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SURFACE WATER DRAINAGE STATEMENT

PROPOSED PREMIER INN EXTENSION

DUKES ROAD, EUSTON

WC1H 9PJ

PREPARED FOR:

WHITBREAD

JOB NO: 14952

DATE: 24 July 2019

DOCUMENT HISTORY

Issue	Description	Date
-	First Issue	24.05.19
A	Minor amendment to Drainage Strategy Drawing	24.06.19
B	Site Layout Updated for Planning Submission	24.07.19

CONTENTS

APPENDICES

1. INTRODUCTION

1.1 This report has been prepared by Simpson Associates on behalf of Whitbread Property PLC to accompany a planning application for the proposed extension of an existing Premier Inn hotel located at Dukes Road, Euston.

1.2 The report details a drainage strategy for the disposal of surface water runoff that will be generated by the development.

2. SURFACE WATER DRAINAGE STRATEGY

Surface Water Runoff Destination

2.1 The NPPF Planning Practice Guidance advises that Sustainable Drainage Systems (SUDS) should be used to control surface water runoff close to where it falls as well as to mimic natural drainage as closely as possible with surface runoff discharged as high up the following hierarchy of drainage options as reasonably practical.

- into the ground (infiltration);
- to a surface water body;
- to a surface water sewer, highway drain, or another drainage system;
- to a combined sewer.

2.2 The methods of disposal are summarised in *Table 1* below with an assessment of each method's suitability also provided.

Table 1: Surface Water Runoff Destination Assessment

Surface Water Runoff Destination	Assessment
Into the ground (infiltration)	Infiltration drainage techniques have been assessed to be inappropriate for the development due to there being insufficient space for positioning of soakaways a minimum of 5m from buildings as required by building regulations.
To a surface water body	Given that no surface water bodies are located nearby to the site it is assessed to not be a viable option for surface water disposal.
To a surface water sewer, highway drain, or another drainage system.	The existing on-site drainage comprises separate surface water and foul water systems. Given the absence of alternative destination within the hierarchy for surface water disposal it is assessed to be appropriate to discharge surface water runoff to the existing on-site surface water drain.
To a combined sewer.	It has been established that it would be appropriate to discharge surface water runoff into the existing private surface water drain. Therefore, it is not necessary to consider the discharge of surface water runoff to a combined sewer.

2.3 Based on the assessment in *Table 1*, it is considered appropriate to discharge surface water runoff into the existing on-site surface water drainage network.

Runoff Management

2.1 Surface water runoff from new development should be managed in accordance with the suggested procedures set out in the March 2015 DEFRA Report "*Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems*."

2.2 The site is considered to be brownfield in nature. For developments on brownfield sites Policy S3 of the DEFRA report advises that the peak runoff rate from the development to any highway drainage, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event. Policy S5 of the DEFRA report advises that where reasonably practicable, for brownfield sites, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should not exceed the runoff volume from the development site prior to redevelopment for that event.

2.3 Greenfield runoff rates and volumes have been calculated using the IH124 method of calculation, using the Source Control Facility in the MicroDrainage Software Package. The results are included in *Appendix B* and are based on a measured drained area of 0.053Ha. The calculated rates and volumes for a variety of storm events up to the 1 in 100 year return period are summarised in *Table 2* below.

Table 1: Pre-development Runoff Rates

Return Period	Greenfield Runoff Rate (l/s)	Greenfield Runoff Volume (m^3)	Brownfield Runoff Rate (l/s)	Brownfield Runoff Volume (m^3)
1 year	0.2	3.1	8.7	9.7
30 year	0.4	7.4	21.3	21.4
100 year	0.6	10.3	27.6	24.8

2.4 *Table 2* also shows the total brownfield runoff rates and volumes discharged from the sites existing drainage network, which have been established using the source control facility in the MicroDrainage software Package by XP Solutions. The design results are included in *Appendix C*.

Sustainable Urban Drainage Systems (SUDS)

2.5 It is proposed to discharge surface water runoff from the development to the existing on-site surface water drainage network, with flows limited to match greenfield runoff rates calculated in *Table 2* as closely as possible and with excess runoff stored and attenuated on site.

2.6 Given the limited scale of proposed development, the greenfield runoff rates are not practical to achieve and it is therefore proposed to provide a Hydrobrake flow control device with a minimum orifice dimeter of 75mm to reduce the risk of blockage.

2.7 Within the drainage strategy it is necessary to consider the use of SUDS, which encompass a wide range of drainage techniques intended to minimise the rate of discharge, volume and environmental impact of runoff and include; grey water

harvesting; soakaways / infiltration systems; infiltration trenches and filter drains; swales and basins; ponds and wetlands; below ground storage tanks. *Table 3* below provides an assessment of each methods suitability.

Table 2: SUDS Assessment

System	Assessment
Grey Water Harvesting	The Water Recycling Manager at Waterscan has been contacted to obtain a specification for a grey water harvesting system, however due to the limited scale of the scheme there is no system available that would be able to efficiently treat such low volumes of water. It is understood that the existing hotel does not have a grey water system, and clearly it would not be feasible to retrospectively install one given that the hotel must remain operational. It is therefore concluded that grey water harvesting will not be viable for the proposed development.
Soakaway / Infiltration Systems / Infiltration Trenches	Infiltration drainage techniques are assessed to be inappropriate for the development due to there being no space for such infiltration drainage techniques to be appropriately positioned with sufficient clearance to buildings.
Swales, basins, ponds, wetlands and below ground storage tanks.	Given the nature of the development, which comprises of a hotel building in a city centre environment, the building has been designed to maximise the available land with its scale and massing chosen so that they are appropriate to the site and its context. Areas of soft landscaping are thus limited, with the building occupying a majority of the site, and no areas available for swales, basins, ponds and wetlands. On this basis, the use of a below ground storage tank is considered the most appropriate technique for additional attenuation and storage of surface water runoff.

2.8 *Table 3* has established that the use of a below ground storage tank would be the most appropriate form of SUDS to match greenfield rates as closely as possible. The proposed location for below ground storage tank has been shown on the drainage strategy drawing included in *Appendix A*.

Hydraulic Analysis

2.9 The source control facility in the MicroDrainage software package by has been used to design the surface water drainage system, which would serve a drained area of 780m^2. The design results for a variety of storm events up to and including the 1 in 100 year storm return period with 40% allowance for increase in peak rainfall intensity over the lifetime of the development are included in *Appendix D*. The design results confirm that the surface water drainage network would store and attenuate surface water flows for all analysed storm events with no surface water flooding identified.

2.10 *Table 4* below compares the maximum rate of discharge / volume analysed for each storm event to the greenfield runoff rates / volumes identified in *Table 2*.

