

Surface Water Drainage Strategy

Roof Level, San Court, Manchester

Client: Polypipe

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Appendix A

EPG MicroDrainage Calculations



Summary

The following proposal outlines the Permavoid surface water management system offered by Polypipe and EPG for 3 different roof areas on the existing Avenue Apartments building known as San Court on Wilmslow Road, Manchester. The roofs have no structures, apart from 2 sets of stairs, and high parapet walls making them ideal to retrofit a blue roof.

The 1in100 year storm event plus 45% for climate change has been considered for the MicroDrainage calculations. The Permavoid design is based on working to as smaller discharge rate as possible.

Table 1 – Summary of the Permavoid design

Area	Catchment Area (m ²)	Attenuation Depth (mm)	Discharge Rate (l/s)
Area 1/Roof 8	490	235	1.5
Area 2/Roof 6	99	150	0.2
Area 3/Roof 7	606	235	2.4

The rainwater is stored either within the geocellular attenuation layer or within the type 3 aggregate surround until it can flow through a flow control outlet, and into the existing rainwater downpipe for each roof level. The flow control from the Permavoid system will be a traditional orifice restrictor plate.

1 Background

The site is located on Wilmslow Road, a short distance away from Manchester city centre. The existing development is currently home to residential apartments with commercial units at street level.

It is currently proposed to retrofit a blue roof system to 3 roof areas, Area 1/Roof 8, Area 2/Roof 6, and Area 3/Roof 7.



Figure 1 – Aerial image of the existing San Court

2 Drainage Proposals

2.1 Sustainable Drainage Systems (SuDS)

The use of sustainable drainage systems to reduce the impact of development on the natural water environment has become increasingly common over the past decade, in response to government guidance and the proactive approach of regulatory agencies such as the Environment Agency (EA) and the National Planning Policy Framework (NPPF). Limited discharge consents for surface water outfalls are now routinely applied to development sites across the UK and the rate of water leaving development sites is controlled by a number of SuDS techniques.

2.2 Design Parameters

Accordingly, EPG have developed the blue roof design based on previous experience of similar sites and current SuDS guidance provided in:

- The National Planning Policy Framework (NPPF 25);
- Manchester City Council Local Flood Risk Management Strategy, March 2014;
- Manchester City, Salford City and Trafford Councils Level 2 Hybrid SFRA, March 2011;
- CIRIA report C753 (2016), The SUDS Manual;
- CIRIA Report C737 (2016), Structural and geotechnical design of modular geocellular drainage systems
- CIRIA report C680 (2008), Structural design of modular geocellular drainage tanks;
- CIRIA Report C724 (2013), Creating water sensitive places-scoping the potential for water sensitive urban design in the UK;
- BS 8582:2013, Code of practice for surface water management for development sites;
- BS EN 12056-3:2000: Gravity drainage systems inside buildings- Part 3: Roof drainage, layout and design.

The NPPF requires that surface water arising from a developed site should as far as practicable be managed in a sustainable manner to mimic the surface water flows arising from the site prior to development. Opportunities to reduce the surface water run-off and the associated flood risk should be identified and climate change should be taken into account. Building Regulations (Part H), the NPPF and the Environment Agency advice notes require the consideration of sustainable drainage techniques based on a hierarchical approach to the management of surface water, with the emphasis on the use of Source Control techniques and a treatment train as the preferred option.

2.3 Hydraulic Conveyance and Control

EPG have reviewed the requirements for a SuDS stormwater drainage system designed to attenuate a 100yr return period storm event plus an additional 45% for climate change.

The following hydraulic parameters have been used within the design:

Rainfall Input:	FEH 2013 (MicroDrainage)
Cv (Summer):	0.950
Cv (Winter):	0.950
Area 1/Roof 8 Catchment Area:	0.049 ha (approx.)
Area 2/Roof 6 Catchment Area:	0.010 ha (approx.)
Area 3/Roof 7 Catchment Area:	0.061 ha (approx.)
Total Attenuated Discharge Rate:	4.5 l/s
Storm Events:	100-year return period – critical duration
Climate Change Factor:	45%

3 Overview of Drainage Proposals

3.1 Outline Design

The proposed design is based on achieving source control of the run-off from multiple roofs of the existing residential and commercial building known as San Court.

