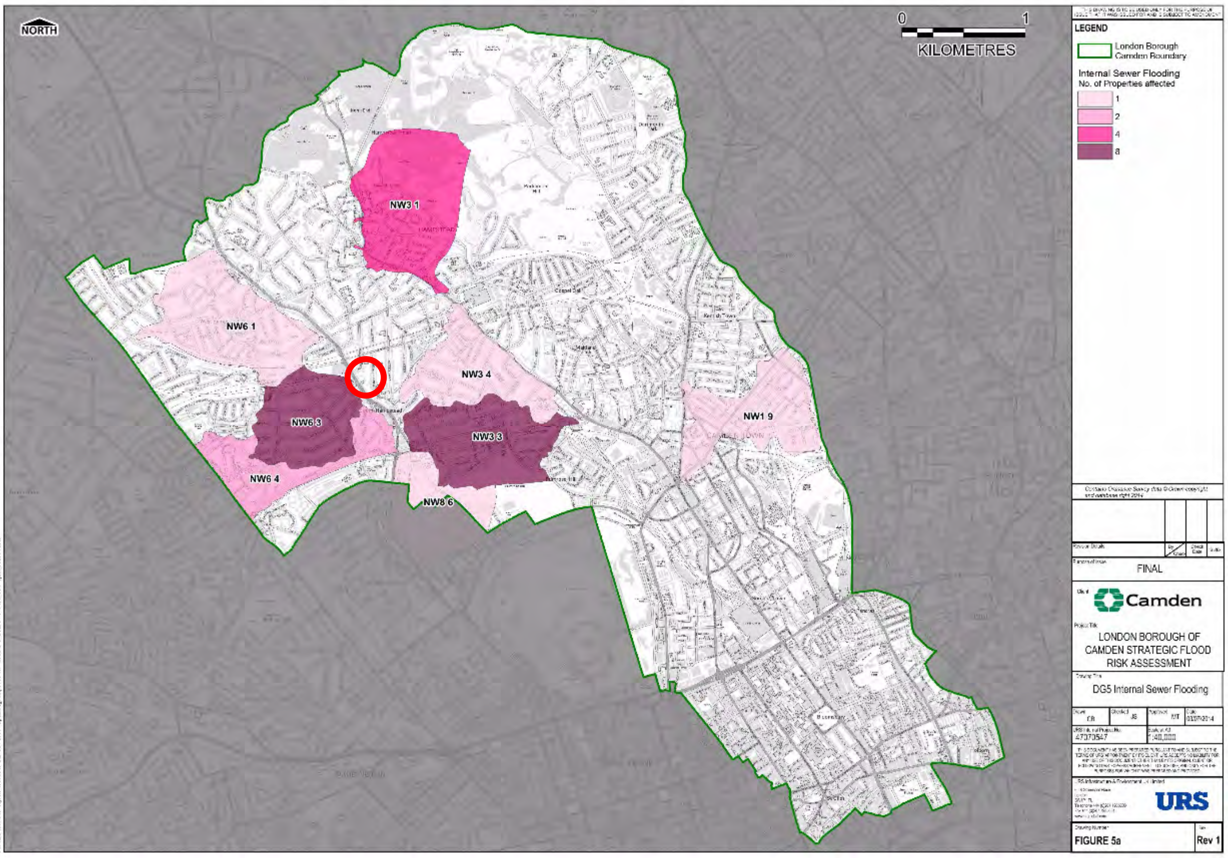
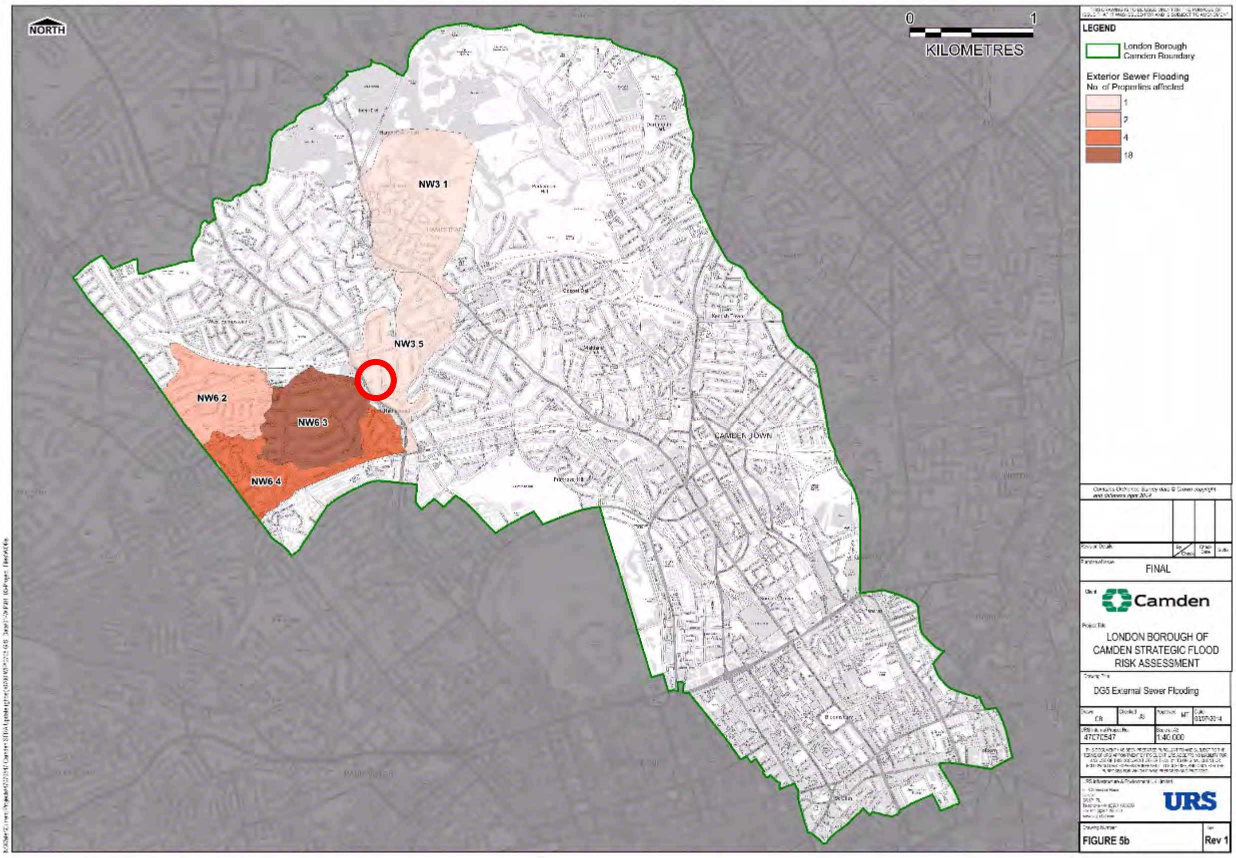


SITE LOCATION

Figure 4.6 Internal sewer flooding (Source: SFRA)



SITE LOCATION

Figure 4.7 External sewer flooding (Source: SFRA)

The EA also provides information on flooding from reservoirs. Figure 4.8 confirms that the site is not at risk of flooding from reservoirs.

