4259 Belgrove House, London

Condition 23 Response

October 2023

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Consulting Structural and Civil Engineers

Contents

Revision	Date	Status
P2	12/10/2023	Issued for Information
P1	08/09/2023	Issued for information

Prepared by: Ander Sarasola

Approved by: Alan Yan

RESPONSE TO PLANNING APPLICATION COMMENTS

London Borough of Camden Comments and Responses to the comments have been provided in the table below.

	COMMENT	RESPONSE
	Prior to commencement of the superstructure, full details of the sustainable drainage system shall be submitted to and approved in writing by the local planning authority. The details shall confirm (using drainage statement/SUDs pro-forma/ supporting evidence as appropriate) All such systems as approved shall be installed prior to first occupation of the development, and thereafter retained and maintained in accordance with the approved maintenance strategy	The Drainage Strategy report Rev 00, has been issued and approved by Camden, this is available on the planning portal with a planning reference 2020/3881/P Within the planning report, the Pre-Planning agreement with Thames Water and the SUDS strategy was included and accepted by the London Borough of Camden. Please refer to Appendix 4 for the extract from the Drainage Strategy Report and pre-planning agreement. The following SuDS will be incorporated into the scheme: rainwater harvesting, **blue roof on level 11, 10 and 5** (attenuation volume of 192.2m³ with a discharge rate of 3.5 litres/sec), **and an attenuation system of 70m³ at basement level 1**, with a discharge rate of 1.5 litres/sec. Please refer to Appendix 2 for the blue roof specialist calculations. A high-level Operation and Maintenance Plan has been provided in Section 5 of our Drainage Strategy Report. A detailed Operation and Maintenance Plan and manual will be agreed with the Client and team, and this will be submitted to Camden Council prior to occupation. Please refer to Appendix 3 for Section 5 of the Drainage Strategy Report.
A.	System design to accommodate all storms up to and including a 1:100 year storm with a 40% provision for climate change such that flooding does not occur in any part of a building or in any utility plant susceptible to water;	Please refer to Appendix 1 for the **Microdrainage Source Control for the whole site**, which confirms a minimum attenuation volume of 180m³ will be required for all storm events up to and including a 1 in 100 year storm with 40% climate change. **Therefore, no flooding would occur within the building.**
B.	Maximum runoff rate of 5 litres/second;	The maximum discharge rate from the site would be 5.0 litres/sec. This discharge rate from the blue roof is 3.5 litres/sec and the attenuation tank is 1.5 litres/sec, totally 5.0 litres/sec. **Please refer to Appendix 2 for the blue roof calculations from the blue roof specialist and the source control for the attenuation tank.**
C.	Storage of at least 150m³ attenuation with a minimum of 143.9m³ blue roof capacity over levels 5, 10 and 11; and	Please refer Appendix 2 for the blue roof calculations and architects plans on the location of the blue roof, level 11, 10, and 5, totalling 192.2m³
D.	A lifetime maintenance strategy.	A high level Operation and Maintenance Plan has been provided in Section 5 of our Drainage Strategy Report. A detailed Operation and Maintenance Plan and manual will be agreed with the Client and team and this will be submitted to Camden Council prior to occupation. Please refer to Appendix 3, Section 5 - extracted from the Drainage Strategy Report.

Appendix 1

MicroDrainage Calculations

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	7.036	0.536	5.0	96.5	O K
30 min Summer	7.182	0.682	5.0	122.8	O K
60 min Summer	7.307	0.807	5.0	145.3	O K
120 min Summer	7.389	0.889	5.0	160.1	O K
180 min Summer	7.402	0.902	5.0	162.4	O K
240 min Summer	7.387	0.887	5.0	159.6	O K
360 min Summer	7.343	0.843	5.0	151.7	O K
480 min Summer	7.302	0.802	5.0	144.4	O K
600 min Summer	7.264	0.764	5.0	137.5	O K
720 min Summer	7.227	0.727	5.0	130.8	O K
960 min Summer	7.156	0.656	5.0	118.1	O K
1440 min Summer	7.029	0.529	5.0	95.1	O K
2160 min Summer	6.869	0.369	5.0	66.5	O K
2880 min Summer	6.749	0.249	5.0	44.7	O K
4320 min Summer	6.615	0.115	5.0	20.8	O K
5760 min Summer	6.586	0.086	4.3	15.6	O K
7200 min Summer	6.573	0.073	3.6	13.1	O K
8640 min Summer	6.563	0.063	3.1	11.3	O K
10080 min Summer	6.555	0.055	2.8	9.9	O K
15 min Winter	7.036	0.536	5.0	96.5	O K
30 min Winter	7.183	0.683	5.0	122.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	149.990	0.0	102.2	25
30 min Summer	96.742	0.0	131.8	40
60 min Summer	59.321	0.0	161.7	68
120 min Summer	35.131	0.0	191.5	126
180 min Summer	25.526	0.0	208.7	182
240 min Summer	20.240	0.0	220.7	240
360 min Summer	14.578	0.0	238.4	296
480 min Summer	11.545	0.0	251.8	356
600 min Summer	9.628	0.0	262.5	422
720 min Summer	8.297	0.0	271.4	490
960 min Summer	6.557	0.0	286.0	624
1440 min Summer	4.699	0.0	307.5	888
2160 min Summer	3.363	0.0	330.1	1260
2880 min Summer	2.651	0.0	346.9	1612
4320 min Summer	1.893	0.0	371.6	2252
5760 min Summer	1.489	0.0	389.8	2944
7200 min Summer	1.236	0.0	404.4	3672
8640 min Summer	1.061	0.0	416.7	4400
10080 min Summer	0.933	0.0	427.2	5136
15 min Winter	149.990	0.0	102.2	25
30 min Winter	96.742	0.0	131.8	39

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	7.309	0.809	5.0	145.6	O K
120 min Winter	7.393	0.893	5.0	160.8	O K
180 min Winter	7.408	0.908	5.0	163.5	O K
240 min Winter	7.395	0.895	5.0	161.0	O K
360 min Winter	7.342	0.842	5.0	151.5	O K
480 min Winter	7.293	0.793	5.0	142.7	O K
600 min Winter	7.241	0.741	5.0	133.4	O K
720 min Winter	7.189	0.689	5.0	124.1	O K
960 min Winter	7.089	0.589	5.0	105.9	O K
1440 min Winter	6.907	0.407	5.0	73.3	O K
2160 min Winter	6.702	0.202	5.0	36.3	O K
2880 min Winter	6.600	0.100	5.0	17.9	O K
4320 min Winter	6.572	0.072	3.6	12.9	O K
5760 min Winter	6.557	0.057	2.8	10.2	O K
7200 min Winter	6.547	0.047	2.4	8.5	O K
8640 min Winter	6.541	0.041	2.0	7.3	O K
10080 min Winter	6.536	0.036	1.8	6.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.321	0.0	161.7	68
120 min Winter	35.131	0.0	191.5	124
180 min Winter	25.526	0.0	208.7	180
240 min Winter	20.240	0.0	220.7	234
360 min Winter	14.578	0.0	238.4	304
480 min Winter	11.545	0.0	251.8	372
600 min Winter	9.628	0.0	262.5	448
720 min Winter	8.297	0.0	271.4	522
960 min Winter	6.557	0.0	286.0	666
1440 min Winter	4.699	0.0	307.5	932
2160 min Winter	3.363	0.0	330.1	1276
2880 min Winter	2.651	0.0	346.9	1500
4320 min Winter	1.893	0.0	371.6	2212
5760 min Winter	1.489	0.0	389.8	2944
7200 min Winter	1.236	0.0	404.4	3672
8640 min Winter	1.061	0.0	416.6	4360
10080 min Winter	0.933	0.0	427.2	5016

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.900
Region	England and Wales	Cv (Winter)	0.900
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.441	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.303

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.101	4	8	0.101	8	12	0.101

Model Details

Storage is Online Cover Level (m) 8.500

Tank or Pond Structure

Invert Level (m) 6.500

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	180.0	0.300	180.0	0.600	180.0	0.900	180.0
0.100	180.0	0.400	180.0	0.700	180.0	1.000	180.0
0.200	180.0	0.500	180.0	0.800	180.0	1.001	0.0

Pump Outflow Control

Invert Level (m) 6.500

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	5.0000	0.400	5.0000	0.700	5.0000	1.000	5.0000
0.200	5.0000	0.500	5.0000	0.800	5.0000		
0.300	5.0000	0.600	5.0000	0.900	5.0000		

Appendix 2

Blue Roof Specialist and attenuation tank calculations

Blue Roof Calculation Summary

Project Name:	Belgrove House	**Client:**	AHMM	**Reference:**	PR7270
Location:	Euston Road	**Completed By:**	J.Watkins	**Date:**	08/08/2023

Roof ID:	Catchment Area (m²)	Area of Blue Roof Storage (m²)	Area of other roofs draining onto Blue Roof (m²)	Max allowable depth of water (mm)	Hmax (mm)	Allowable discharge (l/s)	Achievable discharge (l/s)	Number of outlets
Level 11 A	93	93	0	100	96		0.19	2
Level 11 B	57	57	0	100	97		0.11	1
Level 11 C	153	153	0	100	98		0.30	2
Level 11 D	19	19	0	100	76		0.09	1
Level 10 A	659	647	12	100	100		1.32	4
Level 10 B	77	65	12	100	98		0.26	2
Level 10 C	77	65	12	100	98		0.26	2
Level 10 D	5	5	0	100	46		0.07	1
Level 10 E	5	5	0	100	46		0.07	1
Level 10 F	25	25	0	100	66		0.16	2
Level 5	779	771	8	130	120		0.64	6
					TOTAL discharge	3.50	3.47	

Notes:	Areas of Blue Roof Storage taken from drawing number 230807 Roof Catchment Area Data Capture Form completed by Fearghal Moran. Blue Roof Calculations based on FEH data with a 40% percentage increase for Climate Change. Radmat Blue Roof outlet restrictors incorporate an integral overflow unless otherwise specified. Radmat recommend that at least one additional 'tell-tale' overflow is installed to alert building users of maintenance issues.