Table 4: Comparison of Discharge Rates & Volumes

Return Period	Greenfield		Brownfield		Post Development	
	Peak Runoff Rate (l/s)	6hr Runoff Volume (m^3)	Peak Runoff Rate (l/s)	6hr Runoff Volume (m^3)	Peak Runoff Rate (l/s)	6hr Runoff Volume (m^3)
1 year	0.2	3.1	8.7	9.7	2.2	9.7
30 year	0.4	7.4	21.3	21.4	2.5	21.4
100 year	0.6	10.3	27.6	24.8	2.5	27.8
100 year + 40%	N/A	N/A	38.2	38.9	2.5	38.9

2.11 The Hydrobrake flow control devices have been sized to a minimum practical orifice diameter of 70mm, resulting in a peak discharge rate of 2.5 l/s. The above table therefore confirms that the surface water drainage scheme would comply with Policy with Policy S3 of the DEFRA Report as the peak runoff rate from the development for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event would be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event and would also not exceed the rate of discharge from the development site prior to redevelopment for that event.

2.12 Table 4 shows that the surface water drainage scheme would discharge at a greater volume than the equivalent pre-development volume for the 1 in 100-year 6-hour rainfall event with 40% allowance for climate change. However, Policy S6 of the DEFRA Report advises that where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body, the runoff volume must be discharged at a rate that does not adversely affect flood risk. Surface water runoff from the development has been limited as far as practicable and at a significantly reduced rate compared to the existing scenario. On this basis it is considered that the runoff volume would be discharged at a rate that does not adversely affect flood risk.

3. CONCLUSION

3.1 It is concluded that it will be possible to dispose of surface water runoff from the development without increasing the level of flood risk to the site or neighbouring properties. Therefore, the scheme can be considered acceptable in terms of flood risk and drainage strategy and there should be no drainage related reason to prevent planning approval from being granted.

APPENDIX A
DRAINAGE STRATEGY PLAN

DO NOT SCALE

EXISTING PREMIER INN HOTEL

Existing SVP to be diverted around proposed attenuation tank.

All drainage marked to be removed to be checked for existing live connections and new connection made into the diverted drain runs as required.

Existing flooded FW drain to be cleared and CCTV surveyed, with levels and condition reported to Engineer. Existing downstream drain to be retained if suitable or replaced as required.

Manhole to be fitted with Hydrobrake flow control device to restrict flows to 2.5 l/s.

Proposed 8.0m x 3m x 1.0m deep geocellular storage tank by SDS or similar approved. Tank to store and attenuate surface water runoff for all storm events up to the 1:100 year + 40% allowance for climate change.

CL 20.75
IL 18.95

CL 20.25
IL 18.95

CL 19.96
IL 19.31

CL 19.87
IL 18.90

CL 19.92
IL 18.87

CL 19.97
IL 19.04 (TBC)

CL 19.95
IL 18.79

CL 19.88
IL 19.17

CL 19.93
IL 18.84

300ø 1:225

150mm 1/80

150ø 1:150

[FFL 20.00]

ENGINEERING NOTES

1. This drawing to be read in conjunction with all relevant Architects, Engineers and Subcontractors drawings and details.
2. This drawing is based on topographical survey by Berry Geomatics:
   Drawing Number **83/17** Rev: –
   Dated **26/09/17**
3. All levels relate to levels given on survey drawing.
4. Refer to Architects drawings for details of all paving types & patterns, soft landscaping, fences, gates & bollards.

DRAINAGE STRATEGY LEGEND

- 150mm 1/100 — SURFACE WATER DRAIN
- 150mm 1/100 — FOUL WATER DRAIN
- FW ABANDONED
- SW ABANDONED
- S1 — SURFACE WATER INSPECTION CHAMBER
- F1 — FOUL WATER INSPECTION CHAMBER
- SURFACE WATER MANHOLE
- CELLULAR SURFACE WATER TANK
- [FFL 84.95] PROPOSED FINISHED FLOOR LEVEL

C	UPDATED SITE LAYOUT	APH	24.07.19
B	MINOR ANNOTATION AMENDMENT	GJ	24.06.19
A	DRAINAGE LAYOUT AMENDED TO ALLOW FOR CONTINUED ACCESS TO PARKING BAYS	GJ	17.06.19
–	INITIAL ISSUE	MK	24.05.19
MK	REVISION	BY	DATE

DRAWING STATUS

PRELIMINARY

DRAWING TITLE

DRAINAGE STRATEGY PLAN

PROJECT — Project Number 14952

PREMIER INN
EUSTON DUKES ROAD

simpson
Arlington House
Park Five Business Park
Harrier Way, Exeter
EX2 7HU
T.01392 446648
London, Henley-on Thames, Gloucester and Exeter

Drawn	Ch'kd	Scales	Date
MK	GJ	1:100@A1	MAY'19

Purpose of Issue: PLANNING

Drawing Number: 14952:SK200 — Revision: C

A1

APPENDIX B
GREENFIELD RUNOFF RATES AND VOLUMES

ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 600 Urban 0.000
Area (ha) 0.053 Soil 0.450 Region Number Region 6

Results l/s

QBAR Rural 0.2
QBAR Urban 0.2

Q100 years 0.6

Q1 year 0.2
Q30 years 0.4
Q100 years 0.6

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.900
Ratio R	0.441
Areal Reduction Factor	1.00
Area (ha)	0.053
SAAR (mm)	600
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	27.00
Greenfield Runoff Volume (m^3)	3.129

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.900
Ratio R	0.441
Areal Reduction Factor	1.00
Area (ha)	0.053
SAAR (mm)	600
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	28.96
Greenfield Runoff Volume (m^3)	7.395

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	20.900
Ratio R	0.441
Areal Reduction Factor	1.00
Area (ha)	0.053
SAAR (mm)	600
CWI	45.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	30.98
Greenfield Runoff Volume (m^3)	10.257