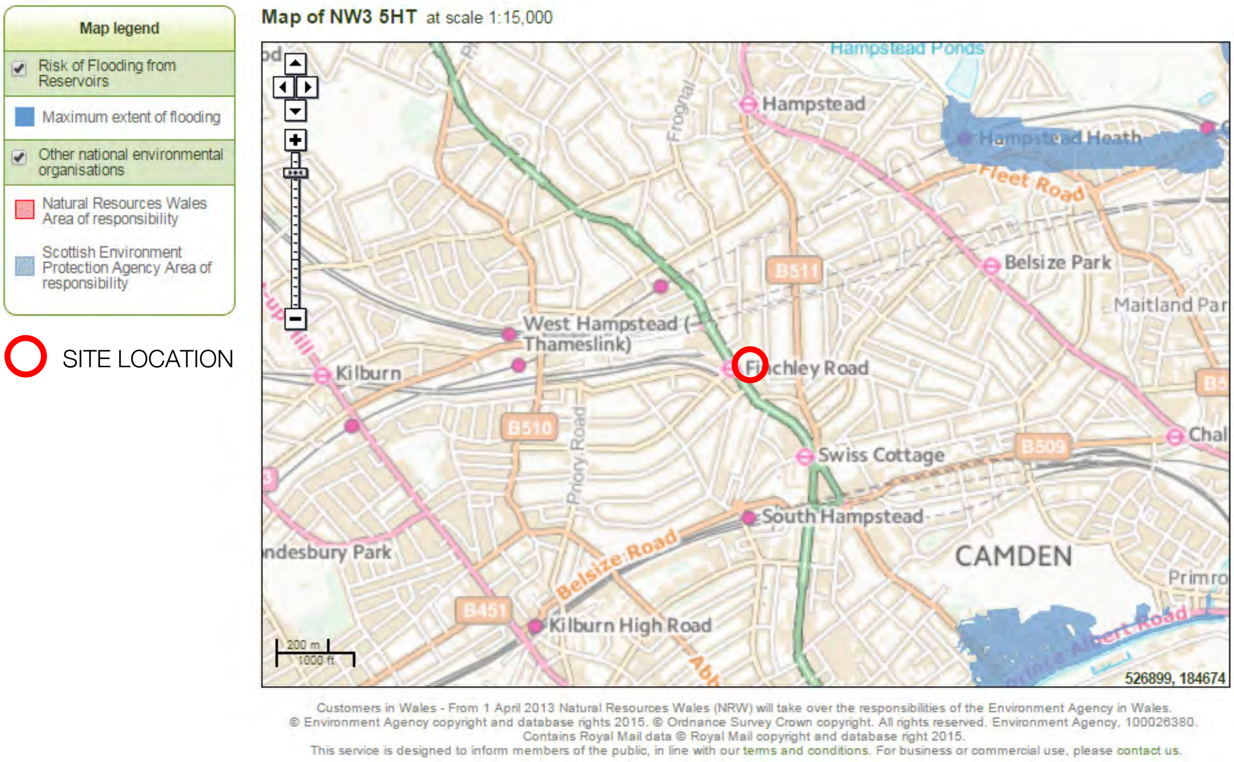


Figure 4.8 Indicative reservoir flooding map (Source: EA website)

5 Run-off Assessment

5.1 Existing Run-off

The site area is approximately 640m^2 (0.064 ha) and is currently occupied by existing buildings. The run-off rate was estimated for the 1 in 100 year storm event using the modified rational method:

Q_{100} = 2.78 x A x i (where "A" is the catchment area in hectares and "i" is the rainfall intensity in mm/hr as estimated from the Micro Drainage software.)

Q_{100} = 2.78 x 0.064 x 106 = 18.9 l/sec

5.2 Proposed Run-off

The proposed development will not increase the impermeable areas on site, therefore the peak surface water flow rate and volume to the public sewer will not be increased and there will be no increase in flood risk from surface water onsite or elsewhere.

However, in accordance with the London Plan, all new developments should aim to reduce run-off to Greenfield rates "utilising SUDS unless there are practical reasons for not doing so".

5.3 SUDS Assessment

In accordance with the London Plan, EA guidelines, CIRIA documents and the Camden SFRA and SWMP, surface water run-off should be managed as close to its source as possible, with the re-use of rainwater within the building prioritised. The following drainage hierarchy was used to determine the most suitable and sustainable SUDS strategy:

1. Store rainwater for later use;
2. Use infiltration techniques, such as porous surface in non-clay areas;
3. Attenuate rainwater in ponds or open water features for gradual release;
4. Attenuate rainwater by storing in tanks or seals 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 a combined sewer.

Rainwater harvesting is considered the most sustainable solution as it reduces the total volume of water drainage to the public sewers as well as reducing the domestic water demand of the building and should therefore be considered for this development. However, the capacity of a rainwater harvesting system to attenuate storm water depends on the water use within the building. If there is no activity in the building and the harvester is full, no attenuation will be provided during a subsequent storm event. In the worst case scenario the rainwater harvesting will provide no attenuation and therefore water demand will dictate its size.

As mentioned in the previous section, the site is underlain by Clay with no superficial deposits and the ground conditions are therefore unlikely to be suitable for infiltration techniques. Furthermore, infiltration devices must be located a minimum of 5m away from any structure and the proposed layout shows that there is insufficient space to accommodate this.

