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	0.020	0.020	1.6	6.1	Flood Risk
30 min Summer	0.023	0.023	1.9	7.0	Flood Risk
60 min Summer	0.025	0.025	2.0	7.5	Flood Risk
120 min Summer	0.025	0.025	2.0	7.4	Flood Risk
180 min Summer	0.023	0.023	1.9	7.0	Flood Risk
240 min Summer	0.022	0.022	1.7	6.5	Flood Risk
360 min Summer	0.019	0.019	1.5	5.8	Flood Risk
480 min Summer	0.017	0.017	1.4	5.2	Flood Risk
600 min Summer	0.016	0.016	1.3	4.7	Flood Risk
720 min Summer	0.015	0.015	1.2	4.4	Flood Risk
960 min Summer	0.013	0.013	1.0	3.8	Flood Risk
1440 min Summer	0.010	0.010	0.8	3.0	Flood Risk
2160 min Summer	0.008	0.008	0.6	2.3	Flood Risk
2880 min Summer	0.006	0.006	0.5	1.9	Flood Risk
4320 min Summer	0.005	0.005	0.4	1.4	Flood Risk
5760 min Summer	0.004	0.004	0.3	1.1	Flood Risk
7200 min Summer	0.003	0.003	0.3	0.9	Flood Risk
8640 min Summer	0.003	0.003	0.2	0.8	Flood Risk
10080 min Summer	0.003	0.003	0.2	0.8	Flood Risk
15 min Winter	0.023	0.023	1.8	6.8	Flood Risk
30 min Winter	0.026	0.026	2.1	7.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	82.032	0.0	6.9	17
30 min Summer	52.486	0.0	8.7	29
60 min Summer	32.061	0.0	10.8	44
120 min Summer	19.005	0.0	12.7	78
180 min Summer	13.855	0.0	13.9	112
240 min Summer	11.027	0.0	14.7	146
360 min Summer	7.980	0.0	16.0	210
480 min Summer	6.341	0.0	17.0	272
600 min Summer	5.302	0.0	17.7	334
720 min Summer	4.580	0.0	18.4	394
960 min Summer	3.632	0.0	19.5	518
1440 min Summer	2.618	0.0	21.1	764
2160 min Summer	1.885	0.0	22.8	1124
2880 min Summer	1.492	0.0	24.0	1496
4320 min Summer	1.073	0.0	25.9	2204
5760 min Summer	0.848	0.0	27.3	2944
7200 min Summer	0.707	0.0	28.6	3736
8640 min Summer	0.609	0.0	29.6	4408
10080 min Summer	0.537	0.0	30.4	5136
15 min Winter	82.032	0.0	7.8	17
30 min Winter	52.486	0.0	9.9	29

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	0.028	0.028	2.2	8.3	Flood Risk
120 min Winter	0.026	0.026	2.1	7.9	Flood Risk
180 min Winter	0.024	0.024	1.9	7.3	Flood Risk
240 min Winter	0.022	0.022	1.8	6.7	Flood Risk
360 min Winter	0.019	0.019	1.5	5.7	Flood Risk
480 min Winter	0.016	0.016	1.3	4.9	Flood Risk
600 min Winter	0.015	0.015	1.2	4.4	Flood Risk
720 min Winter	0.013	0.013	1.1	3.9	Flood Risk
960 min Winter	0.011	0.011	0.9	3.3	Flood Risk
1440 min Winter	0.008	0.008	0.7	2.4	Flood Risk
2160 min Winter	0.006	0.006	0.5	1.8	Flood Risk
2880 min Winter	0.005	0.005	0.4	1.5	Flood Risk
4320 min Winter	0.004	0.004	0.3	1.1	Flood Risk
5760 min Winter	0.003	0.003	0.2	0.8	Flood Risk
7200 min Winter	0.002	0.002	0.2	0.7	Flood Risk
8640 min Winter	0.002	0.002	0.2	0.6	Flood Risk
10080 min Winter	0.002	0.002	0.1	0.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.061	0.0	12.0	46
120 min Winter	19.005	0.0	14.2	84
180 min Winter	13.855	0.0	15.6	120
240 min Winter	11.027	0.0	16.5	154
360 min Winter	7.980	0.0	18.0	220
480 min Winter	6.341	0.0	19.0	284
600 min Winter	5.302	0.0	19.9	344
720 min Winter	4.580	0.0	20.6	404
960 min Winter	3.632	0.0	21.8	532
1440 min Winter	2.618	0.0	23.6	766
2160 min Winter	1.885	0.0	25.5	1124
2880 min Winter	1.492	0.0	26.9	1528
4320 min Winter	1.073	0.0	29.2	2140
5760 min Winter	0.848	0.0	30.8	3000
7200 min Winter	0.707	0.0	32.1	3816
8640 min Winter	0.609	0.0	33.2	4280
10080 min Winter	0.537	0.0	34.1	5240

