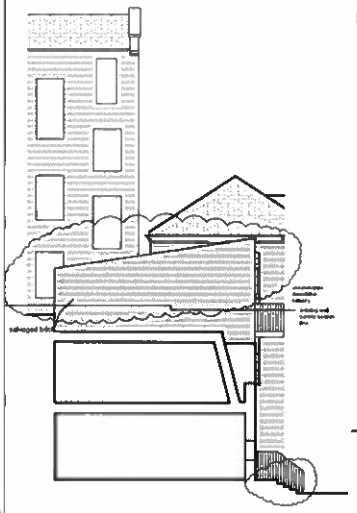
Existing residential windows of Tiverton Mansions

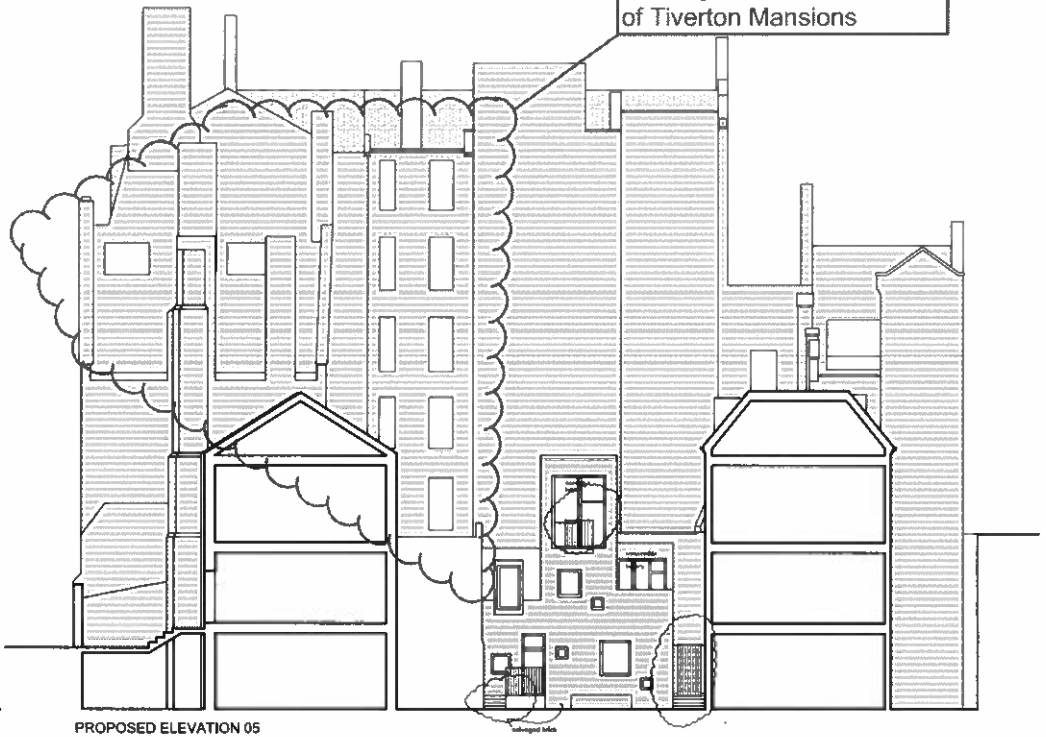


EXISTING ELEVATION 09
(North Elevation of small new build)

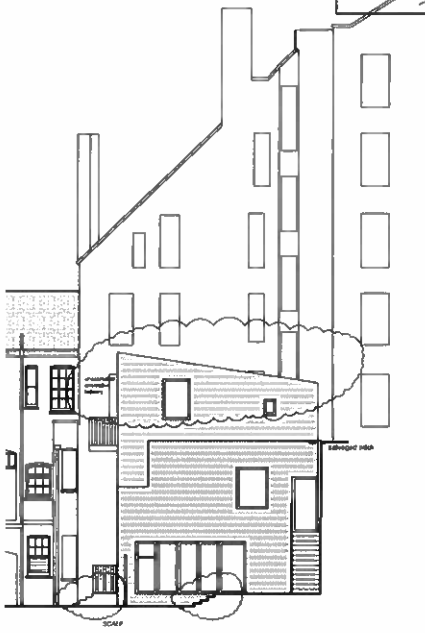


PROPOSED ELEVATION 10
(South Elevation of small new build)





