

APPENDIX 2

Drainage Calculations

Greenfield runoff estimation for sites

Site name: Blendworth Crescent
 Site location: Havant

Site coordinates

Latitude: 50.86150° N

Longitude: 0.98681° W

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Reference: gcp33e13twv1 / 1.16

Date: 12 Mar 2016

Site characteristics

Total site area	1.16	ha
Significant public open space	0	ha
Area positively drained	1.16	ha

Methodology

Greenfield runoff method	IH124
Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	4
HOST class	N/A
SPR	0.47

Hydrological characteristics

	Default	Edited	
SAAR	743	743	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.84	0.84	
Hydrological region	7	7	
Growth curve factor: 1 year	0.85	0.85	
Growth curve factor: 10 year	1.62	1.62	
Growth curve factor: 30 year	2.3	2.3	
Growth curve factor: 100 year	3.19	3.19	

Greenfield runoff rates

	Default	Edited	
Qbar	6.00	6.00	l/s
1 in 1 year	5.10	5.10	l/s
1 in 30 years	13.81	13.81	l/s
1 in 100 years	19.16	19.16	l/s

Please note that a minimum flow of 5 l/s applies to any site



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CALCULATIONS

Job Title	BLUNDWORTH CRESCENT		Job No.	PMC 238	Sht. No.	D2
Element	SURFACE WATER DRAINAGE	Prepared	PL	Date	11 '16	Checked Date

PERMEABLE PAVING CAR PARKING AREAS AS STORAGE.

1) WEST SIDE

DRAINED AREAS

HOUSES PLOTS 1-15. 890 m^2

ACCESS ROAD. 363 m^2

PARKING AREA 576 m^2
TOTAL 1829 m^2

PERMEABLE PAVING $48 \text{ m} \times 16.8 \text{ m}$ PLAN AREA
WITH 600 mm DEPTH OF PERMEABLE SUB BASE.

RESTRICT OUTFLOW TO E.S.L/S. VIA HYDROBRAKE CONTROL

SEE MICRO-DRAINAGE RESULTS OVER.

2) EAST SIDE

DRAINED AREAS

HOUSES PLOTS 16-20 320 m^2

ACCESS ROAD 216 m^2

PARKING AREAS. 320 m^2
 856 m^2

STORAGE IN PERMEABLE PAVING WITH 600 mm SUB-BASE
IMPOUNDING PARKING AREA TO EAST OF PLOT 2.

AREA SAY $50 \text{ m} \times 6.0 \text{ m}$

SEE M/D. RESULTS

3) EAST SIDE CAR PARK + FLATS AREA

FLATS

6000 m^2

700 m^2

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XP Solutions		
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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 E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	10.245	0.295	0.0	2.0	2.0	59.9	O K
60 min Winter	10.313	0.363	0.0	2.0	2.0	76.2	O K
120 min Winter	10.376	0.426	0.0	2.0	2.0	91.5	O K
180 min Winter	10.405	0.455	0.0	2.0	2.0	98.5	O K
240 min Winter	10.418	0.468	0.0	2.0	2.0	101.7	O K
360 min Winter	10.428	0.478	0.0	2.0	2.0	103.9	O K
480 min Winter	10.425	0.475	0.0	2.0	2.0	103.3	O K
600 min Winter	10.416	0.466	0.0	2.0	2.0	101.1	O K
720 min Winter	10.405	0.455	0.0	2.0	2.0	98.6	O K
960 min Winter	10.384	0.434	0.0	2.0	2.0	93.5	O K
1440 min Winter	10.331	0.381	0.0	2.0	2.0	80.5	O K
2160 min Winter	10.248	0.298	0.0	2.0	2.0	60.5	O K
2880 min Winter	10.178	0.228	0.0	2.0	2.0	43.5	O K
4320 min Winter	10.081	0.131	0.0	2.0	2.0	20.0	O K
5760 min Winter	10.040	0.090	0.0	1.8	1.8	10.1	O K
7200 min Winter	10.025	0.075	0.0	1.5	1.5	7.1	O K
8640 min Winter	10.016	0.066	0.0	1.3	1.3	5.5	O K
10080 min Winter	10.010	0.060	0.0	1.2	1.2	4.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	84.745	0.0	62.8	36
60 min Winter	54.368	0.0	81.7	66
120 min Winter	33.674	0.0	102.1	122
180 min Winter	25.065	0.0	114.4	180
240 min Winter	20.180	0.0	123.0	238
360 min Winter	14.839	0.0	136.0	350
480 min Winter	11.923	0.0	145.8	460
600 min Winter	10.054	0.0	153.7	560
720 min Winter	8.741	0.0	160.4	586
960 min Winter	7.003	0.0	171.3	736
1440 min Winter	5.114	0.0	187.4	1040
2160 min Winter	3.727	0.0	204.2	1448
2880 min Winter	2.973	0.0	216.5	1820
4320 min Winter	2.159	0.0	234.2	2468
5760 min Winter	1.718	0.0	246.8	3048
7200 min Winter	1.438	0.0	256.4	3744
8640 min Winter	1.245	0.0	264.7	4408
10080 min Winter	1.102	0.0	271.6	5144