30yr storm

6hr volume = 18.0 m³

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)	20.800	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.045

Time (mins) From:	To:	Area (ha)
0	4	0.045

Model Details

Storage is Online Cover Level (m) 0.200

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	0.100	300.0	0.101	0.0

Pump Outflow Control

Invert Level (m) 0.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.050	4.0000	0.100	4.0000	0.150	4.0000

Heyne Tillett Steel		
4 Pear Tree Court London EC1R 0DS	1508 18-21 Hand Court	
Date 29/06/2018 16:48 File Blue Roof at 4ls.srcx	Designed by KG Checked by	
XP Solutions	Source Control 2017.1.2	

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	0.026	0.026	2.1	7.9	Flood Risk
30 min Summer	0.031	0.031	2.5	9.2	Flood Risk
60 min Summer	0.033	0.033	2.6	9.8	Flood Risk
120 min Summer	0.032	0.032	2.6	9.7	Flood Risk
180 min Summer	0.030	0.030	2.4	9.1	Flood Risk
240 min Summer	0.028	0.028	2.3	8.5	Flood Risk
360 min Summer	0.025	0.025	2.0	7.5	Flood Risk
480 min Summer	0.022	0.022	1.8	6.7	Flood Risk
600 min Summer	0.020	0.020	1.6	6.1	Flood Risk
720 min Summer	0.019	0.019	1.5	5.6	Flood Risk
960 min Summer	0.016	0.016	1.3	4.8	Flood Risk
1440 min Summer	0.013	0.013	1.0	3.8	Flood Risk
2160 min Summer	0.010	0.010	0.8	2.9	Flood Risk
2880 min Summer	0.008	0.008	0.6	2.4	Flood Risk
4320 min Summer	0.006	0.006	0.5	1.8	Flood Risk
5760 min Summer	0.005	0.005	0.4	1.4	Flood Risk
7200 min Summer	0.004	0.004	0.3	1.2	Flood Risk
8640 min Summer	0.004	0.004	0.3	1.1	Flood Risk
10080 min Summer	0.003	0.003	0.3	0.9	Flood Risk
15 min Winter	0.030	0.030	2.4	8.9	Flood Risk
30 min Winter	0.035	0.035	2.8	10.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.744	0.0	9.0	17
30 min Summer	68.804	0.0	11.5	29
60 min Summer	42.167	0.0	14.1	44
120 min Summer	24.963	0.0	16.7	78
180 min Summer	18.137	0.0	18.2	112
240 min Summer	14.381	0.0	19.3	146
360 min Summer	10.352	0.0	20.8	208
480 min Summer	8.196	0.0	22.0	272
600 min Summer	6.834	0.0	22.9	334
720 min Summer	5.888	0.0	23.7	396
960 min Summer	4.652	0.0	25.0	518
1440 min Summer	3.333	0.0	26.9	762
2160 min Summer	2.385	0.0	28.8	1124
2880 min Summer	1.879	0.0	30.3	1496
4320 min Summer	1.342	0.0	32.5	2208
5760 min Summer	1.056	0.0	34.1	2936
7200 min Summer	0.876	0.0	35.3	3680
8640 min Summer	0.752	0.0	36.5	4416
10080 min Summer	0.661	0.0	37.5	5072
15 min Winter	106.744	0.0	10.1	17
30 min Winter	68.804	0.0	12.9	29

Heyne Tillett Steel		
4 Pear Tree Court London EC1R 0DS	1508 18-21 Hand Court	
Date 29/06/2018 16:48 File Blue Roof at 4ls.srcx	Designed by KG Checked by	
XP Solutions	Source Control 2017.1.2	