Belgrove House

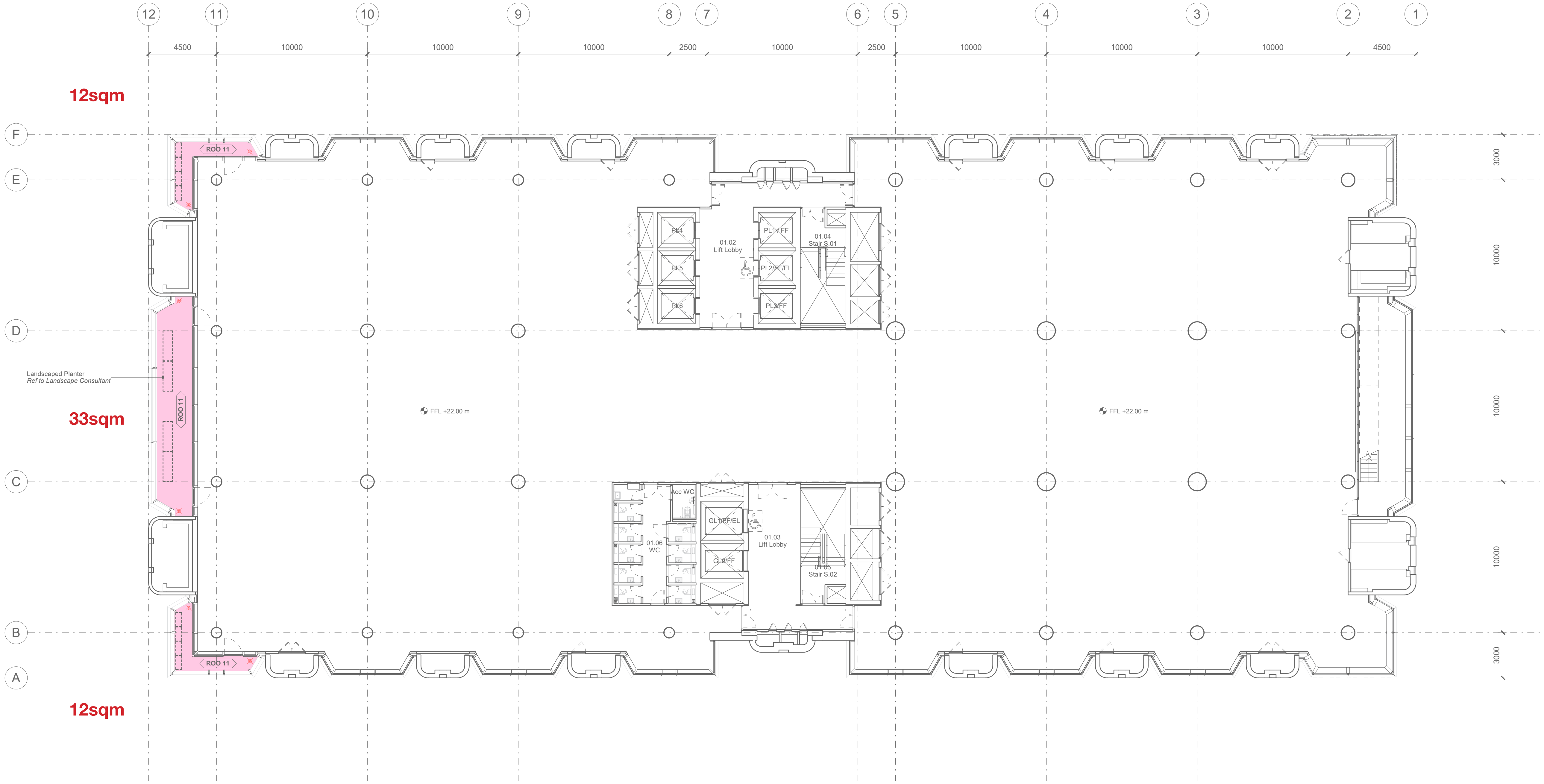
Roof Catchment Area

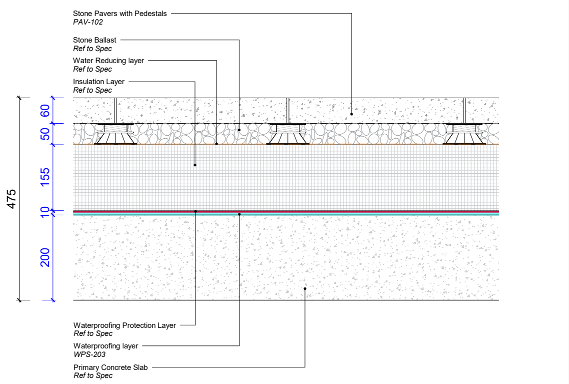
August 2023

ALLFORD
HALL
MONAGHAN
MORRIS

Roof Catchment Area

Level 1

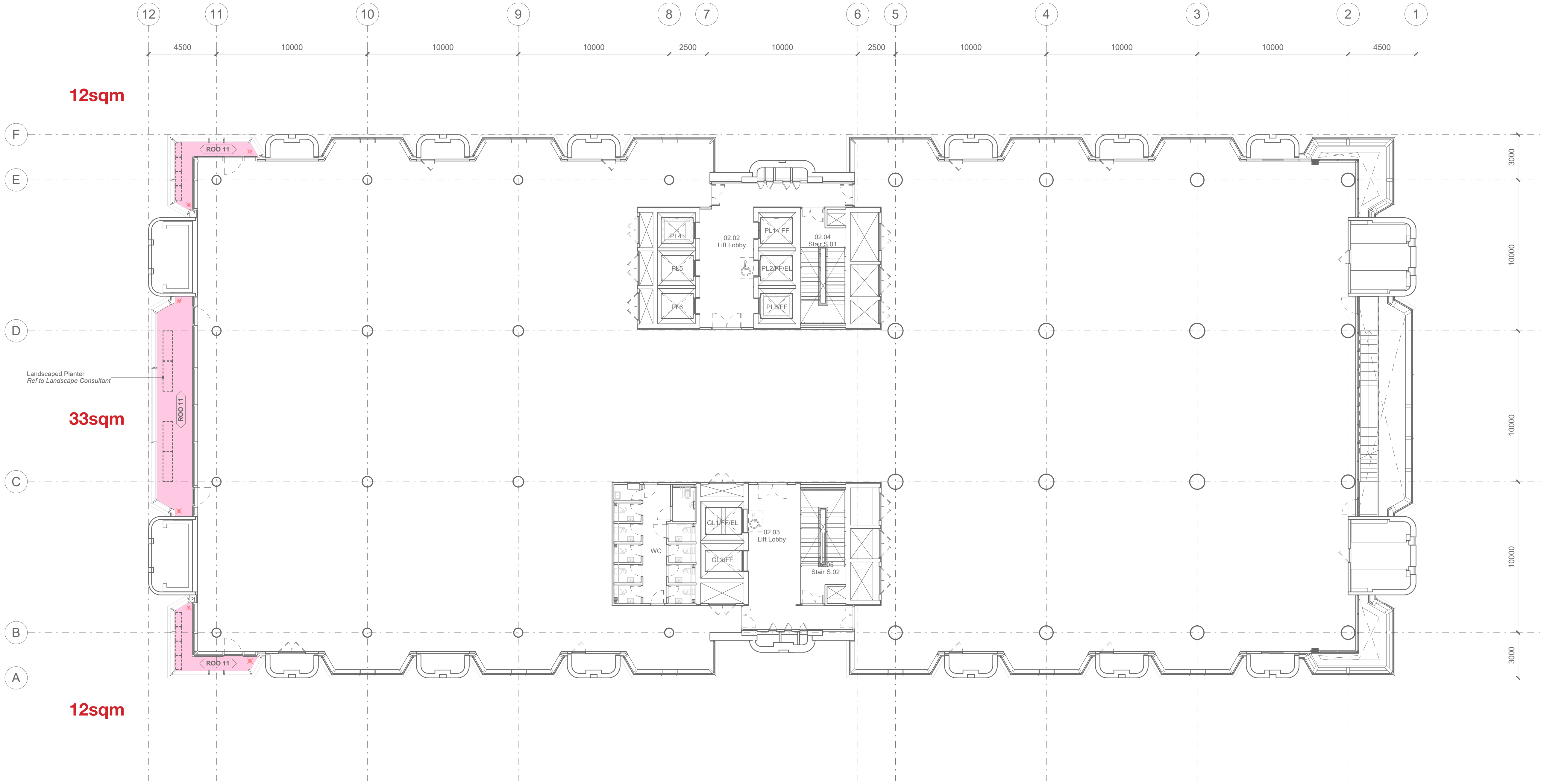


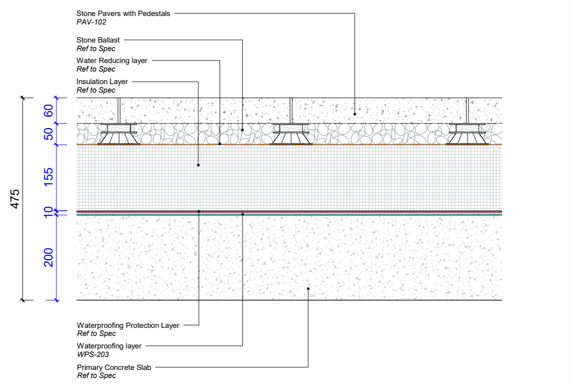


ROO 11	Inverted Roof Balcony

Roof Catchment Area

Level 2

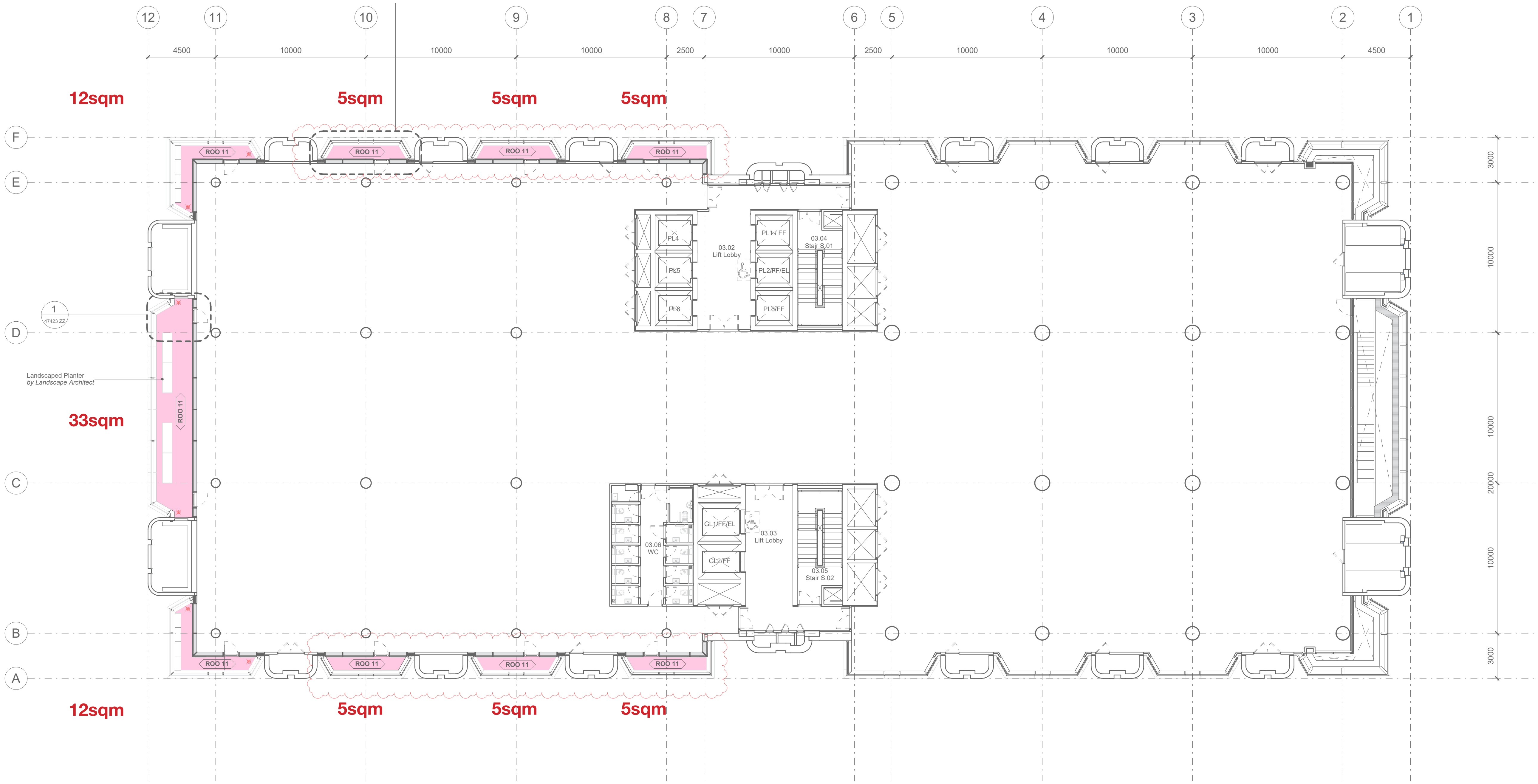


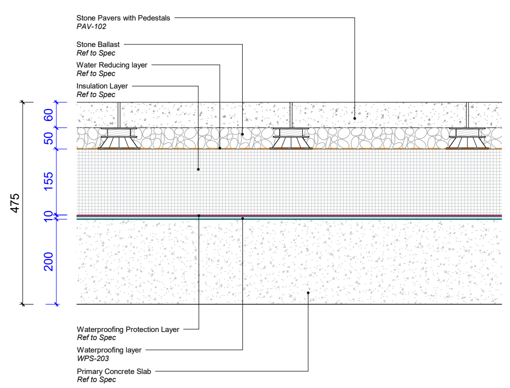


ROO 11	Inverted Roof Balcony	

Roof Catchment Area

Level 3

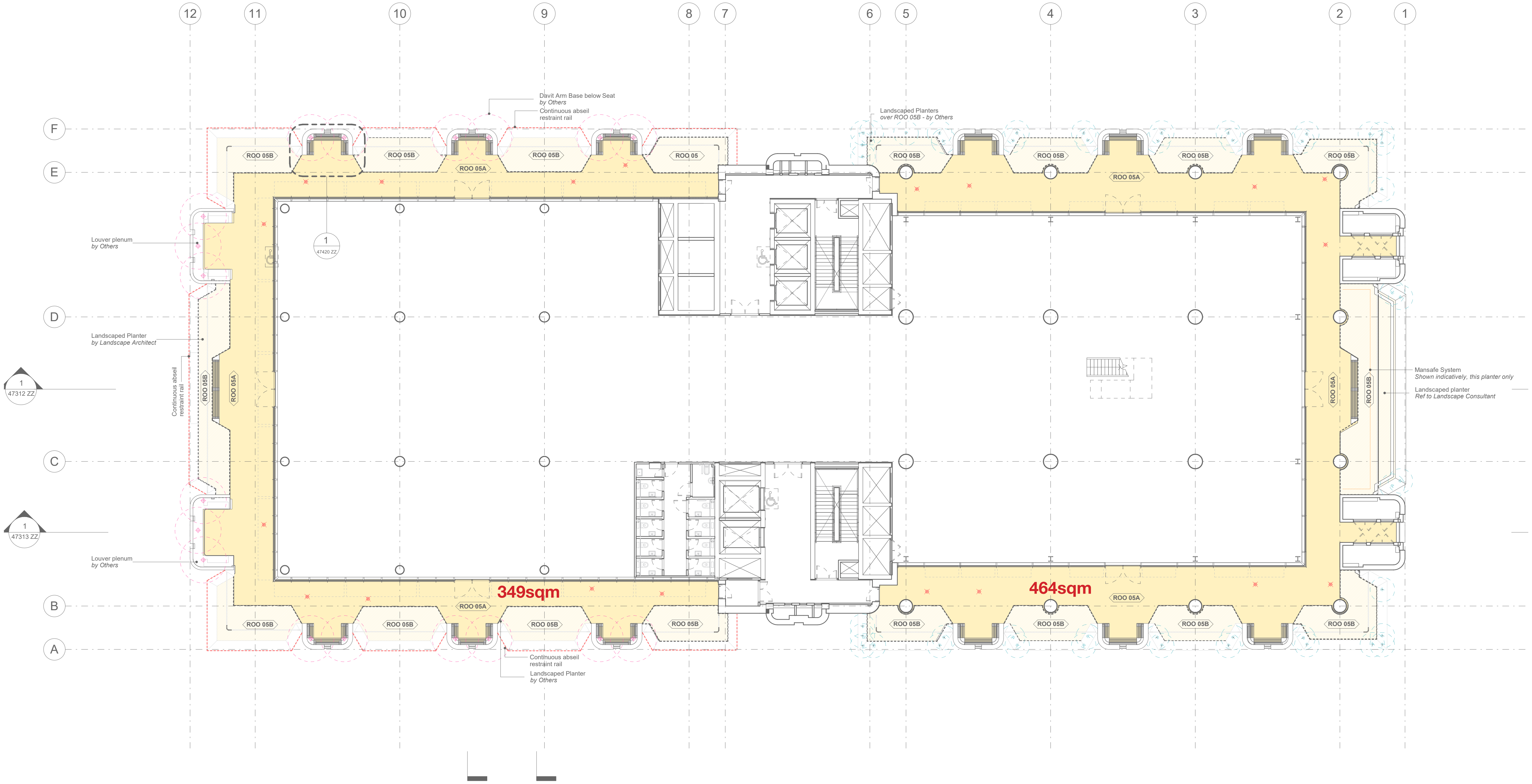


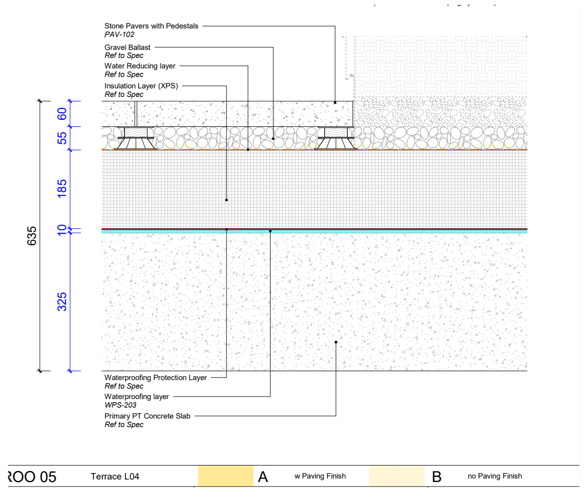


ROO 11 Inverted Roof Balcony

Roof Catchment Area

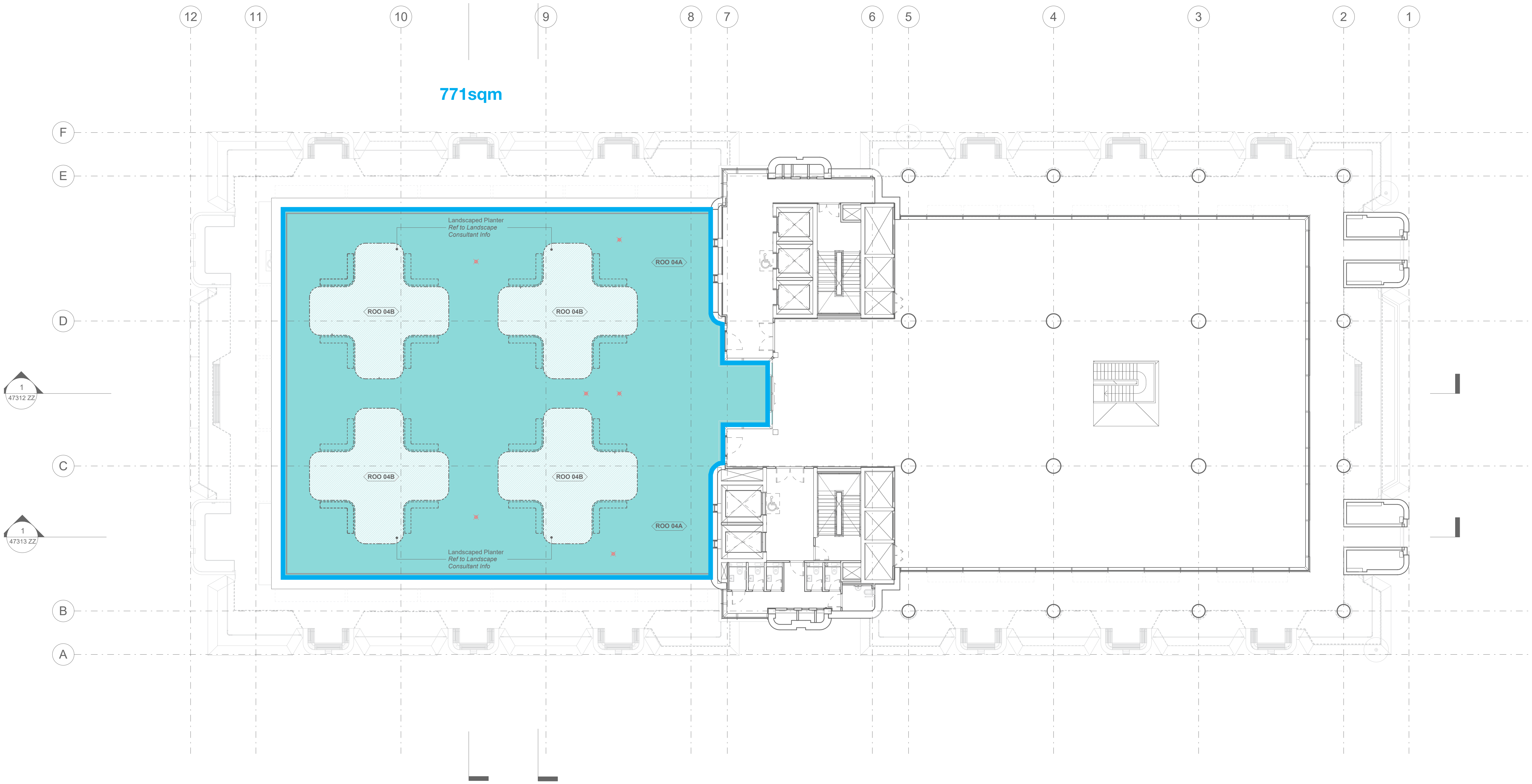
Level 4

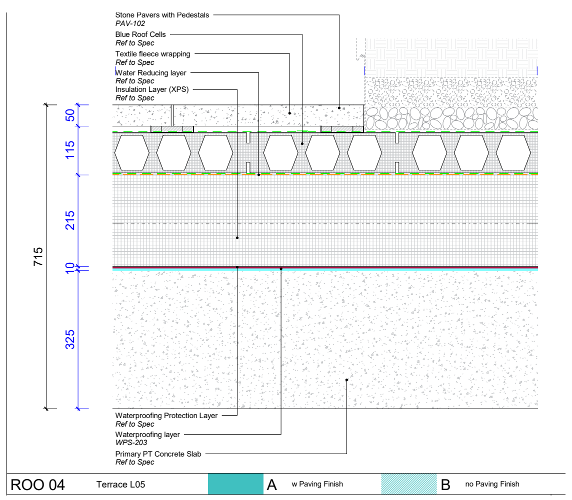




Roof Catchment Area

Level 5

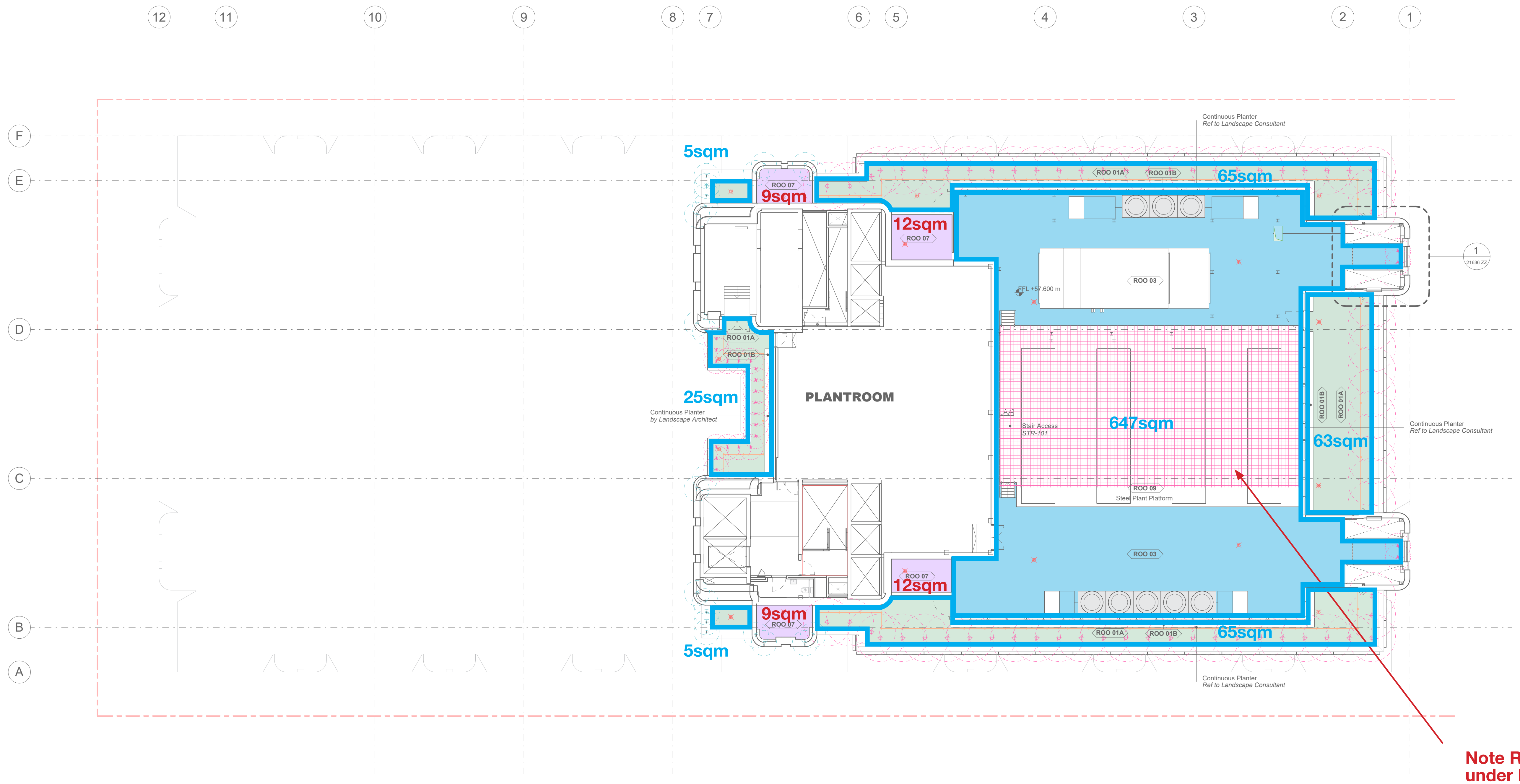




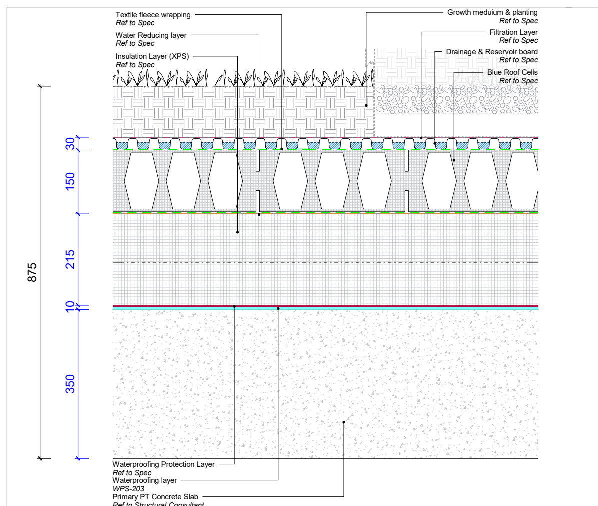
BLUE ROOF AREA

Roof Catchment Area

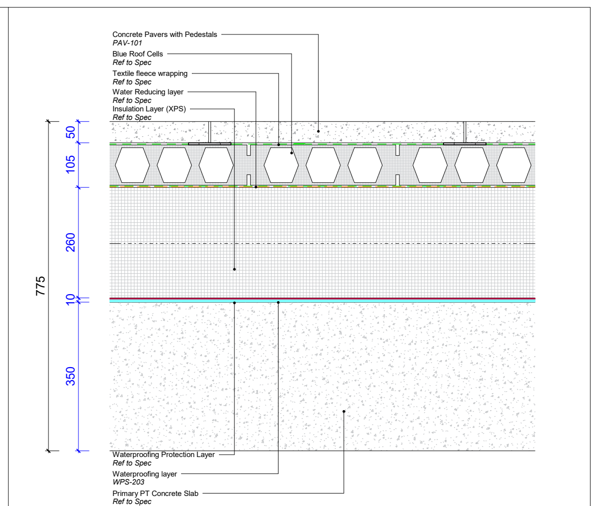
Level 10