PROPOSED ELEVATION 05
(East Elevation facing Main Courtyard)



EXISTING ELEVATION 09
(North Elevation of small new build)

HATCH KEY

- Existing red brick
- Existing yellow brick
- New rustic pale brick
- Slates
- White acrylic render

REVISIONS:
A 29.10.11 DRAFT PLANNING SET
B 02.11.11 ISSUED FOR INFORMATION
C 16.11.11 ISSUED FOR PLANNING
D 12.04.12 ISSUED FOR PLANNING (See clouds)
E 21.08.12 WC B1 BLOCK AMLHOLD
F 24.09.12 ELEVATION COORDINATION
G 13.05.12 ISSUED FOR PLANNING
H 23.10.12 notes and boundary wall amended
I 06.11.12 building height amended

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1/100 @ A1 Date: 06.11

JP PB

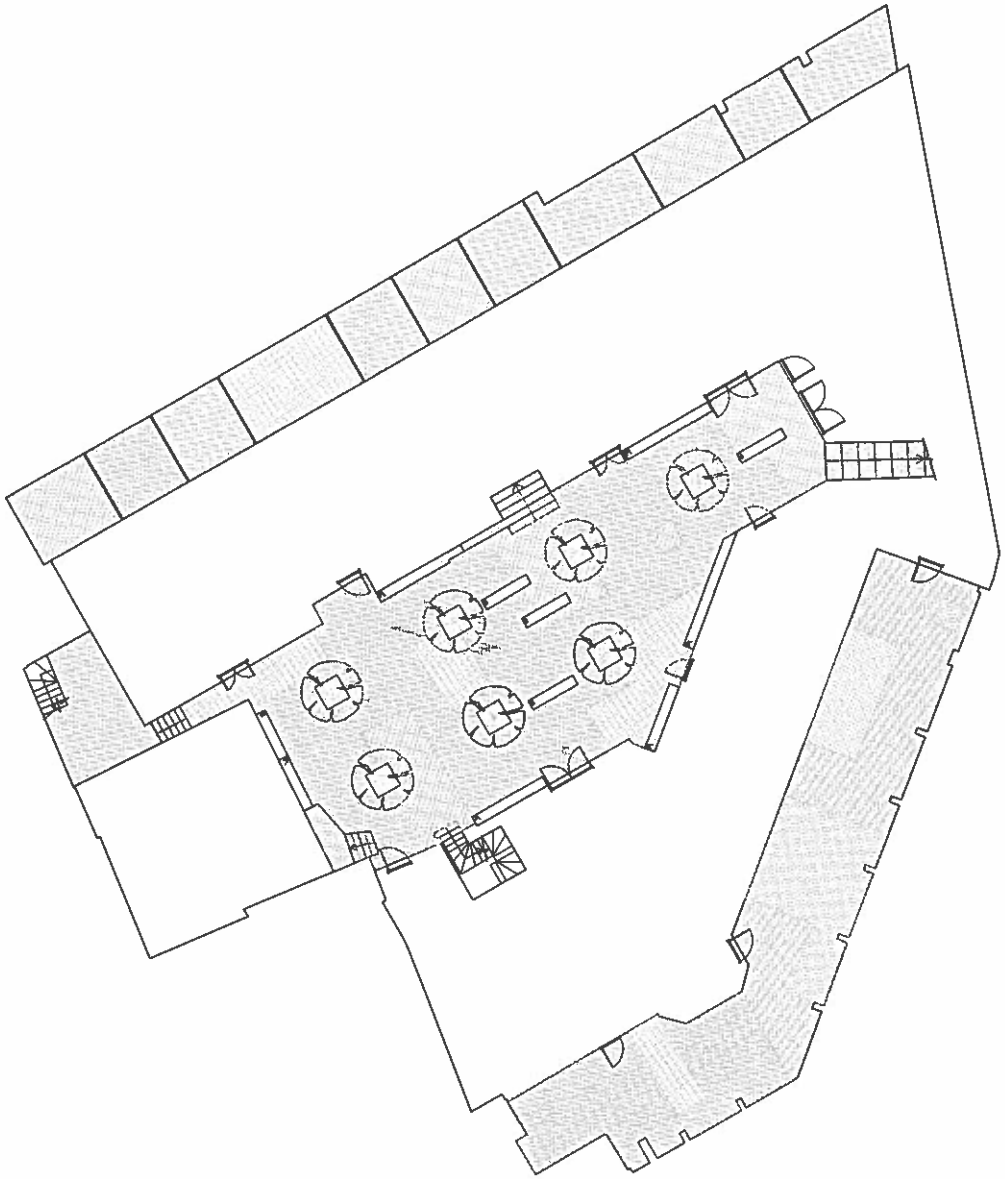
ISSUED FOR PLANNING

Existing and Proposed Elevations 05, 09 & 10: Courtyard East Elevation & small new build elevations

099_E_05 I

APPENDIX C

Proposed courtyard landscaping drawing



= 100x100
= 150x100
= 250x150

Granite effect concrete cobble (Hanson Formpave Ecogranite "Royal Deeside Victoria" or similar approved).

= Bench

= Planter flush with the ffl with climbing plants and shrubs

= Semi mature tree in 1mx1m tree pit flush with ffl. Tree species:
- 2x Fagus Sylvatica ('Pupurea' Copper Beach)
- 2x Prunus Sargentii ('Rancho' Flowering Cherry)
- 2x Pyrus Calleryana ('Chanticleer' Ornamental Pear)
- 1x Acer Campestre ('Elsrijk' Field Maple)