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	0.036	0.036	2.9	10.9	Flood Risk
120 min Winter	0.035	0.035	2.8	10.4	Flood Risk
180 min Winter	0.032	0.032	2.5	9.5	Flood Risk
240 min Winter	0.029	0.029	2.3	8.7	Flood Risk
360 min Winter	0.025	0.025	2.0	7.4	Flood Risk
480 min Winter	0.021	0.021	1.7	6.4	Flood Risk
600 min Winter	0.019	0.019	1.5	5.6	Flood Risk
720 min Winter	0.017	0.017	1.3	5.0	Flood Risk
960 min Winter	0.014	0.014	1.1	4.2	Flood Risk
1440 min Winter	0.010	0.010	0.8	3.1	Flood Risk
2160 min Winter	0.008	0.008	0.6	2.3	Flood Risk
2880 min Winter	0.006	0.006	0.5	1.8	Flood Risk
4320 min Winter	0.005	0.005	0.4	1.4	Flood Risk
5760 min Winter	0.004	0.004	0.3	1.1	Flood Risk
7200 min Winter	0.003	0.003	0.3	0.9	Flood Risk
8640 min Winter	0.003	0.003	0.2	0.8	Flood Risk
10080 min Winter	0.002	0.002	0.2	0.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	42.167	0.0	15.8	46
120 min Winter	24.963	0.0	18.7	84
180 min Winter	18.137	0.0	20.4	120
240 min Winter	14.381	0.0	21.6	152
360 min Winter	10.352	0.0	23.3	218
480 min Winter	8.196	0.0	24.6	282
600 min Winter	6.834	0.0	25.7	346
720 min Winter	5.888	0.0	26.6	408
960 min Winter	4.652	0.0	28.0	532
1440 min Winter	3.333	0.0	30.1	780
2160 min Winter	2.385	0.0	32.3	1124
2880 min Winter	1.879	0.0	33.9	1464
4320 min Winter	1.342	0.0	36.4	2276
5760 min Winter	1.056	0.0	38.3	3024
7200 min Winter	0.876	0.0	39.7	3784
8640 min Winter	0.752	0.0	40.9	4208
10080 min Winter	0.661	0.0	42.0	4976

100yr storm

6hr volume = 23.3 m³

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)	20.800	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.045

Time (mins) From:	To:	Area (ha)
0	4	0.045

Model Details

Storage is Online Cover Level (m) 0.200

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	0.100	300.0	0.101	0.0

Pump Outflow Control

Invert Level (m) 0.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.050	4.0000	0.100	4.0000	0.150	4.0000

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.037	0.037	2.9	11.1	Flood Risk
30 min Summer	0.043	0.043	3.4	12.9	Flood Risk
60 min Summer	0.046	0.046	3.7	13.8	Flood Risk
120 min Summer	0.045	0.045	3.6	13.6	Flood Risk
180 min Summer	0.043	0.043	3.4	12.8	Flood Risk
240 min Summer	0.040	0.040	3.2	12.0	Flood Risk
360 min Summer	0.035	0.035	2.8	10.5	Flood Risk
480 min Summer	0.031	0.031	2.5	9.4	Flood Risk
600 min Summer	0.029	0.029	2.3	8.6	Flood Risk
720 min Summer	0.026	0.026	2.1	7.8	Flood Risk
960 min Summer	0.022	0.022	1.8	6.7	Flood Risk
1440 min Summer	0.018	0.018	1.4	5.3	Flood Risk
2160 min Summer	0.014	0.014	1.1	4.1	Flood Risk
2880 min Summer	0.011	0.011	0.9	3.3	Flood Risk
4320 min Summer	0.008	0.008	0.7	2.5	Flood Risk
5760 min Summer	0.007	0.007	0.5	2.0	Flood Risk
7200 min Summer	0.006	0.006	0.5	1.7	Flood Risk
8640 min Summer	0.005	0.005	0.4	1.4	Flood Risk
10080 min Summer	0.004	0.004	0.3	1.2	Flood Risk
15 min Winter	0.041	0.041	3.3	12.4	Flood Risk
30 min Winter	0.048	0.048	3.9	14.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	149.442	0.0	12.5	17
30 min Summer	96.326	0.0	16.1	29
60 min Summer	59.033	0.0	19.8	44
120 min Summer	34.948	0.0	23.4	78
180 min Summer	25.392	0.0	25.6	112
240 min Summer	20.134	0.0	27.0	146
360 min Summer	14.493	0.0	29.2	210
480 min Summer	11.475	0.0	30.8	272
600 min Summer	9.568	0.0	32.1	332
720 min Summer	8.244	0.0	33.2	396
960 min Summer	6.513	0.0	35.0	520
1440 min Summer	4.667	0.0	37.7	764
2160 min Summer	3.339	0.0	40.4	1124
2880 min Summer	2.631	0.0	42.5	1472
4320 min Summer	1.878	0.0	45.5	2204
5760 min Summer	1.478	0.0	47.7	2936
7200 min Summer	1.226	0.0	49.5	3672
8640 min Summer	1.053	0.0	51.0	4408
10080 min Summer	0.925	0.0	52.3	4984
15 min Winter	149.442	0.0	14.0	17
30 min Winter	96.326	0.0	18.1	29

