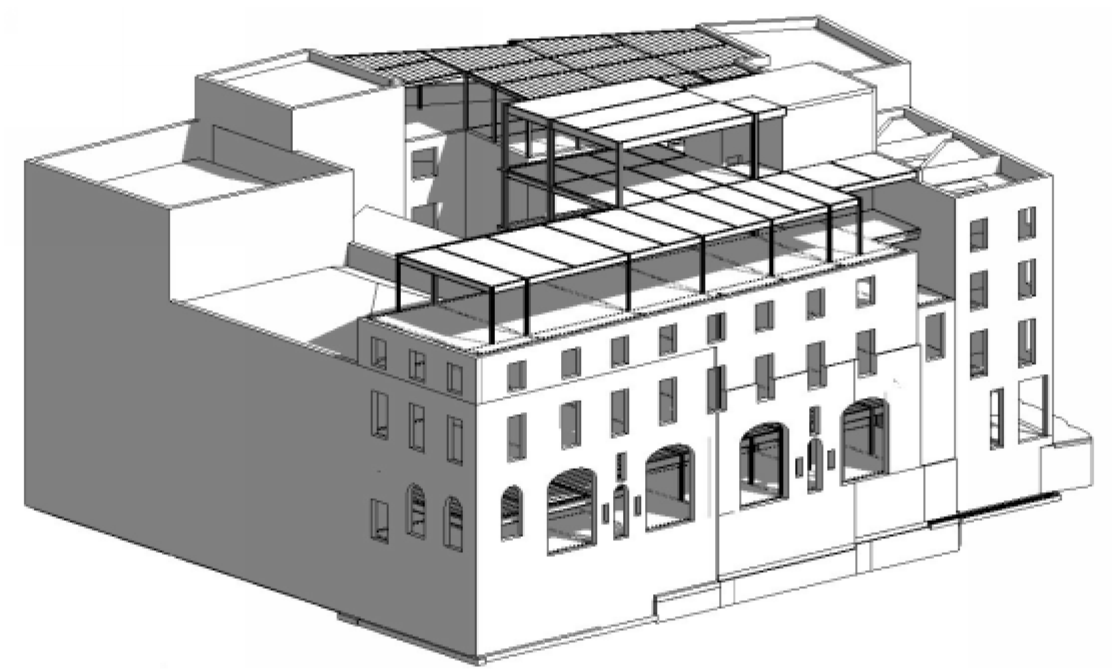
35-41 New Oxford Street, 10-12 Museum Street and 16 West Central Street.

SURFACE WATER DRAINAGE STATEMENT (STAGE -1)



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Contents

1. INTRODUCTION

Mason Navarro Pledge has been commissioned to prepare a surface water drainage statement to include a detailed SUDS strategy for the proposed redevelopment of 35-41 New Oxford Street, 10-12 Museum Street and 16 West Central Street. Reference should also be made to the Flood Risk Assessment (FRA).

The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications came into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and are required to prepare a Surface Water Drainage Statement.

2. REQUIREMENTS

It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with details of its extent and position, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a maintenance plan should be included within the Surface Water Drainage Statement, clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate.

Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1 store rainwater for later use
2 use infiltration techniques, such as porous surfaces in non-clay areas
3 attenuate rainwater in ponds or open water features for gradual release
4 attenuate rainwater by storing in tanks or sealed water features for gradual release
5 discharge rainwater direct to a watercourse
6 discharge rainwater to a surface water sewer/drain
7 discharge rainwater to the combined sewer.

The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event.

Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

This drainage statement has been prepard in accordance with National Planning Policy Framework (NPPF), along with advice and guidance from the Environment Agency (EA), London Borough of Camden Strategic Flood Risk Assessment (SFRA) and CIRIA documents.

The NPPF states that an appropriate flood risk assessment will be required for all development proposals of 1Ha or greater in Flood Zone 1, or for any development within Flood Zones 2 or 3. The site is shown to lie within Flood Zone 1 (flood defended), is less than 1Ha but is considered a major development.

3. THE PROJECT

The project will consolidate several existing buildings into a new residential block with retail space at ground floor level.

3.1 LOCATION

New Oxford Street estate comprises 16a/b and 18 West Central Street (a single building), 35–41 New Oxford Street, and 10 to 12 Museum Street, (NGR 530182 181435: Fig 1). The site is bounded by New Oxford Street to the north, Museum Street to the east, and West Central Street and the 43 and 45 New Oxford Street to the east.

The site addresses are:

35, 37, 39, and 41
New Oxford Street
WC1A 1BH & WC1A 1BN

10, 11, and 12
Museum Street
WC1A 1JJ

16a, 18, and 16b
West Central Street
WC1A 1JJ

The site is located on the southern fringe of the Bloomsbury Conservation Area that was designated in 1968.

The nearest watercourse is the River Thames which runs from west to east approximately 900m to the southeast of the site.

The extent of the existing buildings is indicated in Figure 2.

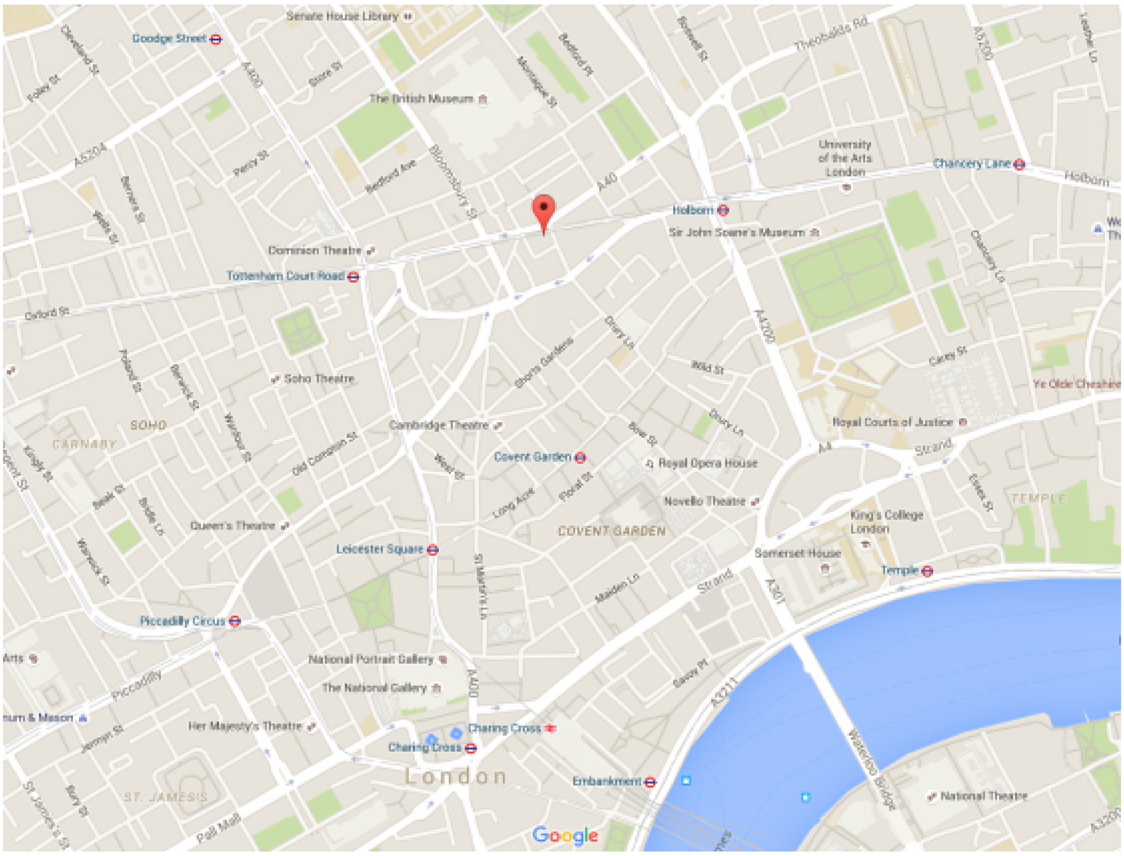


Figure -1 Site Location

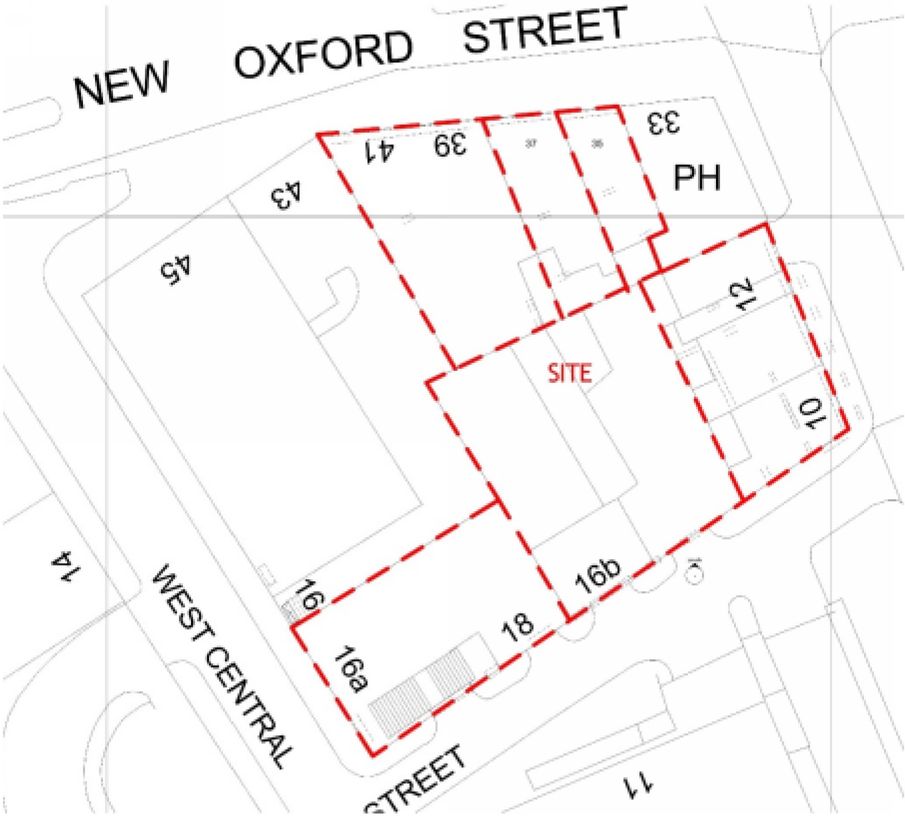


Figure -2 Site Boundary

3.2 EXISTING BUILDINGS

No. 35 & 37 New Oxford Street are three storey residential properties with retail at ground floor. Both buildings contain basements to the entire footprint, and appear to be of concrete construction.