01 MOUNT PLEASANT - PROPOSED LANDSCAPE GA
1:100 / 1:100

PETER BARBER ARCHITECTS

WILLMOTT DIXON

MOUNT PLEASANT HOSTEL
52-54 MOUNT PLEASANT, LONDON

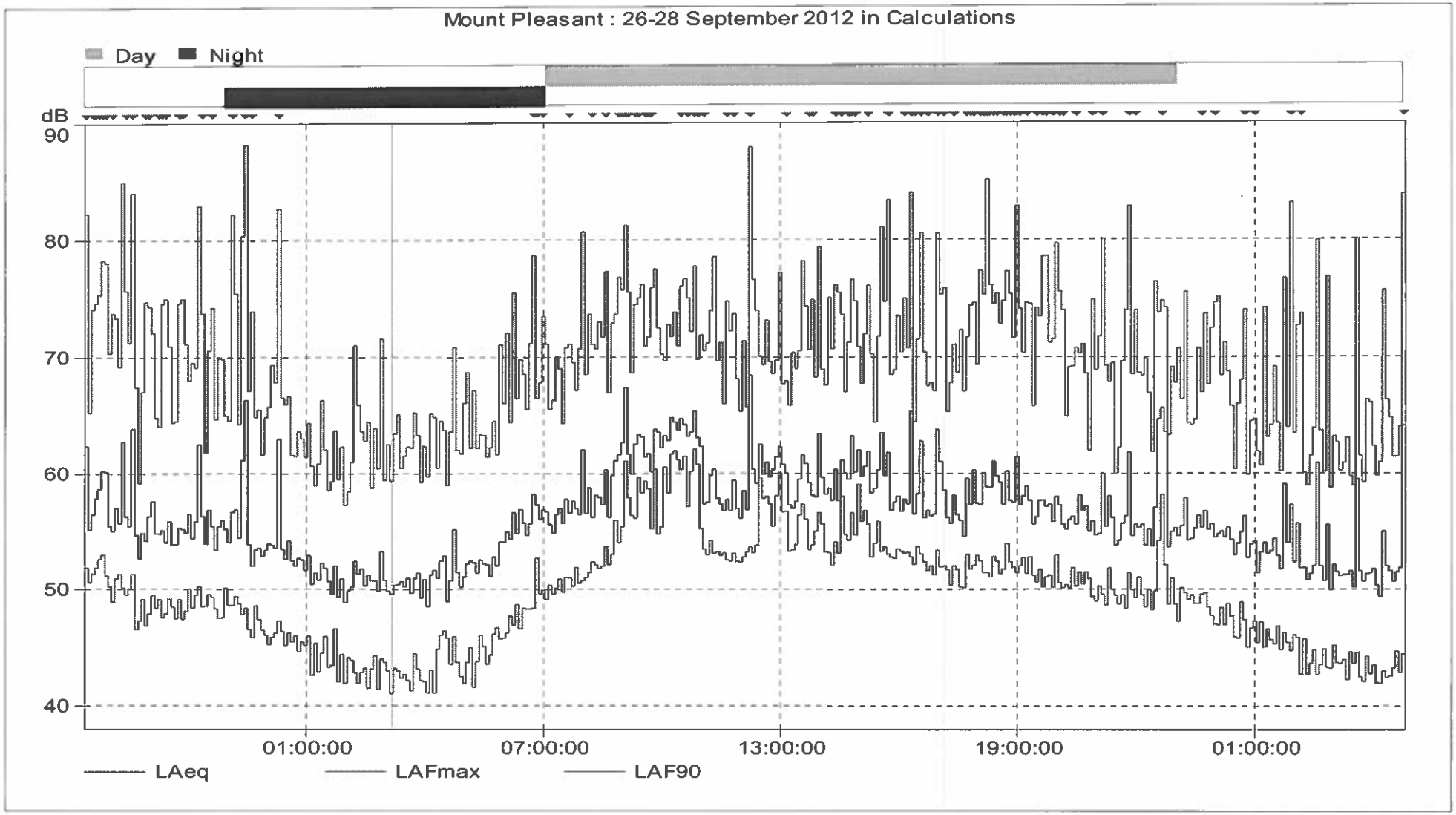