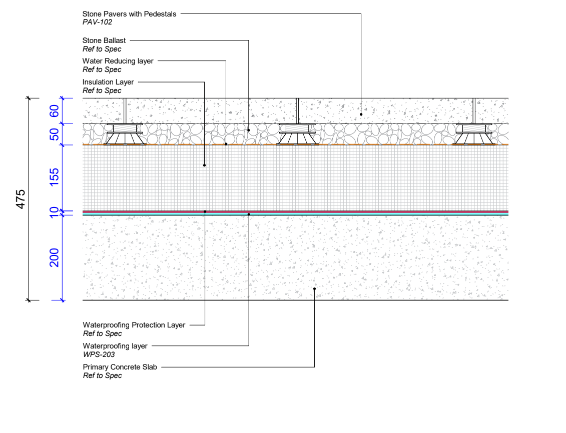
Note R00 03 continues under R00 09 which is an elephant grating



ROO 01 Green Roof L10/11 A Typical Green Roof B w Planter



ROO 03 Blue Roof L11

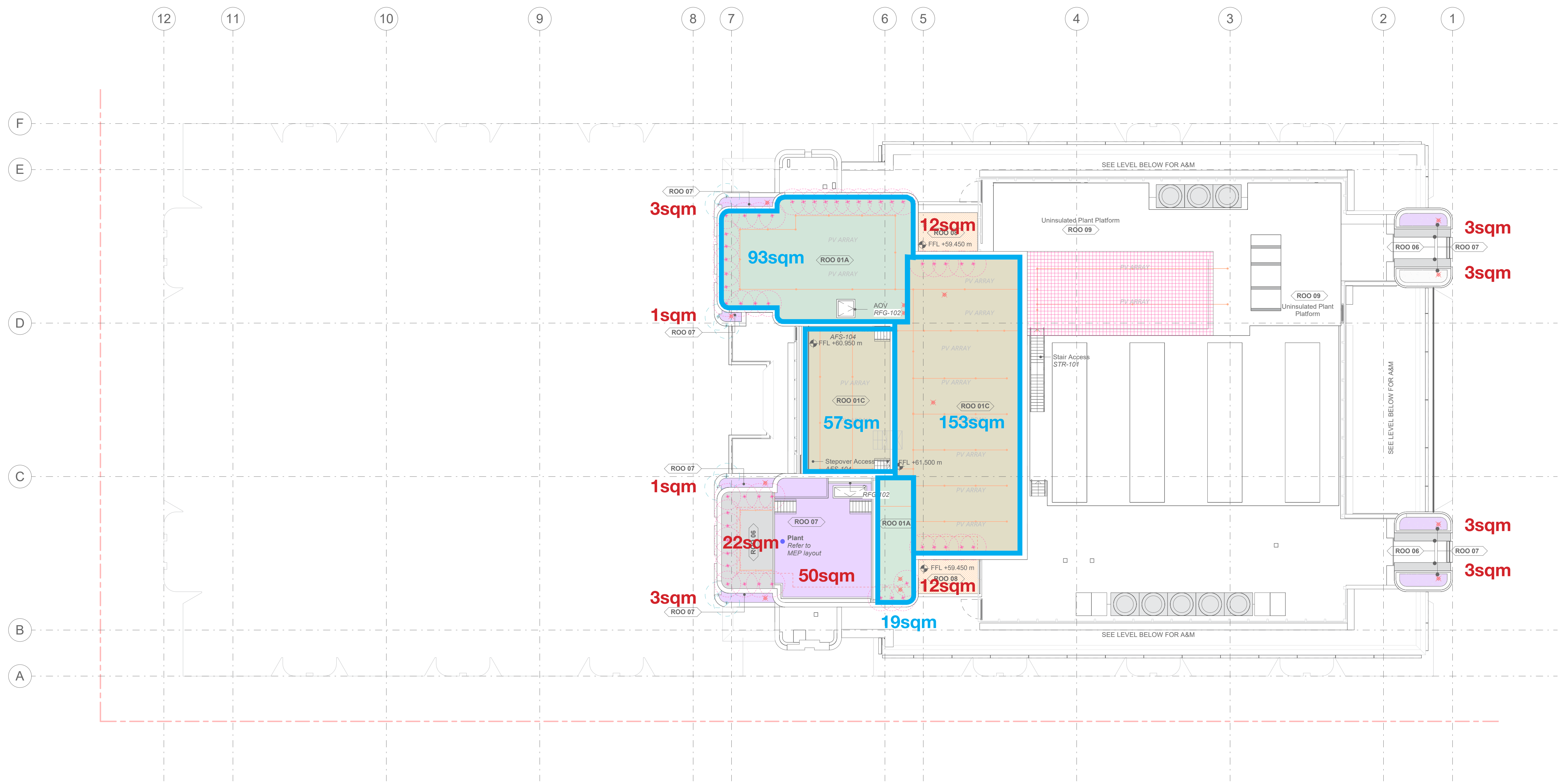


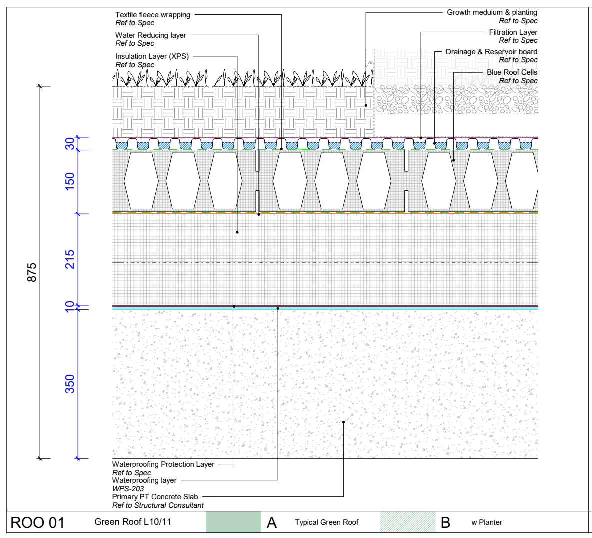
ROO 11 Inverted Roof Balcony

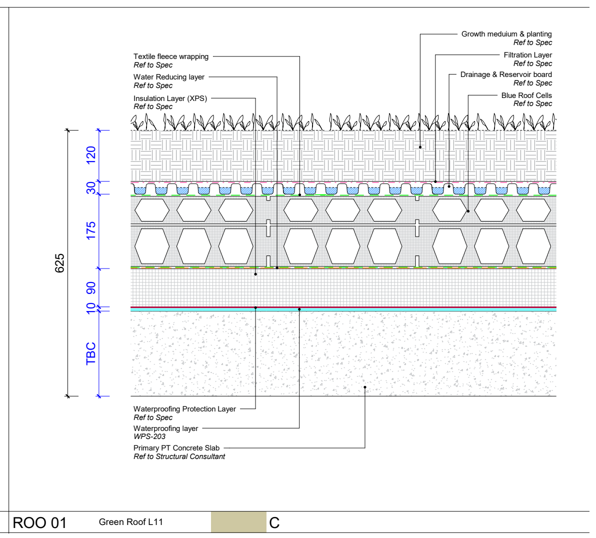
BLUE ROOF AREA

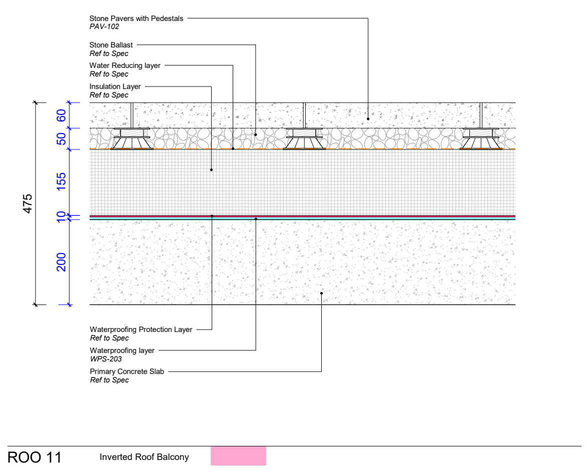
Roof Catchment Area

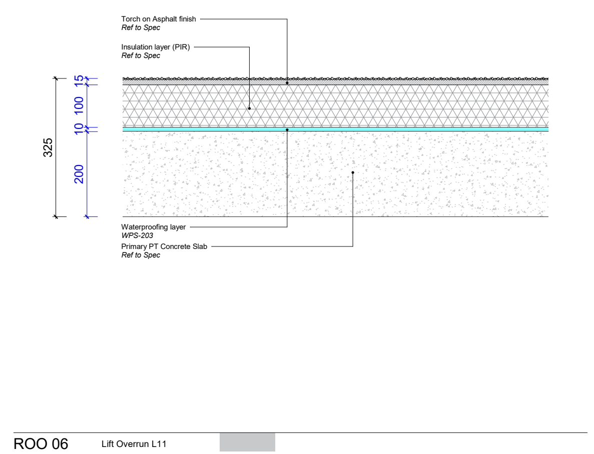
Level RF











BLUE ROOF AREA

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Holland House
Valley Way, Rockingham Road
Market Harborough LE16 7PS
Tel 01858 410372
techenquiries@radmat.com

Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	A		

Roof Details:

BlueRoof	93 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	93 m²	

Storage Details:

Length	93 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m^3)
5 min	25.1	301.8	2.3
10 min	35.9	215.2	3.3
15 min	44.1	176.5	4.0
30 min	56.7	113.5	5.1
45 min	64.0	85.4	5.7
60 min	69.2	69.2	6.1
2 hours	88.6	44.3	7.4
6 hours	120.2	20.0	8.5
24 hours	146.8	6.1	6.8

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.19 l/s
Outlet	2 No
Flow Per Outlet	0.1 l/s

Result:

Outcome	Pass
Critical Storm Duration	6 hrs
Hmax	96 mm
Required Volume	8.5 m³
Time to half empty	6.1 hrs
Roof Loading	91.4 Kg/m²

Blue Roof calculation service is provided in good faith using the information supplied to us in the brief and the stated parameters in the calculation.
If any of these parameters are incorrect or have been superseded, Radmat should be contacted to provide updated calculations.
References should be made to any relevant codes of practice.
Final determination of the suitability of any system is the sole responsibility of the user.
Radmat obligations in respect of any sale of its products are governed by the respective sales contract.