No.10 Museum Street is a three story residential property with retail space at the ground floor. However No 11 – 12 have undergone modernisation and consolidation, as well as an addition of a full height rear extension.

Figure – 3 Existing Elevation along New Oxford Street

Figure – 4 Existing Elevation along Museum Street

18 West Central Street is a two and three storey building, with the lowest section of the building on the corner of West Central Street.

Figure – 5 Existing Elevation along West Central Street

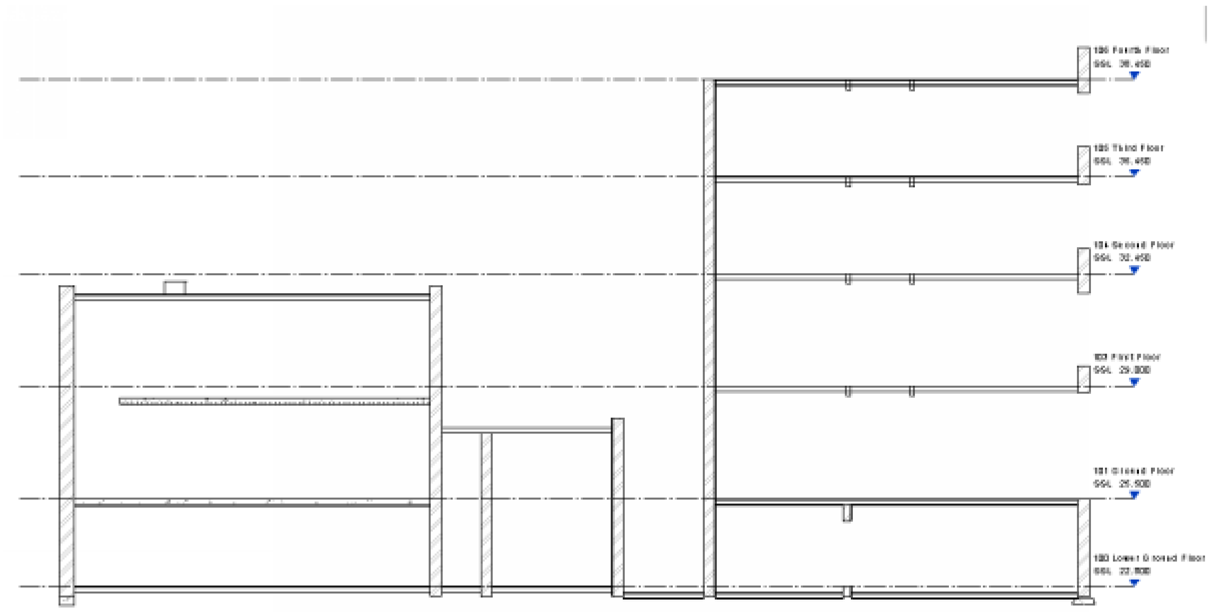


Figure – 6 Existing Section along New Oxford Street & West Central Street

3.3 PROPOSED DEVELOPMENT

3.3.1 35-41 New Oxford Street

The proposal is to retain the existing façade, party walls and floors. A single storey light weight steel framed roof extension will be added to the entire footprint of the New Oxford street frontage

A new steel framed stair case will be created to the rear of No. 35 and 37.

3.3.2 10-12 Museum Street

The façade of No. 10 to 12 Museum Street will be retained including the existing floor construction. The existing stairs will be demolished and infilled with a new timber floor and new opening will be created through the existing walls to accommodate a new residential layout.

3.3.3 West Central Street

The existing properties along West Central Street will require partial demolition and a new residential block.

The substructure will be of concrete frame construction. Concentrated loads from the columns that support the multi-storey buildings over are to be transferred to the ground via a reinforced concrete raft. The superstructure will be of light weight steel framed construction, with precast hollow core floor slab.

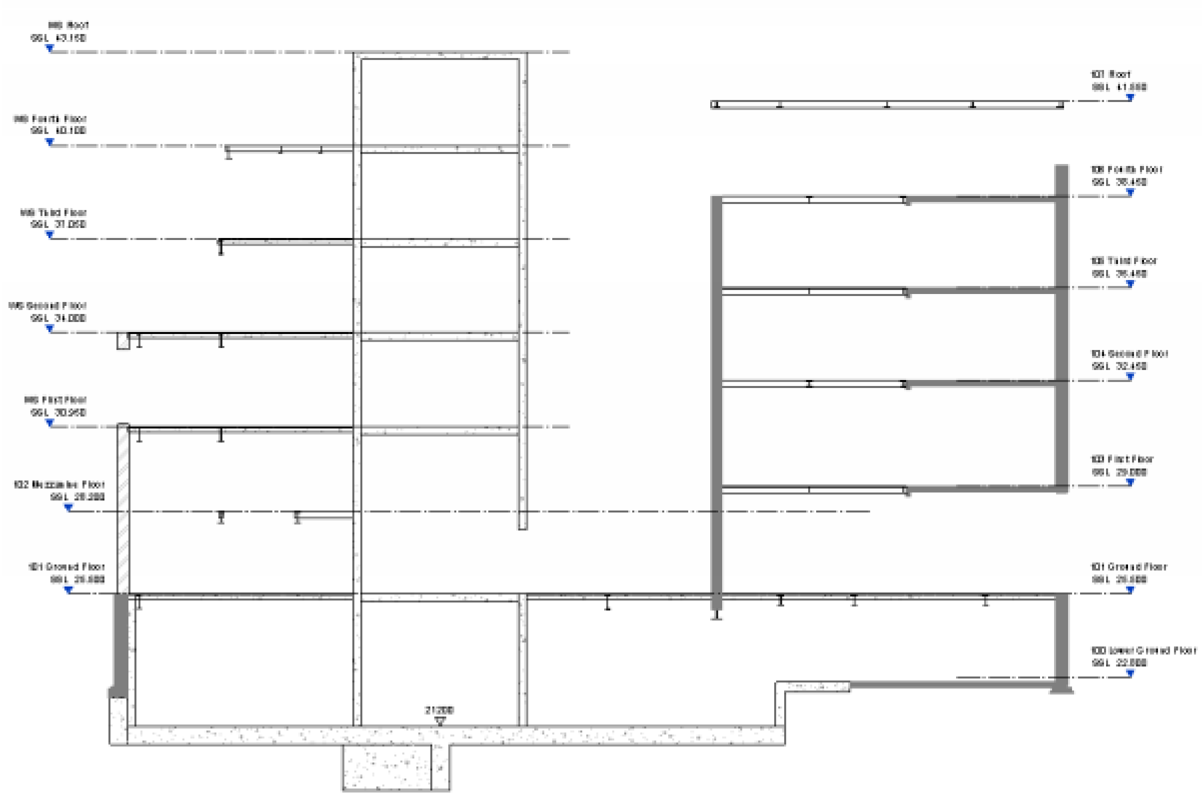


Figure – 7 Proposed Section along New Oxford Street & West Central Street

4. TOPOGRAPHY

The topographical survey information shows the site to be relatively level. The existing pavement levels along New Oxford Street, Museum Street and West Central Street are approximately 25.30m AOD.

5. GROUND CONDITION

An assessment of geology and ground conditions has been made by using the online British Geological Survey historical borehole records and a site investigation undertaken by GEA Ltd in July 2015. The site was found to contain variable thickness of made ground over Lynch Hill Gravel over the London Clay Formation.

British Geological Record BH ref TQ38SW799 – reports the ground conditions as follows:

Depth below ground (garden)	Soil Type
From 0 to 3m	Made Ground
From 3m to 8m	Sandy gravel
8m to 18m plus	London Clay

The opportunity for ground percolation is limited.

6. GROUND WATER

Ground water level are noted on the GEA site investigation report close to the base of the gravel at a depth of approximately 5.0m

7. DRAINAGE RECORDS

Record of public sewer in the vicinity of the site have been provide by Thames Water. These shows that there is a main public combined sewer on New Oxford Street, Museum Street and West Central Street. The sewer is 1676x914 along New Oxford Street, 1727x914 along Museum Street and 1219x787 along West Central Street.