APPENDIX C
BROWNFIELD RUNOFF RATES AND VOLUMES

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.615	0.135	8.7	0.3	O K
30 min Summer	18.601	0.121	7.2	0.2	O K
60 min Summer	18.575	0.095	5.1	0.2	O K
120 min Summer	18.557	0.077	3.4	0.1	O K
180 min Summer	18.549	0.069	2.6	0.1	O K
240 min Summer	18.541	0.061	2.1	0.1	O K
360 min Summer	18.532	0.052	1.6	0.1	O K
480 min Summer	18.527	0.047	1.3	0.1	O K
600 min Summer	18.523	0.043	1.1	0.1	O K
720 min Summer	18.520	0.040	0.9	0.0	O K
960 min Summer	18.516	0.036	0.8	0.0	O K
1440 min Summer	18.511	0.031	0.6	0.0	O K
2160 min Summer	18.506	0.026	0.4	0.0	O K
2880 min Summer	18.504	0.024	0.3	0.0	O K
4320 min Summer	18.499	0.019	0.2	0.0	O K
5760 min Summer	18.497	0.017	0.2	0.0	O K
7200 min Summer	18.495	0.015	0.2	0.0	O K
8640 min Summer	18.494	0.014	0.1	0.0	O K
10080 min Summer	18.494	0.014	0.1	0.0	O K
15 min Winter	18.615	0.135	8.7	0.3	O K
30 min Winter	18.590	0.110	6.3	0.2	O K
60 min Winter	18.564	0.084	4.1	0.1	O K
120 min Winter	18.548	0.068	2.5	0.1	O K
180 min Winter	18.538	0.058	1.9	0.1	O K
240 min Winter	18.532	0.052	1.6	0.1	O K
360 min Winter	18.525	0.045	1.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	33.566	0.0	3.3	10
30 min Summer	21.626	0.0	4.3	18
60 min Summer	13.451	0.0	5.3	32
120 min Summer	8.186	0.0	6.5	62
180 min Summer	6.089	0.0	7.3	92
240 min Summer	4.929	0.0	7.8	122
360 min Summer	3.636	0.0	8.7	182
480 min Summer	2.923	0.0	9.3	242
600 min Summer	2.467	0.0	9.8	304
720 min Summer	2.148	0.0	10.2	360
960 min Summer	1.726	0.0	11.0	488
1440 min Summer	1.269	0.0	12.1	724
2160 min Summer	0.933	0.0	13.3	1068
2880 min Summer	0.750	0.0	14.3	1464
4320 min Summer	0.551	0.0	15.8	2148
5760 min Summer	0.443	0.0	16.9	2920
7200 min Summer	0.374	0.0	17.8	3552
8640 min Summer	0.325	0.0	18.6	4296
10080 min Summer	0.289	0.0	19.3	5120
15 min Winter	33.566	0.0	3.7	10
30 min Winter	21.626	0.0	4.8	18
60 min Winter	13.451	0.0	6.0	32
120 min Winter	8.186	0.0	7.3	64
180 min Winter	6.089	0.0	8.1	92
240 min Winter	4.929	0.0	8.8	120
360 min Winter	3.636	0.0	9.7	178

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
480 min Winter	18.520	0.040	0.9	0.0	O K
600 min Winter	18.516	0.036	0.8	0.0	O K
720 min Winter	18.514	0.034	0.7	0.0	O K
960 min Winter	18.510	0.030	0.5	0.0	O K
1440 min Winter	18.506	0.026	0.4	0.0	O K
2160 min Winter	18.502	0.022	0.3	0.0	O K
2880 min Winter	18.499	0.019	0.2	0.0	O K
4320 min Winter	18.496	0.016	0.2	0.0	O K
5760 min Winter	18.494	0.014	0.1	0.0	O K
7200 min Winter	18.493	0.013	0.1	0.0	O K
8640 min Winter	18.492	0.012	0.1	0.0	O K
10080 min Winter	18.492	0.012	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	2.923	0.0	10.4	238
600 min Winter	2.467	0.0	11.0	306
720 min Winter	2.148	0.0	11.5	372
960 min Winter	1.726	0.0	12.3	474
1440 min Winter	1.269	0.0	13.6	732
2160 min Winter	0.933	0.0	14.9	1068
2880 min Winter	0.750	0.0	16.0	1440
4320 min Winter	0.551	0.0	17.7	2132
5760 min Winter	0.443	0.0	18.9	2928
7200 min Winter	0.374	0.0	20.0	3480
8640 min Winter	0.325	0.0	20.9	4288
10080 min Winter	0.289	0.0	21.6	5056

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

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.800

Pipe Structure

Diameter (m) 0.150 Slope (1:X) 150.000 Length (m) 10.000 Invert Level (m) 18.480

Pipe Outflow Control

Diameter (m) 0.150 Roughness k (mm) 0.600 Upstream Invert Level (m) 18.480
Slope (1:X) 150.0 Entry Loss Coefficient 0.500
Length (m) 5.000 Coefficient of Contraction 0.600

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.777	0.297	21.1	0.5	O K
30 min Summer	18.724	0.244	17.7	0.4	O K
60 min Summer	18.662	0.182	12.7	0.4	O K
120 min Summer	18.608	0.128	7.9	0.2	O K
180 min Summer	18.585	0.105	5.9	0.2	O K
240 min Summer	18.570	0.090	4.7	0.2	O K
360 min Summer	18.557	0.077	3.4	0.1	O K
480 min Summer	18.551	0.071	2.8	0.1	O K
600 min Summer	18.544	0.064	2.3	0.1	O K
720 min Summer	18.539	0.059	2.0	0.1	O K
960 min Summer	18.532	0.052	1.6	0.1	O K
1440 min Summer	18.525	0.045	1.1	0.1	O K
2160 min Summer	18.518	0.038	0.8	0.0	O K
2880 min Summer	18.514	0.034	0.7	0.0	O K
4320 min Summer	18.508	0.028	0.5	0.0	O K
5760 min Summer	18.505	0.025	0.4	0.0	O K
7200 min Summer	18.503	0.023	0.3	0.0	O K
8640 min Summer	18.501	0.021	0.3	0.0	O K
10080 min Summer	18.500	0.020	0.2	0.0	O K
15 min Winter	18.779	0.299	21.3	0.5	O K
30 min Winter	18.693	0.213	15.5	0.4	O K
60 min Winter	18.636	0.156	9.8	0.3	O K
120 min Winter	18.585	0.105	5.9	0.2	O K
180 min Winter	18.566	0.086	4.4	0.1	O K
240 min Winter	18.557	0.077	3.4	0.1	O K
360 min Winter	18.547	0.067	2.5	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	82.449	0.0	8.2	10
30 min Summer	52.748	0.0	10.5	17
60 min Summer	32.216	0.0	12.8	32
120 min Summer	19.093	0.0	15.2	62
180 min Summer	13.916	0.0	16.6	92
240 min Summer	11.075	0.0	17.6	122
360 min Summer	8.015	0.0	19.1	184
480 min Summer	6.369	0.0	20.3	244
600 min Summer	5.325	0.0	21.2	304
720 min Summer	4.599	0.0	21.9	360
960 min Summer	3.648	0.0	23.2	484
1440 min Summer	2.629	0.0	25.1	728
2160 min Summer	1.893	0.0	27.1	1076
2880 min Summer	1.499	0.0	28.6	1436
4320 min Summer	1.077	0.0	30.8	2168
5760 min Summer	0.852	0.0	32.5	2832
7200 min Summer	0.710	0.0	33.9	3632
8640 min Summer	0.612	0.0	35.0	4400
10080 min Summer	0.539	0.0	36.0	4952
15 min Winter	82.449	0.0	9.2	10
30 min Winter	52.748	0.0	11.7	17
60 min Winter	32.216	0.0	14.3	32
120 min Winter	19.093	0.0	17.0	62
180 min Winter	13.916	0.0	18.6	94
240 min Winter	11.075	0.0	19.7	124
360 min Winter	8.015	0.0	21.4	186