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.051	0.051	4.0	15.3	Flood Risk
120 min Winter	0.049	0.049	3.9	14.6	Flood Risk
180 min Winter	0.045	0.045	3.6	13.4	Flood Risk
240 min Winter	0.041	0.041	3.3	12.2	Flood Risk
360 min Winter	0.034	0.034	2.7	10.3	Flood Risk
480 min Winter	0.030	0.030	2.4	8.9	Flood Risk
600 min Winter	0.026	0.026	2.1	7.9	Flood Risk
720 min Winter	0.023	0.023	1.9	7.0	Flood Risk
960 min Winter	0.019	0.019	1.5	5.8	Flood Risk
1440 min Winter	0.015	0.015	1.2	4.4	Flood Risk
2160 min Winter	0.011	0.011	0.9	3.2	Flood Risk
2880 min Winter	0.009	0.009	0.7	2.6	Flood Risk
4320 min Winter	0.006	0.006	0.5	1.8	Flood Risk
5760 min Winter	0.005	0.005	0.4	1.5	Flood Risk
7200 min Winter	0.004	0.004	0.3	1.2	Flood Risk
8640 min Winter	0.004	0.004	0.3	1.1	Flood Risk
10080 min Winter	0.003	0.003	0.3	0.9	Flood Risk

100yr + 40% CC
Storage req. = 15.3 m³

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.033	0.0	22.2	46
120 min Winter	34.948	0.0	26.3	84
180 min Winter	25.392	0.0	28.6	118
240 min Winter	20.134	0.0	30.3	152
360 min Winter	14.493	0.0	32.7	218
480 min Winter	11.475	0.0	34.5	282
600 min Winter	9.568	0.0	36.0	346
720 min Winter	8.244	0.0	37.2	410
960 min Winter	6.513	0.0	39.2	532
1440 min Winter	4.667	0.0	42.2	766
2160 min Winter	3.339	0.0	45.3	1128
2880 min Winter	2.631	0.0	47.6	1456
4320 min Winter	1.878	0.0	51.0	2164
5760 min Winter	1.478	0.0	53.5	3008
7200 min Winter	1.226	0.0	55.5	3672
8640 min Winter	1.053	0.0	57.3	4504
10080 min Winter	0.925	0.0	58.7	4960

100yr + 40% CC
6hr volume = 32.7 m³

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)	20.800	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.045

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.045

Model Details

Storage is Online Cover Level (m) 0.200

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	300.0	0.100	300.0	0.101	0.0

Pump Outflow Control

Invert Level (m) 0.000

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.050	4.0000	0.100	4.0000	0.150	4.0000

BLUE ROOF STORAGE AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

abg creative geosynthetic engineering

Project Name:	18-21 Hand Court, High Holborn, London WC1 - Main Roof
Prepared for:	Buckley Gray Yeoman/Heyne Tillett, London
Date:	02/05/2018
ABG Project ID:	11838 Calculator version: 1.14
Prepared by:	Andrew Keer; 07525-808700; andrew@abgltd.com
Notes/description:	Main Roof = blue roof area combined with a ballasted/paved plant enclosure; and green roof surface finishes, sedum mat or biodiverse finish TBC. Both areas maintenance access only. Additional catchment area from lift overruns. Max AHU plant weight = 2660kg TBC - to be supported on free-standing, support bases min. 300mm x

Input Parameters - Rainfall Information (Flood Studies Report 1975)

Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Location selected for FSR data:	London (Central)		

