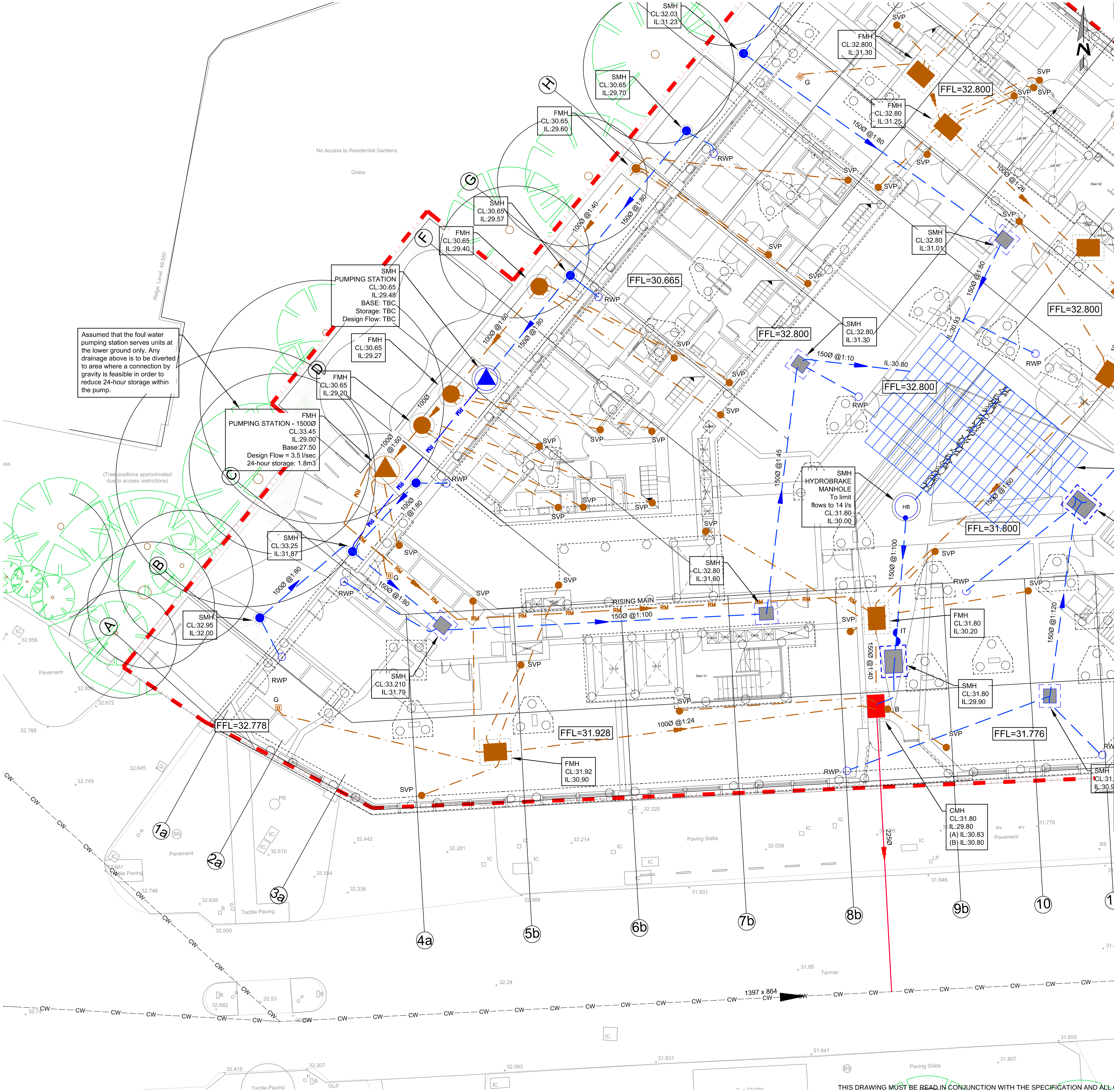
APPENDIX E

Preliminary Drainage Layout & Site Proposals



LEGEND

- Site Boundary
- Existing Combined Sewer
- Proposed Foul Water Sewer
- Proposed Storm Water Sewer
- Proposed Combined Water Sewer

Proposed Private Surface Water Manholes:
- 450mm dia PPIC
- 750 x 675mm RC Insitu Manhole

Proposed Private Foul Water Manholes
- 450mm dia PPIC
- 1200 x 900mm RC Insitu Manhole
- 900mm dia PCC Manhole