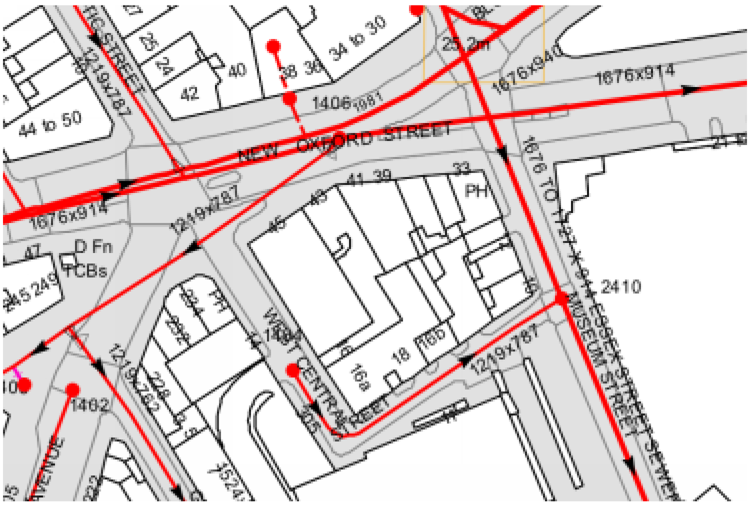


Figure - 8 Thames Water Asset Plan showing combined sewer to NOS

Manhole Reference	Manhole Cover Level	Manhole Invert Level
1427	n/a	n/a
0409	n/a	n/a
151A	n/a	n/a
151B	n/a	n/a
2501	n/a	n/a
1521	25.29	20.98
1505	n/a	n/a
9503	25.9	18.52
1508	25.51	n/a
3502	n/a	n/a
0505	n/a	n/a
0535	n/a	n/a
2602	24.88	21.8
36BC	n/a	n/a
36BD	n/a	n/a
2604	24.86	21.81
2605	n/a	n/a
1610	n/a	n/a
3605	24.74	20.67
3416	24.38	19.26
3503	n/a	n/a
3504	25.02	9.36
35DE	n/a	n/a
35DD	n/a	n/a
3501	n/a	n/a
35DG	n/a	n/a
35DH	n/a	n/a
3604	n/a	n/a
4505	n/a	n/a
451A	n/a	n/a
46DJ	n/a	n/a
46DI	n/a	n/a
1303	23.59	17.34
0303	n/a	n/a
1304	23.52	19.43
2301	n/a	n/a
3303	n/a	n/a
3304	22.68	n/a
1305	24.15	20.1
3306	22.7	18.79
2401	24.14	19.87
1402	25.13	21.01
1403	n/a	n/a
1404	25.2	21.73
2402	n/a	n/a
0406	25.56	n/a
2410	25.15	20.6
3403	23.9	20.21
3404	22.89	20.95
0410	25.36	9.49

Figure -9 Thames water manhole schedule

The sewer along New Oxford Street is located at approximately 19.56m AOD, the sewer along Museum Street is approximately 20.6m AOD and the sewer along West Central Street is approximately 21.73m AOD.

Risk of flooding due to pipe surcharging is very low based on the historical data. Due to the depth of the existing sewer relative to the basement level, non-return valves should be adopted on the outgoing sewer pipes.

8. EXISTING SURFACE WATER DRAINAGE

Existing surface water discharges to a connection on West Central Street to the south of the site. Other roof areas attached to the development (but not part of the application site) discharge to open base rainwater pipes directly on to the footpath. There may also be a connection in to Museum Street but at this stage we have been unable to locate a connection due to occupation and blind connections in the street that cannot be surveyed. The calculations have been modelled based on a single exit pipe on to West Central street of 2m length and 150mm diameter. If 2 pipes exist then the system will have some additional diversity but noting the flow all discharges to the same sewer on Museum Street.

The existing is a summary of the run-off rates as confirmed by Cole Easdon drainage consultants.

Summary of 'pre-development' results below:

Storm event	Greenfield runoff rate	Greenfield runoff volume	Existing runoff rate
1:1 yr	0.1 l/s	-	-
1:30 yr	0.3 l/s	-	-
1:100 yr	0.4 l/s	13.6 m^3 (6 hour duration)	45 l/s

Figure - 10 – pre-development flow rates

9. PROPOSED SURFACE WATER DRAINAGE

A range of SUDS components have been assessed in order to derive appropriate solution for this site. Below is a summary of the hierarchy of prevention, source control, site control and regional control with confirmation of which options are to be adopted:-

SUDS Component	Commentary	Suitability	
Pervious surfaces	Limited opportunity to incorporate pervious pavements		No
Green roofs	Flat roof is compatible with green roof technology	Yes	
Attenuation tanks	The site cannot easily accommodate attenuation tanks		No
Rain water harvesting	Rainwater harvesting can be considered	Yes	
Infiltration devices	Soak-away solution are not suited to the inner city site		No
Filters	There is no change to the existing site strategy		No
Filter drains	Not appropriate to the site		No
Filter strips	Not appropriate to the site		No
Basin, ponds and wetlands	Not appropriate to the site		No
Swales	Not appropriate to the site		No
Bio-retention areas	Not appropriate to the site		No

Figure - 11 SUDS techniques

Each solution is now discussed in detail.

<u>Pervious surfaces</u>

The existing building is full footprint to the existing kerbs and so there is no external surfacing at ground level that could be utilised as pervious.

<u>Green roofs</u>

The existing roof footprint measures 809m^2 pertinent to this development. Certain areas of the roof need to be retained and are pitched and there is a requirement to install various service at roof level. However a good degree of roof area can be utilised for storage and attenuation. Typical green roof systems do not provide much attenuation however the Blueroof system by ABG has been designed to provide storage. Reference should be made to the MNP drawing ‘Green roof areas’ of which the following is an extract.

Figure - 12 Green roof areas.

The green roof system to be adopted will be 'Blueroof' by ABG and appended are their supporting documents confirming the storage feasibility, maintenance regime requirements and built in exceedance features.

ABG blueroof provides stormwater attenuation capacity at source within the green, ballasted or paved roof, or podium deck construction of a development.

It comprises a combined drainage and attenuation void within the roof structure and a series of roof restrictor chambers which sit over each roof outlet. The chambers are designed to release the attenuated water at a controlled discharge rate as permitted in the planning consent of the site. Designing a blue roof in this way allows storage capacities suitable for up to a one in 100 year storm event, plus an allowance (typically 30%) for the effects of climate change, to be achieved. The water is filtered several times as it passes through the system removing suspended solids thus improving the quality of water at discharge. This stored water, as with a 'traditional' storage system, can be released at a controlled rate or even used as grey water or irrigation for the vegetation across the development.

The blueroof system consists of two key components:

- A drainage geocomposite system with integral filter geotextiles which attenuates excess water not absorbed by the vegetation in soft landscape areas, or run off from ballast or paving, in hard landscaped areas. Water filters through the green roof and builds up in to the drainage void formed by the geocomposite layers below.

- This water is gradually dispersed through the zero falls system to the restrictor chamber and discharged to the roof outlet at the rate permitted for the site. The storm water attenuation requirements are met within the roof construction; therefore the need for underground storage can often be reduced/eliminated.

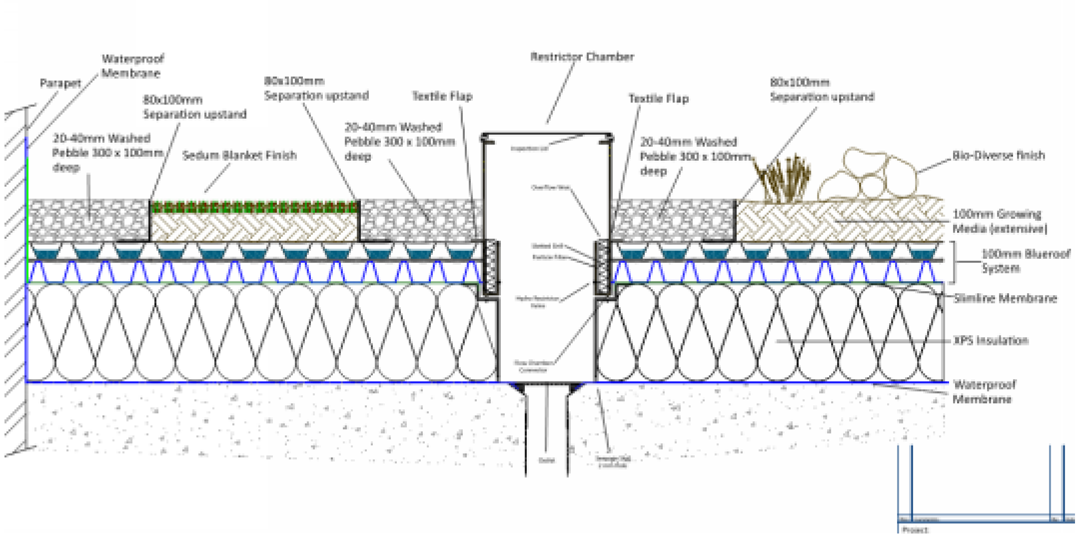


Figure - 13 Section through the Blueroof system.