In accordance with the SUDS hierarchy it is preferable to attenuate rainwater in open features opposed to below ground tanks. As the proposed building occupies the entire site, ponds or swales are not feasible in this instance, however a green roof can be considered. Green roofs intercept storm water at high level and also provide other sustainability benefits. The SUDS manual states that "the hydraulic performance of green roofs during extreme events tends to be fairly similar to standard roofs. So the hydraulic design of green roof drainage should follow the advice in BS EN 12056-3:2000 (although the standard related to the design of normal roof drainage)". This means that green roofs will reduce the run-off rates in small storm events such as the annual and the 1 in 2 year events which are not responsible for surface and sewer flooding. However, these systems provide no attenuation benefits in high storm events such as the 1 in 30 and 1 in 100 year storms which can cause flooding. Therefore, any green roof system will need to be used in conjunction with below ground storage tanks.

There are no watercourses or surface water sewers within the vicinity of the site, therefore attenuated surface water will drain to the public combined sewer located in Finchley Road.

In accordance with the EA's guidelines, the Greenfield run-off rate for the existing site was estimated using the FEH method and the software provided by the UK Sustainable Drainage website (uksuds.com, Appendix C). The 100 year growth curve factor was multiplied by Q_{bar} to give a Greenfield run-off rate of 1.6 l/sec for the 1 in 100 year storm event. In accordance with the joint Defra/EA R&D Technical Report SC030219 "Rainfall Runoff Management for Developments" Revision E, the practicable minimum limit on the discharge rate from an attenuation device is 5 l/sec, as lower flow rates require small orifices which are more prone to blockages. Therefore surface water will be attenuated to 5 l/sec before drainage to the public sewers.

It is important to note that the EA have recently updated their advice regarding climate change. The new guidance states that there is a 10% chance the peak rainfall intensity will increase by 40% or more and that there is a 50% change it will increase by 20% or more, for the years 2070 to 2115. In order to decide which allowance to use the vulnerability of the development and the 'built in' resilience measures should be considered.

Considering the site is at low risk of surface water flooding an allowance of 20% is considered reasonably in this instance.

Preliminary calculations show that a volume of 19.5m^3 is required to attenuate to 5 l/sec for the 1 in 100 year plus 20% (climate change) storm event. It is proposed this volume is provided by a cellular attenuation tank located beneath the ground floor of the proposed building. A preliminary layout showing the proposed location of the attenuation tank can be found in Appendix D.

6 Conclusions

- The site falls within Flood Zone 1 *"areas with little or no potential risk of flooding (annual probability less than 0.1% for fluvial flooding), which are already developed."* Therefore there is no risk of flooding from rivers and/or the sea. Proposed developments in these areas have no restrictions provided that the surface water drainage proposals will not increase the flood risk to the site or the surrounding areas.

- Information from the EA's website and the London Borough of Camden SFRA shows that the site is at low risk of flooding from all sources including: watercourses and/or the sea, groundwater, surface water and infrastructure failure.

- There will be no increase in impermeable areas as a result of the proposed development and therefore no increase in the risk of flooding from surface water, on site or elsewhere.

- The SUDS assessment concludes that the ground conditions are not suitable for infiltration techniques. Surface water will therefore be attenuated to 5l/sec before draining to the public sewer in Finchley Road. Green roofs will also be included in the drainage strategy. This is an improvement on the existing condition as surface water currently drains unattenuated to the public sewer.

- Preliminary calculations show that a volume of 19.5m^3 is required to attenuate surface water to 5 l/sec for the 1 in 100 year plus 20% (climate change) storm event.

- The proposed redevelopment has an acceptable flood risk within the terms and requirements of NPPF and accompanying technical guidance.

Appendix A Ordnance Survey Information


56.3
60.2
64.3
70.9
79.4
78.4
76.2
59.3
71.7
67.9
73.5
74.8
58.1
53.3
72.4
67.6
66
71.1
71.7
68.5
63
56.1
69.9
66
66.5
62.6
66.7
59
62.4
54.6
63.8
53.9
65
62.5
47
48.7
46.7
50.4
59.2
63.7
46.8
62.8
61
57.6
48.6
46
54
47.3
54.9
61.5
62.1
44
44
55.8
57.6
45.6
47.2
56.7
56.1
56.1
42.8
56.7
55.5
56.4
56.1
56.7
42.5
59.4
42.9
54.9
41.4
41.3
44.8
43.7
40.8
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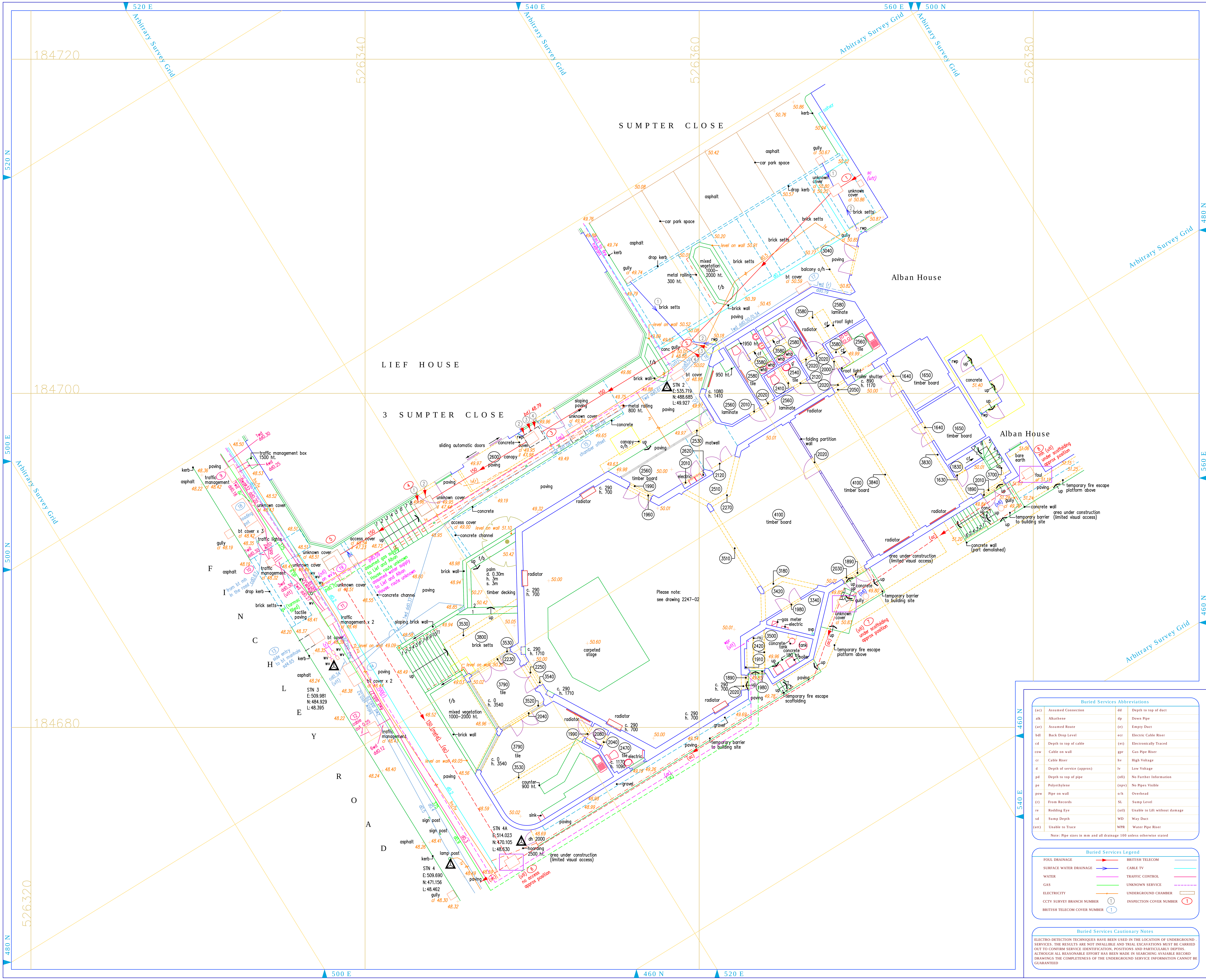
Appendix B Topographical Survey to Local Datum