Proposed Combined Water Manhole 1200 x 900mm RC Insitu Manhole

SVP SS — Soil Vent Pipe/stub Stack

RWP — Proposed Rainwater Pipe

FG — Proposed Floor Gully

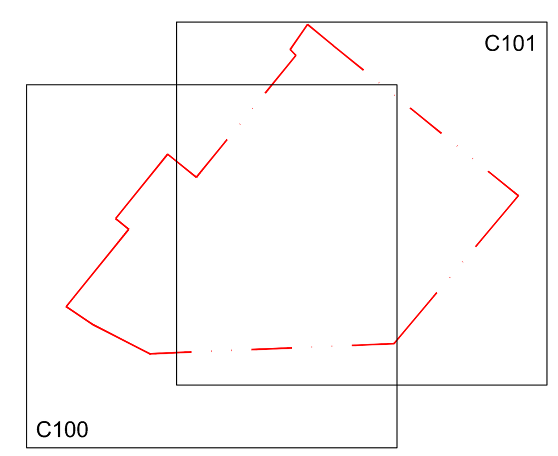
YG — Proposed Yard Gully

Private Pumping station

HB — Manhole with hydro-brake (1200mm dia PCC)

Attenuation Tank with Perforated Distributor Pipe

KEY PLAN



Design Notes :	
Greenfield runoff rates:	
For 1 in 1 year storm event =	1.9 l/s
For 1 in 30 year storm event =	3.9 l/s
For 1 in 100 year storm event =	4.5 l/s
Qbar (urban) =	2.2 l/s
Design Notes :	
Site Area:	2,070 m²
Total Existing Impermeable Area:	2,070 m²
Total Proposed Impermeable Area:	2,070m²
Existing Peak rate run off from Impermeable Areas (50mm/hr):	28.8 l/s
Proposed restricted Surface Water discharge rate	14.0 l/s
Total Attenuation for 100YS + 30%CC:	**70 m³**
Foul Water Discharge:	**T.B.C. l/s.**

Attenuation Notes	
Green Roof	Roof Area = 54m² Max. water depth = 0.08m Total =3**m³**
Blue Roof	Roof Area = 20m² Max. water depth = 0.10m Total =20**m³**
Attenuation Tank	63m² x 0.80m deep **Total = 47m³**
TOTAL ATTENUATION	**70m³**

IMPORTANT NOTE:

- EXTENT AND LOCATION OF MANHOLES AND PUMP STATIONS TO BE DEVELOPED AT THE NEXT DESIGN STAGE.
- ALL DOWN PIPES ARE SHOWN INDICATIVELY. (BASED ON HAND MARK-UP)

NOTES

1. Invert levels and positions of existing drains / chambers / sewers where new connections are to be made must be checked and confirmed to the engineer prior to the commencement of any works.
2. All drainage works shall be carried out in accordance with the requirements of the Local Authority, the Environment Agency and in conjunction with all relevant British Standards, Codes of Practice and 'Sewers for Adoption' 7th Edition and any addendums as appropriate.
3. All drainage shall comply with the typical details and the requirements of BS EN 752 and Part H of the Building Regulations.
4. Any part of the existing drainage system to be retained as part of the new scheme shall be cleaned and inspected. Any structural defects shall be repaired using appropriate and approved means.
5. For setting-out dimensions of SVP's, RWP's etc, refer to Architect's or Mechanical Engineer's drawings. Positions shown are indicative and subject to final design.
6. All foul and RWP connections shall be 100mm diameter unless otherwise specified.
7. All precast concrete units used in the drainage works shall be manufactured using sulphate resisting cement.
8. Manhole covers and frames shall be to BS EN 124 and shall be Kitemarked. Covers and frames shall be heavy duty D400 in carriageways and vehicular areas and medium duty B125 in footways and soft landscaping. In blocked/concrete paved areas covers shall be recessed fabricated steel. All recessed covers shall be in accordance with the FACTA association gradings.
9. All internal inspection chambers to be recessed, double sealed with screw down covers.
10. Cover levels are to be adjusted locally to suit finished ground levels.
11. At least one soil pipe at the head of each foul run shall vent to the atmosphere.
12. Existing drainage to be removed is to be broken out to bed level and void backfilled with granular material, compacted in layers not exceeding 250mm.
13. All drain runs from SVP's, stub stacks or FW gullies to be laid at 1:40 gradient unless otherwise stated. All RWP's to be laid 1:80 min unless otherwise stated.
14. All manholes / inspection chambers in block paved areas, to have recessed covers. MH covers in paved areas to have cover & frame orientated 'square' with paving to minimise cut slabs or blocks.
15. All private drainage to be laid to levels shown using flexibly jointed pipes, either uPVC to BS 4660 and BS 5481 or vitrified clayware to BS EN 295. Pipes below structural building slabs or basements shall be Cast Iron to BS 437.
16. Rodding eyes, etc are to be laid to manufacturers minimum cover and depth to allow adequate fall from adjoining unit.
17. All proposed trees to have appropriate tree barrier details linking pits to ensure roots are directed away from drainage.
18. Where new sewers are constructed within 5m of a new or existing tree the sewer shall be concrete encased against root intrusion. Refer to drainage details.
19. All new drainage to be jetted and CCTV surveyed on completion. Contractor to make sure that the drainage is fully operational. Refer to Drainage maintenance manual for maintenance details.
20. All runs connecting into the public drainage network to be vitrified clay, extra length to BS EN 295 or BS65 with plain sleeved or socketed flexible joints.
21. CDM note: All pipework, silt traps, catchpits, trapped gullies and attenuation tanks to be regularly inspected every three months and cleared out on a regular frequency for the first nine months. After this period the frequency can be reduced to every six months. Porous surface to be regularly swept three times a year to remove the silt.
22. This drawing is to be read in conjunction with all relevant Conisbee drawings.
23. HEALTH AND SAFETY: The works shall be carried out by specialist competent and experienced contractors who are members of a recognised national organisation.Operatives shall have received full and appropriate training for the operations they are to undertake. All work shall be carried out in accordance with all pertinent Health and Safety Regulations.