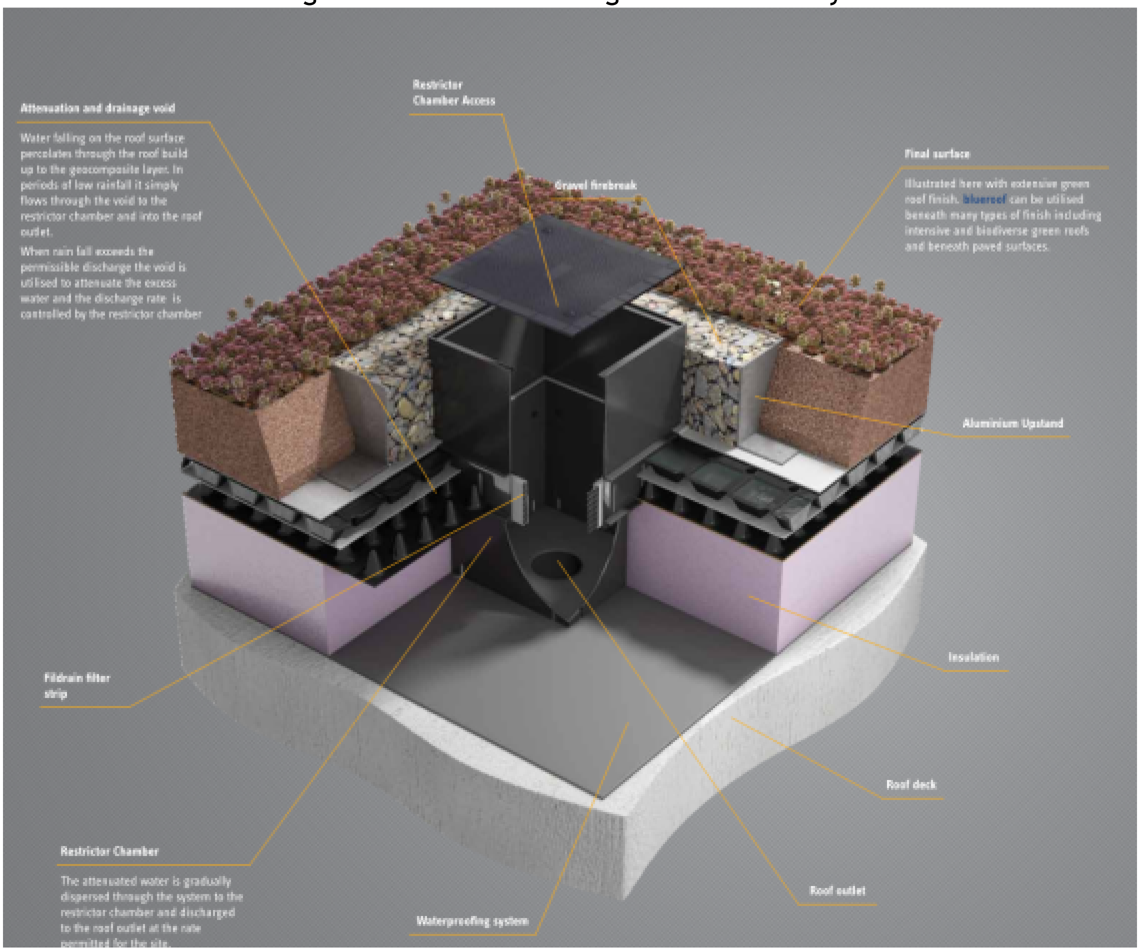


Figure - 14 Green roof system schematic

By using the greenroof system over 189m^2 the discharge rate can be limited to 5l/s under a 1:100 year + 30 climate change condition using a 6 hour rainfall event.

Attenuation tanks

The site has an excavation restriction by virtue of the post office tunnel network directly beneath the site. It is possible to install a tank within the existing basement level. However this may lead to the potential requirement of pumping meaning the tanks fill under gravity but then require energy to pump the stored volume. Overflow weirs could be used to discharge to the local sewer network to prevent against flood risk however at this stage tanks will not be used as sufficient attenuation capacity exists within the green roof.

Rainwater harvesting

The extent of landscaping means the demand for rainwater harvesting is low and therefore the attenuation opportunity is low. Although this system is viable it will be discounted.

Soakaways, swales and filter strips, basins, ponds and bio-retention areas.

The urban nature of this site precludes the use of any of these techniques.

Surface Water run off conclusions

The appended calculations confirm the run-off rates for the proposed system. The Blueroof will attenuate the water to 5l/s thus the system will comply with the local authority requirements for storm water attenuation.

APPENDIX A

GREENFIELD RUN OFF RATES

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	0.090	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.1
QBAR Urban	0.1
Q1 year	0.1
Q1 year	0.1
Q30 years	0.3
Q100 years	0.4

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.442
Areal Reduction Factor	1.00
Area (ha)	0.090
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	30.000

Results

Percentage Runoff (%)	20.50
Greenfield Runoff Volume (m^3)	3.987

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.442
Areal Reduction Factor	1.00
Area (ha)	0.090
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	30.000

Results

Percentage Runoff (%)	22.38
Greenfield Runoff Volume (m^3)	9.611

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.442
Areal Reduction Factor	1.00
Area (ha)	0.090
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	30.000

Results

Percentage Runoff (%)	24.41
Greenfield Runoff Volume (m^3)	13.598

APPENDIX B

EXISTING RUN OFF CALCS

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.849	0.199	14.6	0.2	O K
30 min Summer	10.833	0.183	12.5	0.2	O K
60 min Summer	10.813	0.163	9.1	0.2	O K
120 min Summer	10.783	0.133	5.6	0.2	O K
180 min Summer	10.755	0.105	4.5	0.1	O K
240 min Summer	10.737	0.087	3.6	0.1	O K
360 min Summer	10.720	0.070	2.7	0.1	O K
480 min Summer	10.712	0.062	2.2	0.1	O K
600 min Summer	10.706	0.056	1.8	0.1	O K
720 min Summer	10.702	0.052	1.6	0.1	O K
960 min Summer	10.697	0.047	1.3	0.1	O K
1440 min Summer	10.690	0.040	1.0	0.0	O K
2160 min Summer	10.685	0.035	0.7	0.0	O K
2880 min Summer	10.681	0.031	0.6	0.0	O K
4320 min Summer	10.677	0.027	0.4	0.0	O K
5760 min Summer	10.674	0.024	0.3	0.0	O K
7200 min Summer	10.672	0.022	0.3	0.0	O K
8640 min Summer	10.669	0.019	0.2	0.0	O K
10080 min Summer	10.668	0.018	0.2	0.0	O K
15 min Winter	10.848	0.198	14.4	0.2	O K
30 min Winter	10.821	0.171	10.5	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	32.914	0.0	5.6	10
30 min Summer	21.228	0.0	7.2	17
60 min Summer	13.233	0.0	8.9	34
120 min Summer	8.073	0.0	10.9	62
180 min Summer	6.014	0.0	12.2	92
240 min Summer	4.874	0.0	13.2	118
360 min Summer	3.603	0.0	14.6	182
480 min Summer	2.900	0.0	15.7	244
600 min Summer	2.450	0.0	16.5	300
720 min Summer	2.134	0.0	17.3	358
960 min Summer	1.717	0.0	18.5	476
1440 min Summer	1.264	0.0	20.5	716
2160 min Summer	0.931	0.0	22.6	1100
2880 min Summer	0.749	0.0	24.3	1432
4320 min Summer	0.551	0.0	26.8	2204
5760 min Summer	0.443	0.0	28.7	2920
7200 min Summer	0.375	0.0	30.3	3544
8640 min Summer	0.326	0.0	31.7	4400
10080 min Summer	0.291	0.0	33.0	5040
15 min Winter	32.914	0.0	6.2	10
30 min Winter	21.228	0.0	8.0	18

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.803	0.153	6.8	0.2	O K
120 min Winter	10.754	0.104	4.4	0.1	O K
180 min Winter	10.732	0.082	3.3	0.1	O K
240 min Winter	10.719	0.069	2.6	0.1	O K
360 min Winter	10.708	0.058	1.9	0.1	O K
480 min Winter	10.702	0.052	1.6	0.1	O K
600 min Winter	10.698	0.048	1.3	0.1	O K
720 min Winter	10.695	0.045	1.1	0.0	O K
960 min Winter	10.690	0.040	0.9	0.0	O K
1440 min Winter	10.684	0.034	0.7	0.0	O K
2160 min Winter	10.679	0.029	0.5	0.0	O K
2880 min Winter	10.676	0.026	0.4	0.0	O K
4320 min Winter	10.672	0.022	0.3	0.0	O K
5760 min Winter	10.669	0.019	0.2	0.0	O K
7200 min Winter	10.667	0.017	0.2	0.0	O K
8640 min Winter	10.666	0.016	0.2	0.0	O K
10080 min Winter	10.665	0.015	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	13.233	0.0	10.0	32
120 min Winter	8.073	0.0	12.2	60
180 min Winter	6.014	0.0	13.6	86
240 min Winter	4.874	0.0	14.7	118
360 min Winter	3.603	0.0	16.3	186
480 min Winter	2.900	0.0	17.5	232
600 min Winter	2.450	0.0	18.5	300
720 min Winter	2.134	0.0	19.4	360
960 min Winter	1.717	0.0	20.8	476
1440 min Winter	1.264	0.0	22.9	714
2160 min Winter	0.931	0.0	25.3	1084
2880 min Winter	0.749	0.0	27.2	1436
4320 min Winter	0.551	0.0	30.0	2200
5760 min Winter	0.443	0.0	32.2	2864
7200 min Winter	0.375	0.0	34.0	3624
8640 min Winter	0.326	0.0	35.5	4424
10080 min Winter	0.291	0.0	36.9	5088

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Pipe Structure

Diameter (m)	0.150	Length (m)	1.000
Slope (1:X)	100.000	Invert Level (m)	10.650

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	10.650
Roughness k (mm)	0.600		

