

SW ATTENUATION DESIGN

Using XP Solutions' Micro Drainage Source Control and Cascade

**PREMIER INN
LANGSTONE ROAD
HAVANT
13097**

**Storm event
Climate Change**

1 in 100 years
+ 30%

**Permitted Discharge
Storage Type**

2.3 lit/sec
Permeable Sub-Base & Geocellular Crates

JDC – May 2015

1

1

1

100



Simpson Associates		Page 1
1 Market Place Mews Henley-on-Thames RG9 2AH		
Date 19/05/2015 09:46	Designed by jamescook	
File Cascade Final.casx	Checked by	
Micro Drainage	Source Control 2015.1	

Cascade Summary of Results for Cascade A.srcx

Upstream Outflow To Overflow To
Structures

(None) Cascade B.srcx (None)

Half Drain Time : 35 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	6.081	0.041	0.0	0.8	0.8	2.6	O K
30 min Summer	6.091	0.051	0.0	1.2	1.2	3.4	O K
60 min Summer	6.098	0.058	0.0	1.6	1.6	3.9	O K
120 min Summer	6.101	0.061	0.0	1.8	1.8	4.2	O K
180 min Summer	6.100	0.060	0.0	1.7	1.7	4.1	O K
240 min Summer	6.098	0.058	0.0	1.6	1.6	3.9	O K
360 min Summer	6.094	0.054	0.0	1.4	1.4	3.6	O K
480 min Summer	6.091	0.051	0.0	1.2	1.2	3.4	O K
600 min Summer	6.089	0.049	0.0	1.1	1.1	3.2	O K
720 min Summer	6.087	0.047	0.0	1.0	1.0	3.0	O K
960 min Summer	6.083	0.043	0.0	0.8	0.8	2.7	O K
1440 min Summer	6.077	0.037	0.0	0.7	0.7	2.3	O K
2160 min Summer	6.072	0.032	0.0	0.5	0.5	1.9	O K
2880 min Summer	6.069	0.029	0.0	0.4	0.4	1.6	O K
4320 min Summer	6.065	0.025	0.0	0.3	0.3	1.3	O K
5760 min Summer	6.062	0.022	0.0	0.2	0.2	1.1	O K
7200 min Summer	6.060	0.020	0.0	0.2	0.2	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.408	0.0	2.9	17
30 min Summer	79.579	0.0	4.3	28
60 min Summer	51.031	0.0	5.9	42
120 min Summer	31.581	0.0	7.6	76
180 min Summer	23.488	0.0	8.6	108
240 min Summer	18.897	0.0	9.3	138
360 min Summer	13.902	0.0	10.4	200
480 min Summer	11.169	0.0	11.2	262
600 min Summer	9.417	0.0	11.8	324
720 min Summer	8.187	0.0	12.3	384
960 min Summer	6.558	0.0	13.1	510
1440 min Summer	4.789	0.0	14.3	750
2160 min Summer	3.489	0.0	15.4	1108
2880 min Summer	2.783	0.0	16.2	1472
4320 min Summer	2.020	0.0	17.1	2204
5760 min Summer	1.607	0.0	17.5	2936
7200 min Summer	1.346	0.0	17.8	3672

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1 Market Place Mews Henley-on-Thames RG9 2AH		
Date 19/05/2015 09:46 File Cascade Final.casx	Designed by jamescook Checked by	
Micro Drainage	Source Control 2015.1	