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
480 min Winter	18.539	0.059	2.0	0.1	O K
600 min Winter	18.534	0.054	1.7	0.1	O K
720 min Winter	18.530	0.050	1.5	0.1	O K
960 min Winter	18.525	0.045	1.1	0.1	O K
1440 min Winter	18.518	0.038	0.8	0.0	O K
2160 min Winter	18.512	0.032	0.6	0.0	O K
2880 min Winter	18.508	0.028	0.5	0.0	O K
4320 min Winter	18.504	0.024	0.4	0.0	O K
5760 min Winter	18.501	0.021	0.3	0.0	O K
7200 min Winter	18.499	0.019	0.2	0.0	O K
8640 min Winter	18.497	0.017	0.2	0.0	O K
10080 min Winter	18.496	0.016	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	6.369	0.0	22.7	242
600 min Winter	5.325	0.0	23.7	302
720 min Winter	4.599	0.0	24.6	370
960 min Winter	3.648	0.0	26.0	488
1440 min Winter	2.629	0.0	28.1	734
2160 min Winter	1.893	0.0	30.3	1044
2880 min Winter	1.499	0.0	32.0	1436
4320 min Winter	1.077	0.0	34.5	2088
5760 min Winter	0.852	0.0	36.4	2696
7200 min Winter	0.710	0.0	37.9	3608
8640 min Winter	0.612	0.0	39.2	4248
10080 min Winter	0.539	0.0	40.3	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.800

Pipe Structure

Diameter (m) 0.150 Slope (1:X) 150.000 Length (m) 10.000 Invert Level (m) 18.480

Pipe Outflow Control

Diameter (m) 0.150 Roughness k (mm) 0.600 Upstream Invert Level (m) 18.480
Slope (1:X) 150.0 Entry Loss Coefficient 0.500
Length (m) 5.000 Coefficient of Contraction 0.600

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.902	0.422	27.6	0.6	O K
30 min Summer	18.815	0.335	23.3	0.5	O K
60 min Summer	18.704	0.224	16.3	0.4	O K
120 min Summer	18.643	0.163	10.6	0.3	O K
180 min Summer	18.607	0.127	7.8	0.2	O K
240 min Summer	18.589	0.109	6.2	0.2	O K
360 min Summer	18.568	0.088	4.5	0.1	O K
480 min Summer	18.559	0.079	3.6	0.1	O K
600 min Summer	18.553	0.073	3.0	0.1	O K
720 min Summer	18.548	0.068	2.6	0.1	O K
960 min Summer	18.540	0.060	2.0	0.1	O K
1440 min Summer	18.530	0.050	1.5	0.1	O K
2160 min Summer	18.523	0.043	1.1	0.1	O K
2880 min Summer	18.517	0.037	0.8	0.0	O K
4320 min Summer	18.512	0.032	0.6	0.0	O K
5760 min Summer	18.508	0.028	0.5	0.0	O K
7200 min Summer	18.506	0.026	0.4	0.0	O K
8640 min Summer	18.504	0.024	0.4	0.0	O K
10080 min Summer	18.502	0.022	0.3	0.0	O K
15 min Winter	18.902	0.422	27.6	0.6	O K
30 min Winter	18.762	0.282	20.3	0.5	O K
60 min Winter	18.665	0.185	13.0	0.4	O K
120 min Winter	18.606	0.126	7.8	0.2	O K
180 min Winter	18.583	0.103	5.7	0.2	O K
240 min Winter	18.568	0.088	4.5	0.1	O K
360 min Winter	18.556	0.076	3.3	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	107.305	0.0	10.7	10
30 min Summer	69.157	0.0	13.7	17
60 min Summer	42.372	0.0	16.8	32
120 min Summer	25.075	0.0	19.9	62
180 min Summer	18.213	0.0	21.7	92
240 min Summer	14.438	0.0	23.0	122
360 min Summer	10.395	0.0	24.8	180
480 min Summer	8.230	0.0	26.2	244
600 min Summer	6.862	0.0	27.3	306
720 min Summer	5.912	0.0	28.2	366
960 min Summer	4.671	0.0	29.7	480
1440 min Summer	3.347	0.0	31.9	712
2160 min Summer	2.394	0.0	34.3	1068
2880 min Summer	1.887	0.0	36.0	1428
4320 min Summer	1.347	0.0	38.5	2200
5760 min Summer	1.059	0.0	40.4	2872
7200 min Summer	0.879	0.0	41.9	3544
8640 min Summer	0.755	0.0	43.2	4368
10080 min Summer	0.663	0.0	44.3	5072
15 min Winter	107.305	0.0	11.9	10
30 min Winter	69.157	0.0	15.4	17
60 min Winter	42.372	0.0	18.9	32
120 min Winter	25.075	0.0	22.3	62
180 min Winter	18.213	0.0	24.3	92
240 min Winter	14.438	0.0	25.7	120
360 min Winter	10.395	0.0	27.8	176

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
480 min Winter	18.549	0.069	2.6	0.1	O K
600 min Winter	18.542	0.062	2.2	0.1	O K
720 min Winter	18.537	0.057	1.9	0.1	O K
960 min Winter	18.531	0.051	1.5	0.1	O K
1440 min Winter	18.523	0.043	1.1	0.1	O K
2160 min Winter	18.516	0.036	0.8	0.0	O K
2880 min Winter	18.512	0.032	0.6	0.0	O K
4320 min Winter	18.507	0.027	0.4	0.0	O K
5760 min Winter	18.504	0.024	0.4	0.0	O K
7200 min Winter	18.502	0.022	0.3	0.0	O K
8640 min Winter	18.499	0.019	0.2	0.0	O K
10080 min Winter	18.498	0.018	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	8.230	0.0	29.3	242
600 min Winter	6.862	0.0	30.5	308
720 min Winter	5.912	0.0	31.6	366
960 min Winter	4.671	0.0	33.3	488
1440 min Winter	3.347	0.0	35.8	714
2160 min Winter	2.394	0.0	38.4	1104
2880 min Winter	1.887	0.0	40.3	1496
4320 min Winter	1.347	0.0	43.2	2148
5760 min Winter	1.059	0.0	45.3	2784
7200 min Winter	0.879	0.0	47.0	3688
8640 min Winter	0.755	0.0	48.4	4272
10080 min Winter	0.663	0.0	49.6	4920

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.800

Pipe Structure

Diameter (m) 0.150 Slope (1:X) 150.000 Length (m) 10.000 Invert Level (m) 18.480

Pipe Outflow Control

Diameter (m) 0.150 Roughness k (mm) 0.600 Upstream Invert Level (m) 18.480
Slope (1:X) 150.0 Entry Loss Coefficient 0.500
Length (m) 5.000 Coefficient of Contraction 0.600