Rev.	Description.	Date.
A	Lightwell added together with minor amendments	27/07/15
B	Plan rotated to Ordnance Survey Grid	03/08/15
C	Underground service information added and minor amendments	17/08/15

Abbreviations

a/c	Air Conditioning	g	Gully
b	Bollard	bt	British Telecom Cover
boe	Brick on Edge Coping	gv	Gas Valve
bt	British Telecom Cover	ht	Height
catv	Cable TV Cover	ic	Inspection Cover
c/b	Close Board	il	Invert Level
cf	Ceiling Fall	l/a	Limited Access
cl	Cover Level	l/v/a	Limited Visual Access
conc	Concrete	l/l	Low Level
dk	Drop Kerb	l/p	Lamp Post
dp	Down Pipe	n/a	No Access
er	Earth Rod	o/h	Over Head
fai	Fresh Air Inlet	r / rad	Radiator
far	Flat Asphalt Roof	rwp	Rain Water Pipe
f/b	Flower Bed	s/c	Structural Ceiling
f/c	False Ceiling	svp	Soil & Vent Pipe
fh	Fire Hydrant	wc	Toilet
fhr	Fire Hose Reel	whb	Wash Hand Basin
		wv	Water Valve

Legend

------	Indicates overhead or hidden feature.
-·—·-	Indicates centre of steel , handrail or as annotated.
dh. 1960	Door height from finished floor level. (mm)
c. 950	Cill height from finished floor level. (mm)
h. 1380	Head height from cill level. (mm)
sp. 2250	Spring height from cill or finished floor level. (mm)
(2550)	Height to ceiling/beam/soffit. (mm)
	Trees identified and measured approximately only
	Tree species
	d. 0.5m - Trunk diameter in metres
	h. 8m - Height in metres
	s. 10m - Spread in metres

Please Note:

1) This survey has been produced in accordance with the RICS specifications for Surveys of Land, Buildings and Utility Services.

2) The accuracy of this survey is dependent upon the scale of the commissioned survey. Users must be careful when re-scaling from any plots, using the grid to verify the scale.

3) This survey has been graphically fitted to the Ordnance Survey Grid. Furthermore, the North arrow is indicative only.

North Arrow

N
W E
S

Levels

All levels are related to a Local Site Datum.
Levels are in metres, positions are indicated by a cross or as noted.
Local site datum value: 50.00 m
Location: Ground floor level of Entrance Hall threshold of the Holy Trinity Church.

Buried Services Abbreviations

(ac)	Assumed Connection	dd	Depth to top of duct
alk	Alkathene	dp	Down Pipe
(ar)	Assumed Route	(e)	Empty Duct
bdl	Back Drop Level	ecr	Electric Cable Riser
cd	Depth to top of cable	(et)	Electronically Traced
cow	Cable on wall	gpr	Gas Pipe Riser
cr	Cable Riser	hv	High Voltage
d	Depth of service (approx)	lv	Low Voltage
pd	Depth to top of pipe	(nfi)	No Further Information
pe	Polyethylene	(npv)	No Pipes Visible
pow	Pipe on wall	o/h	Overhead
(r)	From Records	SL	Sump Level
re	Rodding Eye	(utl)	Unable to Lift without damage
sd	Sump Depth	WD	Way Duct
(utt)	Unable to Trace	WPR	Water Pipe Riser

Note: Pipe sizes in mm and all drainage 100 unless otherwise stated

Buried Services Legend

FOUL DRAINAGE
SURFACE WATER DRAINAGE
WATER
GAS
ELECTRICITY
CCTV SURVEY BRANCH NUMBER (1)
BRITISH TELECOM COVER NUMBER (1)
BRITISH TELECOM
CABLE TV
TRAFFIC CONTROL
UNKNOWN SERVICE
UNDERGROUND CHAMBER
INSPECTION COVER NUMBER (1)

Buried Services Cautionary Notes

ELECTRO-DETECTION TECHNIQUES HAVE BEEN USED IN THE LOCATION OF UNDERGROUND . SERVICES. THE RESULTS ARE NOT INFALLIBLE AND TRIAL EXCAVATIONS MUST BE CARRIED OUT TO CONFIRM SERVICE IDENTIFICATION, POSITIONS AND PARTICULARLY DEPTHS. ALTHOUGH ALL REASONABLE EFFORT HAS BEEN MADE IN SEARCHING AVAIABLE RECORD DRAWINGS THE COMPLETENESS OF THE UNDERGROUND SERVICE INFORMATION CANNOT BE GUARANTEED