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Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	B		

Roof Details:

BlueRoof	57 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	57 m²	

Storage Details:

Length	57 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	Intensity mm/h	Required storage(m³)
5 min	25.1	301.8	1.4
10 min	35.9	215.2	2.0
15 min	44.1	176.5	2.5
30 min	56.7	113.5	3.1
45 min	64.0	85.4	3.5
60 min	69.2	69.2	3.7
2 hours	88.6	44.3	4.6
6 hours	120.2	20.0	5.3
24 hours	146.8	6.1	4.2

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	13 mm
Sump Depth	None
Discharge rate	0.11 l/s
Outlet	1 No

Result:

Outcome	Pass
Critical Storm Duration	6 hrs
Hmax	97 mm
Required Volume	5.3 m³
Time to half empty	6.4 hrs
Roof Loading	92.98 Kg/m²

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Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	C		

Roof Details:

BlueRoof	153 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	153 m²	

Storage Details:

Length	153 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period 100 years
Climate Change Factor 40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m³)
5 min	25.1	301.8	3.8
10 min	35.9	215.2	5.4
15 min	44.1	176.5	6.6
30 min	56.7	113.5	8.4
45 min	64.0	85.4	9.4
60 min	69.2	69.2	10.0
2 hours	88.6	44.3	12.3
6 hours	120.2	20.0	14.2
24 hours	146.8	6.1	11.5

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	15 mm
Sump Depth	None
Discharge rate	0.3 l/s
Outlet	2 No
Flow Per Outlet	0.15 l/s

Result:

Outcome	Pass
Critical Storm Duration	6 hrs
Hmax	98 mm
Required Volume	14.2 m³
Time to half empty	6.5 hrs
Roof Loading	92.81 Kg/m²

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Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	D		

Roof Details:

BlueRoof	19 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	19 m²	

Storage Details:

Length	19 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m³)
5 min	25.1	301.8	0.5
10 min	35.9	215.2	0.7
15 min	44.1	176.5	0.8
30 min	56.7	113.5	1.0
45 min	64.0	85.4	1.1
60 min	69.2	69.2	1.1
2 hours	88.6	44.3	1.3
6 hours	120.2	20.0	1.3
24 hours	146.8	6.1	0.8

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.09 l/s
Outlet	1 No

Result:

Outcome	Pass
Critical Storm Duration	4 hrs
Hmax	76 mm
Required Volume	1.4 m³
Time to half empty	2.2 hrs
Roof Loading	73.68 Kg/m²

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Client:	AHMM				
Project:	Belgrove House				
Reference:	PR7270	Designer:	JW	Date:	02/11/2021
Location:	Euston				
Roof Location:	A				

Roof Details:

BlueRoof	647 m^2	x 100 %
Additional Area	12 m^2	x 100 %
Effective Area	659 m^2	

Storage Details:

Length	647 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m^3)
5 min	25.1	301.8	16.5
10 min	35.9	215.2	23.4
15 min	44.1	176.5	28.6
30 min	56.7	113.5	36.3
45 min	64.0	85.4	40.5
60 min	69.2	69.2	43.2
2 hours	88.6	44.3	53.0
6 hours	120.2	20.0	61.2
24 hours	146.8	6.1	49.6

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	22 mm
Sump Depth	None
Discharge rate	1.32 l/s
Outlet	4 No
Flow Per Outlet	0.33 l/s

Result:

Outcome	Pass
Critical Storm Duration	6 hrs
Hmax	100 mm
Required Volume	61.2 m^3
Time to half empty	6.5 hrs
Roof Loading	94.59 Kg/m^2

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Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	B		

Roof Details:

BlueRoof	65 m²	x 100 %
Additional Area	12 m²	x 100 %
Effective Area	77 m²	

Storage Details:

Length	65 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	Intensity mm/h	Required storage(m³)
5 min	25.1	301.8	1.9
10 min	35.9	215.2	2.7
15 min	44.1	176.5	3.3
30 min	56.7	113.5	4.1
45 min	64.0	85.4	4.5
60 min	69.2	69.2	4.8
2 hours	88.6	44.3	5.7
6 hours	120.2	20.0	6.0
24 hours	146.8	6.1	4.0

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	14 mm
Sump Depth	None
Discharge rate	0.26 l/s
Outlet	2 No
Flow Per Outlet	0.13 l/s

Result:

Outcome	Pass
Critical Storm Duration	4.25 hrs
Hmax	98 mm
Required Volume	6.1 m³
Time to half empty	3.2 hrs
Roof Loading	93.85 Kg/m²

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Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	C		

Roof Details:

BlueRoof	65 m²	x 100 %
Additional Area	12 m²	x 100 %
Effective Area	77 m²	

Storage Details:

Length	65 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m³)
5 min	25.1	301.8	1.9
10 min	35.9	215.2	2.7
15 min	44.1	176.5	3.3
30 min	56.7	113.5	4.1
45 min	64.0	85.4	4.5
60 min	69.2	69.2	4.8
2 hours	88.6	44.3	5.7
6 hours	120.2	20.0	6.0
24 hours	146.8	6.1	4.0

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	14 mm
Sump Depth	None
Discharge rate	0.26 l/s
Outlet	2 No
Flow Per Outlet	0.13 l/s

Result:

Outcome	Pass
Critical Storm Duration	4.25 hrs
Hmax	98 mm
Required Volume	6.1 m³
Time to half empty	3.2 hrs
Roof Loading	93.85 Kg/m²

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Client:	AHMM
Project:	Belgrove House
Reference:	PR7270
Designer:	JW
Date:	02/11/2021
Location:	Euston
Roof Location:	D

Roof Details:

BlueRoof	5 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	5 m²	

Storage Details:

Length	5 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	Intensity mm/h	Required storage(m³)
5 min	25.1	301.8	0.1
10 min	35.9	215.2	0.2
15 min	44.1	176.5	0.2
30 min	56.7	113.5	0.2
45 min	64.0	85.4	0.2
60 min	69.2	69.2	0.2
2 hours	88.6	44.3	0.2
6 hours	120.2	20.0	0.2
24 hours	146.8	6.1	0.0

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.07 l/s
Outlet	1 No

Result:

Outcome	Pass
Critical Storm Duration	56 min
Hmax	46 mm
Required Volume	0.2 m³
Time to half empty	27.3 min
Roof Loading	40 Kg/m²

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Client:	AHMM
Project:	Belgrove House
Reference:	PR7270
Designer:	JW
Date:	02/11/2021
Location:	Euston
Roof Location:	E

Roof Details:

BlueRoof	5 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	5 m²	

Storage Details:

Length	5 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m^3)
5 min	25.1	301.8	0.1
10 min	35.9	215.2	0.2
15 min	44.1	176.5	0.2
30 min	56.7	113.5	0.2
45 min	64.0	85.4	0.2
60 min	69.2	69.2	0.2
2 hours	88.6	44.3	0.2
6 hours	120.2	20.0	0.2
24 hours	146.8	6.1	0.0

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.07 l/s
Outlet	1 No

Result:

Outcome	Pass
Critical Storm Duration	56 min
Hmax	46 mm
Required Volume	0.2 m³
Time to half empty	27.3 min
Roof Loading	40 Kg/m²

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Client:	AHMM		
Project:	Belgrove House		
Reference:	PR7270	Designer: JW	Date: 02/11/2021
Location:	Euston		
Roof Location:	F		

Roof Details:

BlueRoof	25 m²	x 100 %
Additional Area	0 m²	x 100 %
Effective Area	25 m²	

Storage Details:

Length	25 m
Width	1 m
Depth	100 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m³)
5 min	25.1	301.8	0.6
10 min	35.9	215.2	0.9
15 min	44.1	176.5	1.0
30 min	56.7	113.5	1.3
45 min	64.0	85.4	1.4
60 min	69.2	69.2	1.4
2 hours	88.6	44.3	1.5
6 hours	120.2	20.0	1.5
24 hours	146.8	6.1	0.7

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.16 l/s
Outlet	2 No
Flow Per Outlet	0.08 l/s

Result:

Outcome	Pass
Critical Storm Duration	3.47 hrs
Hmax	66 mm
Required Volume	1.6 m³
Time to half empty	1.4 hrs
Roof Loading	64 Kg/m²

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Client:	AHMM				
Project:	Belgrove House				
Reference:	PR7270	Designer:	JW	Date:	02/11/2021
Location:	Euston				
Roof Location:					

Roof Details:

BlueRoof	771 m²	x 100 %
Additional Area	8 m²	x 100 %
Effective Area	779 m²	

Storage Details:

Length	771 m
Width	1 m
Depth	130 mm
Porosity	95 %
Slope	none

Rainfall Details - FEH Method:

Return Period	100 years
Climate Change Factor	40 %

Summer Storm Profile

Duration	Intensity mm	mm/h	Required storage(m³)
5 min	25.1	301.8	19.5
10 min	35.9	215.2	27.8
15 min	44.1	176.5	34.2
30 min	56.7	113.5	43.7
45 min	64.0	85.4	49.1
60 min	69.2	69.2	52.8
2 hours	88.6	44.3	66.5
6 hours	120.2	20.0	85.0
24 hours	146.8	6.1	81.3

Outflow Details:

Attenuation Control	Orifice Plate
Control Diameter	12 mm
Sump Depth	None
Discharge rate	0.64 l/s
Outlet	6 No
Flow Per Outlet	0.11 l/s

Result:

Outcome	Fail
Critical Storm Duration	11.77 hrs
Hmax	120 mm
Required Volume	87.7 m³
Time to half empty	18.9 hrs
Roof Loading	113.75 Kg/m²

Blue Roof calculation service is provided in good faith using the information supplied to us in the brief and the stated parameters in the calculation.
If any of these parameters are incorrect or have been superseded, Radmat should be contacted to provide updated calculations.
References should be made to any relevant codes of practice.
Final determination of the suitability of any system is the sole responsibility of the user.
Radmat obligations in respect of any sale of its products are governed by the respective sales contract.