NOT FOR CONSTRUCTION

Rev	Date	Description	Drawn	Check
P4	10.05.16	Architect's Layout Updated	JC	TG
P3	25.04.16	Tank size revised	AW	TG

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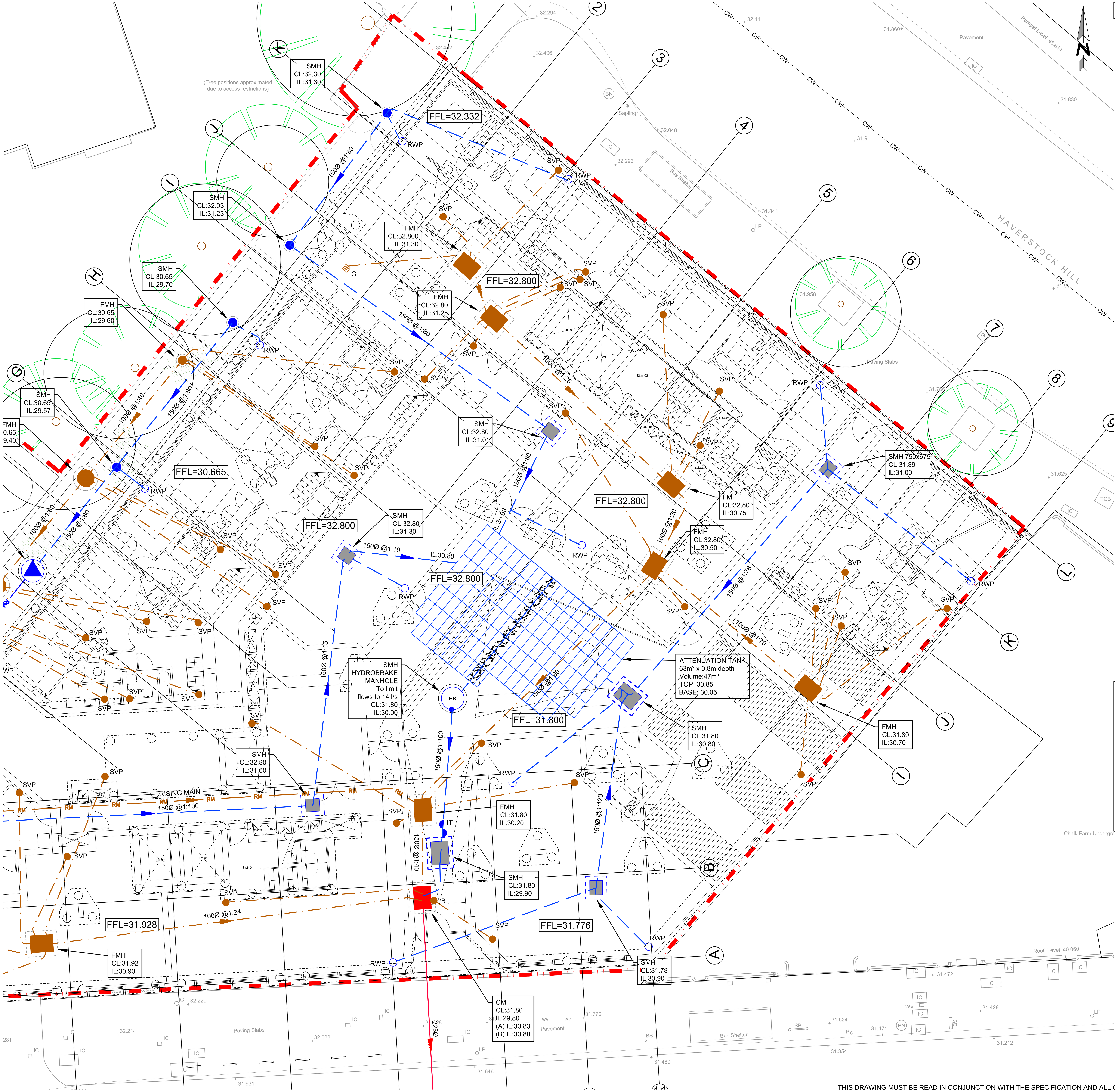
Drawing Status: PRELIMINARY

Project: 5-17 Haverstock Hill, London NW3 2l

Title: DRAINAGE LAYOUT GROUND FLOOR SHEET 1 OF 2

Date: March 2016
Scale: 1:100 @A1
Drawn: AW
Engineer: AW
Project No: 140870
Drawing No: C100
Revision: P4

THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ALL OTHER RELEVANT DRAWINGS. DO NOT SCALE FROM THIS DRAWING.