For the roof areas rainwater permeates into a subterranean geocellular attenuation layer to be collected and attenuated before being discharged. Water also enters the Permavoid via Permavoid Rainwater Downpipe Diffuser units from higher roof levels. The collected surface water flows through the geocellular layer to a flow control outlet. Water is discharged from the roofs by existing rainwater downpipes.

The roof attenuation systems are comprised of either 150mm or 235mm Permavoid. There is also a similar depth of type 3 aggregate layer in areas that can't have Permavoid, for example around the foundations for the stairs. Surface water percolates through the permeable surface and into the Permavoid and aggregate surround until it can flow through a single orifice plate flow control outlet into existing rainwater downpipes (by others). Accompanying MicroDrainage hydraulic calculations can be found in Appendix A.

Table 2 – Summary of the hydraulic calculations

	Area 1/Roof 8	Area 2/Roof 6	Area 3/Roof 7
Catchment Area (m²)	490	99	606
Permavoid Area (m²)	137.10	77.95	154.89
Discharge Rate (1in100+45%)	1.7	0.2	2.8
Attenuation Depth (mm)	235	150	235
Storage Volume* (m³)	30.75	11.81	34.96
H_{max} (mm)	231	92	234
Half Empty Time	188mins	302mins	128mins
No. of Outlets	1	1	1
Orifice Diameter (mm)	42	20	54

**Includes volume from the type 3 aggregate surround*

EPG's drainage layout and details can be found in drawings 55058-EPG-XX-ZZ-DR-Y-0001 and 55058-EPG-XX-ZZ-DR-Y-0100.

3.2 Blue Roof Components

3.2.1 Modular Plastic Geocellular Units (Permavoid)

Permavoid is an 85/ 150mm thick modular interlocking plastic unit storage system designed for use as a combined drainage component and sub-base replacement system and as such has exceptionally high compressive strength and bending resistance within joints to create a horizontal

structural 'raft' that is ideal for the shallow attenuation. The modules have a very high void ratio (92/95%) to achieve highly efficient water storage capacity.

Permavoid has been incorporated into the scheme to ensure the total attenuation requirement for the roofs.

3.2.2 Orifice Flow Control Plates

Flow control outlets incorporating sealed orifice plates are provided within the system at suitable points to ensure that water is held back and temporarily stored in the Permavoid sub-base. Each orifice is sized to give a proportion of the discharge rate appropriate to the drained area (sub-catchment) and the available storage volume. Orifice plates are used as they are simple flow control devices that restrict the flow of surface water through a conveyance system by narrowing the area the water can flow through at the entry to pipework. They are particularly appropriate in shallow drainage systems where the effect of large differences in hydraulic head on flow rate is negligible.

3.2.3 Permafilter Geotextile

The geocellular system shall be encapsulated with a suitable geotextile to provide separation, protection and filtration between the geocellular layer and the overlying landscape finishes and shall also be compatible with and protect the underlying waterproof membrane system.

3.2.4 Permavoid Diffuser Chambers

The roof deck geocellular attenuation systems shall incorporate suitably sized Permavoid 150 rainwater diffuser chambers. The chamber disperses the surface water through the perforated walls into the surrounding Permavoid storage system. Chambers to have access covers (by others) to BS EN 124:2015.

4 Maintenance

We would recommend that Pre-handover inspections and cleaning of all flow control and rainwater diffuser chambers is carried out.

4.1 Routine Inspection

Routine inspection should include:

- Monthly inspections of flow control chambers extending to quarterly inspections after six months.
- Monthly inspections of rainwater diffuser chambers extending to quarterly inspections after six months.
- Visual Inspection of hard landscaped surfaces on an 8-10 week basis extending to six monthly inspections after six months.

4.2 Routine Maintenance

The following routine maintenance procedures are recommended:

- Remove silt and debris from all chambers as required.
- Records of inspections and maintenance undertaken should be kept by the client.