Cascade Summary of Results for Cascade A.srcx

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
8640 min Summer	6.059	0.019	0.0	0.2	0.2	0.8	O K
10080 min Summer	6.057	0.017	0.0	0.1	0.1	0.7	O K
15 min Winter	6.086	0.046	0.0	1.0	1.0	3.0	O K
30 min Winter	6.097	0.057	0.0	1.6	1.6	3.9	O K
60 min Winter	6.104	0.064	0.0	1.9	1.9	4.4	O K
120 min Winter	6.104	0.064	0.0	1.9	1.9	4.4	O K
180 min Winter	6.101	0.061	0.0	1.7	1.7	4.2	O K
240 min Winter	6.097	0.057	0.0	1.6	1.6	3.9	O K
360 min Winter	6.092	0.052	0.0	1.3	1.3	3.5	O K
480 min Winter	6.089	0.049	0.0	1.1	1.1	3.2	O K
600 min Winter	6.085	0.045	0.0	0.9	0.9	2.9	O K
720 min Winter	6.083	0.043	0.0	0.8	0.8	2.7	O K
960 min Winter	6.078	0.038	0.0	0.7	0.7	2.4	O K
1440 min Winter	6.073	0.033	0.0	0.5	0.5	1.9	O K
2160 min Winter	6.068	0.028	0.0	0.4	0.4	1.6	O K
2880 min Winter	6.065	0.025	0.0	0.3	0.3	1.3	O K
4320 min Winter	6.061	0.021	0.0	0.2	0.2	1.0	O K
5760 min Winter	6.059	0.019	0.0	0.2	0.2	0.8	O K
7200 min Winter	6.057	0.017	0.0	0.1	0.1	0.7	O K
8640 min Winter	6.056	0.016	0.0	0.1	0.1	0.6	O K
10080 min Winter	6.055	0.015	0.0	0.1	0.1	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.165	0.0	17.9	4368
10080 min Summer	1.032	0.0	17.9	5144
15 min Winter	118.408	0.0	3.4	17
30 min Winter	79.579	0.0	5.0	28
60 min Winter	51.031	0.0	6.8	44
120 min Winter	31.581	0.0	8.7	80
180 min Winter	23.488	0.0	9.8	112
240 min Winter	18.897	0.0	10.6	144
360 min Winter	13.902	0.0	11.8	208
480 min Winter	11.169	0.0	12.7	270
600 min Winter	9.417	0.0	13.4	336
720 min Winter	8.187	0.0	14.0	396
960 min Winter	6.558	0.0	14.9	512
1440 min Winter	4.789	0.0	16.2	764
2160 min Winter	3.489	0.0	17.6	1144
2880 min Winter	2.783	0.0	18.5	1496
4320 min Winter	2.020	0.0	19.6	2208
5760 min Winter	1.607	0.0	20.2	2928
7200 min Winter	1.346	0.0	20.6	3704
8640 min Winter	1.165	0.0	20.8	4408
10080 min Winter	1.032	0.0	21.0	5240

1 Market Place Mews

Henley-on-Thames

RG9 2AH

Date 19/05/2015 09:46

Designed by jamescook

File Cascade Final.casx

Checked by

Micro Drainage

Source Control 2015.1

Cascade Rainfall Details for Cascade A.srcx

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 %	+30

Time Area Diagram

Total Area (ha) 0.019

Time (mins) Area

From: To: (ha)

0 4 0.019

Time Area Diagram

Total Area (ha) 0.000

Time (mins) Area

From: To: (ha)

0 4 0.000

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1 Market Place Mews Henley-on-Thames RG9 2AH		
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Micro Drainage	Source Control 2015.1	

Cascade Model Details for Cascade A.srcx

Storage is Online Cover Level (m) 6.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.2
Membrane Percolation (mm/hr)	1000	Length (m)	16.2
Max Percolation (l/s)	72.9	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	6.040	Cap Volume Depth (m)	0.250

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	6.040
Roughness k (mm)	0.600		

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1 Market Place Mews Henley-on-Thames RG9 2AH		
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Micro Drainage		Source Control 2015.1

Cascade Summary of Results for Cascade B.srcx

Upstream Outflow To Overflow To
Structures

Cascade A.srcx Cascade E.srcx (None)