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.200	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.188

Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:
0	4 0.094	4	8 0.094

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Model Details

Storage is Online Cover Level (m) 10.550

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.8
Membrane Percolation (mm/hr)	1000	Length (m)	48.0
Max Percolation (l/s)	224.0	Slope (1:X)	500.0
Safety Factor	1.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.950	Membrane Depth (m)	0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	9.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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

Half Drain Time : 122 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	10.999	0.349	0.0	2.5	2.5	16.4	O K
30 min Summer	11.060	0.410	0.0	2.5	2.5	21.9	O K
60 min Summer	11.106	0.456	0.0	2.5	2.5	26.1	O K
120 min Summer	11.122	0.472	0.0	2.5	2.5	27.5	O K
180 min Summer	11.115	0.465	0.0	2.5	2.5	26.8	O K
240 min Summer	11.103	0.453	0.0	2.5	2.5	25.8	O K
360 min Summer	11.079	0.429	0.0	2.5	2.5	23.6	O K
480 min Summer	11.052	0.402	0.0	2.5	2.5	21.2	O K
600 min Summer	11.024	0.374	0.0	2.5	2.5	18.6	O K
720 min Summer	10.997	0.347	0.0	2.5	2.5	16.2	O K
960 min Summer	10.947	0.297	0.0	2.5	2.5	11.9	O K
1440 min Summer	10.856	0.206	0.0	2.5	2.5	5.7	O K
2160 min Summer	10.763	0.113	0.0	2.4	2.4	1.7	O K
2880 min Summer	10.735	0.085	0.0	2.0	2.0	1.0	O K
4320 min Summer	10.715	0.065	0.0	1.5	1.5	0.6	O K
5760 min Summer	10.705	0.055	0.0	1.2	1.2	0.4	O K
7200 min Summer	10.699	0.049	0.0	1.0	1.0	0.3	O K
8640 min Summer	10.695	0.045	0.0	0.9	0.9	0.3	O K
10080 min Summer	10.692	0.042	0.0	0.8	0.8	0.2	O K
15 min Winter	11.026	0.376	0.0	2.5	2.5	18.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	126.074	0.0	18.6	21
30 min Summer	84.745	0.0	25.5	35
60 min Summer	54.368	0.0	33.1	62
120 min Summer	33.674	0.0	41.4	110
180 min Summer	25.065	0.0	46.3	142
240 min Summer	20.180	0.0	49.8	174
360 min Summer	14.839	0.0	55.0	244
480 min Summer	11.923	0.0	59.0	314
600 min Summer	10.054	0.0	62.2	378
720 min Summer	8.741	0.0	64.9	440
960 min Summer	7.003	0.0	69.3	562
1440 min Summer	5.114	0.0	75.8	786
2160 min Summer	3.727	0.0	82.7	1108
2880 min Summer	2.973	0.0	87.7	1468
4320 min Summer	2.159	0.0	94.9	2200
5760 min Summer	1.718	0.0	100.0	2896
7200 min Summer	1.438	0.0	104.0	3608
8640 min Summer	1.245	0.0	107.4	4264
10080 min Summer	1.102	0.0	110.2	5112
15 min Winter	126.074	0.0	21.0	21