Project Title:	Holy Trinity Church, London NW3 5HT		
Project No.:	2247		
Drawing Title:	Site Plan and Ground Floor		
Drawing No.:	2247-01	Revision:	C
Client:	Holy Trinity Church, Swiss Cottage		
	c/o Tandem Projects, Orchard House		
	Mill Lane, Halford, Warwickshire CV36 5BY		
Drawn:	K.A.G.H.	Checked:	M.A.R.
Scale:	1:100	Sheet Size:	A1
Date:	August 2015		

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Appendix C Preliminary Calculations

Greenfield runoff estimation for sites

HR Wallingford
Working with water

Site name:	Holy Trinity Church
Site location:	Swiss Cottage

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site coordinates

Latitude:	51.54697° N
Longitude:	0.17913° W
Reference:	gcpv5zvdcgwv / 0.1
Date:	11 Jan 2016

Site characteristics

Total site area	0.1	ha
Significant public open space	0	ha
Area positively drained	0.1	ha

Methodology

Greenfield runoff method	FEH	
Qmed estimation method	Calculate from BFI and SAAR	
BFI and SPR estimation method	Specify BFI manually	
HOST class	N/A	
BFI / BFIHOST	0.20	
Qmed	0.438	l/s
Qbar / Qmed Conversion Factor	1.136	

Hydrological characteristics

	Default	Edited	
SAAR	640	640	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.75	0.75	
Hydrological region	6	6	
Growth curve factor: 1 year	0.85	0.85	
Growth curve factor: 10 year	1.62	1.62	
Growth curve factor: 30 year	2.3	2.3	
Growth curve factor: 100 year	3.19	3.19	

Greenfield runoff rates

	Default	Edited	
Qbar	0.50	0.50	l/s
1 in 1 year	5.00	5.00	l/s
1 in 30 years	5.00	5.00	l/s
1 in 100 years	5.00	5.00	l/s

Please note that a minimum flow of 5 l/s applies to any site

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 43 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.692	0.692	0.0	4.2	4.2	12.8	O K
30 min Summer	0.799	0.799	0.0	4.5	4.5	14.8	O K
60 min Summer	0.831	0.831	0.0	4.6	4.6	15.4	O K
120 min Summer	0.775	0.775	0.0	4.4	4.4	14.3	O K
180 min Summer	0.696	0.696	0.0	4.2	4.2	12.9	O K
240 min Summer	0.622	0.622	0.0	3.9	3.9	11.5	O K
360 min Summer	0.507	0.507	0.0	3.6	3.6	9.4	O K
480 min Summer	0.420	0.420	0.0	3.2	3.2	7.8	O K
600 min Summer	0.354	0.354	0.0	3.0	3.0	6.5	O K
720 min Summer	0.300	0.300	0.0	2.7	2.7	5.6	O K
960 min Summer	0.222	0.222	0.0	2.4	2.4	4.1	O K
1440 min Summer	0.116	0.116	0.0	2.0	2.0	2.1	O K
2160 min Summer	0.082	0.082	0.0	1.5	1.5	1.5	O K
2880 min Summer	0.068	0.068	0.0	1.2	1.2	1.3	O K
4320 min Summer	0.054	0.054	0.0	0.9	0.9	1.0	O K
5760 min Summer	0.047	0.047	0.0	0.7	0.7	0.9	O K
7200 min Summer	0.042	0.042	0.0	0.6	0.6	0.8	O K
8640 min Summer	0.038	0.038	0.0	0.5	0.5	0.7	O K
10080 min Summer	0.036	0.036	0.0	0.4	0.4	0.7	O K
15 min Winter	0.783	0.783	0.0	4.4	4.4	14.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.206	0.0	15.4	16
30 min Summer	83.007	0.0	19.9	28
60 min Summer	51.094	0.0	24.5	44
120 min Summer	30.359	0.0	29.1	78
180 min Summer	22.092	0.0	31.8	112
240 min Summer	17.530	0.0	33.6	146
360 min Summer	12.660	0.0	36.5	208
480 min Summer	10.040	0.0	38.5	270
600 min Summer	8.381	0.0	40.2	332
720 min Summer	7.228	0.0	41.6	392
960 min Summer	5.719	0.0	43.9	512
1440 min Summer	4.106	0.0	47.3	736
2160 min Summer	2.944	0.0	50.9	1100
2880 min Summer	2.323	0.0	53.5	1468
4320 min Summer	1.661	0.0	57.4	2200
5760 min Summer	1.308	0.0	60.3	2936
7200 min Summer	1.087	0.0	62.6	3672
8640 min Summer	0.934	0.0	64.5	4400
10080 min Summer	0.821	0.0	66.2	5112
15 min Winter	128.206	0.0	17.2	16

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.911	0.911	0.0	4.8	4.8	16.9	O K
60 min Winter	0.939	0.939	0.0	4.8	4.8	17.4	O K
120 min Winter	0.848	0.848	0.0	4.6	4.6	15.7	O K
180 min Winter	0.732	0.732	0.0	4.3	4.3	13.6	O K
240 min Winter	0.629	0.629	0.0	4.0	4.0	11.7	O K
360 min Winter	0.475	0.475	0.0	3.4	3.4	8.8	O K
480 min Winter	0.367	0.367	0.0	3.0	3.0	6.8	O K
600 min Winter	0.289	0.289	0.0	2.7	2.7	5.4	O K
720 min Winter	0.231	0.231	0.0	2.4	2.4	4.3	O K
960 min Winter	0.126	0.126	0.0	2.0	2.0	2.3	O K
1440 min Winter	0.083	0.083	0.0	1.5	1.5	1.5	O K
2160 min Winter	0.064	0.064	0.0	1.1	1.1	1.2	O K
2880 min Winter	0.055	0.055	0.0	0.9	0.9	1.0	O K
4320 min Winter	0.045	0.045	0.0	0.6	0.6	0.8	O K
5760 min Winter	0.039	0.039	0.0	0.5	0.5	0.7	O K
7200 min Winter	0.035	0.035	0.0	0.4	0.4	0.6	O K
8640 min Winter	0.032	0.032	0.0	0.4	0.4	0.6	O K
10080 min Winter	0.030	0.030	0.0	0.3	0.3	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	83.007	0.0	22.3	29
60 min Winter	51.094	0.0	27.5	48
120 min Winter	30.359	0.0	32.6	84
180 min Winter	22.092	0.0	35.6	120
240 min Winter	17.530	0.0	37.7	154
360 min Winter	12.660	0.0	40.8	218
480 min Winter	10.040	0.0	43.2	280
600 min Winter	8.381	0.0	45.0	342
720 min Winter	7.228	0.0	46.6	404
960 min Winter	5.719	0.0	49.2	518
1440 min Winter	4.106	0.0	53.0	736
2160 min Winter	2.944	0.0	57.0	1096
2880 min Winter	2.323	0.0	59.9	1452
4320 min Winter	1.661	0.0	64.3	2196
5760 min Winter	1.308	0.0	67.5	2856
7200 min Winter	1.087	0.0	70.1	3640
8640 min Winter	0.934	0.0	72.3	4336
10080 min Winter	0.821	0.0	74.1	5032