Half Drain Time : 38 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	5.621	0.221	0.0	8.6	8.6	26.3	O K
30 min Summer	5.674	0.274	0.0	9.9	9.9	32.9	O K
60 min Summer	5.711	0.311	0.0	10.7	10.7	37.6	O K
120 min Summer	5.725	0.325	0.0	11.0	11.0	39.3	O K
180 min Summer	5.715	0.315	0.0	10.8	10.8	38.1	O K
240 min Summer	5.699	0.299	0.0	10.4	10.4	36.0	O K
360 min Summer	5.665	0.265	0.0	9.7	9.7	31.9	O K
480 min Summer	5.637	0.237	0.0	9.0	9.0	28.3	O K
600 min Summer	5.614	0.214	0.0	8.4	8.4	25.4	O K
720 min Summer	5.594	0.194	0.0	7.9	7.9	23.0	O K
960 min Summer	5.567	0.167	0.0	7.1	7.1	19.5	O K
1440 min Summer	5.538	0.138	0.0	5.8	5.8	15.9	O K
2160 min Summer	5.517	0.117	0.0	4.4	4.4	13.4	O K
2880 min Summer	5.507	0.107	0.0	3.6	3.6	12.1	O K
4320 min Summer	5.483	0.083	0.0	2.6	2.6	9.1	O K
5760 min Summer	5.469	0.069	0.0	2.1	2.1	7.4	O K
7200 min Summer	5.461	0.061	0.0	1.8	1.8	6.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.408	0.0	33.2	17
30 min Summer	79.579	0.0	45.8	30
60 min Summer	51.031	0.0	59.7	46
120 min Summer	31.581	0.0	74.6	80
180 min Summer	23.488	0.0	83.6	114
240 min Summer	18.897	0.0	89.8	146
360 min Summer	13.902	0.0	99.3	210
480 min Summer	11.169	0.0	106.5	272
600 min Summer	9.417	0.0	112.3	332
720 min Summer	8.187	0.0	117.2	392
960 min Summer	6.558	0.0	125.1	510
1440 min Summer	4.789	0.0	136.8	750
2160 min Summer	3.489	0.0	149.0	1104
2880 min Summer	2.783	0.0	157.9	1472
4320 min Summer	2.020	0.0	170.5	2204
5760 min Summer	1.607	0.0	179.4	2936
7200 min Summer	1.346	0.0	186.3	3672

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File Cascade Final.casx	Checked by	
Micro Drainage		Source Control 2015.1

Cascade Summary of Results for Cascade B.srcx

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
8640 min Summer	5.457	0.057	0.0	1.5	1.5	5.8	O K
10080 min Summer	5.454	0.054	0.0	1.4	1.4	5.4	O K
15 min Winter	5.649	0.249	0.0	9.3	9.3	29.9	O K
30 min Winter	5.712	0.312	0.0	10.7	10.7	37.6	O K
60 min Winter	5.749	0.349	0.0	11.4	11.4	42.3	O K
120 min Winter	5.754	0.354	0.0	11.5	11.5	42.9	O K
180 min Winter	5.732	0.332	0.0	11.1	11.1	40.2	O K
240 min Winter	5.705	0.305	0.0	10.5	10.5	36.8	O K
360 min Winter	5.655	0.255	0.0	9.5	9.5	30.6	O K
480 min Winter	5.617	0.217	0.0	8.5	8.5	25.8	O K
600 min Winter	5.588	0.188	0.0	7.7	7.7	22.2	O K
720 min Winter	5.567	0.167	0.0	7.1	7.1	19.5	O K
960 min Winter	5.542	0.142	0.0	6.0	6.0	16.5	O K
1440 min Winter	5.519	0.119	0.0	4.5	4.5	13.5	O K
2160 min Winter	5.505	0.105	0.0	3.3	3.3	11.8	O K
2880 min Winter	5.485	0.085	0.0	2.6	2.6	9.4	O K
4320 min Winter	5.465	0.065	0.0	1.9	1.9	6.8	O K
5760 min Winter	5.457	0.057	0.0	1.5	1.5	5.8	O K
7200 min Winter	5.452	0.052	0.0	1.3	1.3	5.2	O K
8640 min Winter	5.449	0.049	0.0	1.1	1.1	4.8	O K
10080 min Winter	5.447	0.047	0.0	1.0	1.0	4.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.165	0.0	192.0	4352
10080 min Summer	1.032	0.0	196.8	5080
15 min Winter	118.408	0.0	37.6	17
30 min Winter	79.579	0.0	51.7	30
60 min Winter	51.031	0.0	67.3	48
120 min Winter	31.581	0.0	84.0	86
180 min Winter	23.488	0.0	94.0	122
240 min Winter	18.897	0.0	101.0	156
360 min Winter	13.902	0.0	111.7	222
480 min Winter	11.169	0.0	119.8	284
600 min Winter	9.417	0.0	126.3	344
720 min Winter	8.187	0.0	131.8	398
960 min Winter	6.558	0.0	140.7	514
1440 min Winter	4.789	0.0	153.9	750
2160 min Winter	3.489	0.0	167.6	1108
2880 min Winter	2.783	0.0	177.7	1524
4320 min Winter	2.020	0.0	192.1	2204
5760 min Winter	1.607	0.0	202.4	2936
7200 min Winter	1.346	0.0	210.4	3592
8640 min Winter	1.165	0.0	217.1	4384
10080 min Winter	1.032	0.0	222.7	5016