Input Parameters - Roof Information

Catchment area:	270	m^2	*As supplied by Client*
Storage area:	260	m^2	*As supplied by Client*
Maximum allowable runoff:	3.0	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	2 hours and 30 minutes	1.4
30 mins	2 hours and 50 minutes	1.6
1 hour	3 hours and 0 minutes	1.6
2 hours	2 hours and 50 minutes	1.6
4 hours	2 hours and 10 minutes	1.3
6 hours	1 hour and 30 minutes	1.0
10 hours	0 hours and 20 minutes	0.4
24 hours	0 hours and 0 minutes	0.1
48 hours	0 hours and 0 minutes	0.1

Total storage required: 13.7 m^3

Half empty time: 1 hours and 0 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 79/80mm
Description:	The 79mm blue roof depth includes for a 25mm reservoir board depth. 4 no. drainage points to be confirmed by design team and structural engineer's deflection analysis.
Total storage capacity:	17.1 m^3
Number of Blue Roof outlets:	4

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
3. This estimate is specific to the characteristics of ABG products and is not applicable to other products.
4. The copyright in this document belongs to ABG Ltd.
5. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
6. No guarantee or liability can be drawn from the information in this report.
7. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

BLUE ROOF STORAGE AND OUTFLOW SUMMARY

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abg creative geosynthetic engineering

Project Name:	18-21 Hand Court, High Holborn, London WC1 - 3rd Floor Terrace
Prepared for:	Buckley Gray Yeoman/Heyne Tillett, London
Date:	02/05/2018
ABG Project ID:	11838 Calculator version: 1.14
Prepared by:	Andrew Keer; 07525-808700; andrew@abgltd.com
Notes/description:	Terrace area is an amenity, timber decked area (plus ballast under timber deck). Pedestrian access area only. Local free-standing planters.

Input Parameters - Rainfall Information (Flood Studies Report 1975)

Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Location selected for FSR data:	London (Central)		

Input Parameters - Roof Information

Catchment area:	142	m^2	*As supplied by Client*
Storage area:	142	m^2	*As supplied by Client*
Maximum allowable runoff:	1.0	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	2 hours and 0 minutes	0.9
30 mins	2 hours and 20 minutes	1.0
1 hour	2 hours and 20 minutes	1.0
2 hours	2 hours and 10 minutes	0.9
4 hours	1 hour and 30 minutes	0.7
6 hours	0 hours and 50 minutes	0.5
10 hours	0 hours and 0 minutes	0.1
24 hours	0 hours and 0 minutes	0.0
48 hours	0 hours and 0 minutes	0.0

Total storage required: 6.9 m^3

Half empty time: 1 hours and 10 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 58mm
Description:	2 no. drainage points to be confirmed by design team and structural engineer's deflection analysis.
Total storage capacity:	7.1 m^3
Number of Blue Roof outlets:	2

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
3. This estimate is specific to the characteristics of ABG products and is not applicable to other products.
4. The copyright in this document belongs to ABG Ltd.
5. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
6. No guarantee or liability can be drawn from the information in this report.
7. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

Appendix E

LB of Camden SuDS Proforma

HEYNE TILLETT STEEL

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	18 - 21 Hand Court
Address & post code or LPA reference	High Holborn Estate, London, WC1V 6RQ
Grid reference	TQ308816
Is the existing site developed or Greenfield?	Existing site is 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?	The site is located in Critical Drainage Area Group3_003.
Total Site Area served by drainage system (excluding open space) (Ha)*	0.045 ha (450 m2)