PROPOSED LANDSCAPE GA

PRELIMINARY

099_L_140 P01

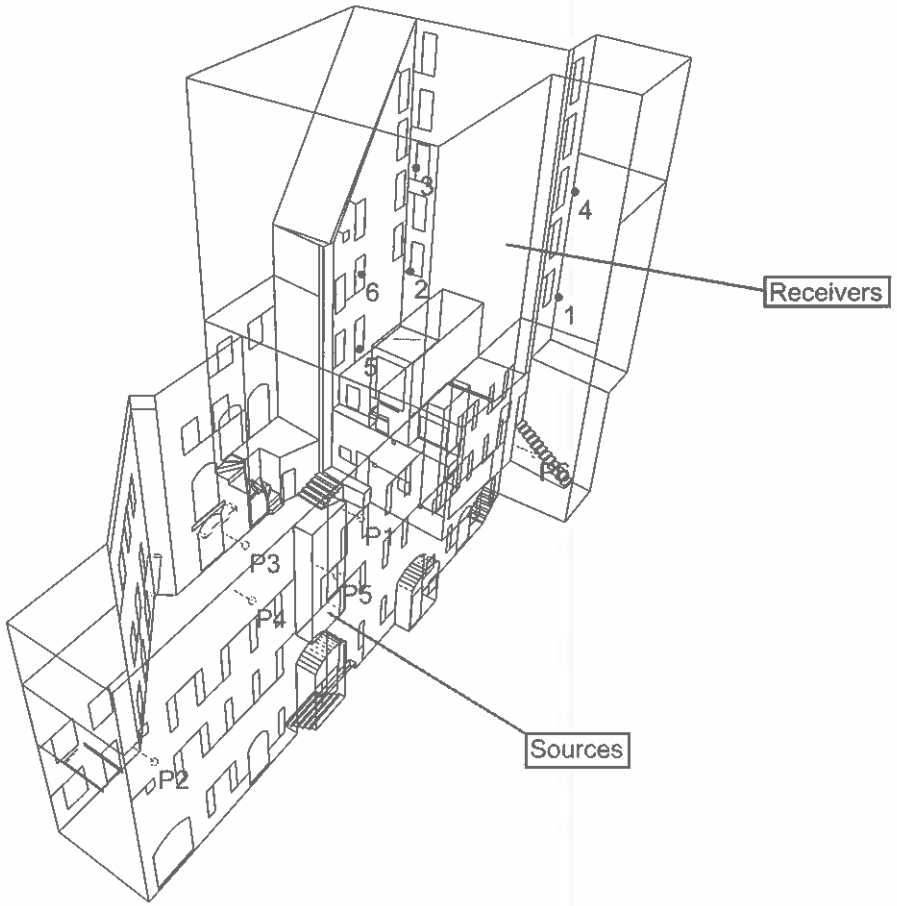
APPENDIX D

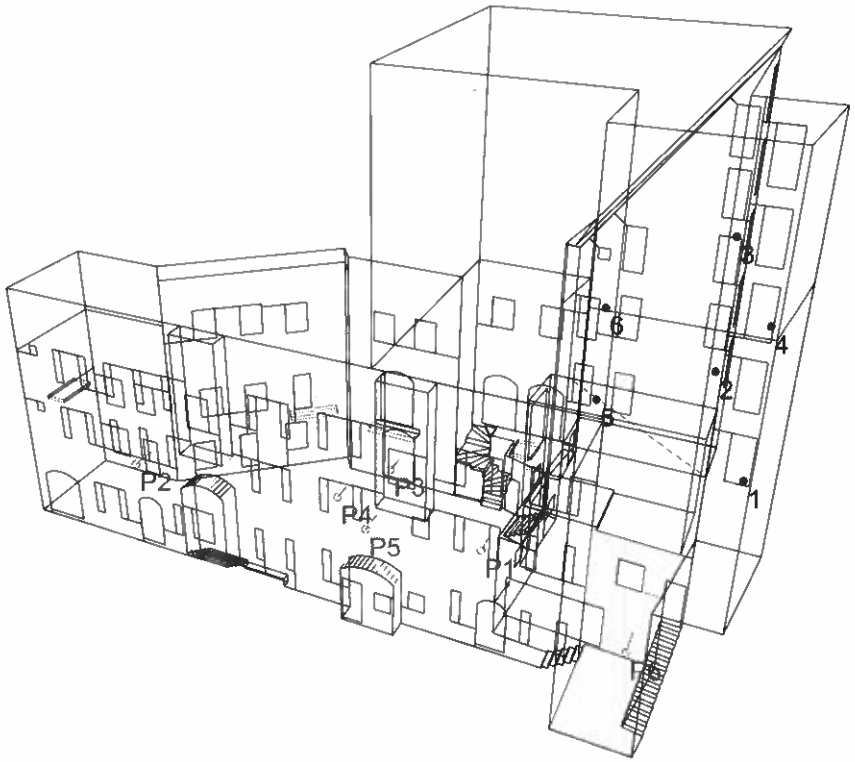
Chart showing results of noise monitoring