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Micro Drainage	Source Control 2015.1	

Cascade Rainfall Details for Cascade B.srcx

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 %	+30

Time Area Diagram

Total Area (ha) 0.146

Time (mins)	Area
From:	To: (ha)

0	4 0.146
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Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area
From:	To: (ha)

0	4 0.000
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Simpson Associates

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1 Market Place Mews

Henley-on-Thames

RG9 2AH

Date 19/05/2015 09:47

Designed by jamescook

File Cascade Final.casx

Checked by



Micro Drainage

Source Control 2015.1

Cascade Model Details for Cascade B.srcx

Storage is Online Cover Level (m) 5.970

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.4
Membrane Percolation (mm/hr)	1000	Length (m)	20.4
Max Percolation (l/s)	115.6	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	5.400	Cap Volume Depth (m)	0.360

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	5.400
Roughness k (mm)	0.600		

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Micro Drainage		Source Control 2015.1

Cascade Summary of Results for Cascade C.srcx

Upstream Outflow To Overflow To
Structures

(None) Cascade D.srcx (None)

Half Drain Time : 43 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.955	0.035	0.0	0.6	0.6	2.6	O K
30 min Summer	5.966	0.046	0.0	0.9	0.9	3.6	O K
60 min Summer	5.972	0.052	0.0	1.3	1.3	4.2	O K
120 min Summer	5.976	0.056	0.0	1.5	1.5	4.6	O K
180 min Summer	5.976	0.056	0.0	1.5	1.5	4.6	O K
240 min Summer	5.975	0.055	0.0	1.5	1.5	4.5	O K
360 min Summer	5.973	0.053	0.0	1.3	1.3	4.2	O K
480 min Summer	5.970	0.050	0.0	1.2	1.2	4.0	O K
600 min Summer	5.968	0.048	0.0	1.1	1.1	3.8	O K
720 min Summer	5.966	0.046	0.0	0.9	0.9	3.6	O K
960 min Summer	5.962	0.042	0.0	0.8	0.8	3.2	O K
1440 min Summer	5.957	0.037	0.0	0.7	0.7	2.7	O K
2160 min Summer	5.952	0.032	0.0	0.5	0.5	2.3	O K
2880 min Summer	5.949	0.029	0.0	0.4	0.4	2.0	O K
4320 min Summer	5.945	0.025	0.0	0.3	0.3	1.6	O K
5760 min Summer	5.942	0.022	0.0	0.2	0.2	1.3	O K
7200 min Summer	5.941	0.021	0.0	0.2	0.2	1.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.408	0.0	2.8	18
30 min Summer	79.579	0.0	4.3	31
60 min Summer	51.031	0.0	6.0	46
120 min Summer	31.581	0.0	7.8	78
180 min Summer	23.488	0.0	8.8	110
240 min Summer	18.897	0.0	9.6	142
360 min Summer	13.902	0.0	10.6	206
480 min Summer	11.169	0.0	11.5	268
600 min Summer	9.417	0.0	12.1	328
720 min Summer	8.187	0.0	12.6	392
960 min Summer	6.558	0.0	13.5	512
1440 min Summer	4.789	0.0	14.6	752
2160 min Summer	3.489	0.0	15.8	1124
2880 min Summer	2.783	0.0	16.5	1496
4320 min Summer	2.020	0.0	17.3	2208
5760 min Summer	1.607	0.0	17.6	2944
7200 min Summer	1.346	0.0	17.7	3672

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Date 19/05/2015 09:47	Designed by jamescook	
File Cascade Final.casx	Checked by	
Micro Drainage	Source Control 2015.1	