ATTENUATION TANK CALCULATIONS

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	6.931	0.431	1.5	30.2	O K
30 min Summer	7.049	0.549	1.5	38.5	O K
60 min Summer	7.152	0.652	1.5	45.7	O K
120 min Summer	7.223	0.723	1.5	50.6	O K
180 min Summer	7.238	0.738	1.5	51.7	O K
240 min Summer	7.230	0.730	1.5	51.1	O K
360 min Summer	7.199	0.699	1.5	48.9	O K
480 min Summer	7.169	0.669	1.5	46.8	O K
600 min Summer	7.139	0.639	1.5	44.8	O K
720 min Summer	7.111	0.611	1.5	42.8	O K
960 min Summer	7.056	0.556	1.5	38.9	O K
1440 min Summer	6.957	0.457	1.5	32.0	O K
15 min Winter	6.931	0.431	1.5	30.2	O K
30 min Winter	7.050	0.550	1.5	38.5	O K
60 min Winter	7.153	0.653	1.5	45.7	O K
120 min Winter	7.226	0.726	1.5	50.8	O K
180 min Winter	7.242	0.742	1.5	52.0	O K
240 min Winter	7.235	0.735	1.5	51.5	O K
360 min Winter	7.198	0.698	1.5	48.9	O K
480 min Winter	7.161	0.661	1.5	46.3	O K
600 min Winter	7.123	0.623	1.5	43.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	149.088	0.0	31.8	26
30 min Summer	96.210	0.0	41.1	40
60 min Summer	59.033	0.0	50.4	68
120 min Summer	34.986	0.0	59.8	126
180 min Summer	25.433	0.0	65.2	184
240 min Summer	20.173	0.0	69.0	240
360 min Summer	14.531	0.0	74.5	302
480 min Summer	11.510	0.0	78.7	362
600 min Summer	9.600	0.0	82.0	426
720 min Summer	8.274	0.0	84.9	494
960 min Summer	6.540	0.0	89.4	628
1440 min Summer	4.688	0.0	96.2	894
15 min Winter	149.088	0.0	31.8	25
30 min Winter	96.210	0.0	41.1	39
60 min Winter	59.033	0.0	50.4	68
120 min Winter	34.986	0.0	59.8	124
180 min Winter	25.433	0.0	65.2	180
240 min Winter	20.173	0.0	69.0	234
360 min Winter	14.531	0.0	74.5	332
480 min Winter	11.510	0.0	78.7	376
600 min Winter	9.600	0.0	82.0	452

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
720 min Winter	7.084	0.584	1.5	40.9	O K
960 min Winter	7.006	0.506	1.5	35.4	O K
1440 min Winter	6.865	0.365	1.5	25.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	8.274	0.0	84.9	528
960 min Winter	6.540	0.0	89.4	672
1440 min Winter	4.688	0.0	96.2	940

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.950
Region	England and Wales	Cv (Winter)	0.950
M5-60 (mm)	20.800	Shortest Storm (mins)	15
Ratio R	0.440	Longest Storm (mins)	1440
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.090

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.030	4	8	0.030	8	12	0.030

Model Details

Storage is Online Cover Level (m) 7.700

Tank or Pond Structure

Invert Level (m) 6.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	70.0	0.300	70.0	0.600	70.0	0.900	70.0
0.100	70.0	0.400	70.0	0.700	70.0	1.000	70.0
0.200	70.0	0.500	70.0	0.800	70.0	1.001	0.0

Pump Outflow Control

Invert Level (m) 6.500

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5000	0.400	1.5000	0.700	1.5000	1.000	1.5000
0.200	1.5000	0.500	1.5000	0.800	1.5000		
0.300	1.5000	0.600	1.5000	0.900	1.5000		

Appendix 3

SuDS Maintenance Statement

5 Maintenance and operation

Before cleaning, final testing and immediately before handover the Contractor will:

- Lift covers to manholes, inspection chambers and access points. Remove mortar droppings, debris and loose wrappings.
- Thoroughly flush pipelines with water to remove silt and check for blockages. Rod pipelines between access points if there is any indication that they may be obstructed.
- Carry out a CCTV of the pipework to ensure that it is free of silt and blockages.

The End User shall then follow the "Waste Management, The Duty of Care – A Code of Practice (Revised 1996)" and shall ensure that their waste does not escape from their control and is transferred only to a registered waste carrier to be sent for recycling or disposal at a suitably licensed facility.

All waste arising from the maintenance of the drains and sewers shall be handled, stored and disposed of correctly to avoid pollution. Waste may be designated as hazardous / special waste and, as such, the End User shall ensure that they comply with the Hazardous Waste (England and Wales) Regulations 2005.

Reference shall be made to CIRIA publication C753 - The SuDS Manual by the Contractor and the End User. A suitable maintenance schedule must be developed, maintained, followed and updated as required to reflect observed performance. The following items are highlighted for guidance.

5.1 General drainage

The below ground drainage network has been designed in accordance with the requirements of the Building Regulations whilst acknowledging the need to limit the number of inspection chambers within "front of house" areas. To this end, all main runs have rodding eyes, manholes or inspection chambers at the head of the run and at all changes of direction to provide access to rod or jet the main pipework.

Where possible, connections from stacks or gullies have been made directly to these manholes or inspection chambers to allow the connection to be rodded or jetted from the downstream end. Where this is not possible, each stack has been detailed to have an access hatch provided just above floor level (see Figure 5.1) to allow the connection to be rodded or jetted from the upstream end. Similarly, the gullies have a rodding access provided within their body allowing the pipework to be rodded or jetted from the gully downstream.

Gullies and channels have been specified with silt buckets and silt trap manholes have been provided upstream of all tanks and infiltration structures to prevent the ingress of silts into the drainage network and impairing the performance of the system.

Maintenance schedule	Required action	Recorded frequency
Regular maintenance	Inspect and identify areas that are not operating correctly. If required, take remedial action.	Monthly for the first three months then six-monthly
	Remove sediment from pre-treatment structures (e.g. gullies, channels, silt traps).	Six-monthly or as required
Occasional maintenance	Debris removal from catchment surface where this may cause risks to performance.	Monthly
Remedial actions	Repair / rehabilitation of inlets, outlets, overflows and vents.	As required
Monitoring	Inspect all manholes, inspection chambers, inlets, outlets, overflows and vents to ensure they are in good condition and operating as designed.	Annually and after large storms

5.2 Pumped systems

Pumps have been designed as duplex units operating on a duty / standby based on hours run, pump failure and high / high water level. A suitable BMS interface shall be provided monitoring each pump system for the following status points:

- Pump 1 running / Pump 2 running – These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump is running.
- Pump 1 failed / Pump 2 failed – These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump is deemed to have failed, i.e. failed to run when requested. This shall cause a latched general alarm on the BMS.
- High water level – This status shall be provided to the BMS in the form of a volt free contact that is closed when a high water level is breached. The level shall be set at a level that is higher than the normal pump control level switch. This shall cause a latched general alarm on the BMS.
- High / High water level – This status shall be provided to the BMS in the form of a volt free contact that is closed when a high / high water level is breached. The level shall be set at a level that is higher than the high water level switch. This shall cause a critical latched alarm on the BMS.
- System not in automatic / not available – This status shall be provided to the BMS in the form of a volt free contact that is open (failsafe) when the system is not available to operate. This shall operate should any event occur that could prevent the system from operating, such as power loss to the control panel, hand / off / auto switches not in Auto, isolators opened. This shall cause a critical latched alarm on the BMS.

The BMS shall be capable of raising the following alarms:

- Excessive Pump Running Alarm – The BMS shall monitor the running status of each pump. Should any pump run for longer than 20 minutes, a general alarm shall be raised on the BMS.
- Excessive Pump Starts Alarm – The BMS shall calculate from the running status the number of starts per hour. Should the number of starts per hour exceed 4, a general alarm shall be raised on the BMS.

A control panel local to each pump station shall be provided to monitor the same status points and alarms as defined for the BMS Interface above.

5.3 Attenuation tanks

In-situ concrete tank to have access provided for future maintenance.

Inspection of the tank is recommended at six-monthly intervals and after every major storm. Should the inspection reveal a build-up of silt at the base of the tank, jetting should be provided to the tank structure to clear the system.

Silt traps prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the tank. It is important to prevent construction silt from entering the tank.

5.4 Petrol separators

The separator shall be provided with a robust device to provide visual and audible warning to an appropriate location when the level of oil reaches 90% of the oil storage volume under static liquid level conditions. Appropriate maintenance shall then be carried out.

Maintenance schedule	Required action	Recorded frequency
Regular maintenance	Follow the manufacturer's recommended guidelines.	As manufacturer's recommendations
	Remove sediment / oil from separator.	Six-monthly or as manufacturer's recommendations
	Service all electrical equipment.	As manufacturer's recommendations
	Inspect integrity of separator and all mechanical parts.	Six-monthly or as manufacturer's recommendations

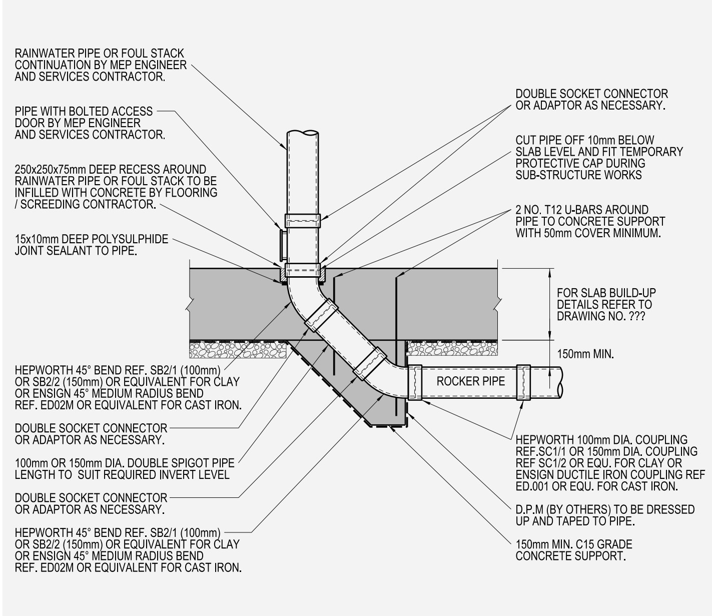

Figure 5.1 Rodding / jetting access detail

5.5 Blue / Green Roofs

Ensure safe access can be gained to the roof and that relevant Health and Safety procedures are followed when working at roof level. It is advised that the contractor should always seek proof of current maintenance for any roof access, fall arrest / restraint systems prior to proceeding with the work on site.

The level of maintenance required is dependent on the final finish. Paved podium decks and extensive green roofs are relatively low maintenance whereas intensive green roofs require maintenance like any garden.

Remove all dead vegetation and debris from the roof and ensuring all outlets, gutters and downpipes are clear. Where the species mix incorporates wildflowers and grasses it is recommended that all dead vegetation is mown / strimmed down and the waste is removed from the roof and disposed off.

Any vegetation which has encroached into drainage outlets, walkways and the vegetation barriers (pebbles) should be removed. Weeding an extensive green roof is necessary to maintain a healthy roof and all aggressive species of shrub sapling and undesirable plants should be removed. Some weeds however are helpful to the biodiversity of the roof and considered as a problem only of aesthetics. If considered excessive, they can be removed ensuring that care is taken to follow specific instructions as to the type and species of vegetation removed. All extensive green roof installations will at times include some moss and grass.

Areas of dead vegetation / bare patches can be easily repaired and this is best done during the main growing seasons of March/April or from late August until the end of September. Take plug plants (new) or vegetation cuttings from surrounding areas of healthy mature plants and place on bare patches, pressing gently into the soil. A light sprinkling of sand mixed with compost should then be dressed over the affected area and watered to improve the uptake of the cuttings. If the vegetation is showing signs of distress, but has received regular rainfall, then the most likely problem is a lack of nutrient and a fertiliser should be applied.

Remove the lids of all Inspection chambers, ensure that all rainwater outlets and downpipes are free from blockages and that water can flow freely away, clean filters to outlets twice yearly and replace every three years. Ensure that any protective metal flashings and termination bars remain securely fixed in place.

Examine all mastic sealant and mortar pointing for signs of degradation. Check that all promenade tiles and paving slabs are securely fixed to the roof surface and in good condition.

Advise the client of the need to repair or renew any defects as necessary.

Ensure that any new items of plant/equipment on the roof are mounted on suitable isolated slabs and that any fixings used to secure the plant/equipment in place do not penetrate the waterproofing. Report signs of damage or degradation to the waterproofing to manufacturer immediately, in order that arrangements can be made for remedial work to be carried out if necessary. It is recommended that a record is kept of the findings of the inspection to avoid confusion and provide an on-going record of roof performance. Plants suitable for an extensive green roof which will colonise in partial and full shade will generally be greener in colour and grow “taller” in these locations. There will be a significant variance in the growth and colour between the plants growing in full or partial shade and those exposed to full sunlight and this should be recognised as a feature of the biodiversity of each individual roof.