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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 E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	11.095	0.445	0.0	2.5	2.5	25.0	O K
60 min Winter	11.151	0.501	0.0	2.5	2.5	30.1	O K
120 min Winter	11.176	0.526	0.0	2.5	2.5	32.3	O K
180 min Winter	11.166	0.516	0.0	2.5	2.5	31.4	O K
240 min Winter	11.150	0.500	0.0	2.5	2.5	30.0	O K
360 min Winter	11.114	0.464	0.0	2.5	2.5	26.8	O K
480 min Winter	11.074	0.424	0.0	2.5	2.5	23.2	O K
600 min Winter	11.028	0.378	0.0	2.5	2.5	19.0	O K
720 min Winter	10.985	0.335	0.0	2.5	2.5	15.2	O K
960 min Winter	10.905	0.255	0.0	2.5	2.5	8.8	O K
1440 min Winter	10.769	0.119	0.0	2.4	2.4	1.9	O K
2160 min Winter	10.728	0.078	0.0	1.9	1.9	0.8	O K
2880 min Winter	10.714	0.064	0.0	1.5	1.5	0.6	O K
4320 min Winter	10.702	0.052	0.0	1.1	1.1	0.4	O K
5760 min Winter	10.695	0.045	0.0	0.9	0.9	0.3	O K
7200 min Winter	10.691	0.041	0.0	0.7	0.7	0.2	O K
8640 min Winter	10.688	0.038	0.0	0.6	0.6	0.2	O K
10080 min Winter	10.685	0.035	0.0	0.6	0.6	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	84.745	0.0	28.7	35
60 min Winter	54.368	0.0	37.3	62
120 min Winter	33.674	0.0	46.5	116
180 min Winter	25.065	0.0	52.1	150
240 min Winter	20.180	0.0	56.0	188
360 min Winter	14.839	0.0	61.8	264
480 min Winter	11.923	0.0	66.3	340
600 min Winter	10.054	0.0	69.9	408
720 min Winter	8.741	0.0	72.9	470
960 min Winter	7.003	0.0	77.9	586
1440 min Winter	5.114	0.0	85.2	768
2160 min Winter	3.727	0.0	92.9	1100
2880 min Winter	2.973	0.0	98.6	1464
4320 min Winter	2.159	0.0	106.8	2204
5760 min Winter	1.718	0.0	112.7	2928
7200 min Winter	1.438	0.0	117.2	3656
8640 min Winter	1.245	0.0	121.1	4280
10080 min Winter	1.102	0.0	124.4	5032

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.200	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.085

Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:
0	4 0.042	4	8 0.043

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Model Details

Storage is Online Cover Level (m) 11.250

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	50.0
Max Percolation (l/s)	83.3	Slope (1:X)	150.0
Safety Factor	1.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.650	Membrane Depth (m)	0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0081-2500-0600-2500
Design Head (m)	0.600
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	10.650
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.5
Flush-Flo™	0.179	2.5
Kick-Flo®	0.404	2.1
Mean Flow over Head Range	-	2.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.4	3.000	5.3	7.000	7.9
0.200	2.5	1.400	3.7	3.500	5.7	7.500	8.1
0.300	2.4	1.600	3.9	4.000	6.0	8.000	8.4
0.400	2.1	1.800	4.1	4.500	6.4	8.500	8.7
0.500	2.3	2.000	4.4	5.000	6.7	9.000	8.9
0.600	2.5	2.200	4.5	5.500	7.0	9.500	9.2
0.800	2.9	2.400	4.7	6.000	7.3		
1.000	3.2	2.600	4.9	6.500	7.6		