Cascade Summary of Results for Cascade C.srcx

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
8640 min Summer	5.939	0.019	0.0	0.2	0.2	1.0	O K
10080 min Summer	5.938	0.018	0.0	0.2	0.2	0.8	O K
15 min Winter	5.960	0.040	0.0	0.8	0.8	3.0	O K
30 min Winter	5.971	0.051	0.0	1.2	1.2	4.1	O K
60 min Winter	5.978	0.058	0.0	1.6	1.6	4.8	O K
120 min Winter	5.980	0.060	0.0	1.7	1.7	5.0	O K
180 min Winter	5.978	0.058	0.0	1.6	1.6	4.8	O K
240 min Winter	5.976	0.056	0.0	1.5	1.5	4.6	O K
360 min Winter	5.972	0.052	0.0	1.3	1.3	4.2	O K
480 min Winter	5.968	0.048	0.0	1.1	1.1	3.8	O K
600 min Winter	5.966	0.046	0.0	0.9	0.9	3.6	O K
720 min Winter	5.963	0.043	0.0	0.8	0.8	3.3	O K
960 min Winter	5.959	0.039	0.0	0.7	0.7	2.9	O K
1440 min Winter	5.953	0.033	0.0	0.5	0.5	2.4	O K
2160 min Winter	5.949	0.029	0.0	0.4	0.4	1.9	O K
2880 min Winter	5.945	0.025	0.0	0.3	0.3	1.6	O K
4320 min Winter	5.942	0.022	0.0	0.2	0.2	1.2	O K
5760 min Winter	5.939	0.019	0.0	0.2	0.2	1.0	O K
7200 min Winter	5.937	0.017	0.0	0.1	0.1	0.8	O K
8640 min Winter	5.936	0.016	0.0	0.1	0.1	0.7	O K
10080 min Winter	5.935	0.015	0.0	0.1	0.1	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.165	0.0	17.7	4408
10080 min Summer	1.032	0.0	17.6	5136
15 min Winter	118.408	0.0	3.3	17
30 min Winter	79.579	0.0	5.0	30
60 min Winter	51.031	0.0	6.9	46
120 min Winter	31.581	0.0	8.9	82
180 min Winter	23.488	0.0	10.1	116
240 min Winter	18.897	0.0	10.9	148
360 min Winter	13.902	0.0	12.1	212
480 min Winter	11.169	0.0	13.1	278
600 min Winter	9.417	0.0	13.8	342
720 min Winter	8.187	0.0	14.4	404
960 min Winter	6.558	0.0	15.4	522
1440 min Winter	4.789	0.0	16.7	768
2160 min Winter	3.489	0.0	18.0	1128
2880 min Winter	2.783	0.0	18.9	1500
4320 min Winter	2.020	0.0	19.9	2224
5760 min Winter	1.607	0.0	20.5	2936
7200 min Winter	1.346	0.0	20.8	3672
8640 min Winter	1.165	0.0	20.9	4328
10080 min Winter	1.032	0.0	20.9	5128

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1 Market Place Mews Henley-on-Thames RG9 2AH		
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Micro Drainage	Source Control 2015.1	

Cascade Rainfall Details for Cascade C.srcx

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 %	+30

Time Area Diagram

Total Area (ha) 0.020

Time (mins)	Area (ha)
From: To:	

0	4	0.020
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Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area (ha)
From: To:	

0	4	0.000
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Cascade Model Details for Cascade C.srcx

Storage is Online Cover Level (m) 6.420

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	18.0
Membrane Percolation (mm/hr)	1000	Length (m)	18.0
Max Percolation (l/s)	90.0	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	5.920	Cap Volume Depth (m)	0.200

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	5.920
Roughness k (mm)	0.600		

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Micro Drainage		Source Control 2015.1

Cascade Summary of Results for Cascade D.srcx

Upstream Outflow To Overflow To
Structures

Cascade C.srcx Cascade E.srcx (None)