Appendix A

EPG MicroDrainage
Calculations

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Unit CU7

Warrington Business Park

Long Lane, Warrington, WA2 8TX

Roof 8/Area 1

San Court

Manchester

Date 23/08/2023

File AREA 1 ROOF 8.SRCX

Designed by George Hudman

Checked by PW

Innovyze

Source Control 2020.1.3

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 188 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max E Outflow (1/s)	Max Volume (m³)	Status
15 min Summer	40.498	0.128	0.0	1.2	1.2	16.8	Flood Risk
30 min Summer	40.538	0.168	0.0	1.4	1.4	22.0	Flood Risk
60 min Summer	40.574	0.204	0.0	1.6	1.6	26.8	Flood Risk
120 min Summer	40.594	0.224	0.0	1.7	1.7	29.4	Flood Risk
180 min Summer	40.599	0.229	0.0	1.7	1.7	30.0	Flood Risk
240 min Summer	40.601	0.231	0.0	1.7	1.7	30.2	Flood Risk
360 min Summer	40.599	0.229	0.0	1.7	1.7	30.0	Flood Risk
480 min Summer	40.593	0.223	0.0	1.7	1.7	29.2	Flood Risk
600 min Summer	40.586	0.216	0.0	1.6	1.6	28.3	Flood Risk
720 min Summer	40.578	0.208	0.0	1.6	1.6	27.3	Flood Risk
960 min Summer	40.563	0.193	0.0	1.5	1.5	25.3	Flood Risk
1440 min Summer	40.536	0.166	0.0	1.4	1.4	21.7	Flood Risk
2160 min Summer	40.506	0.136	0.0	1.2	1.2	17.8	Flood Risk
2880 min Summer	40.485	0.115	0.0	1.1	1.1	15.0	Flood Risk
4320 min Summer	40.458	0.088	0.0	1.0	1.0	11.5	Flood Risk
5760 min Summer	40.443	0.073	0.0	0.8	0.8	9.5	Flood Risk
7200 min Summer	40.433	0.063	0.0	0.8	0.8	8.2	Flood Risk
8640 min Summer	40.428	0.058	0.0	0.7	0.7	7.5	Flood Risk
10080 min Summer	40.424	0.054	0.0	0.6	0.6	7.1	Flood Risk
15 min Winter	40.498	0.128	0.0	1.2	1.2	16.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	153.710	0.0	17.2	28
30 min Summer	102.594	0.0	23.2	41
60 min Summer	65.217	0.0	30.0	68
120 min Summer	39.120	0.0	36.1	120
180 min Summer	28.828	0.0	39.9	154
240 min Summer	23.151	0.0	42.8	184
360 min Summer	16.930	0.0	46.9	252
480 min Summer	13.512	0.0	49.9	320
600 min Summer	11.327	0.0	52.3	388
720 min Summer	9.799	0.0	54.3	456
960 min Summer	7.786	0.0	57.6	588
1440 min Summer	5.623	0.0	62.3	848
2160 min Summer	4.062	0.0	67.9	1220
2880 min Summer	3.235	0.0	72.0	1588
4320 min Summer	2.363	0.0	78.7	2300
5760 min Summer	1.903	0.0	84.9	3008
7200 min Summer	1.617	0.0	90.2	3688
8640 min Summer	1.421	0.0	95.0	4416
10080 min Summer	1.277	0.0	99.4	5144
15 min Winter	153.710	0.0	17.2	28