LEGEND	
	Site Boundary
—CW—	Existing Combined Sewer
	Proposed Foul Water Sewer
	Proposed Storm Water Sewer
	Proposed Combined Water Sewer
	Proposed Private Surface Water Manholes:
	- 450mm dia PPIC
	- 750 x 675mm RC Insitu Manhole
	Proposed Private Foul Water Manholes
	- 450mm dia PPIC
	- 1200 x 900mm RC Insitu Manhole
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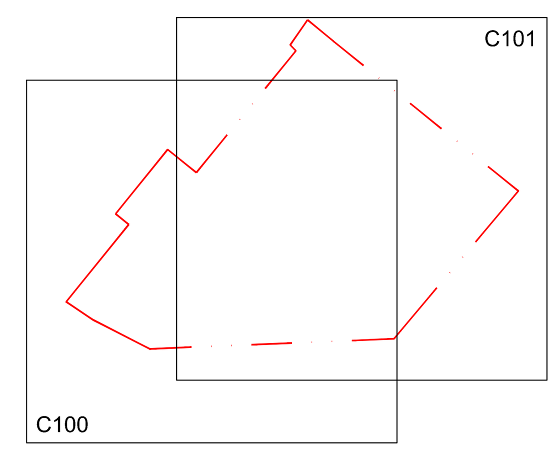
	Proposed Combined Water Manhole 1200 x 900mm RC Insitu Manhole
SVP SS	Soil Vent Pipe/stub Stack
RWP	Proposed Rainwater Pipe
FG	Proposed Floor Gully
YG	Proposed Yard Gully
	Private Pumping station
HB	Manhole with hydro-brake (1200mm dia PCC)
	Attenuation Tank with Perforated Distributor Pipe

KEY PLAN



NOTES

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2. All drainage works shall be carried out in accordance with the requirements of the Local Authority, the Environment Agency and in conjunction with all relevant British Standards, Codes of Practice and 'Sewers for Adoption' 7th Edition and any addendums as appropriate.
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8. Manhole covers and frames shall be to BS EN 124 and shall be Kitemarked. Covers and frames shall be heavy duty D400 in carriageways and vehicular areas and medium duty B125 in footways and soft landscaping. In blocked/concrete paved areas covers shall be recessed fabricated steel. All recessed covers shall in accordance with the FACTA association gradings.
9. All internal inspection chambers to be recessed, double sealed with screw down covers.
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11. At least one soil pipe at the head of each foul run shall vent to the atmosphere.
12. Existing drainage to be removed is to be broken out to bed level and void backfilled with granular material, compacted in layers not exceeding 250mm.
13. All drain runs from SVP's, stub stacks or FW gullies to be laid at 1:40 gradient unless otherwise stated. All RWP's to be laid 1:80 min unless otherwise stated.
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21. CDM note: All pipework, silt traps, catchpits, trapped gullies and attenuation tanks to be regularly inspected every three months and cleared out on a regular frequency for the first nine months. After this period the frequency can be reduced to every six months. Porous surface to be regularly swept three times a year to remove the silt.
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Design Notes :
Greenfield runoff rates:

For 1 in 1 year storm event =	1.9 l/s
For 1 in 30 year storm event =	3.9 l/s
For 1 in 100 year storm event =	4.5 l/s
Qbar (urban) =	2.2 l/s

Design Notes :

Site Area:	2,070 m²
Total Existing Impermeable Area:	2,070 m²
Total Proposed Impermeable Area:	2,070m²
Existing Peak rate run off from Impermeable Areas (50mm/hr):	28.8 l/s
Proposed restricted Surface Water discharge rate	14.0 l/s
Total Attenuation for 100YS + 30%CC:	**70 m³**
Foul Water Discharge:	**T.B.C. l/s.**

Attenuation Notes	
Green Roof	Roof Area = 54m² Max. water depth = 0.08m Total =3m³
Blue Roof	Roof Area = 20m² Max. water depth = 0.10m Total =20m³
Attenuation Tank	63m² x 0.80m deep Total = 47m³
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NOT FOR CONSTRUCTION

Rev	Date	Description	Drawn	Check
P4	10.05.16	Architect's Layout Updated	JC	TG
P3	25.04.16	Tank size revised	AW	TG