Half Drain Time : 60 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	5.006	0.036	0.0	0.2	0.2	2.2	O K
30 min Summer	5.024	0.054	0.0	0.4	0.4	3.6	O K
60 min Summer	5.044	0.074	0.0	0.6	0.6	5.3	O K
120 min Summer	5.065	0.095	0.0	0.8	0.8	7.0	O K
180 min Summer	5.071	0.101	0.0	1.0	1.0	7.4	O K
240 min Summer	5.071	0.101	0.0	1.2	1.2	7.4	O K
360 min Summer	5.072	0.102	0.0	1.3	1.3	7.5	O K
480 min Summer	5.072	0.102	0.0	1.3	1.3	7.5	O K
600 min Summer	5.072	0.102	0.0	1.3	1.3	7.4	O K
720 min Summer	5.071	0.101	0.0	1.2	1.2	7.4	O K
960 min Summer	5.071	0.101	0.0	1.0	1.0	7.4	O K
1440 min Summer	5.061	0.091	0.0	0.7	0.7	6.6	O K
2160 min Summer	5.047	0.077	0.0	0.6	0.6	5.5	O K
2880 min Summer	5.038	0.068	0.0	0.6	0.6	4.7	O K
4320 min Summer	5.026	0.056	0.0	0.4	0.4	3.8	O K
5760 min Summer	5.018	0.048	0.0	0.4	0.4	3.2	O K
7200 min Summer	5.012	0.042	0.0	0.3	0.3	2.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.408	0.0	4.4	73
30 min Summer	79.579	0.0	6.9	72
60 min Summer	51.031	0.0	9.6	86
120 min Summer	31.581	0.0	12.5	126
180 min Summer	23.488	0.0	14.3	160
240 min Summer	18.897	0.0	15.5	180
360 min Summer	13.902	0.0	17.3	238
480 min Summer	11.169	0.0	18.6	300
600 min Summer	9.417	0.0	19.6	372
720 min Summer	8.187	0.0	20.5	432
960 min Summer	6.558	0.0	21.8	570
1440 min Summer	4.789	0.0	23.7	838
2160 min Summer	3.489	0.0	25.5	1204
2880 min Summer	2.783	0.0	26.6	1568
4320 min Summer	2.020	0.0	27.7	2296
5760 min Summer	1.607	0.0	28.2	3008
7200 min Summer	1.346	0.0	28.2	3752

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Cascade Summary of Results for Cascade D.srcx

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
8640 min Summer	5.009	0.039	0.0	0.3	0.3	2.5	O K
10080 min Summer	5.006	0.036	0.0	0.2	0.2	2.2	O K
15 min Winter	5.012	0.042	0.0	0.3	0.3	2.7	O K
30 min Winter	5.033	0.063	0.0	0.5	0.5	4.3	O K
60 min Winter	5.057	0.087	0.0	0.7	0.7	6.3	O K
120 min Winter	5.073	0.103	0.0	1.5	1.5	7.6	O K
180 min Winter	5.074	0.104	0.0	1.7	1.7	7.6	O K
240 min Winter	5.074	0.104	0.0	1.8	1.8	7.7	O K
360 min Winter	5.074	0.104	0.0	1.7	1.7	7.6	O K
480 min Winter	5.073	0.103	0.0	1.5	1.5	7.6	O K
600 min Winter	5.072	0.102	0.0	1.4	1.4	7.5	O K
720 min Winter	5.072	0.102	0.0	1.3	1.3	7.4	O K
960 min Winter	5.071	0.101	0.0	1.0	1.0	7.4	O K
1440 min Winter	5.056	0.086	0.0	0.7	0.7	6.2	O K
2160 min Winter	5.039	0.069	0.0	0.6	0.6	4.9	O K
2880 min Winter	5.029	0.059	0.0	0.5	0.5	4.1	O K
4320 min Winter	5.017	0.047	0.0	0.3	0.3	3.1	O K
5760 min Winter	5.010	0.040	0.0	0.3	0.3	2.6	O K
7200 min Winter	5.006	0.036	0.0	0.2	0.2	2.2	O K
8640 min Winter	5.002	0.032	0.0	0.2	0.2	1.9	O K
10080 min Winter	4.999	0.029	0.0	0.2	0.2	1.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.165	0.0	28.0	4456
10080 min Summer	1.032	0.0	27.6	5160
15 min Winter	118.408	0.0	5.2	68
30 min Winter	79.579	0.0	8.0	70
60 min Winter	51.031	0.0	11.1	84
120 min Winter	31.581	0.0	14.4	112
180 min Winter	23.488	0.0	16.4	138
240 min Winter	18.897	0.0	17.7	170
360 min Winter	13.902	0.0	19.7	234
480 min Winter	11.169	0.0	21.2	302
600 min Winter	9.417	0.0	22.4	370
720 min Winter	8.187	0.0	23.4	438
960 min Winter	6.558	0.0	25.0	584
1440 min Winter	4.789	0.0	27.2	864
2160 min Winter	3.489	0.0	29.2	1236
2880 min Winter	2.783	0.0	30.6	1612
4320 min Winter	2.020	0.0	32.2	2336
5760 min Winter	1.607	0.0	32.9	3112
7200 min Winter	1.346	0.0	33.2	3744
8640 min Winter	1.165	0.0	33.3	4448
10080 min Winter	1.032	0.0	33.1	5072

