STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.313	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.139	4-8	0.129

Total Area Contributing (ha) = 0.267

Total Pipe Volume (m³) = 8.040

Network Design Table for Surface Network 1

- Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	16.830	0.125	134.6	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	16.367	0.073	224.2	0.051	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	40.349	0.179	225.4	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	14.010#	0.063	222.4	0.102	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	11.777	0.051	230.9	0.019	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	12.038	0.005	2407.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	5.870#	0.026	225.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.32	157.638	0.071	0.0	0.0	0.0	0.86	15.3	9.6
2.000	50.00	5.26	157.436	0.051	0.0	0.0	0.0	1.05	73.9	6.9
1.001	50.00	5.97	157.363	0.145	0.0	0.0	0.0	1.04	73.7	19.7
1.002	50.00	6.19	157.184	0.248	0.0	0.0	0.0	1.05	74.2	33.6
1.003	50.00	6.38	157.121	0.267	0.0	0.0	0.0	1.03	72.8	36.2
1.004	50.00	7.03	157.070	0.267	0.0	0.0	0.0	0.31	22.0«	36.2
1.005	50.00	7.12	157.015	0.267	0.0	0.0	0.0	1.04	73.7	36.2

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Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.006	9.125	0.041	222.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.006	50.00	7.27	156.989	0.267	0.0	0.0	0.0	1.05	74.2	36.2

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Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.026	0.026	0.026
	User	-	100	0.021	0.021	0.047
	User	-	100	0.024	0.024	0.071
2.000	User	-	100	0.021	0.021	0.021
	User	-	100	0.030	0.030	0.051
1.001	User	-	100	0.024	0.024	0.024
1.002	User	-	100	0.031	0.031	0.031
	User	-	100	0.002	0.002	0.033
	User	-	100	0.053	0.053	0.086
	User	-	100	0.011	0.011	0.097
	User	-	100	0.005	0.005	0.102
1.003	User	-	100	0.019	0.019	0.019
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.267	0.267	0.267

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006	S9	159.000	156.948	0.000	1350	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model		FSR	Profile Type Summer
Return Period (years)		100	Cv (Summer) 0.750
Region	England and Wales		Cv (Winter) 0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.313		

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S6, DS/PN: 1.005, Volume (m³): 7.3

Unit Reference	MD-SHE-0196-2000-1200-2000
Design Head (m)	1.200
Design Flow (l/s)	20.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	196
Invert Level (m)	157.015
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	20.0	Kick-Flo®	0.827	16.8
Flush-Flo™	0.376	20.0	Mean Flow over Head Range	-	17.1

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)	Depth (m)	Flow (l/s)
0.100	6.8	0.800	17.4	2.000	25.5	4.000	35.6	7.000	46.7
0.200	18.3	1.000	18.3	2.200	26.7	4.500	37.7	7.500	48.2
0.300	19.8	1.200	20.0	2.400	27.8	5.000	39.6	8.000	49.8
0.400	20.0	1.400	21.5	2.600	28.9	5.500	41.5	8.500	51.3
0.500	19.7	1.600	22.9	3.000	31.0	6.000	43.3	9.000	52.7
0.600	19.4	1.800	24.3	3.500	33.4	6.500	45.0	9.500	54.1

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Storage Structures for Surface Network 1

Cellular Storage Manhole: S6, DS/PN: 1.005

Invert Level (m) 157.065 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
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	100.0	0.0	1.200	100.0	0.0	1.201	0.0	0.0

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.000
Region	England and Wales	Ratio R	0.313
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30
Climate Change (%)	0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	S1	15 Winter	1	+0%	30/15 Summer				157.723	-0.065	0.000
2.000	S8	15 Winter	1	+0%					157.504	-0.232	0.000
1.001	S2	15 Winter	1	+0%	30/15 Summer				157.465	-0.198	0.000
1.002	S3	15 Winter	1	+0%	30/15 Summer				157.358	-0.126	0.000
1.003	S4	15 Winter	1	+0%	30/15 Summer				157.335	-0.086	0.000
1.004	S5	15 Winter	1	+0%	30/15 Summer				157.309	-0.061	0.000
1.005	S6	60 Winter	1	+0%	30/30 Summer				157.184	-0.131	0.000
1.006	S7	60 Winter	1	+0%					157.066	-0.223	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.60		8.5	OK	
2.000	S8	0.10		6.1	OK	
1.001	S2	0.24		16.7	OK	
1.002	S3	0.40		24.6	OK	
1.003	S4	0.44		25.6	OK	
1.004	S5	1.00		25.5	OK	
1.005	S6	0.17		8.6	OK	
1.006	S7	0.15		8.6	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.000
Region	England and Wales	Ratio R	0.313
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30
Climate Change (%)	0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	S1	15 Winter	30	+0%	30/15 Summer				157.961	0.173	0.000
2.000	S8	15 Winter	30	+0%					157.736	0.000	0.000
1.001	S2	15 Summer	30	+0%	30/15 Summer				157.709	0.046	0.000
1.002	S3	15 Winter	30	+0%	30/15 Summer				157.609	0.125	0.000
1.003	S4	15 Winter	30	+0%	30/15 Summer				157.518	0.097	0.000
1.004	S5	15 Winter	30	+0%	30/15 Summer				157.432	0.062	0.000
1.005	S6	60 Winter	30	+0%	30/30 Summer				157.360	0.045	0.000
1.006	S7	60 Winter	30	+0%					157.108	-0.181	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	1.42		20.2	SURCHARGED	
2.000	S8	0.23		14.6	OK	
1.001	S2	0.55		37.9	SURCHARGED	
1.002	S3	1.07		65.7	SURCHARGED	
1.003	S4	1.20		70.2	SURCHARGED	
1.004	S5	2.74		70.3	SURCHARGED	
1.005	S6	0.37		19.1	SURCHARGED	
1.006	S7	0.33		19.1	OK	

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