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

Half Drain Time : 47 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
15 min Summer	10.934	0.234	0.0	2.0	2.0	6.1	O K
30 min Summer	10.970	0.270	0.0	2.0	2.0	8.2	O K
60 min Summer	10.988	0.288	0.0	2.0	2.0	9.3	O K
120 min Summer	10.989	0.289	0.0	2.0	2.0	9.4	O K
180 min Summer	10.978	0.278	0.0	2.0	2.0	8.7	O K
240 min Summer	10.964	0.264	0.0	2.0	2.0	7.9	O K
360 min Summer	10.931	0.231	0.0	2.0	2.0	6.0	O K
480 min Summer	10.898	0.198	0.0	2.0	2.0	4.4	O K
600 min Summer	10.867	0.167	0.0	2.0	2.0	3.1	O K
720 min Summer	10.838	0.138	0.0	2.0	2.0	2.1	O K
960 min Summer	10.796	0.096	0.0	2.0	2.0	1.0	O K
1440 min Summer	10.772	0.072	0.0	1.6	1.6	0.6	O K
2160 min Summer	10.756	0.056	0.0	1.1	1.1	0.4	O K
2880 min Summer	10.749	0.049	0.0	0.9	0.9	0.3	O K
4320 min Summer	10.740	0.040	0.0	0.7	0.7	0.2	O K
5760 min Summer	10.735	0.035	0.0	0.5	0.5	0.1	O K
7200 min Summer	10.732	0.032	0.0	0.4	0.4	0.1	O K
8640 min Summer	10.729	0.029	0.0	0.4	0.4	0.1	O K
10080 min Summer	10.727	0.027	0.0	0.3	0.3	0.1	O K
15 min Winter	10.953	0.253	0.0	2.0	2.0	7.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	126.074	0.0	7.3	17
30 min Summer	84.745	0.0	10.4	31
60 min Summer	54.368	0.0	13.8	52
120 min Summer	33.674	0.0	17.5	86
180 min Summer	25.065	0.0	19.7	120
240 min Summer	20.180	0.0	21.2	154
360 min Summer	14.839	0.0	23.5	218
480 min Summer	11.923	0.0	25.2	280
600 min Summer	10.054	0.0	26.6	336
720 min Summer	8.741	0.0	27.8	390
960 min Summer	7.003	0.0	29.7	494
1440 min Summer	5.114	0.0	32.4	734
2160 min Summer	3.727	0.0	35.2	1080
2880 min Summer	2.973	0.0	37.1	1436
4320 min Summer	2.159	0.0	39.7	2188
5760 min Summer	1.718	0.0	41.5	2920
7200 min Summer	1.438	0.0	42.7	3656
8640 min Summer	1.245	0.0	43.6	4264
10080 min Summer	1.102	0.0	44.3	5008
15 min Winter	126.074	0.0	8.4	17

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XP Solutions		Source Control 2016.1

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
30 min Winter	10.991	0.291	0.0	2.0	2.0	9.5	O K
60 min Winter	11.011	0.311	0.0	2.0	2.0	10.9	O K
120 min Winter	11.010	0.310	0.0	2.0	2.0	10.8	O K
180 min Winter	10.994	0.294	0.0	2.0	2.0	9.7	O K
240 min Winter	10.973	0.273	0.0	2.0	2.0	8.4	O K
360 min Winter	10.920	0.220	0.0	2.0	2.0	5.5	O K
480 min Winter	10.866	0.166	0.0	2.0	2.0	3.1	O K
600 min Winter	10.815	0.115	0.0	2.0	2.0	1.5	O K
720 min Winter	10.788	0.088	0.0	1.9	1.9	0.9	O K
960 min Winter	10.771	0.071	0.0	1.6	1.6	0.6	O K
1440 min Winter	10.756	0.056	0.0	1.1	1.1	0.4	O K
2160 min Winter	10.746	0.046	0.0	0.8	0.8	0.2	O K
2880 min Winter	10.740	0.040	0.0	0.7	0.7	0.2	O K
4320 min Winter	10.733	0.033	0.0	0.5	0.5	0.1	O K
5760 min Winter	10.729	0.029	0.0	0.4	0.4	0.1	O K
7200 min Winter	10.727	0.027	0.0	0.3	0.3	0.1	O K
8640 min Winter	10.725	0.025	0.0	0.3	0.3	0.1	O K
10080 min Winter	10.723	0.023	0.0	0.2	0.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	84.745	0.0	11.9	31
60 min Winter	54.368	0.0	15.7	58
120 min Winter	33.674	0.0	19.8	92
180 min Winter	25.065	0.0	22.3	130
240 min Winter	20.180	0.0	24.0	168
360 min Winter	14.839	0.0	26.6	232
480 min Winter	11.923	0.0	28.5	288
600 min Winter	10.054	0.0	30.1	336
720 min Winter	8.741	0.0	31.4	376
960 min Winter	7.003	0.0	33.5	492
1440 min Winter	5.114	0.0	36.6	736
2160 min Winter	3.727	0.0	39.7	1084
2880 min Winter	2.973	0.0	42.0	1444
4320 min Winter	2.159	0.0	45.1	2224
5760 min Winter	1.718	0.0	47.2	2920
7200 min Winter	1.438	0.0	48.6	3576
8640 min Winter	1.245	0.0	49.8	4280
10080 min Winter	1.102	0.0	50.8	4984