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Unit CU7			Roof 8/Area 1				
Warrington Business Park			San Court				
Long Lane, Warrington, WA2 8TX			Manchester				
Date 23/08/2023			Designed by George Hudman				
File AREA 1 ROOF 8.SRCX			Checked by PW				
Innovyze			Source Control 2020.1.3				
<u>Summary of Results for 100 year Return Period (+45%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	40.538	0.168	0.0	1.4	1.4	22.0	Flood Risk
60 min Winter	40.575	0.205	0.0	1.6	1.6	26.8	Flood Risk
120 min Winter	40.595	0.225	0.0	1.7	1.7	29.5	Flood Risk
180 min Winter	40.599	0.229	0.0	1.7	1.7	30.0	Flood Risk
240 min Winter	40.599	0.229	0.0	1.7	1.7	30.0	Flood Risk
360 min Winter	40.594	0.224	0.0	1.7	1.7	29.3	Flood Risk
480 min Winter	40.585	0.215	0.0	1.6	1.6	28.1	Flood Risk
600 min Winter	40.574	0.204	0.0	1.6	1.6	26.7	Flood Risk
720 min Winter	40.563	0.193	0.0	1.5	1.5	25.3	Flood Risk
960 min Winter	40.543	0.173	0.0	1.4	1.4	22.6	Flood Risk
1440 min Winter	40.510	0.140	0.0	1.3	1.3	18.3	Flood Risk
2160 min Winter	40.476	0.106	0.0	1.1	1.1	13.8	Flood Risk
2880 min Winter	40.454	0.084	0.0	0.9	0.9	11.1	Flood Risk
4320 min Winter	40.431	0.061	0.0	0.7	0.7	8.0	Flood Risk
5760 min Winter	40.423	0.053	0.0	0.6	0.6	6.9	Flood Risk
7200 min Winter	40.418	0.048	0.0	0.5	0.5	6.2	Flood Risk
8640 min Winter	40.414	0.044	0.0	0.5	0.5	5.8	Flood Risk
10080 min Winter	40.411	0.041	0.0	0.4	0.4	5.4	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	102.594	0.0	23.2	41			
60 min Winter	65.217	0.0	30.0	68			
120 min Winter	39.120	0.0	36.1	120			
180 min Winter	28.828	0.0	39.9	160			
240 min Winter	23.151	0.0	42.8	192			
360 min Winter	16.930	0.0	46.9	268			
480 min Winter	13.512	0.0	49.9	344			
600 min Winter	11.327	0.0	52.3	416			
720 min Winter	9.799	0.0	54.3	486			
960 min Winter	7.786	0.0	57.6	624			
1440 min Winter	5.623	0.0	62.3	884			
2160 min Winter	4.062	0.0	67.9	1256			
2880 min Winter	3.235	0.0	72.0	1616			
4320 min Winter	2.363	0.0	78.7	2296			
5760 min Winter	1.903	0.0	84.9	3008			
7200 min Winter	1.617	0.0	90.2	3688			
8640 min Winter	1.421	0.0	95.0	4496			
10080 min Winter	1.277	0.0	99.5	5144			
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<u>Rainfall Details</u> <table><tr><td>Rainfall Model</td><td>FEH</td></tr><tr><td>Return Period (years)</td><td>100</td></tr><tr><td>FEH Rainfall Version</td><td>2013</td></tr><tr><td>Site Location</td><td>GB 385148 397932 SJ 85148 97932</td></tr><tr><td>Data Type</td><td>Point</td></tr><tr><td>Summer Storms</td><td>Yes</td></tr><tr><td>Winter Storms</td><td>Yes</td></tr><tr><td>Cv (Summer)</td><td>0.950</td></tr><tr><td>Cv (Winter)</td><td>0.950</td></tr><tr><td>Shortest Storm (mins)</td><td>15</td></tr><tr><td>Longest Storm (mins)</td><td>10080</td></tr><tr><td>Climate Change %</td><td>+45</td></tr></table> <u>Time Area Diagram</u> Total Area (ha) 0.049 <table><tr><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th></tr><tr><th>From:</th><th>To:</th><th>From:</th><th>To:</th><th>From:</th><th>To:</th><th>From:</th><th>To:</th></tr><tr><td>0</td><td>4</td><td>4</td><td>8</td><td>8</td><td>12</td><td>12</td><td>16</td></tr><tr><td colspan="2">0.013</td><td colspan="2">0.012</td><td colspan="2">0.012</td><td colspan="2">0.012</td></tr></table>				Rainfall Model	FEH	Return Period (years)	100	FEH Rainfall Version	2013	Site Location	GB 385148 397932 SJ 85148 97932	Data Type	Point	Summer Storms	Yes	Winter Storms	Yes	Cv (Summer)	0.950	Cv (Winter)	0.950	Shortest Storm (mins)	15	Longest Storm (mins)	10080	Climate Change %	+45	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From:	To:	From:	To:	From:	To:	From:	To:	0	4	4	8	8	12	12	16	0.013		0.012		0.012		0.012	
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Date 23/08/2023 File AREA 1 ROOF 8.SRCX	Designed by George Hudman Checked by PW	
Innovyze Source Control 2020.1.3		