***** 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)	0.045	0.045	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)	Combined Public Sewer	Combined Public 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	X			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		X		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		X		e.g. Is there a watercourse nearby?
To surface water sewer		X		Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		X		e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	X			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.	X			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	0.2	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	5.4	4.0	- 1.4	- 26%	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	13.2	4.0	- 9.2	- 70%	
1in 100	17.2	4.0	- 13.2	- 77%	
1 in 100 plus climate change	N/A	4.0	- 13.2	- 77%	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	2	8.1	8.1	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	4.8	18	18	0	
1in 100 6 hour	6.8	23.3	23.3	0	
1 in 100 6 hour plus climate change	9.5	N/A	32.7	N/A	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)	Not possible	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)	~ 10 m³ @ 8.6 l/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)	~ 15.3 m³ @ 4.0 l/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)	~ 4.5 m³ @ 17.2	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,	100% blue roofs	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)**	Not in SPZ and underlined by 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?	N/A	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?	N/A	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.	N/A	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, attenuation.	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 Simple, Attenuation required = 15.3 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?	All surface water storage will occur at roof level.	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, attenuation volume was designed for storms up to 1 in 100 + 40% Climate Change.	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.	No flooding	**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)?	Current design provides additional storage, due to minimum depth of blue roof storage, therefore exceedance events would be contained on site. Currently, the design provides 24.2m³ of storage but only requires ~15m³ for 1in100+CC storms.	**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)	Blue roof design. Access for maintenance will be provided.	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.	Private ownership.	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?	Private maintenance agreement.	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	Architects Layouts	Appendix A
Section 3	Drainage Strategy Report	Section 7
Section 4	Drainage Strategy Report	Section 8
Section 5	MicroDrainage Calculations	Appendix D
Section 6	MicroDrainage Calculations	Appendix D
Section 7	Drainage Strategy Report	Appendix C
Section 8	Blue Roof specialist calculations	Appendix D

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 Karol Gyba……………………………………………………………………………….......................
Qualification of person responsible for signing off this pro-forma Infrastructure Engineer (BEng)........................

Company Hayne Tillett Steel Limited………………………………………………………,..
On behalf of (Client's details) SRG Holborn Limited...
Date: 29.06.2018……………………..........................