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)	21.000	Shortest Storm (mins)	15
Ratio R	0.431	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.064

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.064

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	19.5	19.5	1.001	0.0	38.5
1.000	19.5	38.5			

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md7 Invert Level (m) 0.000
Design Flow (l/s) 5.0 Diameter (mm) 86

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	1.9	1.200	5.5	3.000	8.6	7.000	13.2
0.200	2.2	1.400	5.9	3.500	9.3	7.500	13.7
0.300	2.7	1.600	6.3	4.000	10.0	8.000	14.1
0.400	3.2	1.800	6.7	4.500	10.6	8.500	14.6
0.500	3.5	2.000	7.1	5.000	11.2	9.000	15.0
0.600	3.9	2.200	7.4	5.500	11.7	9.500	15.4
0.800	4.5	2.400	7.7	6.000	12.2		
1.000	5.0	2.600	8.0	6.500	12.7		

Appendix D Attenuation Tank Location Plan

Notes :

1. This drawing is to be read in conjunction with all relevant Architect's Engineer's and specialists' drawings and specifications.
2. Do not scale from this drawing in either paper or digital form. Use written dimensions only. To check that this drawing has been printed to the intended scale this bar should be 50mm long @ A1 or 25mm long @ A3.
3. Health & Safety : All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".
4. For general notes refer to Drawing No. 22247/01.

Contractor to allow for temporary de-watering of excavations. Refer to site investigation report by GEA Ltd

STAGE 3 REPORT ISSUE
NOT FOR CONSTRUCTION

Ver	Date	Drawn	Eng	Amendment
P1	29.11.16	SA	DD	Issued for Stage 3 report

HOLY TRINITY CHURCH SWISS COTTAGE

FOUNDATION PLAN

Status: FOR INFORMATION
NOT FOR CONSTRUCTION

Drawn: Sophie Arup
Eng: Daniel Dowek
Scales: 1:50 at A1, 1:100 at A3
Drawing No: 22247/09
Ver: P1

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Consulting Engineers
37 Alfred Place London WC1E 7DP
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E mail@pricemyers.com www.pricemyers.com

Notes :

1. This drawing is to be read in conjunction with all relevant Architect's Engineer's and specialists' drawings and specifications.
2. Do not scale from this drawing in either paper or digital form. Use written dimensions only. To check that this drawing has been printed to the intended scale this bar should be 50mm long @ A1 or 25mm long @ A3.
3. Health & Safety : All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".
4. For general notes refer to Drawing No. 22247/01.

COLUMNS	
C1	225x225 RC column
C2	250x250 RC column
C3	400x250 RC column
C4	350x350 RC column
C5	500x250 RC column
C6	600x500 RC column
C7	600x350 RC column
C8	350Ø RC column
C9	450Ø RC column
C10	250Ø RC column

WALLS	
W1	350 RC wall
W2	325 RC wall
W3	250 RC wall
W4	200 RC wall

STAGE 3 REPORT ISSUE
NOT FOR CONSTRUCTION

Ver	Date	Drawn	Eng	Amendment
P2	28.11.16	SA	DD	Issued for Stage 3 report
P1	06.10.16	SA	DD	Issued for interim coordination

HOLY TRINITY CHURCH
SWISS COTTAGE

GROUND FLOOR PLAN

Status
FOR INFORMATION
NOT FOR CONSTRUCTION

Drawn Sophie Arup | Eng Daniel Dowek
Scales 1:50 at A1 | 1:100 at A3
Drawing No 22247/10 | Ver P2

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Appendix E SUDS Maintenance Strategy

Holy Trinity Church, Swiss Cottage

Drainage Maintenance and Management Plan

This long-term Drainage network maintenance and management plan should be implemented at the proposed development at Holy Trinity Church, Finchley Road to ensure that the drainage network functions as designed. This plan is intended to cover all on-site drainage structures. The site owner possesses the primary responsibility for overseeing and implementing the maintenance and management plan and designating a person who will be responsible for the proper operation and maintenance of the foul and surface water structures.

Surface water Runoff Quality

The surface water management system protects and enhances the surface water runoff water quality through the removal of sediment and pollutants. The attenuation tank allows for settlement of sediments and silt trapped gullies significantly reduce the amount of pollutants entering the system. Preventive maintenance of the system will include a comprehensive source reduction program of regular sweeping and litter removal, prohibitions on the use of pesticides, and maintenance of bin areas.

Drainage System

Maintenance and cleaning of gullies, drain manholes and attenuation tanks will assure adequate performance. This maintenance program is outlined below.

Maintenance Program

The site maintenance staff will conduct the operation and maintenance program set forth in this document. The management company will ensure that inspections and record keeping are timely and accurate. Inspection & Maintenance Log Forms (attached) should include the date and physical conditions of the structures, depth of sediment in structures, evidence of overtopping or debris blockage and maintenance required of each structure. Records of maintenance will be kept on file at the site management company's office and copies of Inspection & Maintenance Log sheets indicating all work and inspections will be available to the Council or any other stakeholder upon request.

Concurrent with inspection and cleaning, all litter shall be picked up and removed from the parking areas and landscaped areas.