Model Details

Storage is Online Cover Level (m) 40.605

Complex Structure

Cellular Storage

Invert Level (m) 40.370 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.94
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	137.1	137.1	0.236	0.0	192.3
0.235	137.1	192.3			

Infiltration Blanket

Infiltration Coefficient Base (m/hr) 0.00000 Diameter/Width (m) 6.9
Safety Factor 2.0 Length (m) 1.0
Porosity 0.30 Cap Volume Depth (m) 0.235
Invert Level (m) 40.370

Complex Outflow Control

Orifice

Diameter (m) 0.042 Discharge Coefficient 0.600 Invert Level (m) 40.370

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Unit CU7

Warrington Business Park

Long Lane, Warrington, WA2 8TX

Roof 6/Area 2

San Court

Manchester

Date 23/08/2023

File AREA 2 ROOF 6.SRCX

Designed by George Hudman

Checked by PW

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Source Control 2020.1.3

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 302 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	40.497	0.047	0.0	0.2	0.2	3.5	Flood Risk
30 min Summer	40.511	0.061	0.0	0.2	0.2	4.6	Flood Risk
60 min Summer	40.526	0.076	0.0	0.2	0.2	5.7	Flood Risk
120 min Summer	40.536	0.086	0.0	0.2	0.2	6.5	Flood Risk
180 min Summer	40.540	0.090	0.0	0.2	0.2	6.8	Flood Risk
240 min Summer	40.541	0.091	0.0	0.2	0.2	6.8	Flood Risk
360 min Summer	40.542	0.092	0.0	0.2	0.2	6.9	Flood Risk
480 min Summer	40.542	0.092	0.0	0.2	0.2	6.9	Flood Risk
600 min Summer	40.541	0.091	0.0	0.2	0.2	6.8	Flood Risk
720 min Summer	40.539	0.089	0.0	0.2	0.2	6.7	Flood Risk
960 min Summer	40.536	0.086	0.0	0.2	0.2	6.4	Flood Risk
1440 min Summer	40.528	0.078	0.0	0.2	0.2	5.9	Flood Risk
2160 min Summer	40.518	0.068	0.0	0.2	0.2	5.1	Flood Risk
2880 min Summer	40.510	0.060	0.0	0.2	0.2	4.5	Flood Risk
4320 min Summer	40.499	0.049	0.0	0.2	0.2	3.7	Flood Risk
5760 min Summer	40.492	0.042	0.0	0.1	0.1	3.1	Flood Risk
7200 min Summer	40.486	0.036	0.0	0.1	0.1	2.7	Flood Risk
8640 min Summer	40.483	0.033	0.0	0.1	0.1	2.5	Flood Risk
10080 min Summer	40.480	0.030	0.0	0.1	0.1	2.3	Flood Risk
15 min Winter	40.497	0.047	0.0	0.2	0.2	3.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	153.710	0.0	3.3	29
30 min Summer	102.594	0.0	4.5	42
60 min Summer	65.217	0.0	6.0	68
120 min Summer	39.120	0.0	7.3	124
180 min Summer	28.828	0.0	8.0	182
240 min Summer	23.151	0.0	8.6	216
360 min Summer	16.930	0.0	9.5	276
480 min Summer	13.512	0.0	10.1	342
600 min Summer	11.327	0.0	10.5	410
720 min Summer	9.799	0.0	10.9	480
960 min Summer	7.786	0.0	11.6	616
1440 min Summer	5.623	0.0	12.5	882
2160 min Summer	4.062	0.0	13.8	1272
2880 min Summer	3.235	0.0	14.6	1648
4320 min Summer	2.363	0.0	15.9	2380
5760 min Summer	1.903	0.0	17.3	3112
7200 min Summer	1.617	0.0	18.4	3824
8640 min Summer	1.421	0.0	19.3	4504
10080 min Summer	1.277	0.0	20.2	5240
15 min Winter	153.710	0.0	3.3	29