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Cascade Rainfall Details for Cascade D.srcx

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 %	+30

Time Area Diagram

Total Area (ha) 0.013

Time (mins)	Area
From:	To: (ha)

0	4	0.013
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Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area
From:	To: (ha)

0	4	0.000
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Micro Drainage	Source Control 2015.1	

Cascade Model Details for Cascade D.srcx

Storage is Online Cover Level (m) 5.430

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.3
Membrane Percolation (mm/hr)	1000	Length (m)	16.3
Max Percolation (l/s)	73.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	4.970	Cap Volume Depth (m)	0.250

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	1000.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	4.970
Roughness k (mm)	0.600		

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Micro Drainage	Source Control 2015.1	

Cascade Summary of Results for Cascade E.srcx

Upstream Outflow To Overflow To
Structures

Cascade B.srcx (None) (None)
 Cascade A.srcx
 Cascade D.srcx
 Cascade C.srcx

Half Drain Time : 658 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	4.785	0.085	0.0	2.2	2.2	43.0	O K
30 min Summer	4.825	0.125	0.0	2.2	2.2	63.9	O K
60 min Summer	4.874	0.174	0.0	2.2	2.2	89.3	O K
120 min Summer	4.924	0.224	0.0	2.2	2.2	115.2	O K
180 min Summer	4.951	0.251	0.0	2.3	2.3	129.8	O K
240 min Summer	4.969	0.269	0.0	2.3	2.3	139.2	O K
360 min Summer	4.992	0.292	0.0	2.4	2.4	150.8	O K
480 min Summer	5.004	0.304	0.0	2.4	2.4	157.4	O K
600 min Summer	5.007	0.307	0.0	2.5	2.5	159.8	O K
720 min Summer	5.008	0.308	0.0	2.5	2.5	159.8	O K
960 min Summer	5.006	0.306	0.0	2.5	2.5	158.8	O K
1440 min Summer	4.998	0.298	0.0	2.4	2.4	154.4	O K
2160 min Summer	4.980	0.280	0.0	2.4	2.4	144.7	O K
2880 min Summer	4.959	0.259	0.0	2.3	2.3	133.9	O K
4320 min Summer	4.918	0.218	0.0	2.2	2.2	112.5	O K
5760 min Summer	4.878	0.178	0.0	2.2	2.2	91.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.408	0.0	63.4	96
30 min Summer	79.579	0.0	88.1	127
60 min Summer	51.031	0.0	118.0	168
120 min Summer	31.581	0.0	148.3	216
180 min Summer	23.488	0.0	166.5	256
240 min Summer	18.897	0.0	179.2	296
360 min Summer	13.902	0.0	198.5	386
480 min Summer	11.169	0.0	213.0	484
600 min Summer	9.417	0.0	224.3	600
720 min Summer	8.187	0.0	233.6	674
960 min Summer	6.558	0.0	248.4	798
1440 min Summer	4.789	0.0	268.1	1052
2160 min Summer	3.489	0.0	297.2	1452
2880 min Summer	2.783	0.0	314.2	1848
4320 min Summer	2.020	0.0	337.9	2648
5760 min Summer	1.607	0.0	354.0	3448

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Cascade Summary of Results for Cascade E.srcx