Rushby Brewster Associates		Page 13
Town House, St George's Square	Blendworth Crescent	
Bishops Waltham	Leigh Park	
Southampton, SO32 1AF	Havant	
Date Nov. 2016	Designed by AWR	
File Entrance Road.srcx	Checked by	
XP Solutions	Source Control 2016.1	

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)	19.200	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.038

Time (mins)	Area (ha)
From: 0	To: 4 0.038

Rushby Brewster Associates		Page 414
Town House, St George's Square	Blendworth Crescent	
Bishops Waltham	Leigh Park	
Southampton, SO32 1AF	Havant	
Date Nov. 2016	Designed by AWR	
File Entrance Road.srcx	Checked by	
XP Solutions		Source Control 2016.1

Model Details

Storage is Online Cover Level (m) 11.050

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	65.0
Max Percolation (l/s)	90.3	Slope (1:X)	150.0
Safety Factor	1.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.700	Membrane Depth (m)	0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0076-2000-0350-2000		
Design Head (m)	0.350		
Design Flow (l/s)	2.0		
Flush-Flo™	Calculated		
Objective	Minimise upstream storage		
Application	Surface		
Sump Available	Yes		
Diameter (mm)	76		
Invert Level (m)	10.700		
Minimum Outlet Pipe Diameter (mm)	100		
Suggested Manhole Diameter (mm)	1200		

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.350	2.0
Flush-Flo™	0.117	2.0
Kick-Flo®	0.256	1.7
Mean Flow over Head Range	-	1.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	1.200	3.5	3.000	5.4	7.000	8.2
0.200	1.9	1.400	3.8	3.500	5.8	7.500	8.5
0.300	1.9	1.600	4.0	4.000	6.2	8.000	8.7
0.400	2.1	1.800	4.2	4.500	6.5	8.500	9.0
0.500	2.3	2.000	4.4	5.000	6.9	9.000	9.3
0.600	2.6	2.200	4.7	5.500	7.2	9.500	9.5
0.800	2.9	2.400	4.8	6.000	7.6		
1.000	3.2	2.600	5.0	6.500	7.9		