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Unit CU7 Warrington Business Park Long Lane, Warrington, WA2 8TX	Roof 6/Area 2 San Court Manchester	
Date 23/08/2023 File AREA 2 ROOF 6.SRCX	Designed by George Hudman Checked by PW	
Innovyze Source Control 2020.1.3		

Model Details

Storage is Online Cover Level (m) 40.600

Complex Structure

Cellular Storage

Invert Level (m) 40.450 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	77.9	77.9	0.151	0.0	109.5
0.150	77.9	109.5			

Infiltration Blanket

Infiltration Coefficient Base (m/hr) 0.00000 Diameter/Width (m) 3.8
Safety Factor 2.0 Length (m) 1.0
Porosity 0.30 Cap Volume Depth (m) 0.150
Invert Level (m) 40.450

Complex Outflow Control

Orifice

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 40.450

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Unit CU7
Warrington Business Park
Long Lane, Warrington, WA2 8TX

Roof 7/Area 3
San Court
Manchester

Date 23/08/2023
File AREA 3 ROOF 7.SRCX

Designed by George Hudman
Checked by PW

Innovyze

Source Control 2020.1.3

Micro Drainage

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 128 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	42.138	0.138	0.0	2.0	2.0	20.5	Flood Risk
30 min Summer	42.179	0.179	0.0	2.4	2.4	26.6	Flood Risk
60 min Summer	42.215	0.215	0.0	2.6	2.6	32.0	Flood Risk
120 min Summer	42.231	0.231	0.0	2.7	2.7	34.3	Flood Risk
180 min Summer	42.234	0.234	0.0	2.8	2.8	34.9	Flood Risk
240 min Summer	42.234	0.234	0.0	2.8	2.8	34.8	Flood Risk
360 min Summer	42.228	0.228	0.0	2.7	2.7	33.9	Flood Risk
480 min Summer	42.218	0.218	0.0	2.7	2.7	32.5	Flood Risk
600 min Summer	42.208	0.208	0.0	2.6	2.6	30.9	Flood Risk
720 min Summer	42.197	0.197	0.0	2.5	2.5	29.4	Flood Risk
960 min Summer	42.178	0.178	0.0	2.4	2.4	26.5	Flood Risk
1440 min Summer	42.148	0.148	0.0	2.1	2.1	22.0	Flood Risk
2160 min Summer	42.117	0.117	0.0	1.8	1.8	17.5	Flood Risk
2880 min Summer	42.098	0.098	0.0	1.6	1.6	14.6	Flood Risk
4320 min Summer	42.077	0.077	0.0	1.4	1.4	11.4	Flood Risk
5760 min Summer	42.067	0.067	0.0	1.1	1.1	10.0	Flood Risk
7200 min Summer	42.061	0.061	0.0	1.0	1.0	9.1	Flood Risk
8640 min Summer	42.057	0.057	0.0	0.9	0.9	8.5	Flood Risk
10080 min Summer	42.053	0.053	0.0	0.8	0.8	7.9	Flood Risk
15 min Winter	42.138	0.138	0.0	2.0	2.0	20.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	153.710	0.0	21.6	28
30 min Summer	102.594	0.0	29.0	40
60 min Summer	65.217	0.0	37.4	64
120 min Summer	39.120	0.0	45.0	106
180 min Summer	28.828	0.0	49.7	138
240 min Summer	23.151	0.0	53.3	172
360 min Summer	16.930	0.0	58.5	240
480 min Summer	13.512	0.0	62.2	308
600 min Summer	11.327	0.0	65.2	374
720 min Summer	9.799	0.0	67.7	440
960 min Summer	7.786	0.0	71.7	570
1440 min Summer	5.623	0.0	77.6	818
2160 min Summer	4.062	0.0	84.5	1180
2880 min Summer	3.235	0.0	89.7	1536
4320 min Summer	2.363	0.0	98.1	2248
5760 min Summer	1.903	0.0	105.7	2952
7200 min Summer	1.617	0.0	112.3	3680
8640 min Summer	1.421	0.0	118.3	4416
10080 min Summer	1.277	0.0	123.8	5144
15 min Winter	153.710	0.0	21.6	28