Regular maintenance should include:

1. Inspect gully inlet grates and remove any debris monthly or as determined to be reasonable based on experience with the installed systems to ensure that the gullies are working in their intended capacity and that they are free of debris. Quarterly, inspect gully sumps and bottom of drain manholes; if depth of sediment in sumps exceeds 50% capacity, sediment must be removed. Excessive sediment shall be removed and properly disposed by a licensed drainage cleaning company.

2. Inspection of bin and recycling enclosures for spillage and scattered litter must be performed on a regular basis to prevent the spread of pollutants into the surface water management system. Long-term management practices include monthly sweeping of landscaped areas. The sweeping program will remove sand and contaminants directly from paved surfaces before they become mobilised during rain events and transported to the drainage system. Pavement sweeping is a highly effective source control measure for

reducing pollutant loading in surface water. All sweepings will be disposed of in a legal manner. This activity is vital for the efficient operation of the drainage system, considering the presence of trees in this area.

3. Attenuation tank inlets, outlet and vents should be checked annually and after large storms to ensure that they are in good condition and operating as designed. Regular maintenance includes inspection and identification of any areas that are not operating correctly monthly for the first 3 months and then every 6 months after.

4. Fill all internal gullies with water every 3 month to reduce the risk of drying out and releasing unpleasant smells.

Winter Maintenance Program

Ensure that drainage structures are not blocked by ice, snow, debris or rubbish during winter months.

Fertiliser Use

Only slow-release organic low-phosphorous fertilisers will be used in any landscaped areas in order to limit the amount of nutrients that could enter the surface water system.

Prepared by:	Lucinda Hazell MEng
Checked by:	Dimitris Linardatos BEng MSc CEng MICE
Date:	November 2016
Job No.:	22247

Drainage Operation and Maintenance Log
Site Maintenance Supervisor:_______________________ Date:__________
☐ Routine ☐ Response to rainfall event ___ in ☐ Other:_______________

BMP	Frequency	Date Performed	Comments
Gullies and Manholes	Monthly Inspections		
	Maintenance Quarterly and as necessary		
Pavement Areas (parking, service areas)	Monthly Sweeping		
	Rubbish & Litter Removal as Necessary		
Landscaped Areas	Maintenance as necessary		
Attenuation Tanks	Inspect and identify areas not operating property every 3 months (for the first 3 months) and every 6 months after		
	Survey inside of tank for sediment build-up and remove if necessary		

Appendix F Surface Water Drainage Pro-forma for New Developments

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	HOLY TRINITY CHURCH, HAMPSTEAD
Address & post code or LPA reference	HOLY TRINITY CHURCH, FINCHLEY ROAD, LONDON, NW3 5HT
Grid reference	526371, 184697
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, REFER TO FRA.
Total Site Area served by drainage system (excluding open space) (Ha)*	0.064 ha.

* 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)	0.064	0.064	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 Attenuation tank the public sewer.

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations	✓		REFER TO FRA SECTIONS 5 AND APPENDIX C + D.	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		✓		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		✓		e.g. Is there a watercourse nearby?
To surface water sewer	✓		EXISTING SITE DRAINS TO SEWER.	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		✓		e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	✓		REFER TO FRA SECTION 5.	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.	✓		REFER TO APPEDIX D OF FRA.	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	0.5	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	5.9	2.2	-3.7	-62%	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	14.6	3.7	-10.9	-75%	
1in 100	18.9	4.3	-14.6	-77%	
1 in 100 plus climate change	N/A	4.8	-14.1	-75%	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 6 HOUR	6.6	14	14	0	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 6 HOUR	17.4	37	37	0	
1in 100 6 hour	24.7	52.	52	0	
1 in 100 6 hour plus climate change	25.9	/	55	3	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. – NOT REQUIRED AS IMPERMEABLE AREAS NOT INCREASING.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)		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)		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)**		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)		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,		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)**	LONDON 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 ~1x10^{-8} m/s	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 - BELOW GROUND ATTENUATION TANK.	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 – 19.5 m^3	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 ROOFS + BELOW GROUND ATTENUATION TANK.	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.	N/A – DESIGNED TO ACCOMODATE 1IN100+CC EVENT.	**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)?	SITE WILL DRAIN TO MAIN ROAD AS PER EXISTING CONDITIONS.	**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)	VORTEX CONTROL	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.	HOLY TRINITY CHURCH.	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?	DIRECTLY BY OWNERS - REFER TO MAINTENANCE SCHEDULE IN APPENDIX E OF FRA.	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	EXISTING +PROPOSED SITE PLANS	
Section 3	FLOOD RISK ASSESSMENT SECTION 5 + APPENDICES C+D	
Section 4	FLOOD RISK ASSESSMENT SECTIONS + APPENDIX C	
Section 5	FLOOD RISK ASSESSMENT APPENDIX F (BACK OF THIS DOCUMENT)	
Section 6	N/A.	
Section 7	FLOOD RISK ASSESSMENT SECTIONS 4 AND 5	
Section 8	FLOOD RISK ASSESSMENT SECTION 5 AND APPENDICES C+D+E	

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..LUCINDA HAZELL..........
Qualification of person responsible for signing off this pro-forma ..MENG..........

Company..PRICE + MYERS..........
On behalf of (Client's details) ..HOLY TRINITY CHURCH..........
Date:..29-11-2016..........

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Consulting Engineers

Job No 24447 Page 1 Ver
Date NOV. 16 Eng LH Chd
Job HOLY TRINITY CHURCH.

GREENFIELD RUNOFF VOLUMES

GF_{VOL} = RD x AREA x 10 x SPR (EQU. TAKEN FROM UKSUDS WEBSITE)

WHERE: RD = RAINFALL DEPTH (MM) (FROM FEH)
AREA = TOTAL SITE AREA (Ha)
10 = UNIT CONVERSION
SPR = STANDARD PERCENTAGE RUNOFF = 0.47 (UK SUDS WEBSITE)

1 IN 1 YEAR, 6 HOUR

$GF_{VOL 1}$ = 22 x 0.064 x 10 x 0.47 = 6.6 m^3

1 IN 30 YEAR, 6 HOUR

$GF_{VOL 30}$ = 58 x 0.064 x 10 x 0.47 = 17.4 m^3

1 IN 100 YEAR, 6 HOUR

$GF_{VOL 100}$ = 82 x 0.064 x 10 x 0.47 = 24.7 m^3

1 IN 100 YEAR + CC, 6 HOUR

$GF_{VOL 100CC}$ = 86 x 0.064 x 10 x 0.47 = 25.9 m^3

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Job HOLY TRINITY CHURCH.