5.6 Outlets from blue roof

Inspection chambers containing orifice plates to be inspected regularly in accordance with the manufacturer recommendations (minimum twice annually):

- Remove litter and blockages as required
- Records of inspections and maintenance undertaken should be kept by the client.
- Check orifice plate for any sign of blockages Drainage design standards

The following guides and current British Standards will be used for the design of the drainage elements on this project:

6 Drainage design standards

- BS EN 752:2017 Drain and Sewer Systems Outside Buildings. Sewer System Management
- BS EN 12056 Gravity Drainage Systems Inside Buildings: Part 2
- Building Regulations 2010 Part H1 – Foul Water Drainage (2015 Edition)
- Building Regulations 2010 Part H2 – Wastewater Treatment Systems and Cesspools (2015 Edition)
- Building Regulations 2010 Part H3 – Rainwater Drainage (2015 Edition)
- Building Regulations 2010 Part H4 – Building Over Sewers (2015 Edition)
- Building Regulations 2010 Part H5 – Separate Systems of Drainage (2015 Edition)
- Building Regulations 2010 Part H6 – Solid Waste Storage (2015 Edition)
- Environment Agency “Control of Runoff from New Developments Interim Regional Guidance”
- National Planning Policy Framework
- Planning Practice Guidance

7 Materials

	Item	Material	British standard
a)	Drainage pipe work	Vitrified clayware	BS EN 295-1
		Cast iron	BS EN 877
		Concrete	BS 5911-1 and BS EN 1916
		uPVC	BS EN 1401-1
b)	Precast inspection chambers	Precast concrete	BS 5911 Part 200
c)	Drainage gullies and gratings	Vitrified clayware	BS EN 295-1
		Ductile iron	BS EN 124 D 400
d)	Drainage channels and gratings	Polymer concrete	
		Ductile iron	BS EN 124 D 400
e)	Access covers	Grey iron	BS EN 124
		Galvanised steel	Facta Class A, B & D
f)	Cellular units	Polypropylene	
g)	Geotextiles		

Appendix 4

Extract from the Drainage Strategy Report

1 Surface water drainage

1.1 Existing scheme

The available Thames Water record plans indicate that the closest surface water or combined public sewers to the site are:

- A 1219 × 813 mm combined sewer running under Crestfield Street to the east of the site.
- A 1372 × 737 mm combined sewer running under Argyle Square to the south of the site.
- A 1119 × 787 mm which changes to 1448 × 787 mm combined sewer running under Belgrove Street to the west of the site.
- A 2438 mm dia. storm relief sewer running under Belgrove Street to the west of the site.

An extract from the record plans is shown Figure 1.2 for reference.

It is believed that all surface water from the building currently discharges directly to one of these public combined sewers without any form of attenuation but it is not clear which one and it is therefore recommended that a CCTV survey of the existing site drainage network is undertaken to confirm the location and size of all existing connections from the site.

The total site area is approximately 3,025 m² which is currently 100% hardstanding. In accordance with the Modified Rational Method, the peak existing run-off from the site is calculated from the formula:

$Q = 3.61 \times C_v \times A \times i$

where C_v is the volumetric runoff coefficient, A is the catchment area in hectares and i is the peak rainfall intensity in mm / hr.

For the peak 1-in-1-year return period storm event this gives an existing discharge rate from the site of:

Q_1 = 3.61 × 0.75 × 0.3025 × 39.1 = **32.0 litres / sec**

and for the peak 1-in-100-year return period storm event this gives an existing discharge rate from the site of:

Q_{100} = 3.61 × 0.75 × 0.3025 × 107.2 = **87.8 litres / sec**

Manhole reference	Manhole cover level	Manhole invert level
2804	16.99	12.96
2888	N/A	N/A
2968	N/A	N/A
3803	N/A	N/A

Figure 1.1 Thames Water Manhole Reference and Levels

1.2 Proposed scheme

The proposed development area will also be 100% impermeable. Again using the Modified Rational Method, the proposed (unattenuated) peak run-off from the site for the 1-in-1-year return period storm would be:

Q_1 = 3.61 × 0.75 × 0.3025 × 39.1 = **32.0 litres / sec**

and for the peak 1-in-100-year return period storm event:

Q_{100} = 3.61 × 0.75 × 0.3025 × 107.2 = **87.8 litres / sec**

The Environment Agency updated their guidance on climate change allowance in February 2016 to include an upper and lower allowance to be considered depending on the specific site characteristics. Figure 1.3 shows the revised figures based on various building life spans. Therefore, making an allowance for climate change of 40 % this would give an unattenuated design discharge of:

$Q_{1\,(+40\%)}$ = **44.9 litres / sec** and $Q_{100\,(+40\%)}$ = **122.9 litres / sec**

In accordance with the Environment Agency's guidelines, the Building Regulations and the Water Authority's advice, the preferred means of surface water drainage for any new development is into a suitable soakaway or infiltration drainage system. Sustainable Urban Drainage Systems (SuDS) can reduce the impact of urbanisation on watercourse flows, ensure the protection and enhancement of water quality and encourage recharging of groundwater in a manner which mimics nature.

In addition to this, the National Planning Policy Framework requires that surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic surface water flows arising from the site prior to the proposed development, whilst reducing flood risk to the site itself and elsewhere, taking climate change into account.

Figure 1.2 Thames Water Sewer Record

Therefore, as an absolute minimum, the proposed site discharge under the 1-in-100-year storm plus climate change should be no greater than the existing 1-in-100-year storm discharge (i.e. mitigate the impact of climate change and any increase in the area of hardstanding). In this case, this would mean that, rather than discharging 122.9 litres / sec, the maximum permissible discharge from the site would be **87.8 litres / sec**.

Further to the above, the London Plan's Policy 5.13 states that "Development proposals should aim to get as close to greenfield run-off rates as possible depending on site conditions" but "recognises that in such a densely built-up city as London this may not always be possible in particular given that the vast majority of development is targeted on brownfield sites". The Environment Agency (EA) also suggests that Developers should aim to achieve greenfield run off from their site. In accordance with the method outlined in the Institute of Hydrology Report 124, the Greenfield runoff for the site is calculated from the formula:

$Q_{BAR} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

where AREA is the site area in km² (pro rata of 50 ha if the site is less than 50 ha), SAAR is the Standard Average Annual Rainfall in mm and SOIL is the Soil Index both read from The Wallingford Procedure maps. This gives a greenfield runoff for the site of:

Q_{BAR} = 0.00108 × $0.5^{0.89}$ × $600^{1.17}$ × $0.45^{2.17}$ = **183.4 litres / sec (for 50 ha)**

Scaling this for the actual site area gives:

Q_{BAR} = (183.4 × 0.3025) ÷ 50 = **1.11 litres / sec**

Using the Hydrological Growth Curve for south east England, the growth factor from Q_{BAR} to Q_{100} is 3.146 which gives a value for Q_{100} = **3.54 litres / sec.**

However, Clause 17 of the DEFRA / EA publication 'Rainfall runoff management for developments' states that "A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level. This limit is set at 5 litres per second, using an appropriate vortex or other flow control device. Where sedimentation could be an issue, the minimum size of orifice for controlling flow from an attenuation device should normally be 150 mm laid at a gradient not flatter than 1 in 150, which meets the requirements of Sewers for Adoption 7th Edition".

Following the Pre-Planning Enquiry with Thames Water, they have agreed the site's peak surface water discharge rate would be **5.0 litres/sec**. Refer to Appendix 3 for the Pre-Planning Enquiry approval with Thames Water. Confirmation would be required from Local Authority and EA in regards to the proposed rates.

Range	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2059	Total potential change anticipated for 2060-2115
Upper end	10 %	20 %	40 %
Central	5 %	10 %	20 %

Figure 1.3 Peak rainfall intensity allowance

1.3 Disposal methods

SuDS management train

A useful concept used in the development of sustainable drainage systems is the SuDS management train (sometimes referred to as the treatment train). Just as in a natural catchment, drainage techniques can be used in series to change flow and quality characteristics of the runoff in stages. There are a variety of measures that can be implemented to achieve these goals:

Site management / Prevention

Site management procedures are used to limit or prevent runoff and pollution and include:

- Minimising the hardened areas within the site
- Frequent maintenance of impermeable surfaces
- Minimising the use of de-icing products

Source control

Source control techniques will be used where possible as they control runoff at source in smaller catchments. They can also provide effective pollution control and treatment, thereby improving the quality of the effluent discharged to the receiving waters.

Site control

Where source control techniques do not provide adequate protection to the receiving watercourses in terms of flood protection and pollution control, site control may be required.

Regional control

Where large areas of public space are available regional control can be incorporated to provide additional 'communal' storage and treatment to runoff from a number of sites. However, in this case, all storage and treatment will be implemented on site.

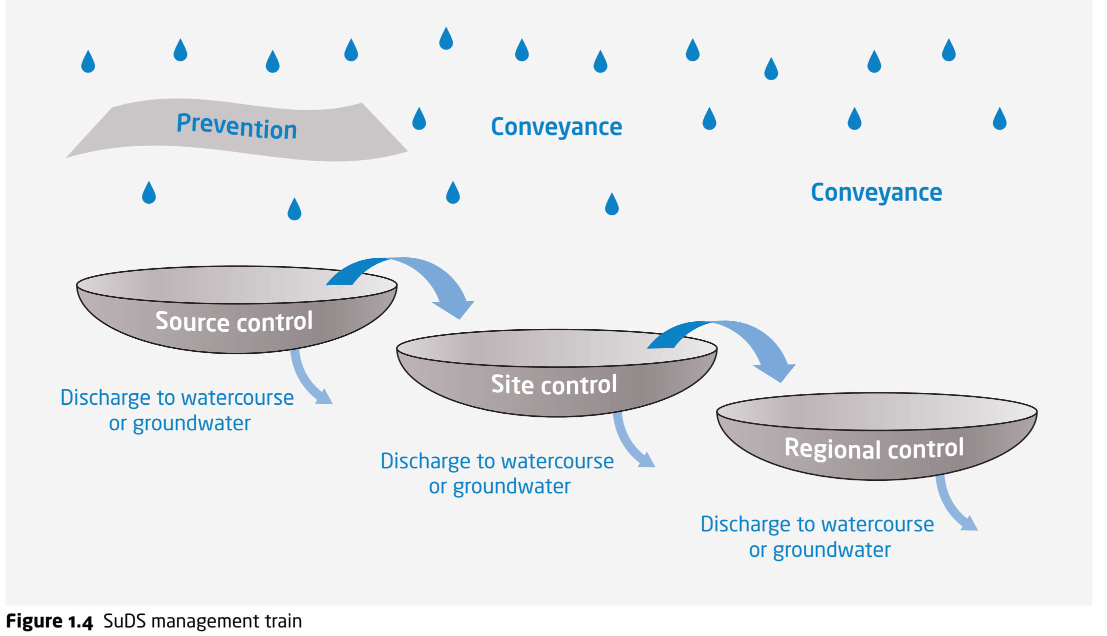

Figure 1.4 SuDS management train

Drainage hierarchy

Based on the above and in line with the London Plan and the Sustainable Drainage Manual published by CIRIA, the following drainage hierarchy will therefore need to be considered when preparing the surface water disposal strategy:

1. Store water for later use
2. Use infiltration techniques such as porous surfaces in non-clay area
3. Attenuate rainwater in ponds or open water features for gradual release to a watercourse
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water drain
7. Discharge rainwater to a combined sewer

Assessment of SuDS techniques

Rainwater harvesting

This involves the capture of rainwater into a tank for re-use (usually non-potable) such as irrigation, toilet flushing or vehicle cleaning. Systems are now available which combine rainwater harvesting with tanked attenuation. This means that water is stored during dry periods for re-use but released ahead of predicted storms in order to ensure that the full attenuation capacity remains available when it is needed.