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	19.215	0.735	38.1	0.9	O K
30 min Summer	19.022	0.542	32.1	0.7	O K
60 min Summer	18.809	0.329	23.0	0.5	O K
120 min Summer	18.684	0.204	14.7	0.4	O K
180 min Summer	18.646	0.166	11.0	0.3	O K
240 min Summer	18.615	0.135	8.7	0.3	O K
360 min Summer	18.590	0.110	6.3	0.2	O K
480 min Summer	18.574	0.094	5.0	0.2	O K
600 min Summer	18.565	0.085	4.2	0.1	O K
720 min Summer	18.559	0.079	3.6	0.1	O K
960 min Summer	18.552	0.072	2.9	0.1	O K
1440 min Summer	18.540	0.060	2.0	0.1	O K
2160 min Summer	18.530	0.050	1.5	0.1	O K
2880 min Summer	18.525	0.045	1.2	0.1	O K
4320 min Summer	18.517	0.037	0.8	0.0	O K
5760 min Summer	18.513	0.033	0.7	0.0	O K
7200 min Summer	18.510	0.030	0.5	0.0	O K
8640 min Summer	18.508	0.028	0.5	0.0	O K
10080 min Summer	18.506	0.026	0.4	0.0	O K
15 min Winter	19.215	0.735	38.2	0.9	O K
30 min Winter	18.918	0.438	28.3	0.6	O K
60 min Winter	18.729	0.249	18.1	0.4	O K
120 min Winter	18.646	0.166	11.0	0.3	O K
180 min Winter	18.608	0.128	8.0	0.2	O K
240 min Winter	18.591	0.111	6.3	0.2	O K
360 min Winter	18.568	0.088	4.6	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.226	0.0	14.9	10
30 min Summer	96.820	0.0	19.2	17
60 min Summer	59.321	0.0	23.6	32
120 min Summer	35.105	0.0	27.9	62
180 min Summer	25.498	0.0	30.4	92
240 min Summer	20.213	0.0	32.1	122
360 min Summer	14.552	0.0	34.7	182
480 min Summer	11.522	0.0	36.6	242
600 min Summer	9.606	0.0	38.2	302
720 min Summer	8.277	0.0	39.5	366
960 min Summer	6.539	0.0	41.6	480
1440 min Summer	4.685	0.0	44.7	732
2160 min Summer	3.352	0.0	48.0	1076
2880 min Summer	2.641	0.0	50.4	1420
4320 min Summer	1.885	0.0	54.0	2156
5760 min Summer	1.483	0.0	56.6	2928
7200 min Summer	1.231	0.0	58.7	3632
8640 min Summer	1.057	0.0	60.5	4288
10080 min Summer	0.928	0.0	62.0	5072
15 min Winter	150.226	0.0	16.7	10
30 min Winter	96.820	0.0	21.6	17
60 min Winter	59.321	0.0	26.4	32
120 min Winter	35.105	0.0	31.3	62
180 min Winter	25.498	0.0	34.1	92
240 min Winter	20.213	0.0	36.0	120
360 min Winter	14.552	0.0	38.9	180

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
480 min Winter	18.559	0.079	3.7	0.1	O K
600 min Winter	18.553	0.073	3.0	0.1	O K
720 min Winter	18.549	0.069	2.6	0.1	O K
960 min Winter	18.540	0.060	2.1	0.1	O K
1440 min Winter	18.531	0.051	1.5	0.1	O K
2160 min Winter	18.523	0.043	1.1	0.1	O K
2880 min Winter	18.518	0.038	0.8	0.0	O K
4320 min Winter	18.512	0.032	0.6	0.0	O K
5760 min Winter	18.508	0.028	0.5	0.0	O K
7200 min Winter	18.506	0.026	0.4	0.0	O K
8640 min Winter	18.504	0.024	0.3	0.0	O K
10080 min Winter	18.502	0.022	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	11.522	0.0	41.0	242
600 min Winter	9.606	0.0	42.8	294
720 min Winter	8.277	0.0	44.2	362
960 min Winter	6.539	0.0	46.6	476
1440 min Winter	4.685	0.0	50.1	716
2160 min Winter	3.352	0.0	53.7	1060
2880 min Winter	2.641	0.0	56.4	1464
4320 min Winter	1.885	0.0	60.4	2208
5760 min Winter	1.483	0.0	63.4	2920
7200 min Winter	1.231	0.0	65.8	3608
8640 min Winter	1.057	0.0	67.7	4192
10080 min Winter	0.928	0.0	69.4	4984

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.800

Pipe Structure

Diameter (m) 0.150 Slope (1:X) 150.000 Length (m) 10.000 Invert Level (m) 18.480

Pipe Outflow Control

Diameter (m) 0.150 Roughness k (mm) 0.600 Upstream Invert Level (m) 18.480
Slope (1:X) 150.0 Entry Loss Coefficient 0.500
Length (m) 5.000 Coefficient of Contraction 0.600

APPENDIX D
MICRODRAINAGE DESIGN RESULTS

Summary of Results for 1 year Return Period

Half Drain Time : 14 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	19.057	0.107	0.0	2.1	2.1	2.4	O K
30 min Summer	19.069	0.119	0.0	2.2	2.2	2.7	O K
60 min Summer	19.066	0.116	0.0	2.2	2.2	2.6	O K
120 min Summer	19.049	0.099	0.0	2.1	2.1	2.2	O K
180 min Summer	19.036	0.086	0.0	1.8	1.8	1.9	O K
240 min Summer	19.026	0.076	0.0	1.6	1.6	1.7	O K
360 min Summer	19.014	0.064	0.0	1.3	1.3	1.4	O K
480 min Summer	19.006	0.056	0.0	1.1	1.1	1.3	O K
600 min Summer	19.001	0.051	0.0	1.0	1.0	1.1	O K
720 min Summer	18.997	0.047	0.0	0.9	0.9	1.1	O K
960 min Summer	18.992	0.042	0.0	0.7	0.7	0.9	O K
1440 min Summer	18.986	0.036	0.0	0.5	0.5	0.8	O K
2160 min Summer	18.980	0.030	0.0	0.4	0.4	0.7	O K
2880 min Summer	18.977	0.027	0.0	0.3	0.3	0.6	O K
4320 min Summer	18.973	0.023	0.0	0.2	0.2	0.5	O K
5760 min Summer	18.971	0.021	0.0	0.2	0.2	0.5	O K
7200 min Summer	18.969	0.019	0.0	0.2	0.2	0.4	O K
8640 min Summer	18.968	0.018	0.0	0.1	0.1	0.4	O K
10080 min Summer	18.967	0.017	0.0	0.1	0.1	0.4	O K
15 min Winter	19.071	0.121	0.0	2.2	2.2	2.7	O K
30 min Winter	19.080	0.130	0.0	2.2	2.2	2.9	O K
60 min Winter	19.071	0.121	0.0	2.2	2.2	2.7	O K
120 min Winter	19.043	0.093	0.0	2.0	2.0	2.1	O K
180 min Winter	19.027	0.077	0.0	1.6	1.6	1.7	O K
240 min Winter	19.017	0.067	0.0	1.4	1.4	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	33.566	0.0	3.3	14
30 min Summer	21.626	0.0	4.3	22
60 min Summer	13.451	0.0	5.3	38
120 min Summer	8.186	0.0	6.5	70
180 min Summer	6.089	0.0	7.2	100
240 min Summer	4.929	0.0	7.8	130
360 min Summer	3.636	0.0	8.7	190
480 min Summer	2.923	0.0	9.3	250
600 min Summer	2.467	0.0	9.8	310
720 min Summer	2.148	0.0	10.2	370
960 min Summer	1.726	0.0	11.0	492
1440 min Summer	1.269	0.0	12.1	736
2160 min Summer	0.933	0.0	13.3	1100
2880 min Summer	0.750	0.0	14.3	1464
4320 min Summer	0.551	0.0	15.8	2204
5760 min Summer	0.443	0.0	16.9	2912
7200 min Summer	0.374	0.0	17.8	3608
8640 min Summer	0.325	0.0	18.6	4384
10080 min Summer	0.289	0.0	19.3	5120
15 min Winter	33.566	0.0	3.7	14
30 min Winter	21.626	0.0	4.8	24
60 min Winter	13.451	0.0	6.0	42
120 min Winter	8.186	0.0	7.3	72
180 min Winter	6.089	0.0	8.1	104
240 min Winter	4.929	0.0	8.8	132