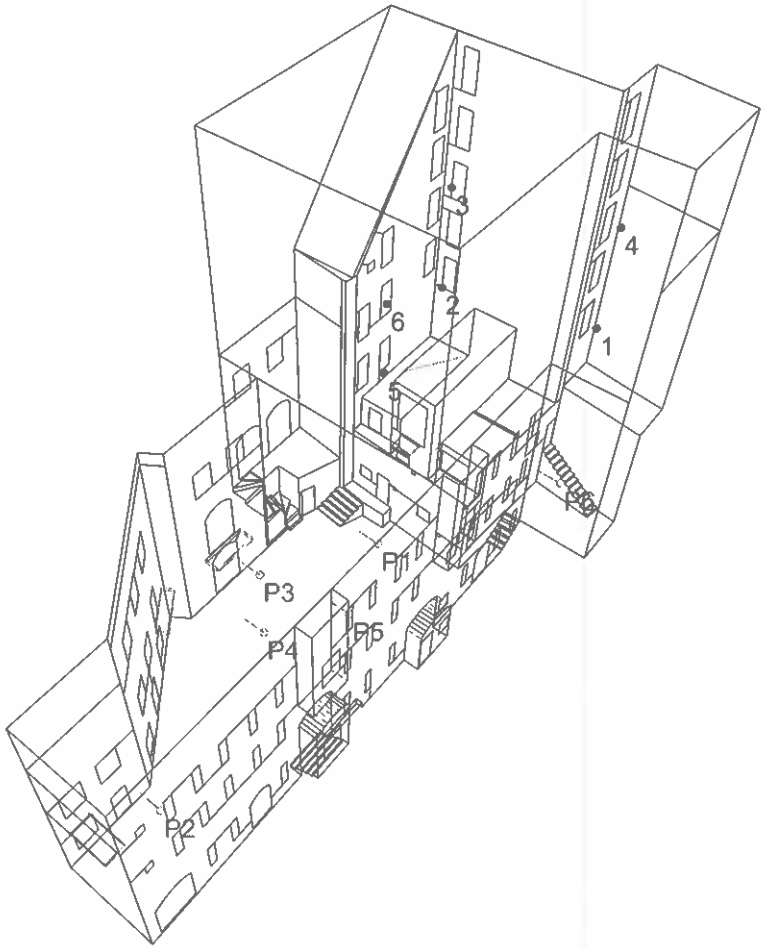

Mount Pleasant : 26-28 September 2012 in Calculations
Day
Night
dB
90
80
70
60
50
40
01:00:00
07:00:00
13:00:00
19:00:00
01:00:00
LAeq
LAFmax
LAF90

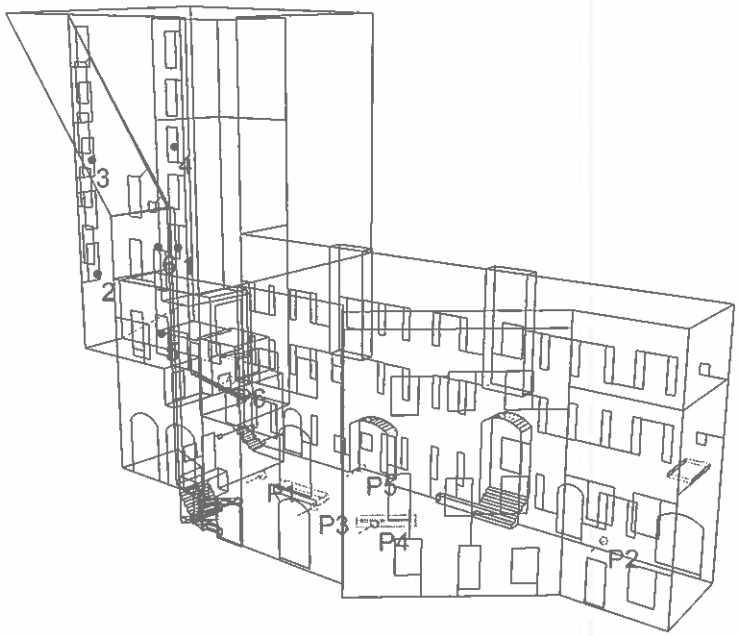
APPENDIX E

3D visualisation and output of Odeon noise model




P2
P3
P4
P5
P1
1
2
3
4
5
6





Scenario 1: Normal Use

Receiver Number: 1 Receiver 1 **(x,y,z) = (0.20, -5.00, 11.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.39	1.39	1.45	1.40	1.36	1.54	1.05	0.62
T30	(s)	1.47	1.43	1.53	1.56	1.47	1.77	1.08	0.74
SPL	(dB)	-21.9	35.0	44.1	49.2	50.7	45.5	35.5	29.0