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
7200 min Summer	4.839	0.139	0.0	2.2	2.2	71.2	O K
8640 min Summer	4.811	0.111	0.0	2.2	2.2	56.7	O K
10080 min Summer	4.793	0.093	0.0	2.2	2.2	46.9	O K
15 min Winter	4.798	0.098	0.0	2.2	2.2	49.9	O K
30 min Winter	4.846	0.146	0.0	2.2	2.2	74.7	O K
60 min Winter	4.901	0.201	0.0	2.2	2.2	103.2	O K
120 min Winter	4.956	0.256	0.0	2.3	2.3	132.1	O K
180 min Winter	4.987	0.287	0.0	2.4	2.4	148.6	O K
240 min Winter	5.006	0.306	0.0	2.5	2.5	159.2	O K
360 min Winter	5.033	0.333	0.0	2.5	2.5	172.5	O K
480 min Winter	5.059	0.359	0.0	2.6	2.6	179.8	O K
600 min Winter	5.080	0.380	0.0	2.7	2.7	183.2	O K
720 min Winter	5.085	0.385	0.0	2.7	2.7	183.9	O K
960 min Winter	5.068	0.368	0.0	2.7	2.7	181.5	O K
1440 min Winter	5.039	0.339	0.0	2.6	2.6	174.9	O K
2160 min Winter	5.008	0.308	0.0	2.5	2.5	160.0	O K
2880 min Winter	4.977	0.277	0.0	2.4	2.4	143.2	O K
4320 min Winter	4.915	0.215	0.0	2.2	2.2	110.9	O K
5760 min Winter	4.848	0.148	0.0	2.2	2.2	76.0	O K
7200 min Winter	4.800	0.100	0.0	2.2	2.2	50.8	O K
8640 min Winter	4.781	0.081	0.0	2.1	2.1	40.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.346	0.0	365.7	4104
8640 min Summer	1.165	0.0	375.3	4752
10080 min Summer	1.032	0.0	382.9	5360
15 min Winter	118.408	0.0	72.1	103
30 min Winter	79.579	0.0	99.6	138
60 min Winter	51.031	0.0	133.4	176
120 min Winter	31.581	0.0	167.5	222
180 min Winter	23.488	0.0	187.9	260
240 min Winter	18.897	0.0	202.2	298
360 min Winter	13.902	0.0	223.8	386
480 min Winter	11.169	0.0	239.7	482
600 min Winter	9.417	0.0	252.2	590
720 min Winter	8.187	0.0	262.6	692
960 min Winter	6.558	0.0	278.9	848
1440 min Winter	4.789	0.0	299.7	1114
2160 min Winter	3.489	0.0	335.3	1556
2880 min Winter	2.783	0.0	354.8	1992
4320 min Winter	2.020	0.0	382.1	2836
5760 min Winter	1.607	0.0	401.0	3568
7200 min Winter	1.346	0.0	415.2	4104
8640 min Winter	1.165	0.0	426.8	4672

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Cascade Summary of Results for Cascade E.srcx

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
10080 min Winter	4.771	0.071	0.0	1.9	1.9	35.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.032	0.0	436.2	5376

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Cascade Rainfall Details for Cascade E.srcx

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 %	+30

Time Area Diagram

Total Area (ha) 0.139

Time (mins)	Area
From:	To: (ha)

0	4 0.139
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Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area
From:	To: (ha)

0	4 0.000
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Cascade Model Details for Cascade E.srcx

Storage is Online Cover Level (m) 5.160

Complex Structure

Cellular Storage

Invert Level (m) 4.700 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	412.5	412.5	0.400	0.0	441.6
0.300	412.5	441.6			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.8
Membrane Percolation (mm/hr)	1000	Length (m)	20.8
Max Percolation (l/s)	120.2	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	4.700	Cap Volume Depth (m)	0.330

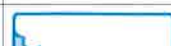
Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.5
Max Percolation (l/s)	114.6	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	5.000	Cap Volume Depth (m)	0.130

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SCL-0075-2300-0260-2300
Design Head (m)	0.260
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Diameter (mm)	75
Invert Level (m)	4.690
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.260	2.2
Flush-Flo™	0.098	2.2
Kick-Flo®	0.190	2.0

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Hydro-Brake Optimum® Outflow Control

Control Points Head (m) Flow (l/s)

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	2.2	1.200	4.5	3.000	6.9	7.000	10.6
0.200	2.0	1.400	4.9	3.500	7.5	7.500	11.0
0.300	2.4	1.600	5.2	4.000	8.0	8.000	11.4
0.400	2.7	1.800	5.5	4.500	8.5	8.500	11.7
0.500	3.0	2.000	5.7	5.000	9.0	9.000	12.0
0.600	3.3	2.200	6.0	5.500	9.4	9.500	12.4
0.800	3.7	2.400	6.2	6.000	9.8		
1.000	4.2	2.600	6.5	6.500	10.2		