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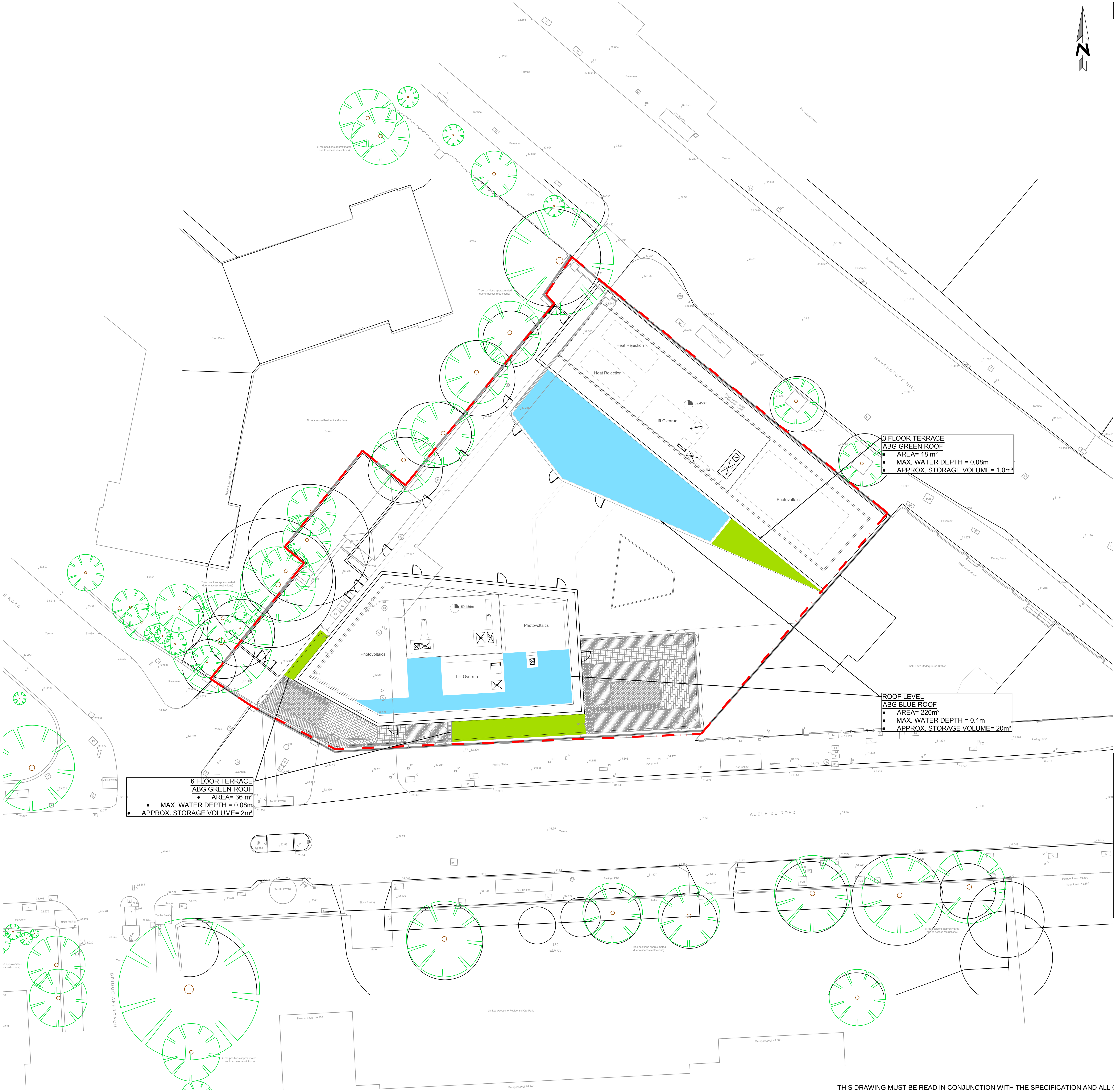
Drawing Status
PRELIMINARY

Project
5-17 Haverstock Hill
London NW3 2I

Title
DRAINAGE LAYOUT
GROUND FLOOR
SHEET 2 OF 2

Date	March 2016
Scale	1:100 @A1
Drawn	AW
Engineer	AW
Project No	140870
Drawing No	C101
Revision	P4

THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ALL OTHER RELEVANT DRAWINGS. DO NOT SCALE FROM THIS DRAWING.



LEGEND

Linetype Legend:

Site Boundary

Blocks Legend:

RWP

Blue Roof

Green Roof

NOTES

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Attenuation Tank	63m³ x 0.80m deep Total = 47m³
TOTAL ATTENUATION	**70m³**

NOT FOR CONSTRUCTION

Rev	Date	Description	Drawn	Check
P4	26.04.16	Green roof area revised	AW	TG
P3	25.04.16	Blue / green roof area revised	AW	TG
P2	08.04.16	Water depths revised.	DN	TG

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Drawing Status
PRELIMINARY

Project
5-17 Haverstock Hill
London NW3 2I

Title
DRAINAGE LAYOUT
GROUND FLOOR

Date March 2016
Scale 1:200 @A1
Drawn AW
Engineer AW
Project No
140870
Drawing No
C105
Revision
P4

THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ALL OTHER RELEVANT DRAWINGS. DO NOT SCALE FROM THIS DRAWING.