SPL(A) = 53.3(dB)
STI = 0.57 (Theoretical based on T30, STI = 0.53)

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 2 Receiver 2 **(x,y,z) = (8.00, -2.80, 11.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.57	1.57	1.66	1.61	1.50	1.88	1.18	0.94
T30	(s)	1.55	1.54	1.71	1.69	1.58	1.80	1.12	0.71
SPL	(dB)	-26.0	31.0	40.3	45.4	46.9	41.6	31.6	24.0

SPL(A) = 49.5(dB)
STI = 0.46 (Theoretical based on T30, STI = 0.52)

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 3 Receiver 3 **(x,y,z) = (8.00, -2.80, 17.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.14	1.05	1.16	1.19	1.15	1.32	0.71	0.49
T30	(s)	2.11	2.06	2.26	0.00	2.11	0.00	1.12	0.72
SPL	(dB)	-26.0	31.0	40.1	45.2	46.8	41.0	31.9	25.0

SPL(A) = 49.2(dB)
STI = 0.61 (Theoretical based on T30, STI = 0.65)

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 4 Receiver 4 **(x,y,z) = (0.20, -5.00, 17.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.04	1.01	1.06	1.07	1.09	1.19	0.72	0.52
T30	(s)	1.61	1.64	1.68	1.79	1.61	2.03	1.04	0.64
SPL	(dB)	-24.4	32.6	41.6	46.8	48.3	42.8	33.5	27.0

SPL(A) = 50.8(dB)
STI = 0.64 (Theoretical based on T30, STI = 0.51)

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 5 Receiver 5 **(x,y,z) = (8.00, 2.00, 8.50)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.83	1.83	1.88	1.87	1.80	2.04	1.33	0.90
T30	(s)	1.49	1.49	1.58	1.55	1.50	1.58	1.20	0.78
SPL	(dB)	-24.7	32.3	41.6	46.8	48.3	43.0	33.2	26.1

SPL(A) = 50.9(dB)
STI = 0.46 (Theoretical based on T30, STI = 0.52)

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 6 Receiver 6 **(x,y,z) = (8.00, 2.00, 13.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.56	1.63	1.62	1.67	1.52	1.75	1.19	0.85
T30	(s)	1.65	1.66	1.72	1.73	1.55	1.97	1.10	0.72
SPL	(dB)	-24.4	32.6	41.8	47.0	48.5	43.0	33.4	26.4

SPL(A) = 51.0(dB)
STI = 0.49 (Theoretical based on T30, STI = 0.51)

Warning: Reflection density is less than 50 reflections per millisecond

EDT (s)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	1.04	1.01	1.06	1.07	1.09	1.19	0.71	0.49
Maximum	1.83	1.83	1.88	1.87	1.80	2.04	1.33	0.94
Average	1.42	1.41	1.47	1.47	1.40	1.62	1.03	0.72

T30 (s)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	1.47	1.43	1.53	0.00	1.47	0.00	1.04	0.64
Maximum	2.11	2.06	2.26	1.79	2.11	2.03	1.20	0.78
Average	1.65	1.64	1.75	1.39	1.64	1.52	1.11	0.72

SPL (dB)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	-26.0	31.0	40.1	45.2	46.8	41.0	31.6	24.0
Maximum	-21.9	35.0	44.1	49.2	50.7	45.5	35.5	29.0
Average	-24.6	32.4	41.6	46.7	48.3	42.8	33.2	26.2

SPL(A), minimum = 49.2(dB)
SPL(A), maximum = 53.3(dB)
SPL(A), Average = 50.8(dB)

STI, minimum = 0.46STI
STI, maximum = 0.64STI
STI, Average = 0.54STI

Receiver Number: 1 Receiver 1 **(x,y,z) = (0.20, -5.00, 11.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.39	1.39	1.45	1.40	1.36	1.54	1.05	0.62
T30	(s)	1.47	1.43	1.53	1.56	1.47	1.77	1.08	0.74
SPL	(dB)	-13.9	43.0	52.1	57.2	58.7	53.5	43.5	37.0