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	11.280	0.630	35.0	0.6	O K
30 min Summer	11.115	0.465	29.3	0.5	O K
60 min Summer	10.918	0.268	20.6	0.3	O K
120 min Summer	10.839	0.189	13.3	0.2	O K
180 min Summer	10.817	0.167	9.8	0.2	O K
240 min Summer	10.808	0.158	8.1	0.2	O K
360 min Summer	10.794	0.144	5.9	0.2	O K
480 min Summer	10.759	0.109	4.7	0.1	O K
600 min Summer	10.747	0.097	4.0	0.1	O K
720 min Summer	10.737	0.087	3.6	0.1	O K
960 min Summer	10.721	0.071	2.8	0.1	O K
1440 min Summer	10.708	0.058	1.9	0.1	O K
2160 min Summer	10.699	0.049	1.4	0.1	O K
2880 min Summer	10.694	0.044	1.1	0.0	O K
4320 min Summer	10.687	0.037	0.8	0.0	O K
5760 min Summer	10.683	0.033	0.7	0.0	O K
7200 min Summer	10.680	0.030	0.5	0.0	O K
8640 min Summer	10.678	0.028	0.5	0.0	O K
10080 min Summer	10.677	0.027	0.4	0.0	O K
15 min Winter	11.280	0.630	35.0	0.6	O K
30 min Winter	11.024	0.374	25.7	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	80.827	0.0	13.6	10
30 min Summer	51.838	0.0	17.5	17
60 min Summer	31.749	0.0	21.4	32
120 min Summer	18.872	0.0	25.5	62
180 min Summer	13.779	0.0	27.9	92
240 min Summer	10.980	0.0	29.6	118
360 min Summer	7.955	0.0	32.2	182
480 min Summer	6.327	0.0	34.2	246
600 min Summer	5.294	0.0	35.7	302
720 min Summer	4.575	0.0	37.1	360
960 min Summer	3.633	0.0	39.2	492
1440 min Summer	2.622	0.0	42.5	730
2160 min Summer	1.890	0.0	45.9	1100
2880 min Summer	1.498	0.0	48.5	1436
4320 min Summer	1.078	0.0	52.4	2140
5760 min Summer	0.853	0.0	55.3	2864
7200 min Summer	0.712	0.0	57.6	3672
8640 min Summer	0.613	0.0	59.6	4320
10080 min Summer	0.541	0.0	61.3	4992
15 min Winter	80.827	0.0	15.3	10
30 min Winter	51.838	0.0	19.6	17

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.864	0.214	16.4	0.2	O K
120 min Winter	10.817	0.167	9.9	0.2	O K
180 min Winter	10.806	0.156	7.5	0.2	O K
240 min Winter	10.792	0.142	5.8	0.2	O K
360 min Winter	10.754	0.104	4.4	0.1	O K
480 min Winter	10.737	0.087	3.6	0.1	O K
600 min Winter	10.724	0.074	2.9	0.1	O K
720 min Winter	10.717	0.067	2.5	0.1	O K
960 min Winter	10.709	0.059	2.0	0.1	O K
1440 min Winter	10.699	0.049	1.4	0.1	O K
2160 min Winter	10.692	0.042	1.0	0.0	O K
2880 min Winter	10.687	0.037	0.8	0.0	O K
4320 min Winter	10.682	0.032	0.6	0.0	O K
5760 min Winter	10.678	0.028	0.5	0.0	O K
7200 min Winter	10.676	0.026	0.4	0.0	O K
8640 min Winter	10.674	0.024	0.4	0.0	O K
10080 min Winter	10.672	0.022	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	31.749	0.0	24.0	32
120 min Winter	18.872	0.0	28.5	64
180 min Winter	13.779	0.0	31.3	100
240 min Winter	10.980	0.0	33.2	124
360 min Winter	7.955	0.0	36.1	182
480 min Winter	6.327	0.0	38.3	224
600 min Winter	5.294	0.0	40.0	290
720 min Winter	4.575	0.0	41.5	366
960 min Winter	3.633	0.0	43.9	472
1440 min Winter	2.622	0.0	47.6	718
2160 min Winter	1.890	0.0	51.4	1104
2880 min Winter	1.498	0.0	54.3	1432
4320 min Winter	1.078	0.0	58.7	2140
5760 min Winter	0.853	0.0	61.9	2896
7200 min Winter	0.712	0.0	64.5	3592
8640 min Winter	0.613	0.0	66.8	4304
10080 min Winter	0.541	0.0	68.7	5008

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Pipe Structure

Diameter (m)	0.150	Length (m)	1.000
Slope (1:X)	100.000	Invert Level (m)	10.650

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	10.650
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	11.641	0.991	45.0	1.0	O K
30 min Summer	11.384	0.734	38.1	0.8	O K
60 min Summer	11.061	0.411	27.2	0.4	O K
120 min Summer	10.876	0.226	17.6	0.2	O K
180 min Summer	10.837	0.187	13.1	0.2	O K
240 min Summer	10.820	0.170	10.5	0.2	O K
360 min Summer	10.807	0.157	7.9	0.2	O K
480 min Summer	10.801	0.151	6.1	0.2	O K
600 min Summer	10.770	0.120	5.2	0.1	O K
720 min Summer	10.754	0.104	4.4	0.1	O K
960 min Summer	10.734	0.084	3.5	0.1	O K
1440 min Summer	10.717	0.067	2.5	0.1	O K
2160 min Summer	10.705	0.055	1.8	0.1	O K
2880 min Summer	10.699	0.049	1.4	0.1	O K
4320 min Summer	10.692	0.042	1.0	0.0	O K
5760 min Summer	10.687	0.037	0.8	0.0	O K
7200 min Summer	10.684	0.034	0.7	0.0	O K
8640 min Summer	10.681	0.031	0.6	0.0	O K
10080 min Summer	10.679	0.029	0.5	0.0	O K
15 min Winter	11.643	0.993	45.0	1.0	O K
30 min Winter	11.232	0.582	33.4	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.122	0.0	17.7	10
30 min Summer	67.935	0.0	22.9	18
60 min Summer	41.754	0.0	28.2	32
120 min Summer	24.792	0.0	33.5	62
180 min Summer	18.043	0.0	36.5	92
240 min Summer	14.324	0.0	38.7	122
360 min Summer	10.321	0.0	41.8	180
480 min Summer	8.179	0.0	44.2	242
600 min Summer	6.825	0.0	46.1	300
720 min Summer	5.884	0.0	47.7	360
960 min Summer	4.653	0.0	50.2	470
1440 min Summer	3.338	0.0	54.1	724
2160 min Summer	2.391	0.0	58.1	1100
2880 min Summer	1.885	0.0	61.1	1456
4320 min Summer	1.347	0.0	65.5	2188
5760 min Summer	1.061	0.0	68.7	2856
7200 min Summer	0.881	0.0	71.3	3672
8640 min Summer	0.756	0.0	73.5	4344
10080 min Summer	0.665	0.0	75.4	5112
15 min Winter	105.122	0.0	19.9	10
30 min Winter	67.935	0.0	25.7	17

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.939	0.289	21.7	0.3	O K
120 min Winter	10.837	0.187	13.1	0.2	O K
180 min Winter	10.816	0.166	9.6	0.2	O K
240 min Winter	10.807	0.157	7.9	0.2	O K
360 min Winter	10.781	0.131	5.5	0.1	O K
480 min Winter	10.754	0.104	4.4	0.1	O K
600 min Winter	10.739	0.089	3.6	0.1	O K
720 min Winter	10.732	0.082	3.3	0.1	O K
960 min Winter	10.717	0.067	2.5	0.1	O K
1440 min Winter	10.706	0.056	1.8	0.1	O K
2160 min Winter	10.697	0.047	1.3	0.1	O K
2880 min Winter	10.692	0.042	1.0	0.0	O K
4320 min Winter	10.685	0.035	0.7	0.0	O K
5760 min Winter	10.681	0.031	0.6	0.0	O K
7200 min Winter	10.679	0.029	0.5	0.0	O K
8640 min Winter	10.676	0.026	0.4	0.0	O K
10080 min Winter	10.675	0.025	0.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.754	0.0	31.6	32
120 min Winter	24.792	0.0	37.5	60
180 min Winter	18.043	0.0	40.9	94
240 min Winter	14.324	0.0	43.3	116
360 min Winter	10.321	0.0	46.8	184
480 min Winter	8.179	0.0	49.5	238
600 min Winter	6.825	0.0	51.6	308
720 min Winter	5.884	0.0	53.4	370
960 min Winter	4.653	0.0	56.3	490
1440 min Winter	3.338	0.0	60.6	732
2160 min Winter	2.391	0.0	65.1	1084
2880 min Winter	1.885	0.0	68.4	1456
4320 min Winter	1.347	0.0	73.3	2204
5760 min Winter	1.061	0.0	77.0	2720
7200 min Winter	0.881	0.0	79.9	3632
8640 min Winter	0.756	0.0	82.4	4128
10080 min Winter	0.665	0.0	84.5	4920

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.090

Time From:	(mins) To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Pipe Structure

Diameter (m)	0.150	Length (m)	1.000
Slope (1:X)	100.000	Invert Level (m)	10.650

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	10.650
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	12.000	1.350	53.0	1.8	FLOOD
30 min Summer	11.830	1.180	49.4	1.2	Flood Risk
60 min Summer	11.283	0.633	35.1	0.7	O K
120 min Summer	10.959	0.309	22.7	0.3	O K
180 min Summer	10.871	0.221	17.1	0.2	O K
240 min Summer	10.842	0.192	13.7	0.2	O K
360 min Summer	10.817	0.167	9.8	0.2	O K
480 min Summer	10.807	0.157	7.9	0.2	O K
600 min Summer	10.802	0.152	6.5	0.2	O K
720 min Summer	10.786	0.136	5.7	0.2	O K
960 min Summer	10.759	0.109	4.7	0.1	O K
1440 min Summer	10.734	0.084	3.5	0.1	O K
2160 min Summer	10.714	0.064	2.3	0.1	O K
2880 min Summer	10.706	0.056	1.8	0.1	O K
4320 min Summer	10.698	0.048	1.3	0.1	O K
5760 min Summer	10.693	0.043	1.1	0.0	O K
7200 min Summer	10.688	0.038	0.9	0.0	O K
8640 min Summer	10.686	0.036	0.8	0.0	O K
10080 min Summer	10.684	0.034	0.7	0.0	O K
15 min Winter	12.000	1.350	53.0	1.8	FLOOD
30 min Winter	11.580	0.930	43.4	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.659	0.4	23.1	11
30 min Summer	88.315	0.0	29.8	18
60 min Summer	54.281	0.0	36.6	32
120 min Summer	32.230	0.0	43.5	62
180 min Summer	23.456	0.0	47.5	92
240 min Summer	18.621	0.0	50.3	122
360 min Summer	13.418	0.0	54.3	182
480 min Summer	10.633	0.0	57.4	246
600 min Summer	8.872	0.0	59.9	294
720 min Summer	7.649	0.0	62.0	360
960 min Summer	6.048	0.0	65.3	474
1440 min Summer	4.339	0.0	70.3	710
2160 min Summer	3.108	0.0	75.5	1100
2880 min Summer	2.451	0.0	79.4	1432
4320 min Summer	1.752	0.0	85.1	2184
5760 min Summer	1.379	0.0	89.4	2920
7200 min Summer	1.145	0.0	92.8	3632
8640 min Summer	0.983	0.0	95.6	4376
10080 min Summer	0.864	0.0	98.0	4984
15 min Winter	136.659	0.5	25.8	11
30 min Winter	88.315	0.0	33.4	18