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Date 17/11/2016 17:23		Designed by allen.rushby			
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XP Solutions		Source Control 2016.1			
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	10.074	0.424	1.9	17.4	O K
30 min Summer	10.198	0.548	1.9	22.6	O K
60 min Summer	10.310	0.660	1.9	27.3	O K
120 min Summer	10.368	0.718	1.9	29.8	O K
180 min Summer	10.364	0.714	1.9	29.6	O K
240 min Summer	10.348	0.698	1.9	28.9	O K
360 min Summer	10.310	0.660	1.9	27.3	O K
480 min Summer	10.267	0.617	1.9	25.5	O K
600 min Summer	10.217	0.567	1.9	23.4	O K
720 min Summer	10.169	0.519	1.9	21.4	O K
960 min Summer	10.083	0.433	1.9	17.8	O K
1440 min Summer	9.948	0.298	1.9	12.1	O K
2160 min Summer	9.828	0.178	1.9	7.1	O K
2880 min Summer	9.768	0.118	1.7	4.6	O K
4320 min Summer	9.727	0.077	1.4	2.8	O K
5760 min Summer	9.712	0.062	1.1	2.2	O K
7200 min Summer	9.704	0.054	0.9	1.9	O K
8640 min Summer	9.699	0.049	0.8	1.6	O K
10080 min Summer	9.695	0.045	0.7	1.5	O K
15 min Winter	10.127	0.477	1.9	19.7	O K
30 min Winter	10.272	0.622	1.9	25.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	127.517	0.0	18.9	18	
30 min Summer	85.701	0.0	25.4	33	
60 min Summer	54.957	0.0	32.6	62	
120 min Summer	34.010	0.0	40.3	120	
180 min Summer	25.295	0.0	45.0	154	
240 min Summer	20.351	0.0	48.2	186	
360 min Summer	14.971	0.0	53.2	254	
480 min Summer	12.028	0.0	57.0	324	
600 min Summer	10.141	0.0	60.1	388	
720 min Summer	8.817	0.0	62.7	452	
960 min Summer	7.063	0.0	67.0	578	
1440 min Summer	5.157	0.0	73.3	810	
2160 min Summer	3.757	0.0	80.1	1152	
2880 min Summer	2.997	0.0	85.2	1500	
4320 min Summer	2.176	0.0	92.8	2204	
5760 min Summer	1.731	0.0	98.5	2936	
7200 min Summer	1.449	0.0	103.0	3672	
8640 min Summer	1.255	0.0	107.1	4352	
10080 min Summer	1.111	0.0	110.6	5080	
15 min Winter	127.517	0.0	21.2	18	
30 min Winter	85.701	0.0	28.4	32	
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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	10.400	0.750	1.9	31.1	O K
120 min Winter	10.477	0.827	1.9	34.3	O K
180 min Winter	10.477	0.827	1.9	34.3	O K
240 min Winter	10.453	0.803	1.9	33.3	O K
360 min Winter	10.402	0.752	1.9	31.2	O K
480 min Winter	10.341	0.691	1.9	28.6	O K
600 min Winter	10.275	0.625	1.9	25.8	O K
720 min Winter	10.193	0.543	1.9	22.4	O K
960 min Winter	10.057	0.407	1.9	16.7	O K
1440 min Winter	9.874	0.224	1.9	9.0	O K
2160 min Winter	9.757	0.107	1.7	4.1	O K
2880 min Winter	9.728	0.078	1.4	2.9	O K
4320 min Winter	9.707	0.057	1.0	2.0	O K
5760 min Winter	9.699	0.049	0.8	1.6	O K
7200 min Winter	9.693	0.043	0.7	1.4	O K
8640 min Winter	9.690	0.040	0.6	1.3	O K
10080 min Winter	9.687	0.037	0.5	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.957	0.0	36.5	60
120 min Winter	34.010	0.0	45.1	118
180 min Winter	25.295	0.0	50.4	170
240 min Winter	20.351	0.0	54.0	194
360 min Winter	14.971	0.0	59.6	272
480 min Winter	12.028	0.0	63.9	350
600 min Winter	10.141	0.0	67.3	428
720 min Winter	8.817	0.0	70.2	492
960 min Winter	7.063	0.0	75.0	614
1440 min Winter	5.157	0.0	82.1	838
2160 min Winter	3.757	0.0	89.8	1148
2880 min Winter	2.997	0.0	95.5	1472
4320 min Winter	2.176	0.0	103.9	2204
5760 min Winter	1.731	0.0	110.3	2880
7200 min Winter	1.449	0.0	115.4	3672
8640 min Winter	1.255	0.0	119.9	4312
10080 min Winter	1.111	0.0	123.8	5136

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XP Solutions	Source Control 2016.1
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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.400	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.079

Time (mins)	Area
From: To:	(ha)
0 4	0.079

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Date 17/11/2016 17:23	Designed by allen.rushby	
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Model Details

Storage is Online Cover Level (m) 11.300

Double Box Culvert Structure

Height (m) 1.000 Slope (1:X) 500.000 Downstream Invert (m) 9.650
Width (m) 2.000 Length (m) 10.000

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	9.650
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		



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CALCULATIONS

Job Title	BLUNDWORTH CRESCENT		Job No.	PWC 238		Sht. No.	D19	
Element	SURFACE WATER DRAINAGE		Prepared	ME	Date	11 '16	Checked	Date

OUTFALL PIPE SPACING.

USING EQ 20.1 SUDS MANUAL

$$q_v = k(h/b)^2$$

q_v MAX INTENSITY OF RAINFALL m/s.

k COEFFICIENT OF PERMEABILITY OF SUB-BASE m/s.

h MAX DEPTH OF WATER m

$2b$ = DISTANCE BETWEEN APES. m

PLOTS 1-15.

FROM MICRO-DRAINAGE ANALYSIS.

MAX RAINFALL q_v (30 MIN WINTER) = 84.7 mm/hr.

$$= \frac{84.7}{60 \times 1000} \text{ m/s}$$

$$= 2.35 \times 10^{-5} \text{ m/s}$$

$$k = 6 \times 10^{-2} \text{ m/s}$$

$$h = 0.5 \text{ m}$$

$$\text{TRY } b = 10 \text{ m}$$

$$q_v = \frac{6}{100} \times \left(\frac{0.5}{10}\right)^2 = 1.5 \times 10^{-4} > 2.35 \times 10^{-5} \therefore \text{OK}$$

SPACING PIPES AT $2 \times b = 20 \text{ m}$ ADEQUATE.