SPL(A) = 61.3(dB)
STI = 0.57 **(Theoretical based on T30, STI = 0.53)**

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 2 Receiver 2 **(x,y,z) = (8.00, -2.80, 11.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.57	1.57	1.66	1.61	1.50	1.88	1.18	0.94
T30	(s)	1.55	1.54	1.71	1.69	1.58	1.80	1.12	0.71
SPL	(dB)	-18.0	39.0	48.3	53.4	54.9	49.6	39.6	32.0

SPL(A) = 57.5(dB)
STI = 0.46 **(Theoretical based on T30, STI = 0.52)**

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 3 Receiver 3 **(x,y,z) = (8.00, -2.80, 17.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.14	1.05	1.16	1.19	1.15	1.32	0.71	0.49
T30	(s)	2.11	2.06	2.26	0.00	2.11	0.00	1.12	0.72
SPL	(dB)	-18.0	39.0	48.1	53.2	54.8	49.0	39.9	33.0

SPL(A) = 57.2(dB)
STI = 0.61 **(Theoretical based on T30, STI = 0.65)**

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 4 Receiver 4 **(x,y,z) = (0.20, -5.00, 17.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.04	1.01	1.06	1.07	1.09	1.19	0.72	0.52
T30	(s)	1.61	1.64	1.68	1.79	1.61	2.03	1.04	0.64
SPL	(dB)	-16.4	40.6	49.6	54.8	56.3	50.8	41.5	35.0

SPL(A) = 58.8(dB)
STI = 0.64 **(Theoretical based on T30, STI = 0.51)**

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 5 Receiver 5 **(x,y,z) = (8.00, 2.00, 8.50)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.83	1.83	1.88	1.87	1.80	2.04	1.33	0.90
T30	(s)	1.49	1.49	1.58	1.55	1.50	1.58	1.20	0.78
SPL	(dB)	-16.7	40.3	49.6	54.8	56.3	51.0	41.2	34.1

SPL(A) = 58.9(dB)
STI = 0.46 **(Theoretical based on T30, STI = 0.52)**

Warning: Reflection density is less than 50 reflections per millisecond

Receiver Number: 6 Receiver 6 **(x,y,z) = (8.00, 2.00, 13.00)**

Band (Hz)		63	125	250	500	1000	2000	4000	8000
EDT	(s)	1.56	1.63	1.62	1.67	1.52	1.75	1.19	0.85
T30	(s)	1.65	1.66	1.72	1.73	1.55	1.97	1.10	0.72
SPL	(dB)	-16.4	40.6	49.8	55.0	56.5	51.0	41.4	34.4

SPL(A) = 59.0(dB)
STI = 0.49 **(Theoretical based on T30, STI = 0.51)**

Warning: Reflection density is less than 50 reflections per millisecond

EDT (s)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	1.04	1.01	1.06	1.07	1.09	1.19	0.71	0.49
Maximum	1.83	1.83	1.88	1.87	1.80	2.04	1.33	0.94
Average	1.42	1.41	1.47	1.47	1.40	1.62	1.03	0.72

T30 (s)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	1.47	1.43	1.53	0.00	1.47	0.00	1.04	0.64
Maximum	2.11	2.06	2.26	1.79	2.11	2.03	1.20	0.78
Average	1.65	1.64	1.75	1.39	1.64	1.52	1.11	0.72

SPL (dB)

Band (Hz)	63	125	250	500	1000	2000	4000	8000
Minimum	-18.0	39.0	48.1	53.2	54.8	49.0	39.6	32.0
Maximum	-13.9	43.0	52.1	57.2	58.7	53.5	43.5	37.0
Average	-16.6	40.4	49.6	54.7	56.3	50.8	41.2	34.2

SPL(A), minimum = 57.2(dB)
SPL(A), maximum = 61.3(dB)
SPL(A), Average = 58.8(dB)

STI, minimum = 0.46STI
STI, maximum = 0.64STI
STI, Average = 0.54STI

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