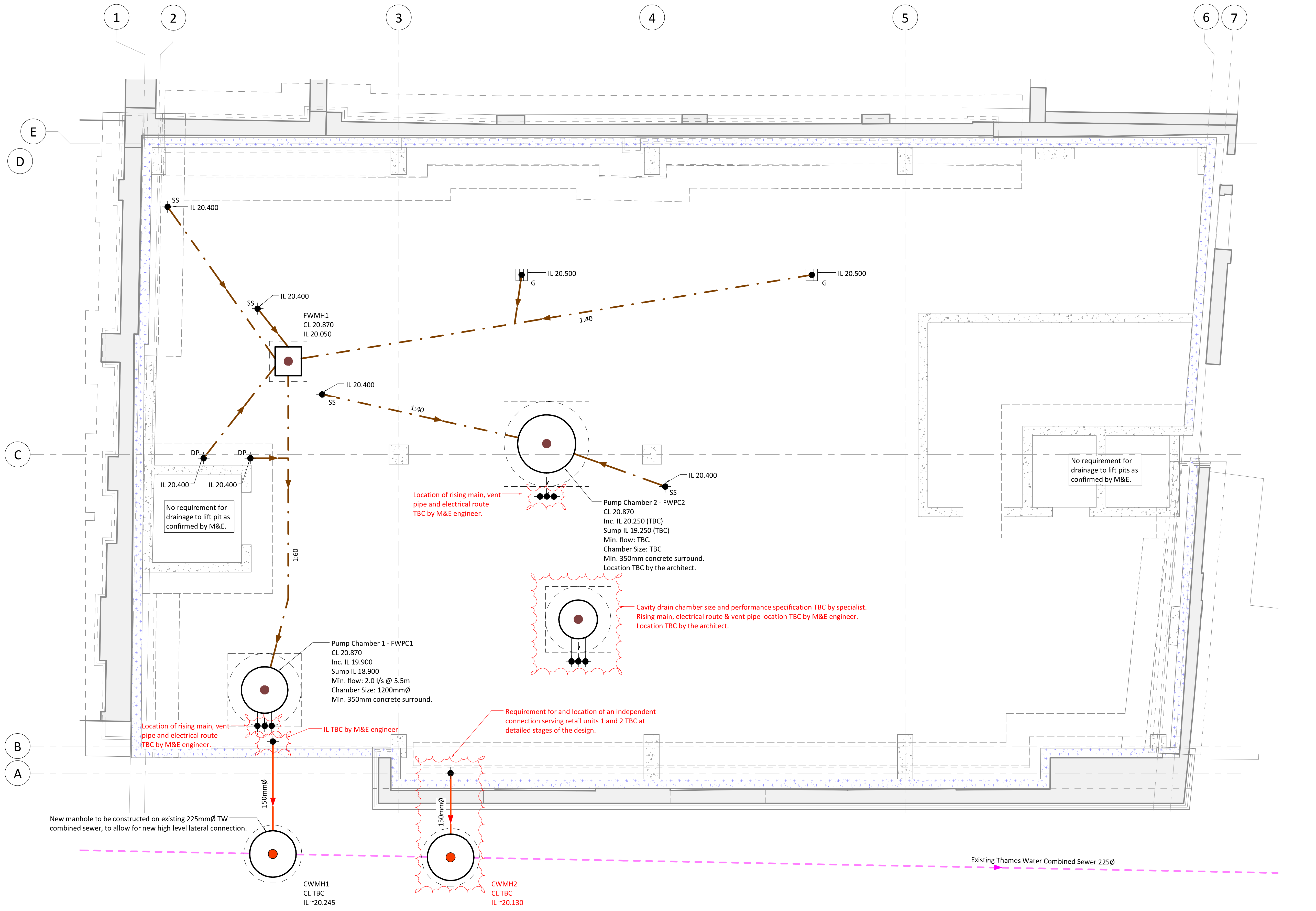
Appendix F

Proposed Drainage Layout

HEYNE TILLETT STEEL

Proposed manhole schedule

Ref	Cover level	Invert level	Chamber size	MH Material / Type	Cover Class	Cover Size	Notes
FWMH1	20.870	20.050	675 x 750	Cast in situ	A15	675 x 750	-
FWPC1	20.870	19.900	1200mmØ	GRP	A15	1000 x 600	Sump IL 18.900
FWPC2	20.870	20.250 *	1500mmØ *	GRP	A15	1000 x 600 *	* Details TBC, Indicative size only.
CWMH1	TBC	~20.245	1200mmØ	Type B	D400	600 x 600	Adoptable Manhole
CWMH2	TBC	~20.130	1200mmØ	Type B	D400	600 x 600	Adoptable Manhole - TBC



100mm @ A1 (50mm @ A3)

1 This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

3 Do not scale from this drawing in either paper or digital form. Use written dimensions only. To check drawing has been printed to the intended scale the above bar should be 100mm

3 Abbreviations:-

- CL - Cover Level
- IL - Invert Level
- MH - Manhole
- OD - Outer Diameter
- RWP - Rainwater Pipe
- SVP - Soil Vent Pipe

4 For general drainage notes, refer to drawing no. 1508/HC/DR400.

Proposed Drainage Key

- Proposed SW drain run
- Proposed FW drain run
- Proposed CW drain run
- Proposed Pumped Rising Main
- Existing Public sewer
- Unspecified drain run
- Proposed Channel Drain
- SVP Proposed / Existing Soil Vent Pipe
- DP Proposed / Existing Drainage Point
- SS Proposed / Existing Stub Stack
- G Proposed / Existing Gully
- Proposed SW Manhole
- Proposed FW Manhole
- Proposed CW Manhole
- Public Sewer Manhole
- Existing Manhole

Rev	Date	By	Eng	Amendments
P1	20.06.18	KG	KG	Preliminary Issue

HEYNE TILLETT STEEL

STRUCTURAL ENGINEERS

hts.uk.com

Job Name
High Holborn Estate
18-21 Hand Court

Drawing Title
Proposed Below Ground Drainage
Lower Ground Floor

Purpose of Issue **Preliminary** Scale at A1 1:50

Drawing No **1508 / HC/DR500** Rev **P1**

Appendix G

Foul Water Calculations

HEYNE TILLETT STEEL

Project:	High Holborn Estate	**Project No:**	1508
Address:	18-21 Hand Court	**Date:**	02/07/18
	Existing Foul Water Calculations	**Calcs by:**	KG
		Page No:	3

Existing Foul Water Peak Discharge Rate (DU method - BS EN 752)

Development Type:-

- (●) Dwelling, guesthouse, office (intermittent use)
- ( ) Hospital, School, Restaurant, Hotel (frequent use)
- ( ) Toilets and/or shower open to the public (congested use)
- ( ) Laboratory buildings (special use)

Appliance	No.	Discharge Units per Appliance	Total Units
Washbasin	10	0.6	6
Shower	0	0.6	0
Urinal	0	0.8	0
Bath	0	1.3	0
Kitchen Sink	2	1.3	2.6
Dishwasher	1	0.8	0.8
Household Washing Machine	0	0.8	0
Commercial Washing Machine	0	1.5	0
WCs	7	2.5	17.5
Floor Drains	0	2	0

Total Discharge Units for Site 26.9

Therefore, total flow from site = 2.59 l/s