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	0.207	Urban	0.750
SAAR (mm)	609	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.8
QBAR Urban	2.2
Q100 years	4.5
Q1 year	1.9
Q30 years	3.9
Q100 years	4.5

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Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.438
Areal Reduction Factor	1.00
Area (ha)	0.207
SAAR (mm)	609
CWI	88.620
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	37.91
Greenfield Runoff Volume (m^3)	17.304

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Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.438
Areal Reduction Factor	1.00
Area (ha)	0.207
SAAR (mm)	609
CWI	88.620
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	41.93
Greenfield Runoff Volume (m³)	54.601

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Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.438
Areal Reduction Factor	1.00
Area (ha)	0.207
SAAR (mm)	609
CWI	88.620
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	39.92
Greenfield Runoff Volume (m^3)	40.107

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Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	8.034	0.034	34.1	O K
360 min Winter	8.038	0.038	38.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	3.663	0.0	376
360 min Winter	3.663	0.0	376

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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)	21.000	Shortest Storm (mins)	360
Ratio R	0.441	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.207

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.051	4	8	0.052	8	12	0.052	12	16	0.052

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Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	2.800	0.0	5.600	0.0	8.400	0.0
0.400	1000.0	3.200	0.0	6.000	0.0	8.800	0.0
0.800	1000.0	3.600	0.0	6.400	0.0	9.200	0.0
1.200	0.0	4.000	0.0	6.800	0.0	9.600	0.0
1.600	0.0	4.400	0.0	7.200	0.0	10.000	0.0
2.000	0.0	4.800	0.0	7.600	0.0		
2.400	0.0	5.200	0.0	8.000	0.0		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	8.127	0.127	126.6	O K
360 min Winter	8.142	0.142	141.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	13.593	0.0	376
360 min Winter	13.593	0.0	376

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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)	360
Ratio R	0.441	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+30

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Total Area (ha) 0.207

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.051	4	8	0.052	8	12	0.052	12	16	0.052

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Model Details

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Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	2.800	0.0	5.600	0.0	8.400	0.0
0.400	1000.0	3.200	0.0	6.000	0.0	8.800	0.0
0.800	1000.0	3.600	0.0	6.400	0.0	9.200	0.0
1.200	0.0	4.000	0.0	6.800	0.0	9.600	0.0
1.600	0.0	4.400	0.0	7.200	0.0	10.000	0.0
2.000	0.0	4.800	0.0	7.600	0.0		
2.400	0.0	5.200	0.0	8.000	0.0		

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Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	8.097	0.097	97.4	O K
360 min Winter	8.109	0.109	109.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	10.456	0.0	376
360 min Winter	10.456	0.0	376

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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)	360
Ratio R	0.441	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.207

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.051	4	8	0.052	8	12	0.052	12	16	0.052

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Model Details

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Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	2.800	0.0	5.600	0.0	8.400	0.0
0.400	1000.0	3.200	0.0	6.000	0.0	8.800	0.0
0.800	1000.0	3.600	0.0	6.400	0.0	9.200	0.0
1.200	0.0	4.000	0.0	6.800	0.0	9.600	0.0
1.600	0.0	4.400	0.0	7.200	0.0	10.000	0.0
2.000	0.0	4.800	0.0	7.600	0.0		
2.400	0.0	5.200	0.0	8.000	0.0		

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	8.075	0.075	75.1	O K
360 min Winter	8.084	0.084	84.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	8.066	0.0	376
360 min Winter	8.066	0.0	376

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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)	21.000	Shortest Storm (mins)	360
Ratio R	0.441	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.207

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.051	4	8	0.052	8	12	0.052	12	16	0.052

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Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	2.800	0.0	5.600	0.0	8.400	0.0
0.400	1000.0	3.200	0.0	6.000	0.0	8.800	0.0
0.800	1000.0	3.600	0.0	6.400	0.0	9.200	0.0
1.200	0.0	4.000	0.0	6.800	0.0	9.600	0.0
1.600	0.0	4.400	0.0	7.200	0.0	10.000	0.0
2.000	0.0	4.800	0.0	7.600	0.0		
2.400	0.0	5.200	0.0	8.000	0.0		