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	11.084	0.434	28.1	0.5	O K
120 min Winter	10.870	0.220	17.0	0.2	O K
180 min Winter	10.833	0.183	12.5	0.2	O K
240 min Winter	10.817	0.167	9.9	0.2	O K
360 min Winter	10.805	0.155	7.2	0.2	O K
480 min Winter	10.786	0.136	5.7	0.2	O K
600 min Winter	10.764	0.114	4.9	0.1	O K
720 min Winter	10.749	0.099	4.1	0.1	O K
960 min Winter	10.734	0.084	3.5	0.1	O K
1440 min Winter	10.715	0.065	2.3	0.1	O K
2160 min Winter	10.704	0.054	1.7	0.1	O K
2880 min Winter	10.698	0.048	1.3	0.1	O K
4320 min Winter	10.690	0.040	1.0	0.0	O K
5760 min Winter	10.686	0.036	0.8	0.0	O K
7200 min Winter	10.683	0.033	0.6	0.0	O K
8640 min Winter	10.680	0.030	0.5	0.0	O K
10080 min Winter	10.678	0.028	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.281	0.0	41.0	32
120 min Winter	32.230	0.0	48.7	64
180 min Winter	23.456	0.0	53.2	90
240 min Winter	18.621	0.0	56.3	118
360 min Winter	13.418	0.0	60.9	182
480 min Winter	10.633	0.0	64.3	242
600 min Winter	8.872	0.0	67.1	300
720 min Winter	7.649	0.0	69.4	372
960 min Winter	6.048	0.0	73.2	508
1440 min Winter	4.339	0.0	78.7	720
2160 min Winter	3.108	0.0	84.6	1072
2880 min Winter	2.451	0.0	88.9	1444
4320 min Winter	1.752	0.0	95.3	2188
5760 min Winter	1.379	0.0	100.1	2840
7200 min Winter	1.145	0.0	103.9	3728
8640 min Winter	0.983	0.0	107.1	4120
10080 min Winter	0.864	0.0	109.8	4752

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Pipe Structure

Diameter (m)	0.150	Length (m)	1.000
Slope (1:X)	100.000	Invert Level (m)	10.650

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	10.650
Roughness k (mm)	0.600		

APPENDIX C

PROPOSED RUN OFF CALCS WITH BLUEROOF SYSTEM

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.834	0.334	4.0	20.7	O K
30 min Summer	10.903	0.403	4.4	25.0	O K
60 min Summer	10.936	0.436	4.6	27.0	O K
120 min Summer	10.937	0.437	4.6	27.1	O K
180 min Summer	10.918	0.418	4.5	25.9	O K
240 min Summer	10.893	0.393	4.4	24.4	O K
360 min Summer	10.847	0.347	4.1	21.5	O K
480 min Summer	10.808	0.308	3.8	19.1	O K
600 min Summer	10.775	0.275	3.6	17.1	O K
720 min Summer	10.748	0.248	3.4	15.4	O K
960 min Summer	10.706	0.206	3.1	12.8	O K
1440 min Summer	10.651	0.151	2.5	9.4	O K
2160 min Summer	10.608	0.108	2.0	6.7	O K
2880 min Summer	10.586	0.086	1.7	5.3	O K
4320 min Summer	10.569	0.069	1.3	4.3	O K
5760 min Summer	10.559	0.059	1.0	3.7	O K
7200 min Summer	10.553	0.053	0.8	3.3	O K
8640 min Summer	10.549	0.049	0.7	3.0	O K
10080 min Summer	10.545	0.045	0.6	2.8	O K
15 min Winter	10.876	0.376	4.3	23.3	O K
30 min Winter	10.956	0.456	4.7	28.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.659	0.0	22.9	17
30 min Summer	88.315	0.0	29.7	31
60 min Summer	54.281	0.0	36.6	50
120 min Summer	32.230	0.0	43.5	84
180 min Summer	23.456	0.0	47.4	118
240 min Summer	18.621	0.0	50.2	152
360 min Summer	13.418	0.0	54.3	218
480 min Summer	10.633	0.0	57.4	282
600 min Summer	8.872	0.0	59.8	344
720 min Summer	7.649	0.0	61.9	406
960 min Summer	6.048	0.0	65.2	528
1440 min Summer	4.339	0.0	70.2	766
2160 min Summer	3.108	0.0	75.5	1124
2880 min Summer	2.451	0.0	79.4	1472
4320 min Summer	1.752	0.0	85.0	2204
5760 min Summer	1.379	0.0	89.3	2936
7200 min Summer	1.145	0.0	92.7	3672
8640 min Summer	0.983	0.0	95.5	4408
10080 min Summer	0.864	0.0	97.9	5128
15 min Winter	136.659	0.0	25.7	17
30 min Winter	88.315	0.0	33.3	31

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.993	0.493	4.9	30.6	O K
120 min Winter	10.987	0.487	4.9	30.2	O K
180 min Winter	10.955	0.455	4.7	28.2	O K
240 min Winter	10.919	0.419	4.5	26.0	O K
360 min Winter	10.852	0.352	4.1	21.8	O K
480 min Winter	10.799	0.299	3.8	18.5	O K
600 min Winter	10.757	0.257	3.5	15.9	O K
720 min Winter	10.723	0.223	3.2	13.8	O K
960 min Winter	10.674	0.174	2.8	10.8	O K
1440 min Winter	10.617	0.117	2.2	7.3	O K
2160 min Winter	10.582	0.082	1.6	5.1	O K
2880 min Winter	10.570	0.070	1.3	4.3	O K
4320 min Winter	10.556	0.056	0.9	3.5	O K
5760 min Winter	10.549	0.049	0.7	3.0	O K
7200 min Winter	10.543	0.043	0.6	2.7	O K
8640 min Winter	10.539	0.039	0.5	2.4	O K
10080 min Winter	10.536	0.036	0.5	2.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.281	0.0	41.0	56
120 min Winter	32.230	0.0	48.7	90
180 min Winter	23.456	0.0	53.1	126
240 min Winter	18.621	0.0	56.3	162
360 min Winter	13.418	0.0	60.8	232
480 min Winter	10.633	0.0	64.3	296
600 min Winter	8.872	0.0	67.0	360
720 min Winter	7.649	0.0	69.3	422
960 min Winter	6.048	0.0	73.1	542
1440 min Winter	4.339	0.0	78.6	780
2160 min Winter	3.108	0.0	84.6	1108
2880 min Winter	2.451	0.0	88.9	1468
4320 min Winter	1.752	0.0	95.2	2204
5760 min Winter	1.379	0.0	100.1	2936
7200 min Winter	1.145	0.0	103.9	3640
8640 min Winter	0.983	0.0	107.0	4288
10080 min Winter	0.864	0.0	109.7	5080

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Tank or Pond Structure

Invert Level (m) 10.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	62.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	62.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	62.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	62.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	62.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	62.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Orifice Outflow Control

Diameter (m) 0.059 Discharge Coefficient 0.600 Invert Level (m) 10.500

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.939	0.439	20.6	14.1	O K
30 min Summer	10.959	0.459	21.2	14.7	O K
60 min Summer	10.899	0.399	19.5	12.8	O K
120 min Summer	10.796	0.296	16.2	9.5	O K
180 min Summer	10.730	0.230	13.7	7.4	O K
240 min Summer	10.691	0.191	12.0	6.1	O K
360 min Summer	10.655	0.155	9.3	5.0	O K
480 min Summer	10.635	0.135	7.5	4.3	O K
600 min Summer	10.622	0.122	6.4	3.9	O K
720 min Summer	10.612	0.112	5.5	3.6	O K
960 min Summer	10.597	0.097	4.4	3.1	O K
1440 min Summer	10.577	0.077	3.2	2.5	O K
2160 min Summer	10.566	0.066	2.3	2.1	O K
2880 min Summer	10.560	0.060	1.8	1.9	O K
4320 min Summer	10.550	0.050	1.3	1.6	O K
5760 min Summer	10.544	0.044	1.0	1.4	O K
7200 min Summer	10.540	0.040	0.9	1.3	O K
8640 min Summer	10.537	0.037	0.7	1.2	O K
10080 min Summer	10.534	0.034	0.6	1.1	O K
15 min Winter	10.986	0.486	21.9	15.6	O K
30 min Winter	10.987	0.487	21.9	15.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.659	0.0	23.0	13
30 min Summer	88.315	0.0	29.8	21
60 min Summer	54.281	0.0	36.6	38
120 min Summer	32.230	0.0	43.5	68
180 min Summer	23.456	0.0	47.5	98
240 min Summer	18.621	0.0	50.3	126
360 min Summer	13.418	0.0	54.3	186
480 min Summer	10.633	0.0	57.4	246
600 min Summer	8.872	0.0	59.9	308
720 min Summer	7.649	0.0	61.9	368
960 min Summer	6.048	0.0	65.3	490
1440 min Summer	4.339	0.0	70.3	734
2160 min Summer	3.108	0.0	75.5	1096
2880 min Summer	2.451	0.0	79.4	1468
4320 min Summer	1.752	0.0	85.1	2188
5760 min Summer	1.379	0.0	89.3	2936
7200 min Summer	1.145	0.0	92.7	3632
8640 min Summer	0.983	0.0	95.6	4336
10080 min Summer	0.864	0.0	98.0	5136
15 min Winter	136.659	0.0	25.8	13
30 min Winter	88.315	0.0	33.4	22