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Unit CU7 Warrington Business Park Long Lane, Warrington, WA2 8TX				Roof 7/Area 3 San Court Manchester			
Date 23/08/2023 File AREA 3 ROOF 7.SRCX				Designed by George Hudman Checked by PW			
Innovyze				Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+45%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	42.179	0.179	0.0	2.4	2.4	26.7	Flood Risk
60 min Winter	42.216	0.216	0.0	2.6	2.6	32.1	Flood Risk
120 min Winter	42.230	0.230	0.0	2.7	2.7	34.3	Flood Risk
180 min Winter	42.232	0.232	0.0	2.8	2.8	34.5	Flood Risk
240 min Winter	42.229	0.229	0.0	2.7	2.7	34.1	Flood Risk
360 min Winter	42.218	0.218	0.0	2.7	2.7	32.4	Flood Risk
480 min Winter	42.203	0.203	0.0	2.6	2.6	30.3	Flood Risk
600 min Winter	42.189	0.189	0.0	2.4	2.4	28.1	Flood Risk
720 min Winter	42.175	0.175	0.0	2.3	2.3	26.1	Flood Risk
960 min Winter	42.152	0.152	0.0	2.1	2.1	22.6	Flood Risk
1440 min Winter	42.117	0.117	0.0	1.8	1.8	17.5	Flood Risk
2160 min Winter	42.087	0.087	0.0	1.5	1.5	13.0	Flood Risk
2880 min Winter	42.073	0.073	0.0	1.3	1.3	10.9	Flood Risk
4320 min Winter	42.060	0.060	0.0	0.9	0.9	8.9	Flood Risk
5760 min Winter	42.052	0.052	0.0	0.8	0.8	7.8	Flood Risk
7200 min Winter	42.048	0.048	0.0	0.7	0.7	7.1	Flood Risk
8640 min Winter	42.044	0.044	0.0	0.6	0.6	6.6	Flood Risk
10080 min Winter	42.041	0.041	0.0	0.5	0.5	6.1	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	102.594	0.0	29.0	40			
60 min Winter	65.217	0.0	37.4	64			
120 min Winter	39.120	0.0	45.0	114			
180 min Winter	28.828	0.0	49.7	146			
240 min Winter	23.151	0.0	53.3	184			
360 min Winter	16.930	0.0	58.5	258			
480 min Winter	13.512	0.0	62.2	328			
600 min Winter	11.327	0.0	65.2	398			
720 min Winter	9.799	0.0	67.7	464			
960 min Winter	7.786	0.0	71.7	596			
1440 min Winter	5.623	0.0	77.6	844			
2160 min Winter	4.062	0.0	84.5	1196			
2880 min Winter	3.235	0.0	89.7	1536			
4320 min Winter	2.363	0.0	98.1	2252			
5760 min Winter	1.903	0.0	105.7	3000			
7200 min Winter	1.617	0.0	112.3	3672			
8640 min Winter	1.421	0.0	118.3	4408			
10080 min Winter	1.277	0.0	123.9	5152			
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Unit CU7

Warrington Business Park

Long Lane, Warrington, WA2 8TX

Roof 7/Area 3

San Court

Manchester

Date	23/08/2023
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File AREA 3 ROOF 7.SRCX

Designed by George Hudman

Checked by PW



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Source Control 2020.1.3

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 385148 397932 SJ 85148 97932
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.950
Cv (Winter)	0.950
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.061

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0	4 0.016	4	8 0.015	8	12 0.015	12	16 0.015

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Model Details

Storage is Online Cover Level (m) 42.235

Complex Structure

Cellular Storage

Invert Level (m) 42.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.94
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	154.8	154.8	0.236	0.0	217.1
0.235	154.8	217.1			

Infiltration Blanket

Infiltration Coefficient Base (m/hr) 0.00000 Diameter/Width (m) 11.1
Safety Factor 2.0 Length (m) 1.0
Porosity 0.30 Cap Volume Depth (m) 0.235
Invert Level (m) 42.000

Complex Outflow Control

Orifice

Diameter (m) 0.054 Discharge Coefficient 0.600 Invert Level (m) 42.000

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