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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	8.552	0.552	13.7	55.2	O K
30 min Summer	8.666	0.666	13.8	66.6	O K
60 min Summer	8.683	0.683	13.9	68.3	O K
120 min Summer	8.624	0.624	13.7	62.4	O K
180 min Summer	8.556	0.556	13.7	55.6	O K
240 min Summer	8.486	0.486	13.7	48.6	O K
360 min Summer	8.358	0.358	13.7	35.8	O K
480 min Summer	8.226	0.226	13.7	22.6	O K
600 min Summer	8.128	0.128	13.7	12.8	O K
720 min Summer	8.061	0.061	13.7	6.1	O K
960 min Summer	8.001	0.001	13.7	0.1	O K
1440 min Summer	8.000	0.000	9.9	0.0	O K
2160 min Summer	8.000	0.000	7.1	0.0	O K
2880 min Summer	8.000	0.000	5.6	0.0	O K
4320 min Summer	8.000	0.000	4.0	0.0	O K
5760 min Summer	8.000	0.000	3.1	0.0	O K
7200 min Summer	8.000	0.000	2.6	0.0	O K
8640 min Summer	8.000	0.000	2.2	0.0	O K
10080 min Summer	8.000	0.000	2.0	0.0	O K
15 min Winter	8.554	0.554	13.7	55.4	O K
30 min Winter	8.670	0.670	13.8	67.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.783	0.0	72.4	23
30 min Summer	90.217	0.0	93.2	34
60 min Summer	55.351	0.0	114.1	56
120 min Summer	32.791	0.0	136.5	90
180 min Summer	23.828	0.0	147.6	124
240 min Summer	18.892	0.0	155.8	158
360 min Summer	13.617	0.0	169.1	224
480 min Summer	10.786	0.0	178.2	284
600 min Summer	8.997	0.0	186.3	338
720 min Summer	7.754	0.0	192.5	390
960 min Summer	6.129	0.0	203.0	490
1440 min Summer	4.394	0.0	218.3	0
2160 min Summer	3.146	0.0	234.4	0
2880 min Summer	2.480	0.0	246.4	0
4320 min Summer	1.771	0.0	264.0	0
5760 min Summer	1.394	0.0	277.0	0
7200 min Summer	1.157	0.0	287.4	0
8640 min Summer	0.993	0.0	296.1	0
10080 min Summer	0.873	0.0	303.6	0
15 min Winter	139.783	0.0	72.4	23
30 min Winter	90.217	0.0	93.0	34

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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	8.691	0.691	13.9	69.1	O K
120 min Winter	8.606	0.606	13.7	60.6	O K
180 min Winter	8.506	0.506	13.7	50.6	O K
240 min Winter	8.401	0.401	13.7	40.1	O K
360 min Winter	8.185	0.185	13.7	18.5	O K
480 min Winter	8.043	0.043	13.7	4.3	O K
600 min Winter	8.000	0.000	13.1	0.0	O K
720 min Winter	8.000	0.000	11.3	0.0	O K
960 min Winter	8.000	0.000	8.9	0.0	O K
1440 min Winter	8.000	0.000	6.4	0.0	O K
2160 min Winter	8.000	0.000	4.6	0.0	O K
2880 min Winter	8.000	0.000	3.6	0.0	O K
4320 min Winter	8.000	0.000	2.6	0.0	O K
5760 min Winter	8.000	0.000	2.0	0.0	O K
7200 min Winter	8.000	0.000	1.7	0.0	O K
8640 min Winter	8.000	0.000	1.4	0.0	O K
10080 min Winter	8.000	0.000	1.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	55.351	0.0	115.2	58
120 min Winter	32.791	0.0	135.5	94
180 min Winter	23.828	0.0	148.1	132
240 min Winter	18.892	0.0	156.7	168
360 min Winter	13.617	0.0	169.0	228
480 min Winter	10.786	0.0	178.4	276
600 min Winter	8.997	0.0	186.2	0
720 min Winter	7.754	0.0	192.6	0
960 min Winter	6.129	0.0	203.0	0
1440 min Winter	4.394	0.0	218.3	0
2160 min Winter	3.146	0.0	234.4	0
2880 min Winter	2.480	0.0	246.4	0
4320 min Winter	1.771	0.0	264.0	0
5760 min Winter	1.394	0.0	277.0	0
7200 min Winter	1.157	0.0	287.4	0
8640 min Winter	0.993	0.0	296.1	0
10080 min Winter	0.873	0.0	303.6	0

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.207

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.069	4	8	0.069	8	12	0.069

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Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	2.800	0.0	5.600	0.0	8.400	0.0
0.400	100.0	3.200	0.0	6.000	0.0	8.800	0.0
0.800	100.0	3.600	0.0	6.400	0.0	9.200	0.0
1.200	0.0	4.000	0.0	6.800	0.0	9.600	0.0
1.600	0.0	4.400	0.0	7.200	0.0	10.000	0.0
2.000	0.0	4.800	0.0	7.600	0.0		
2.400	0.0	5.200	0.0	8.000	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0166-1400-1200-1400
Design Head (m)	1.200
Design Flow (l/s)	14.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	166
Invert Level (m)	7.500
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	13.9
Flush-Flo™	0.363	13.9
Kick-Flo®	0.798	11.5
Mean Flow over Head Range	-	12.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	13.9	3.000	21.6	7.000	32.4
0.200	13.1	1.400	15.0	3.500	23.2	7.500	33.5
0.300	13.8	1.600	16.0	4.000	24.8	8.000	34.6
0.400	13.9	1.800	16.9	4.500	26.2	8.500	35.6
0.500	13.7	2.000	17.8	5.000	27.6	9.000	36.6
0.600	13.4	2.200	18.6	5.500	28.9	9.500	37.6
0.800	11.5	2.400	19.4	6.000	30.1		
1.000	12.8	2.600	20.1	6.500	31.3		

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APPENDIX F

The SUDS Management Train

The SUDS Management Train

Prevention

The use of good site design and site housekeeping measures to prevent runoff and pollution (eg sweeping to remove surface dust and detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.