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.892	0.392	19.3	12.5	O K
120 min Winter	10.755	0.255	14.7	8.2	O K
180 min Winter	10.687	0.187	11.8	6.0	O K
240 min Winter	10.659	0.159	9.6	5.1	O K
360 min Winter	10.630	0.130	7.0	4.1	O K
480 min Winter	10.613	0.113	5.6	3.6	O K
600 min Winter	10.602	0.102	4.7	3.2	O K
720 min Winter	10.591	0.091	4.0	2.9	O K
960 min Winter	10.578	0.078	3.2	2.5	O K
1440 min Winter	10.566	0.066	2.3	2.1	O K
2160 min Winter	10.557	0.057	1.7	1.8	O K
2880 min Winter	10.550	0.050	1.3	1.6	O K
4320 min Winter	10.542	0.042	0.9	1.3	O K
5760 min Winter	10.537	0.037	0.7	1.2	O K
7200 min Winter	10.534	0.034	0.6	1.1	O K
8640 min Winter	10.531	0.031	0.5	1.0	O K
10080 min Winter	10.529	0.029	0.5	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.281	0.0	41.0	38
120 min Winter	32.230	0.0	48.7	70
180 min Winter	23.456	0.0	53.2	98
240 min Winter	18.621	0.0	56.3	128
360 min Winter	13.418	0.0	60.8	188
480 min Winter	10.633	0.0	64.3	246
600 min Winter	8.872	0.0	67.1	308
720 min Winter	7.649	0.0	69.4	370
960 min Winter	6.048	0.0	73.1	490
1440 min Winter	4.339	0.0	78.7	734
2160 min Winter	3.108	0.0	84.6	1084
2880 min Winter	2.451	0.0	88.9	1444
4320 min Winter	1.752	0.0	95.3	2204
5760 min Winter	1.379	0.0	100.1	2936
7200 min Winter	1.145	0.0	103.9	3672
8640 min Winter	0.983	0.0	107.0	4304
10080 min Winter	0.864	0.0	109.8	4992

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.090

Time From:	(mins) To:	Area (ha)
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Tank or Pond Structure

Invert Level (m) 10.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	32.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	32.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	32.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	32.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	32.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	32.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Orifice Outflow Control

Diameter (m) 0.127 Discharge Coefficient 0.600 Invert Level (m) 10.500

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.987	0.487	44.0	6.8	O K
30 min Summer	10.931	0.431	40.7	6.0	O K
60 min Summer	10.804	0.304	32.2	4.3	O K
120 min Summer	10.716	0.216	22.0	3.0	O K
180 min Summer	10.680	0.180	16.6	2.5	O K
240 min Summer	10.658	0.158	13.4	2.2	O K
360 min Summer	10.629	0.129	9.8	1.8	O K
480 min Summer	10.610	0.110	7.8	1.5	O K
600 min Summer	10.601	0.101	6.6	1.4	O K
720 min Summer	10.594	0.094	5.7	1.3	O K
960 min Summer	10.586	0.086	4.5	1.2	O K
1440 min Summer	10.571	0.071	3.2	1.0	O K
2160 min Summer	10.560	0.060	2.3	0.8	O K
2880 min Summer	10.553	0.053	1.8	0.7	O K
4320 min Summer	10.545	0.045	1.3	0.6	O K
5760 min Summer	10.540	0.040	1.0	0.6	O K
7200 min Summer	10.536	0.036	0.9	0.5	O K
8640 min Summer	10.533	0.033	0.7	0.5	O K
10080 min Summer	10.531	0.031	0.7	0.4	O K
15 min Winter	11.008	0.508	45.1	7.1	O K
30 min Winter	10.895	0.395	38.5	5.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.659	0.0	23.1	11
30 min Summer	88.315	0.0	29.8	19
60 min Summer	54.281	0.0	36.6	34
120 min Summer	32.230	0.0	43.5	64
180 min Summer	23.456	0.0	47.5	94
240 min Summer	18.621	0.0	50.3	124
360 min Summer	13.418	0.0	54.3	184
480 min Summer	10.633	0.0	57.4	244
600 min Summer	8.872	0.0	59.9	304
720 min Summer	7.649	0.0	61.9	360
960 min Summer	6.048	0.0	65.3	484
1440 min Summer	4.339	0.0	70.3	732
2160 min Summer	3.108	0.0	75.5	1080
2880 min Summer	2.451	0.0	79.4	1428
4320 min Summer	1.752	0.0	85.1	2184
5760 min Summer	1.379	0.0	89.4	2856
7200 min Summer	1.145	0.0	92.7	3592
8640 min Summer	0.983	0.0	95.6	4368
10080 min Summer	0.864	0.0	98.0	4992
15 min Winter	136.659	0.0	25.8	11
30 min Winter	88.315	0.0	33.4	19

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.753	0.253	27.6	3.5	O K
120 min Winter	10.682	0.182	16.9	2.6	O K
180 min Winter	10.651	0.151	12.4	2.1	O K
240 min Winter	10.630	0.130	9.9	1.8	O K
360 min Winter	10.605	0.105	7.1	1.5	O K
480 min Winter	10.594	0.094	5.7	1.3	O K
600 min Winter	10.588	0.088	4.8	1.2	O K
720 min Winter	10.582	0.082	4.1	1.1	O K
960 min Winter	10.571	0.071	3.2	1.0	O K
1440 min Winter	10.560	0.060	2.3	0.8	O K
2160 min Winter	10.551	0.051	1.7	0.7	O K
2880 min Winter	10.545	0.045	1.3	0.6	O K
4320 min Winter	10.538	0.038	0.9	0.5	O K
5760 min Winter	10.533	0.033	0.7	0.5	O K
7200 min Winter	10.530	0.030	0.6	0.4	O K
8640 min Winter	10.528	0.028	0.5	0.4	O K
10080 min Winter	10.526	0.026	0.5	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.281	0.0	41.0	34
120 min Winter	32.230	0.0	48.7	64
180 min Winter	23.456	0.0	53.2	94
240 min Winter	18.621	0.0	56.3	124
360 min Winter	13.418	0.0	60.9	182
480 min Winter	10.633	0.0	64.3	244
600 min Winter	8.872	0.0	67.1	306
720 min Winter	7.649	0.0	69.4	364
960 min Winter	6.048	0.0	73.2	480
1440 min Winter	4.339	0.0	78.7	732
2160 min Winter	3.108	0.0	84.6	1072
2880 min Winter	2.451	0.0	88.9	1464
4320 min Winter	1.752	0.0	95.3	2172
5760 min Winter	1.379	0.0	100.1	2888
7200 min Winter	1.145	0.0	103.9	3624
8640 min Winter	0.983	0.0	107.1	4408
10080 min Winter	0.864	0.0	109.8	5008

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.090

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.090

Model Details

Storage is Online Cover Level (m) 12.000

Tank or Pond Structure

Invert Level (m) 10.500

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	14.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	14.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	14.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	14.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	14.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	14.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Orifice Outflow Control

Diameter (m) 0.183 Discharge Coefficient 0.600 Invert Level (m) 10.500

APPENDIX D

SURFACE DRAINAGE PROFORMA

Section 4 – Discharge rates

Existing peak runoff rates are based on the critical duration storm for each return period.

If the orifice plate flow control is designed to restrict the flows to 5.0l/s for the 1:100 year + 30% event then the rate will be less than 5.0l/s for smaller duration events due to the reduced head behind the orifice plate. As we can't model the blueroof system in MicroDrainage we are unable to provide a more definitive figure for these events but betterment would still be provided in comparison to the existing situation.

Section 5 – storage volumes

Existing and greenfield runoff volumes are based upon the 6 hour duration storm event for each return period.

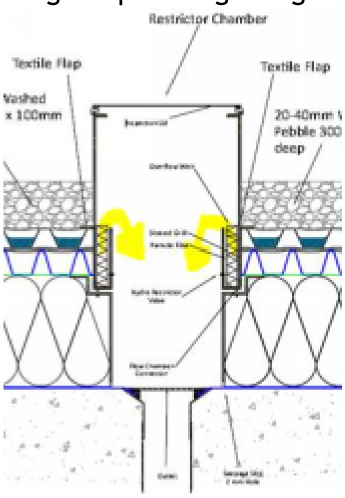
Again, as MicroDrainage can't model the blueroof system we are unable to provide the proposed runoff volumes. Presumably ABG would be able to provide this information? The proposed runoff volume should be less as the blueroof system provides interception and attenuation storage but we are unable to quantify it.

Section 6 – attenuation storage

We have altered the first line of this table; as greenfield runoff rates are very small it would not be practical to restrict development runoff to them due to flow control blockage risk. We have assumed 5.0l/s as a minimum rate in accordance with standard practice.

Section 8 - how are rates restricted?

Any overflow (if required) is managed internally by our blue roof restrictor chamber. Hence any exceedance/overspill is over the internal wall of the restrictor chamber, and then down into the RWO position. The height of this internal wall is designed to meet the requirements of the original planning design storm events.



Advice Note on contents of a Surface Water Drainage Statement

London Borough of Camden

1. Introduction

1.1 The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications will come into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

1.2 The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

1.3 Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and we'd encourage this is shown in a **Surface Water Drainage Statement**.