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	19.005	0.055	0.0	1.1	1.1	1.2	O K
480 min Winter	18.998	0.048	0.0	0.9	0.9	1.1	O K
600 min Winter	18.994	0.044	0.0	0.8	0.8	1.0	O K
720 min Winter	18.990	0.040	0.0	0.7	0.7	0.9	O K
960 min Winter	18.986	0.036	0.0	0.5	0.5	0.8	O K
1440 min Winter	18.980	0.030	0.0	0.4	0.4	0.7	O K
2160 min Winter	18.976	0.026	0.0	0.3	0.3	0.6	O K
2880 min Winter	18.973	0.023	0.0	0.2	0.2	0.5	O K
4320 min Winter	18.969	0.019	0.0	0.2	0.2	0.4	O K
5760 min Winter	18.967	0.017	0.0	0.1	0.1	0.4	O K
7200 min Winter	18.966	0.016	0.0	0.1	0.1	0.3	O K
8640 min Winter	18.965	0.015	0.0	0.1	0.1	0.3	O K
10080 min Winter	18.964	0.014	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	3.636	0.0	9.7	194
480 min Winter	2.923	0.0	10.4	252
600 min Winter	2.467	0.0	11.0	312
720 min Winter	2.148	0.0	11.5	374
960 min Winter	1.726	0.0	12.3	490
1440 min Winter	1.269	0.0	13.5	724
2160 min Winter	0.933	0.0	14.9	1116
2880 min Winter	0.750	0.0	16.0	1428
4320 min Winter	0.551	0.0	17.6	2204
5760 min Winter	0.443	0.0	18.9	2936
7200 min Winter	0.374	0.0	19.9	3488
8640 min Winter	0.325	0.0	20.8	4312
10080 min Winter	0.289	0.0	21.6	5144

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

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.950

Cellular Storage Structure

Invert Level (m) 18.950 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.93
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.0	0.0	1.000	24.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	18.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.5	Kick-Flo®	0.627	2.0
Flush-Flo™	0.307	2.5	Mean Flow over Head Range	-	2.2

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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.4	4.000	4.7	7.000	6.2
0.200	2.4	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.4
0.300	2.5	1.200	2.7	2.400	3.7	5.000	5.3	8.000	6.6
0.400	2.5	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.8
0.500	2.4	1.600	3.1	3.000	4.1	6.000	5.7	9.000	7.0
0.600	2.1	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.1

Summary of Results for 30 year Return Period

Half Drain Time : 31 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	19.246	0.296	0.0	2.5	2.5	6.6	O K
30 min Summer	19.285	0.335	0.0	2.5	2.5	7.5	O K
60 min Summer	19.290	0.340	0.0	2.5	2.5	7.6	O K
120 min Summer	19.249	0.299	0.0	2.5	2.5	6.7	O K
180 min Summer	19.203	0.253	0.0	2.5	2.5	5.7	O K
240 min Summer	19.163	0.213	0.0	2.4	2.4	4.8	O K
360 min Summer	19.105	0.155	0.0	2.3	2.3	3.5	O K
480 min Summer	19.068	0.118	0.0	2.2	2.2	2.6	O K
600 min Summer	19.047	0.097	0.0	2.0	2.0	2.2	O K
720 min Summer	19.035	0.085	0.0	1.8	1.8	1.9	O K
960 min Summer	19.021	0.071	0.0	1.5	1.5	1.6	O K
1440 min Summer	19.006	0.056	0.0	1.1	1.1	1.2	O K
2160 min Summer	18.996	0.046	0.0	0.8	0.8	1.0	O K
2880 min Summer	18.990	0.040	0.0	0.6	0.6	0.9	O K
4320 min Summer	18.983	0.033	0.0	0.5	0.5	0.7	O K
5760 min Summer	18.979	0.029	0.0	0.4	0.4	0.6	O K
7200 min Summer	18.976	0.026	0.0	0.3	0.3	0.6	O K
8640 min Summer	18.974	0.024	0.0	0.3	0.3	0.5	O K
10080 min Summer	18.973	0.023	0.0	0.2	0.2	0.5	O K
15 min Winter	19.287	0.337	0.0	2.5	2.5	7.5	O K
30 min Winter	19.335	0.385	0.0	2.5	2.5	8.6	O K
60 min Winter	19.334	0.384	0.0	2.5	2.5	8.6	O K
120 min Winter	19.270	0.320	0.0	2.5	2.5	7.1	O K
180 min Winter	19.200	0.250	0.0	2.5	2.5	5.6	O K
240 min Winter	19.143	0.193	0.0	2.4	2.4	4.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	82.449	0.0	8.2	16
30 min Summer	52.748	0.0	10.5	27
60 min Summer	32.216	0.0	12.8	44
120 min Summer	19.093	0.0	15.2	78
180 min Summer	13.916	0.0	16.6	110
240 min Summer	11.075	0.0	17.6	142
360 min Summer	8.015	0.0	19.1	200
480 min Summer	6.369	0.0	20.2	258
600 min Summer	5.325	0.0	21.2	314
720 min Summer	4.599	0.0	21.9	374
960 min Summer	3.648	0.0	23.2	492
1440 min Summer	2.629	0.0	25.1	736
2160 min Summer	1.893	0.0	27.1	1100
2880 min Summer	1.499	0.0	28.6	1468
4320 min Summer	1.077	0.0	30.8	2204
5760 min Summer	0.852	0.0	32.5	2872
7200 min Summer	0.710	0.0	33.9	3672
8640 min Summer	0.612	0.0	35.0	4304
10080 min Summer	0.539	0.0	36.0	5056
15 min Winter	82.449	0.0	9.2	16
30 min Winter	52.748	0.0	11.7	29
60 min Winter	32.216	0.0	14.3	48
120 min Winter	19.093	0.0	17.0	84
180 min Winter	13.916	0.0	18.6	118
240 min Winter	11.075	0.0	19.7	148