EXISTING + PROPOSED RUNOFF VOLUMES

VOL = RD x AREA

WHERE: RD = RAINFALL DEPTH (m) (FROM FEH)
AREA = TOTAL IMPERMEABLE AREA (m) - NOTE UNCHANGE FOR PROPOSED DEV.

1 IN 1 YEAR, 6 HOUR

$VOL_1 = 0.022 \times 640 = 14 m^3$

1 IN 30 YEAR, 6 HOUR

$VOL_{30} = 0.058 \times 640 = 37 m^3$

1 IN 100 YEAR, 6 HOUR

$VOL_{100} = 0.082 \times 640 = 52 m^3$

1 IN 100 YEAR + CC, 6 HOUR

$VOL_{100+CC} = 0.086 \times 640 = 55$

Appendix E

Example Past Projects

Price & Myers

Example Past Projects
Price & Myers

21 Wilton Street	Complete overhaul of a listed house in Belgravia, including pool, gym, media room etc. within a new basement.
17 Phillimore Gardens	Refurbishing a listed house and constructing a new basement with swimming pool under the garden and part of the house.
44 Grove End Road	Extensive refurbishment of a listed building plus construction of a basement swimming pool and car park.
7 Wilton Crescent	Rebuilding a mews house to include double storey basement with swimming pool plus renovation and rooftop extension of listed house.
15 Thurloe Square	Refurbishment of a listed house and construction of a basement extension.
7 St James Square	Construction of a two-storey basement with swimming pool under a grade 2 listed house designed by Lutyens.
2 Alma Terrace	Construction of a basement under the full footprint of the house and garden. The house above remains occupied and the work is done using a tunnelling method.
12a-14 Cheyne Row	Construction of a new basement under a central courtyard of a collection of houses.
44 Markham Square	Refurbishment and extension of a house including new basement.
15 Addison Crescent	Construction of a deep basement with swimming pool under an existing house.
40 St Petersburg Place	Alterations to house and mews house featuring new basement.
23a Earls Court Square	A basement extension under the house to include a gym and 20m lap pool.
22 Frognal Way	Retaining a listed 1970's modernist house and constructing a new basement with swimming pool under the house and garden.
4 Frognal Way	Refurbishment of an existing house including an extension and new basement with swimming pool.
20 Rutland Mews South	Construction of a new basement under an existing house.

Appendix F

Preliminary Design Calculation

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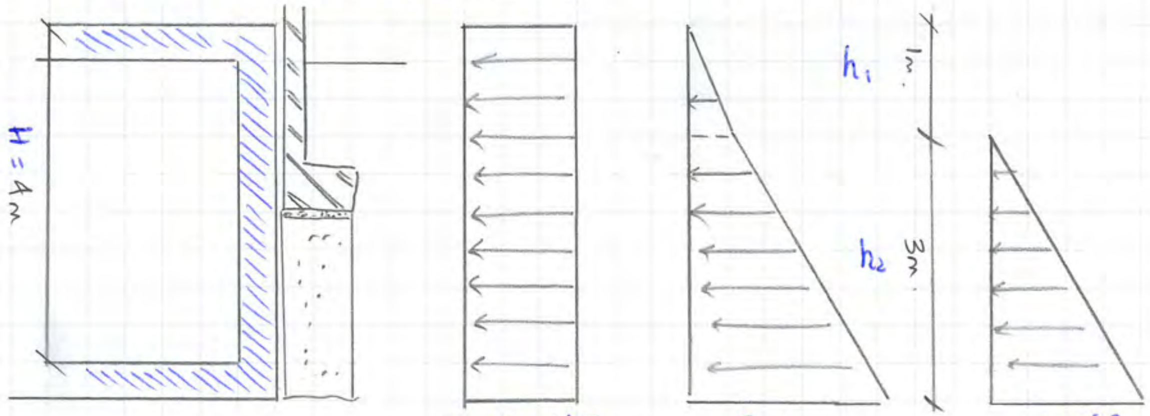
Rear retaining wall example calculation

REAR RETAINING WALL - GRIDLINE 11

- PROPPED RETAINING WALL.



ASSUMPTIONS.
- $k_a = 0.33$
- WATER 1m BELOW GL.
- $\gamma_{SAT} = 20\ kN/m^3$
- $\gamma_w = 10\ kN/m^3$
- $\gamma_{DRY} = 18\ kN/m^3$.
- SURCHARGE $w = 10\ kN/m^2$

$f_{cu} = 40\ N/mm^2$
$f_y = 500\ N/mm^2$

INTERNAL COVER = 30mm

LOADS ON WALL.

- SURCHARGE - $k_a w H$ = 13.3
- DRY SOIL - $k_a \gamma_{DRY} \frac{h_1^2}{2}$ = 3.0
- DRY SOIL OVERBURDEN = $k_a \gamma_{DRY} h_1 h_2$ 18.0
- NET PRESSURE OF SATURATED SOIL = $k_a(\gamma_{sat} - \gamma_w)\frac{h_2^2}{2}$ 3.0
- WATER = $\frac{\gamma_w h_2^2}{2}$ 4.1

TOTAL FORCE = 82.3 kN/m SLS.

ULTIMATE = $1.4G_k + 1.6Q_k$ = 117.9 kN/m WIDTH.

FOR PROPPED CANTILEVER BENDING MOMENT $M = \frac{WH}{7}$ = 67kNm

325mm RETAINING WALL $d = 325 - 30 - 8 - 5 = 282$ mm.

REINFORCEMENT REQUIRED.

$K = \frac{M}{bd^2 f_{cu}} = \frac{67 \times 10^6}{1000 \times 282^2 \times 40} = 0.02$ $As_{req} = \frac{M}{0.87 f_{cu} (0.95d)} = 575\ mm^2/m$

PROVIDE H16s AT 200 CRS. - $As_{prov} = 1005\ mm^2/m \Rightarrow$ OK.