1.4 The purpose of this advice note is to set out what information should be included in such statements.

2. Requirements

2.1 It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with **details of its extent and position**, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

2.2 It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

2.3 The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a **maintenance plan** should be included within the Surface Water Drainage Statement,clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate Planning Practice Guidance suggests that this should be considered by reference to the costs that would be incurred by consumers for the use of an effective drainage system connecting directly to a public sewer.

2.4 Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve **greenfield run-off rates** and ensure that surface water run-off is managed as close to its source as possible in line with the following **drainage hierarchy**:

1 store rainwater for later use
2 use infiltration techniques, such as porous surfaces in non-clay areas
3 attenuate rainwater in ponds or open water features for gradual release
4 attenuate rainwater by storing in tanks or sealed water features for gradual release
5 discharge rainwater direct to a watercourse
6 discharge rainwater to a surface water sewer/drain
7 discharge rainwater to the combined sewer.

2.6 The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

2.7 Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

2.8 Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the **greenfield runoff volume** for the same event.

2.9 Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

2.10 Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

2.11 Where an application is part of a larger site which already has planning permission it is essential that the new proposal does not compromise the drainage scheme already approved.

3. Further information and guidance

3.1 Applicants are strongly advised to discuss their proposals with the Lead Local Flood Authority at the pre-application stage to ensure that an acceptable SuDS scheme is submitted.

3.2 For general clarification of these requirements please Camden's Local Planning Authority or Lead Local Flood Authority

Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	35-41 New Oxford Street, London, WC1A 1BH
Address & post code or LPA reference	35-41 New Oxford Street, London, WC1A 1BH
Grid reference	NGR 530182 181435
Is the existing site developed or Greenfield?	Developed
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	No
Total Site Area served by drainage system (excluding open space) (Ha)*	0.09

***** The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.09	0.09	0	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	sewer	sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations	y		attached	Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed.
Infiltration		n		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		n		e.g. Is there a watercourse nearby?
To surface water sewer		n		Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above	y			e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	y			Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	y		attached. See drawing 214312 - green roof areas.	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	0.16	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	14.6	<5	-9.6	-66%	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	35	<5	--30	-86%	
1in 100	45	<5	-40	-89%	
1 in 100 plus climate change	N/A	5	n/a	n/a	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1	4.0	16.3			Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	9.6	36.1			
1in 100 6 hour	13.6	46.8			
1 in 100 6 hour plus climate change	17.7	60.9			The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	N/A (GF too small)	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	16m3 (@ 22.5l/s)	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3)	31m3 (@ 5l/s)	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	7.1m3 (@45 l/s)	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	88% in green roof	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	Gravel over clay	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	no.	Infiltration rates should be no lower than $1x10^{-6}$ m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	n/a	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

	Were infiltration rates obtained by desk study or infiltration test?	desk study	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	no	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	no.	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	option 1	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	Green roof.	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	yes	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	yes	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	yes	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	design has been carried out in excess of policy requirements. no flooding under 1:100+30%.	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	Any overflow is managed internally by our blue roof restrictor chamber.	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	Solidon Ltd	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	The green roof will have an annual maintenance as part of the service charge and building management.	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	MNP flood risk assessment and drawing 214312 - Green roof areas	
Section 3	MNP flood risk assessment and drawing 214312 - Green roof areas	
Section 4	MNP drainage statement 214312 - appended calculations.	
Section 5	n/a	
Section 6	MNP drainage statement 214312 - appended calculations.	
Section 7	GEA site investigation report	
Section 8	MNP drainage statement 214312 - appended calculations.	

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By Stuart Pledge.

Qualification of person responsible for signing off this pro-forma BEng (Hons) CEng MIStructE

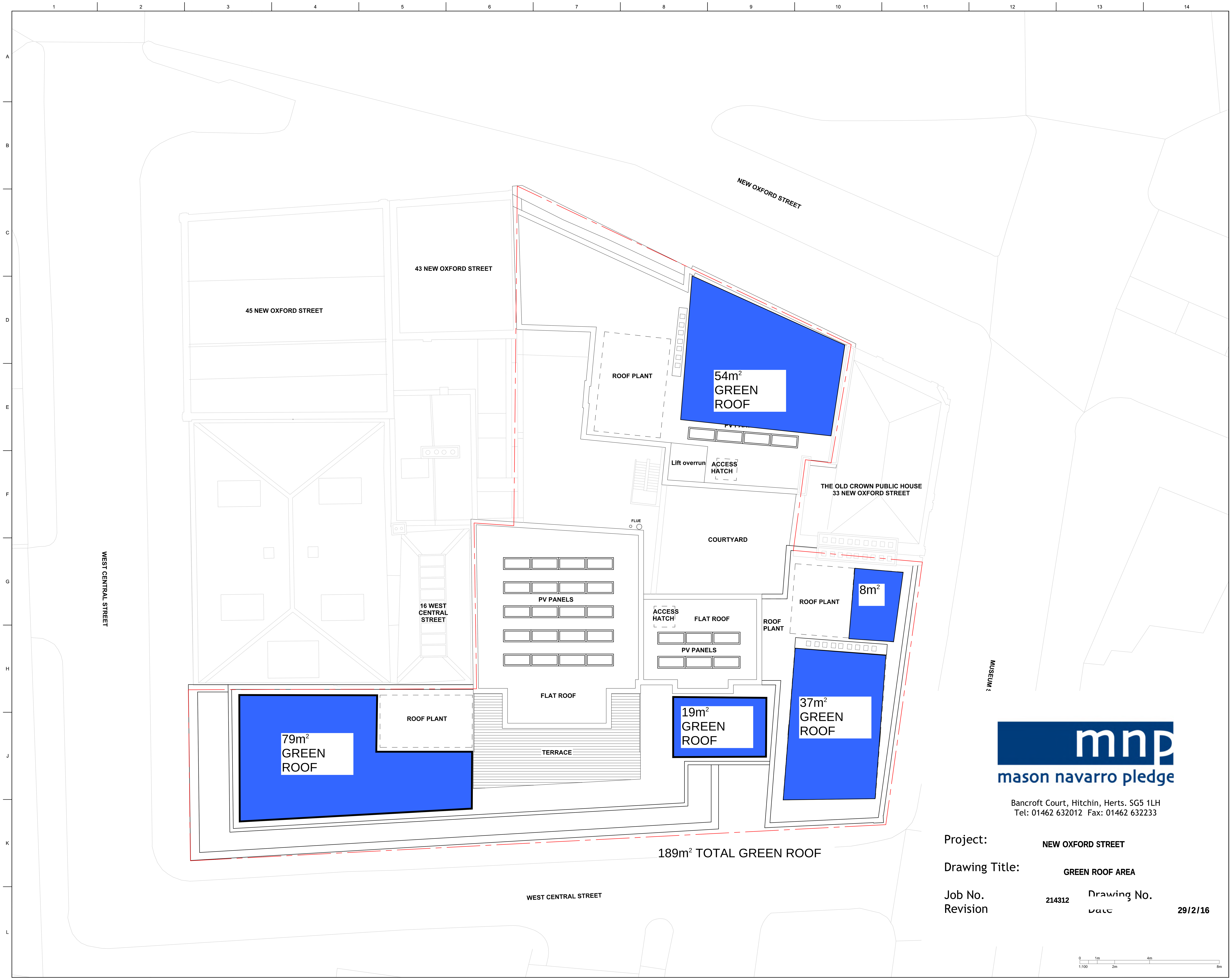
Company MASON NAVARRO PLEDGE

On behalf of (Client's details) Sollidon Ltd

Date: 12.05.2016

APPENDIX E

GREEN ROOF DRAWING



mason navarro pledge

Bancroft Court, Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Project: NEW OXFORD STREET

Drawing Title: GREEN ROOF AREA

Job No. 214312 Drawing No.

Revision Date 29/2/16

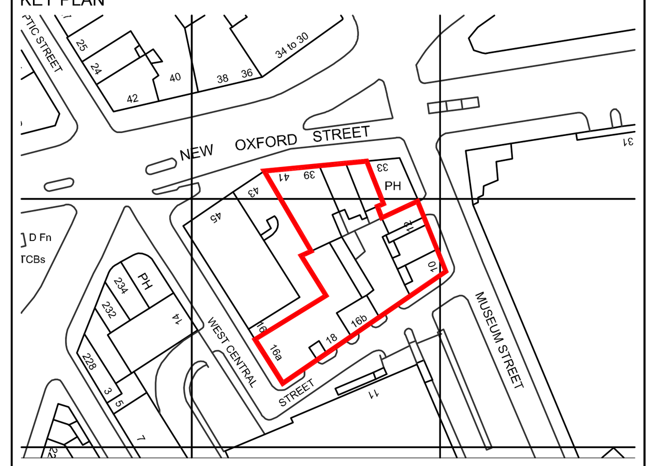
CLIENT
Triangle Investments and Development LTD

STRUCTURAL ENGINEER
Mason Navarro Pledge

SERVICES ENGINEER
Hurley Palmer Flatt

CONSULTANT
Montagu Evans

KEY PLAN



NOTES:

DO NOT SCALE. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING. CHECK DIMENSIONS ON SITE AND REPORT DISCREPANCIES TO THE ARCHITECT.

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No.	Date	Comment	Drawn	Chk'd
P2	08/01/16	Flat roof over Apartment 303 revised.	CB	GP
P1	23/11/15	First Issue	CH	GP

Revisions

Issue Status
PLANNING

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architecture
interiors
planning

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Project
New Oxford Street Estate

Drawing Title
Proposed
Roof Plan

Drawn	Date	Scale @ A1	Alt. Ref.
CH	23.11.2015	1:100	

tp bennett Project No.	Drawing Number	Rev
A10862	D 0105	P2

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