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	19.070	0.120	0.0	2.2	2.2	2.7	O K
480 min Winter	19.040	0.090	0.0	1.9	1.9	2.0	O K
600 min Winter	19.026	0.076	0.0	1.6	1.6	1.7	O K
720 min Winter	19.017	0.067	0.0	1.4	1.4	1.5	O K
960 min Winter	19.006	0.056	0.0	1.1	1.1	1.3	O K
1440 min Winter	18.996	0.046	0.0	0.8	0.8	1.0	O K
2160 min Winter	18.988	0.038	0.0	0.6	0.6	0.8	O K
2880 min Winter	18.983	0.033	0.0	0.5	0.5	0.7	O K
4320 min Winter	18.978	0.028	0.0	0.3	0.3	0.6	O K
5760 min Winter	18.974	0.024	0.0	0.3	0.3	0.5	O K
7200 min Winter	18.972	0.022	0.0	0.2	0.2	0.5	O K
8640 min Winter	18.971	0.021	0.0	0.2	0.2	0.5	O K
10080 min Winter	18.969	0.019	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	8.015	0.0	21.4	204
480 min Winter	6.369	0.0	22.7	256
600 min Winter	5.325	0.0	23.7	314
720 min Winter	4.599	0.0	24.6	374
960 min Winter	3.648	0.0	26.0	492
1440 min Winter	2.629	0.0	28.1	736
2160 min Winter	1.893	0.0	30.3	1100
2880 min Winter	1.499	0.0	32.0	1452
4320 min Winter	1.077	0.0	34.5	2168
5760 min Winter	0.852	0.0	36.4	2936
7200 min Winter	0.710	0.0	37.9	3584
8640 min Winter	0.612	0.0	39.2	4328
10080 min Winter	0.539	0.0	40.3	5000

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.950

Cellular Storage Structure

Invert Level (m) 18.950 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.93
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.0	0.0	1.000	24.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	18.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.5	Kick-Flo®	0.627	2.0
Flush-Flo™	0.307	2.5	Mean Flow over Head Range	-	2.2

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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.4	4.000	4.7	7.000	6.2
0.200	2.4	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.4
0.300	2.5	1.200	2.7	2.400	3.7	5.000	5.3	8.000	6.6
0.400	2.5	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.8
0.500	2.4	1.600	3.1	3.000	4.1	6.000	5.7	9.000	7.0
0.600	2.1	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.1

Summary of Results for 100 year Return Period

Half Drain Time : 45 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	19.350	0.400	0.0	2.5	2.5	8.9	O K
30 min Summer	19.420	0.470	0.0	2.5	2.5	10.5	O K
60 min Summer	19.434	0.484	0.0	2.5	2.5	10.8	O K
120 min Summer	19.392	0.442	0.0	2.5	2.5	9.9	O K
180 min Summer	19.336	0.386	0.0	2.5	2.5	8.6	O K
240 min Summer	19.282	0.332	0.0	2.5	2.5	7.4	O K
360 min Summer	19.195	0.245	0.0	2.5	2.5	5.5	O K
480 min Summer	19.135	0.185	0.0	2.4	2.4	4.1	O K
600 min Summer	19.094	0.144	0.0	2.3	2.3	3.2	O K
720 min Summer	19.067	0.117	0.0	2.2	2.2	2.6	O K
960 min Summer	19.039	0.089	0.0	1.9	1.9	2.0	O K
1440 min Summer	19.017	0.067	0.0	1.4	1.4	1.5	O K
2160 min Summer	19.003	0.053	0.0	1.0	1.0	1.2	O K
2880 min Summer	18.996	0.046	0.0	0.8	0.8	1.0	O K
4320 min Summer	18.988	0.038	0.0	0.6	0.6	0.8	O K
5760 min Summer	18.983	0.033	0.0	0.5	0.5	0.7	O K
7200 min Summer	18.980	0.030	0.0	0.4	0.4	0.7	O K
8640 min Summer	18.977	0.027	0.0	0.3	0.3	0.6	O K
10080 min Summer	18.976	0.026	0.0	0.3	0.3	0.6	O K
15 min Winter	19.406	0.456	0.0	2.5	2.5	10.2	O K
30 min Winter	19.492	0.542	0.0	2.5	2.5	12.1	O K
60 min Winter	19.511	0.561	0.0	2.5	2.5	12.5	O K
120 min Winter	19.446	0.496	0.0	2.5	2.5	11.1	O K
180 min Winter	19.359	0.409	0.0	2.5	2.5	9.1	O K
240 min Winter	19.277	0.327	0.0	2.5	2.5	7.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	107.305	0.0	10.7	17
30 min Summer	69.157	0.0	13.7	30
60 min Summer	42.372	0.0	16.8	48
120 min Summer	25.075	0.0	19.9	82
180 min Summer	18.213	0.0	21.7	114
240 min Summer	14.438	0.0	22.9	146
360 min Summer	10.395	0.0	24.8	208
480 min Summer	8.230	0.0	26.2	266
600 min Summer	6.862	0.0	27.3	322
720 min Summer	5.912	0.0	28.2	378
960 min Summer	4.671	0.0	29.7	492
1440 min Summer	3.347	0.0	31.9	736
2160 min Summer	2.394	0.0	34.3	1100
2880 min Summer	1.887	0.0	36.0	1452
4320 min Summer	1.347	0.0	38.5	2204
5760 min Summer	1.059	0.0	40.4	2920
7200 min Summer	0.879	0.0	41.9	3600
8640 min Summer	0.755	0.0	43.2	4296
10080 min Summer	0.663	0.0	44.3	5080
15 min Winter	107.305	0.0	11.9	17
30 min Winter	69.157	0.0	15.4	31
60 min Winter	42.372	0.0	18.9	56
120 min Winter	25.075	0.0	22.3	88
180 min Winter	18.213	0.0	24.3	124
240 min Winter	14.438	0.0	25.7	156

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	19.157	0.207	0.0	2.4	2.4	4.6	O K
480 min Winter	19.086	0.136	0.0	2.2	2.2	3.0	O K
600 min Winter	19.049	0.099	0.0	2.1	2.1	2.2	O K
720 min Winter	19.035	0.085	0.0	1.8	1.8	1.9	O K
960 min Winter	19.018	0.068	0.0	1.5	1.5	1.5	O K
1440 min Winter	19.003	0.053	0.0	1.0	1.0	1.2	O K
2160 min Winter	18.993	0.043	0.0	0.7	0.7	1.0	O K
2880 min Winter	18.988	0.038	0.0	0.6	0.6	0.8	O K
4320 min Winter	18.981	0.031	0.0	0.4	0.4	0.7	O K
5760 min Winter	18.978	0.028	0.0	0.3	0.3	0.6	O K
7200 min Winter	18.975	0.025	0.0	0.3	0.3	0.6	O K
8640 min Winter	18.973	0.023	0.0	0.2	0.2	0.5	O K
10080 min Winter	18.971	0.021	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	10.395	0.0	27.8	216
480 min Winter	8.230	0.0	29.3	270
600 min Winter	6.862	0.0	30.5	320
720 min Winter	5.912	0.0	31.6	376
960 min Winter	4.671	0.0	33.3	492
1440 min Winter	3.347	0.0	35.7	736
2160 min Winter	2.394	0.0	38.4	1100
2880 min Winter	1.887	0.0	40.3	1432
4320 min Winter	1.347	0.0	43.2	2144
5760 min Winter	1.059	0.0	45.3	2928
7200 min Winter	0.879	0.0	47.0	3560
8640 min Winter	0.755	0.0	48.4	4408
10080 min Winter	0.663	0.0	49.6	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.950