Source Control

Control of runoff at or very near its source (eg soakaways, other infiltration methods, green roofs, pervious pavements).

Site Control

Management of water in a local area or site (eg routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).

Regional Control

Management of runoff from a site or several sites, typically in a balancing pond or wetland.

Runoff Quality Control Processes

There is a range of natural water quality treatment processes that can be exploited within the design of a sustainable drainage system.

Sedimentation

Sedimentation is one of the primary removal mechanisms in SUDS. Most pollution in runoff is attached to sediment particles and therefore removal of sediment results in a significant reduction in pollutant loads. Sedimentation is achieved by reducing flow velocities to a level at which the sediment particles fall out of suspension. Care has to be taken in design to minimise the risk of re-suspension when extreme rainfall events occur.

Filtration and Biofiltration

Pollutants that are conveyed in association with sediment may be filtered from percolating waters. This may occur through trapping within the soil or aggregate matrix, on plants or on geotextile layers within the construction. The location of any filtration will depend upon the internal structure of the particular SUDS technique, for example whether a geotextile layer is near the surface or at the subgrade in a previous surface.

Adsorption

Adsorption occurs when pollutants attach or bind to the surface of soil or aggregate particles. The actual process is complex but tends to be a combination of surface reactions grouped as sorption processes:

Adsorption	Pollutants bind to surface of soil/aggregate
Cation exchange	Attraction between cations and clay minerals
Chemisorption	Solute is incorporated in the structure of a soil/aggregate
Absorption	The solute diffuses into the soil/aggregate/organic maters

Change in acidity of runoff can either increase or decrease the adsorption of pollutants by construction materials or soils. Eventually the materials onto which pollutants adsorb will become saturated and thus this method of treatment will stop.

Biodegration

In addition to the physical and chemical processes, which may occur on and within a SUDS technique, biological treatment may also occur. Microbial communities may be established within the ground, using the oxygen within the free-draining materials and the nutrients supplied with the inflows, to degrade organic pollutants such as oils and grease. The level of activity of such bioremediation will be affected by the environmental conditions such as temperature and the supply of oxygen and nutrients. It also depends on the physical conditions within the ground such as the suitability of the materials for colonisation.

Volatilisation

Volatilisation comprises the transfer of a compound from solution in water to the soil atmosphere and then to the general atmosphere. The conversion to a gas or vapour occurs due to heat, reducing pressure, chemical reaction or a combination of these processes. The rate of volatilisation of a compound is controlled by a number of its properties and those of the surrounding soil. In SUDS schemes volatilisation is primarily concerned with organic compounds in petroleum products and pesticides.

Precipitation

This process is the most common mechanism for removing soluble metals. Precipitation involves chemical reactions between pollutants and the soil or aggregate that transform dissolved constituents to form a suspension of particles of insoluble precipitates. Metals are precipitated as hydroxides, sulphides, and carbonates depending on which precipitants are present and the pH level. Precipitation can remove most metals (arsenic, cadmium, chromium **III**, copper, iron, lead, mercury, nickel, zinc) and many anionic species (phosphates, sulphates, fluorides).

Uptake By Plants

In ponds and wetlands, uptake by plants is an important removal mechanism for nutrients (phosphorous and nitrogen). Metals can also be removed in this manner (although intermittent maintenance is required to remove the plants otherwise the metals will be returned to the water when the plants die). Plants also create suitable conditions for deposition of metals, for example as sulphides the root zone.

Nitrification

Ammonia and ammonium ions can be oxidised by bacteria in the ground to form nitrate, which is a highly soluble form of nitrogen. Nitrate is readily used as a nutrient by plants

Photolysis

The breakdown of organic pollutants by exposure to ultra-violet light.

The removal mechanism appropriate for each pollutant category is presented in the Table below.

Table 3 - removal mechanism appropriate for each pollutant

Pollutant	**Removal mechanisms in SUDS**
Nutrients Phosphorous, nitrogen	Sedimentation, biodegradation, precipitation, de-nitrification
Sediments Total suspended solids	Sedimentation, filtration
Hydrocarbons TPH, PAH, VOC, MTBE	Biodegradation, photolysis, filtration and adsorption
Metals Lead, copper, cadmium, mercury, zinc, chromium, aluminium	Sedimentation, adsorption, filtration, precipitation, plant uptake
Pesticides	Biodegradation, adsorption, volatilisation
Chlorides	Prevention
Cyanides	Volatilisation, photolysis
Litter	Trapping, removal during routine maintenance
Organic matter, BOD	Filtration, sedimentation, biodegradation