MEP Engineer confirmed that rainwater harvesting (RWH) is proposed to be incorporated in the development. Specifically, the rainwater falling on the areas not attenuated by the blue roof is proposed to be routed to a RWH tank at basement level and reused for irrigation purposes within the building. Details of the RWH system to be confirmed by MEP Engineer in the next stages design stages

Green / brown / blue roofs

These are used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater. Depending on the design, these roofs can attenuate differing volumes of rainwater. The term 'blue roof' is reserved for those roofs designed to maximise water retention. This is a relatively recent area of increased focus and can involve effectively an attenuation tank at roof level which reduces (or avoids) the need for pumping of basement tanks.

This technique would provide attenuation and water treatment during smaller storm events although during large storm events the impact will be negligible and would have minimal effect on the attenuation tank.

Blue roof is proposed on the podiums at levels 5, 10 and 11 (refer to Appendix 5 for the blue roof study by MEP Engineer and to Appendix 6 for the sketch of the blue roof by the Architect). Green / Brown roof on top of the blue roof are proposed at levels 10 and 11.

Raingardens

Raingardens are planted areas (usually close to buildings but not immediately adjacent) that allow the diversion of a portion of rainwater from either downpipes or the surrounding paved surfaces. These techniques can be incorporated into the landscaping plans for a site and are most effective where the landscaping regime is designed with the aim of capturing as much rainfall as possible. They can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions. There are also a number of vertical raingardens attached to building walls with rainwater downpipes diverted through a stacked series of planters.

As the development consists of a new building up to the site boundary with no external areas, there is no available space for a raingarden. Therefore raingardens will not be incorporated.

Bio-retention

This refers to a chain of landscaped features, potentially including reed beds, filter drains, etc. designed to hold and treat surface water. They are often used where there is a high risk of low-level pollution, for example from road run-off. However, it does require areas of open space. The design of a bio-retention system can vary widely depending on site conditions and available space. At a small scale this could include flow through planters or tree pits.

As the development consists of a new building with basement up to the site boundary with no external areas there is no available space between the building boundary and the site boundary to incorporate bio-retention into the scheme. Therefore, Bio-retention will not be incorporated.

Permeable surfacing

Permeable hard surfaces which work in much the same way as traditional impermeable surfaces apart from the ability to allow rainwater to pass through. Permeable blocks are traditionally used but there are now a range of permeable asphalt and resin bound gravel pavings being used increasingly commonly. Permeable surfaces can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions. They are suitable in even the most densely built-up development. However, they're not well suited to roads carrying heavy or fast motor traffic.

As there are no external areas within the site boundary, it is not feasible to incorporate permeable paving for the development. Therefore, permeable pavings will not be incorporated.

Swales

These are dry ditches used as landscape features to allow the storage, carriage and infiltration of rainwater and are often used as linear features alongside roads, footpaths or rail lines. They can also be integrated into the design of many open spaces.

As the development consists of a new building and a basement up to the site boundary with no external areas, there is no available space between the building boundary and site boundary to incorporate swales into the scheme. Therefore, swales will not be incorporated.

Detention basin / pond

Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.

As the site is heavily developed with limited external areas there is insufficient space to provide a basin or pond. Therefore, detention basin / ponds will not be incorporated.

AKT II Ltd
White Collar Factory
1 Old Street Yard
London
EC1Y 8AF

Wastewater pre-planning
Our ref DS6073136

13 May 2020

Pre-planning enquiry: Confirmation of sufficient capacity

Dear Mr Zilio,

Thank you for providing information on your development.

Site: Belgrove House, Belgrove Street, London, WC1H 8AA.

Proposed site: Demolition of existing building and redevelopment of site for a 8 or 9 storeys mixed use office development. Office space is 19,892m2 and proposed ancillary space is 3,211m2.
Proposed foul water: To reuse existing connections to public combined water sewers in Crestfield Street to the east of the site, Argyle Square and Belgrove Street.
Proposed surface water sewer: Surface water discharge limited to 5l/s, to reuse existing connections to public combined water sewers in Crestfield Street to the east of the site, Argyle Square and Belgrove Street.

We're pleased to confirm that there will be sufficient foul water capacity in the public combined water network to serve your development. If the surface water from the site discharges at the above proposed rates, there will also be sufficient capacity within the public combined water sewer system.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity.

Thames Water Utilities Limited – Registered Office: Clearwater Court, Vastern Road, Reading RG1 8DB
Company number 02366661. VAT registration no GB 537-4569-15

What happens next?

Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.
If you've any further questions, please contact me on 0203 577 9223.

Yours sincerely

Alan Dovey
Development Engineer
Developer Services – Sewer Adoptions Team

Discharge to tidal river / dock / canals

Discharging clean rainwater directly to tidal rivers, canals or docks isn't normally a sustainable drainage technique. Other more productive techniques should be used first. However, it is generally more sustainable than discharging to the combined or surface drainage systems. Residual surface water can be discharged to tidal / large waterbodies, in some cases with no limitation on volumes. Some storage may be required to allow for outfalls becoming tide locked. Care is needed to prevent scour in the receiving waterbody and potentially to prevent pollution. Consent from the Environment Agency, the asset owner and where applicable the Canal and River Trust is required.

There are no adjacent rivers or ponds and so discharge to a watercourse will not be a viable disposal method.

Infiltration

Geological maps from the British Geological Society (Figure 1.5) and the London Borough of Camden Surface Water Management Plan suggest the underlying bedrock to be London Clay. London Clay is classified as an "unproductive strata" due to its low permeability. Therefore, it is believed it would not be possible to achieve infiltration although this would need to be confirmed by a detailed site investigation. An extract from Ground Conditions section from the Desk study Report has been included in Appendix 2 for reference.

Additionally, the new proposed basement footprint extends up to the site area, therefore it will not be possible to utilise infiltration devices for surface water disposal as they cannot be located at a suitable distance from foundations or boundaries. Therefore, infiltration will not be incorporated.

Legend

London Clay

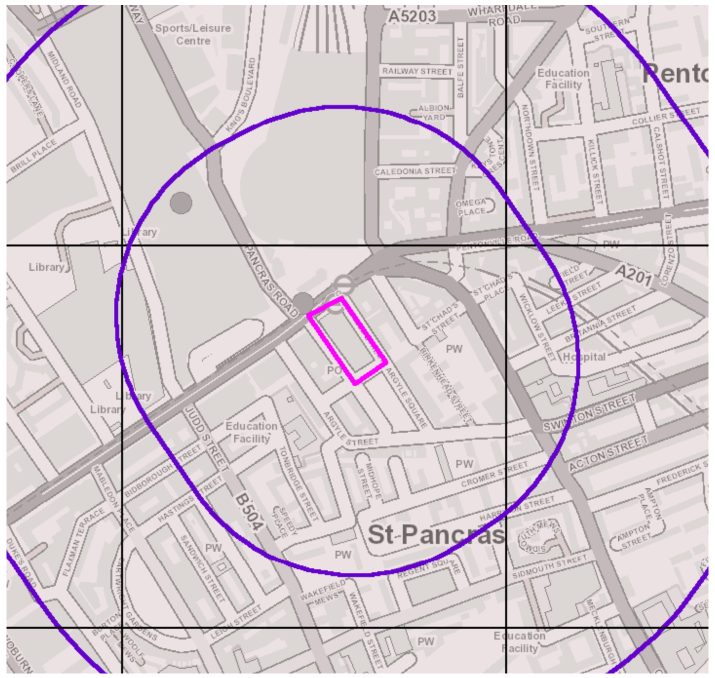

Figure 1.5 Site plan showing bedrock geology

Storage tanks / geocellular storage

Storage tanks are single GRP units usually located (but not necessarily) below ground level which attenuate rainwater for later slow release back into the drainage system but do not provide the wider benefits of green infrastructure sustainable drainage. They can also have the disadvantage that pumping may be required to empty the tank into the drainage system – especially if the tank is located at or below basement level. Where tanks are designed for large storm events, care is needed to ensure that they still perform a useful sustainable drainage function for low order storms.

Geocellular storage tanks are similar to storage tanks except that the volume is made up from multiple units rather than a single tank meaning they can be more flexible in terms of shape to suit constrained sites.

It is believed that this is the most feasibly disposal option for the site and the table below presents the approximate tank volumes required for a range of discharge rates under the 1-in-100-year (plus 40 % climate change) storm event:

Discharge condition	Discharge rate	Storage volume required
Mitigate climate change only (Absolute minimum)	87.8 litres / sec	50 m³
Post-development Q_{100} reduced to 50 % of existing Q_{100}	43.9 litres / sec	80 m³
Post-development Q_{100} reduced to pre-development 1-year peak flow rate	32.1 litres / sec	90 m³
Post-development Q_{100} reduced to 5 litres/sec (DEFRA/EA Guidance and Thames Water Agreement)	**5.0 litres/sec**	**150 m³**
Post-development Q_{100} reduced to Greenfield Q_{100} (Environment Agency's preferred rate)	3.54 litres / sec	200 m³

As per the Pre-planning enquiry with Thames Water, the permissible peak discharge rate from the site will be 5.0 litres/sec. Therefore, the required attenuation volume for the development would be a minimum 150m³. However, should the Local Authority insist on the development to limit the surface water discharge rate to greenfield runoff rate 3.54 litres/sec, the development would need to provide a minimum attenuation volume of 200m³. Therefore at this stage it is recommended that a cost and space allowance is made for a storage volume of 200m³ (Calculated Greenfield rate) until the Local Authority approves the 5.0 litres/sec discharge rate.

The attenuation tank should be located at a high enough level so as to allow a connection to be made to the public sewer by gravity. Locating the tank below this level would result in a pumped surface water system which is both unsustainable and uneconomical. The proposal is to locate the attenuation tank above slab and within level 1 basement, therefore it is likely a pumping system would need to be incorporated.

Oversized piping

Using larger than necessary pipework creates more room to store rainwater. Potentially more sustainable than storage tanks / geocellular storage if the pipes drain by gravity and do not require pumping. However, they lack the wider benefits of the green infrastructure based techniques.

Due to the restricted nature of the site the pipework would become impractically large to provide the volume of storage required to achieve the required run-off rate.

Design for exceedance

This involves designing areas within a site such that they will flood and hold water during rare storm events (typically a frequency of once in ten years or longer).

As the other SuDS measures will be sized to accommodate the 1-in-100-year plus climate change event there is no need to design for exceedance.

Summary of the proposed SuDS strategy

Blue roofs are proposed on levels 5, 10 and 11 to attenuate and restrict the peak discharge rate to 5.0 litres/sec. Green / Brown roofs are proposed on top of the blue roof at levels 10 and 11.

If the blue roof system could not provide sufficient attenuation or restrict the surface water to the required rates, then an attenuation volume of 150m³ has been allowed for within level B1. The attenuation tank has been sized in association of the surface water discharge rate of 5.0 litres/sec per Thames Water requirement.

The existing drainage connection should be reused to prevent the need to constructing a new, deep connection. This would minimise the work and disruption to the surrounding roads which are busy thoroughfares and consequently require significant traffic management to be provided during the work.

Once the CCTV survey of the existing network has been undertaken it will be possible to confirm the exact location, invert, and condition of the existing connection. Therefore, it is recommended that at the current stage an allowance is made for any repair works that might be required for the reuse of the existing outfall. This will also confirm whether the discharge would be via gravity or via pumping system.

Element	Management stage	Water quantity	Water quality	Amenity & biodiversity	Proposed in scheme
Rainwater harvesting	Prevention	✓	✗	✗	✓
Green / brown / blue roof	Source control	✓	✓	✓	✓
Raingardens	Source control	✓	✓	✓	✗
Bio-retention	Source control	✓	✓	✓	✗
Permeable surfacing	Source control	✓	✓	✗	✗
Swales	Source control	✓	✓	✓	✗
Detention basin / ponds	Source control	✓	✓	✓	✗
Discharge to tidal river / dock / canals	Site control	✓	✗	✗	✗
Storage tanks / Geocellular storage	Site control	✓	✗	✗	✓ / ✗
Oversized piping	Site control	✓	✗	✗	✗
Design for exceedance	Site control	✓	✗	✗	✗

Figure 1.6 Summary of proposed SuDS devices