Cellular Storage Structure

Invert Level (m) 18.950 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.93
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.0	0.0	1.000	24.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	18.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.5	Kick-Flo®	0.627	2.0
Flush-Flo™	0.307	2.5	Mean Flow over Head Range	-	2.2

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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.4	4.000	4.7	7.000	6.2
0.200	2.4	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.4
0.300	2.5	1.200	2.7	2.400	3.7	5.000	5.3	8.000	6.6
0.400	2.5	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.8
0.500	2.4	1.600	3.1	3.000	4.1	6.000	5.7	9.000	7.0
0.600	2.1	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.1

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

Half Drain Time : 74 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	19.538	0.588	0.0	2.5	2.5	13.1	O K
30 min Summer	19.663	0.713	0.0	2.5	2.5	15.9	Flood Risk
60 min Summer	19.712	0.762	0.0	2.5	2.5	17.0	Flood Risk
120 min Summer	19.675	0.725	0.0	2.5	2.5	16.2	Flood Risk
180 min Summer	19.616	0.666	0.0	2.5	2.5	14.9	O K
240 min Summer	19.544	0.594	0.0	2.5	2.5	13.3	O K
360 min Summer	19.418	0.468	0.0	2.5	2.5	10.4	O K
480 min Summer	19.318	0.368	0.0	2.5	2.5	8.2	O K
600 min Summer	19.239	0.289	0.0	2.5	2.5	6.4	O K
720 min Summer	19.180	0.230	0.0	2.5	2.5	5.1	O K
960 min Summer	19.104	0.154	0.0	2.3	2.3	3.4	O K
1440 min Summer	19.043	0.093	0.0	2.0	2.0	2.1	O K
2160 min Summer	19.018	0.068	0.0	1.4	1.4	1.5	O K
2880 min Summer	19.007	0.057	0.0	1.1	1.1	1.3	O K
4320 min Summer	18.996	0.046	0.0	0.8	0.8	1.0	O K
5760 min Summer	18.990	0.040	0.0	0.6	0.6	0.9	O K
7200 min Summer	18.986	0.036	0.0	0.5	0.5	0.8	O K
8640 min Summer	18.983	0.033	0.0	0.5	0.5	0.7	O K
10080 min Summer	18.981	0.031	0.0	0.4	0.4	0.7	O K
15 min Winter	19.618	0.668	0.0	2.5	2.5	14.9	O K
30 min Winter	19.762	0.812	0.0	2.5	2.5	18.1	Flood Risk
60 min Winter	19.828	0.878	0.0	2.5	2.5	19.6	Flood Risk
120 min Winter	19.782	0.832	0.0	2.5	2.5	18.6	Flood Risk
180 min Winter	19.703	0.753	0.0	2.5	2.5	16.8	Flood Risk
240 min Winter	19.610	0.660	0.0	2.5	2.5	14.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.226	0.0	14.9	17
30 min Summer	96.820	0.0	19.2	32
60 min Summer	59.321	0.0	23.6	60
120 min Summer	35.105	0.0	27.9	90
180 min Summer	25.498	0.0	30.4	124
240 min Summer	20.213	0.0	32.1	158
360 min Summer	14.552	0.0	34.7	220
480 min Summer	11.522	0.0	36.6	282
600 min Summer	9.606	0.0	38.2	338
720 min Summer	8.277	0.0	39.5	396
960 min Summer	6.539	0.0	41.6	510
1440 min Summer	4.685	0.0	44.7	736
2160 min Summer	3.352	0.0	48.0	1100
2880 min Summer	2.641	0.0	50.4	1464
4320 min Summer	1.885	0.0	54.0	2200
5760 min Summer	1.483	0.0	56.6	2920
7200 min Summer	1.231	0.0	58.7	3616
8640 min Summer	1.057	0.0	60.5	4400
10080 min Summer	0.928	0.0	62.0	5008
15 min Winter	150.226	0.0	16.7	18
30 min Winter	96.820	0.0	21.5	31
60 min Winter	59.321	0.0	26.4	58
120 min Winter	35.105	0.0	31.2	96
180 min Winter	25.498	0.0	34.0	134
240 min Winter	20.213	0.0	36.0	174

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	19.408	0.458	0.0	2.5	2.5	10.2	O K
480 min Winter	19.264	0.314	0.0	2.5	2.5	7.0	O K
600 min Winter	19.166	0.216	0.0	2.4	2.4	4.8	O K
720 min Winter	19.104	0.154	0.0	2.3	2.3	3.4	O K
960 min Winter	19.046	0.096	0.0	2.0	2.0	2.1	O K
1440 min Winter	19.019	0.069	0.0	1.5	1.5	1.5	O K
2160 min Winter	19.004	0.054	0.0	1.1	1.1	1.2	O K
2880 min Winter	18.996	0.046	0.0	0.8	0.8	1.0	O K
4320 min Winter	18.988	0.038	0.0	0.6	0.6	0.8	O K
5760 min Winter	18.983	0.033	0.0	0.5	0.5	0.7	O K
7200 min Winter	18.980	0.030	0.0	0.4	0.4	0.7	O K
8640 min Winter	18.978	0.028	0.0	0.3	0.3	0.6	O K
10080 min Winter	18.976	0.026	0.0	0.3	0.3	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	14.552	0.0	38.9	236
480 min Winter	11.522	0.0	41.0	294
600 min Winter	9.606	0.0	42.8	348
720 min Winter	8.277	0.0	44.2	400
960 min Winter	6.539	0.0	46.6	500
1440 min Winter	4.685	0.0	50.0	734
2160 min Winter	3.352	0.0	53.7	1088
2880 min Winter	2.641	0.0	56.4	1436
4320 min Winter	1.885	0.0	60.4	2184
5760 min Winter	1.483	0.0	63.4	2904
7200 min Winter	1.231	0.0	65.7	3576
8640 min Winter	1.057	0.0	67.7	4392
10080 min Winter	0.928	0.0	69.4	4976

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.900	Shortest Storm (mins)	15
Ratio R	0.443	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.053

Time (mins) From:	To:	Area (ha)
0	4	0.053

Model Details

Storage is Online Cover Level (m) 19.950

Cellular Storage Structure

Invert Level (m) 18.950 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.93
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.0	0.0	1.000	24.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	18.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.5	Kick-Flo®	0.627	2.0
Flush-Flo™	0.307	2.5	Mean Flow over Head Range	-	2.2

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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.4	4.000	4.7	7.000	6.2
0.200	2.4	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.4
0.300	2.5	1.200	2.7	2.400	3.7	5.000	5.3	8.000	6.6
0.400	2.5	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.8
0.500	2.4	1.600	3.1	3.000	4.1	6.000	5.7	9.000	7.0
0.600	2.1	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.1