STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 2

Pipe Sizes Manhole Sizes

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.360	Minimum Backdrop Height (m)	0.600
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.	1.000	Min Slope for Optimisation (1:X)	400

Designed with Level Soffits

Time Area Diagram for Surface Network 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.281	4-8	0.198

Total Area Contributing (ha) = 0.480

Total Pipe Volume (m³) = 233.804

Network Design Table for Surface Network 2

« - 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	24.700	0.062	400.0	0.213	5.00	0.0	0.600	o	1200	Pipe/Conduit	
1.001	58.642	0.147	400.0	0.053	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.002	21.687	0.054	401.6	0.121	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.003	10.614	0.027	400.0	0.052	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.004	41.933	0.105	400.0	0.000	0.00	0.0	0.600	o	1200	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	5.22	56.876	0.213	0.0	0.0	0.0	1.86	2108.6	38.5
1.001	50.00	5.75	56.815	0.266	0.0	0.0	0.0	1.86	2108.6	48.0
1.002	50.00	5.94	56.668	0.387	0.0	0.0	0.0	1.86	2104.3	69.8
1.003	50.00	6.03	56.614	0.439	0.0	0.0	0.0	1.86	2108.6	79.2
1.004	50.00	6.41	56.587	0.439	0.0	0.0	0.0	1.86	2108.6	79.2

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Network Design Table for Surface Network 2

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
2.000	4.057	0.041	99.0	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	5.097	0.051	99.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	31.755	0.079	402.0	0.000	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.006	17.176	0.043	400.0	0.041	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.007	4.966	0.050	99.3	0.000	0.00	0.0	0.600	o	150	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)
2.000	50.00	5.07	57.126	0.000	0.0	0.0	0.0	1.01	17.9	0.0
2.001	50.00	5.15	57.085	0.000	0.0	0.0	0.0	1.01	17.8	0.0
1.005	50.00	6.69	56.483	0.439	0.0	0.0	0.0	1.86	2103.4	79.2
1.006	50.00	6.85	56.403	0.480	0.0	0.0	0.0	1.86	2108.6	86.6
1.007	50.00	6.93	56.360	0.480	0.0	0.0	0.0	1.01	17.8«	86.6

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Area Summary for Surface Network 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.004	0.004	0.004
	User	-	100	0.000	0.000	0.005
	User	-	100	0.009	0.009	0.014
	User	-	100	0.007	0.007	0.021
	User	-	100	0.004	0.004	0.025
	User	-	100	0.011	0.011	0.036
	User	-	100	0.001	0.001	0.037
	User	-	100	0.009	0.009	0.047
	User	-	100	0.011	0.011	0.058
	User	-	100	0.011	0.011	0.069
	User	-	100	0.009	0.009	0.078
	User	-	100	0.001	0.001	0.078
	User	-	100	0.011	0.011	0.089
	User	-	100	0.001	0.001	0.090
	User	-	100	0.011	0.011	0.101
	User	-	100	0.011	0.011	0.112
	User	-	100	0.001	0.001	0.113
	User	-	100	0.011	0.011	0.124
	User	-	100	0.001	0.001	0.125
	User	-	100	0.012	0.012	0.137
	User	-	100	0.011	0.011	0.147
	User	-	100	0.001	0.001	0.148
	User	-	100	0.014	0.014	0.162
	User	-	100	0.001	0.001	0.163
	User	-	100	0.013	0.013	0.177
	User	-	100	0.001	0.001	0.178
	User	-	100	0.003	0.003	0.181
	User	-	100	0.007	0.007	0.188
	User	-	100	0.002	0.002	0.191
	User	-	100	0.002	0.002	0.193
	User	-	100	0.002	0.002	0.196
	User	-	100	0.002	0.002	0.198
	User	-	100	0.002	0.002	0.201
	User	-	100	0.002	0.002	0.203
	User	-	100	0.004	0.004	0.207
	User	-	100	0.002	0.002	0.209
	User	-	100	0.002	0.002	0.211
	User	-	100	0.002	0.002	0.213
1.001	User	-	100	0.053	0.053	0.053
1.002	User	-	100	0.028	0.028	0.028
	User	-	100	0.007	0.007	0.035
	User	-	100	0.001	0.001	0.036
	User	-	100	0.011	0.011	0.047
	User	-	100	0.001	0.001	0.048
	User	-	100	0.006	0.006	0.054
	User	-	100	0.001	0.001	0.054
	User	-	100	0.009	0.009	0.063
	User	-	100	0.001	0.001	0.064
	User	-	100	0.009	0.009	0.072
	User	-	100	0.001	0.001	0.073
	User	-	100	0.011	0.011	0.084

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Area Summary for Surface Network 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	100	0.001	0.001	0.085
	User	-	100	0.011	0.011	0.096
	User	-	100	0.001	0.001	0.097
	User	-	100	0.002	0.002	0.099
	User	-	100	0.002	0.002	0.100
	User	-	100	0.002	0.002	0.102
	User	-	100	0.004	0.004	0.106
	User	-	100	0.002	0.002	0.108
	User	-	100	0.002	0.002	0.110
	User	-	100	0.002	0.002	0.111
	User	-	100	0.002	0.002	0.114
	User	-	100	0.004	0.004	0.117
	User	-	100	0.004	0.004	0.121
1.003	User	-	100	0.016	0.016	0.016
	User	-	100	0.001	0.001	0.017
	User	-	100	0.002	0.002	0.019
	User	-	100	0.002	0.002	0.020
	User	-	100	0.003	0.003	0.023
	User	-	100	0.016	0.016	0.039
	User	-	100	0.002	0.002	0.041
	User	-	100	0.001	0.001	0.042
	User	-	100	0.001	0.001	0.043
	User	-	100	0.004	0.004	0.047
	User	-	100	0.001	0.001	0.049
	User	-	100	0.001	0.001	0.050
	User	-	100	0.002	0.002	0.052
1.004	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
1.006	User	-	100	0.015	0.015	0.015
	User	-	100	0.014	0.014	0.029
	User	-	100	0.002	0.002	0.031
	User	-	100	0.002	0.002	0.033
	User	-	100	0.000	0.000	0.033
	User	-	100	0.002	0.002	0.036
	User	-	100	0.001	0.001	0.037
	User	-	100	0.001	0.001	0.038
	User	-	100	0.003	0.003	0.041
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.480	0.480	0.480

Free Flowing Outfall Details for Surface Network 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.007	EX UU9613	59.650	56.310	0.000	1050	0

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Simulation Criteria for Surface Network 2

Volumetric Runoff Coeff	1.000	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 Storage Structures	1
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	2	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.360		

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Online Controls for Surface Network 2

Non Return Valve Manhole: S8, DS/PN: 2.001, Volume (m³): 2.9

Hydro-Brake® Optimum Manhole: MH 08, DS/PN: 1.007, Volume (m³): 35.5

Unit Reference	MD-SHE-0085-5000-2700-5000
Design Head (m)	2.700
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	85
Invert Level (m)	56.360
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.700	5.0
Flush-Flo™	0.369	3.5
Kick-Flo®	0.760	2.8
Mean Flow over Head Range	-	3.7

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	2.6	1.200	3.4	3.000	5.2	7.000	7.8
0.200	3.3	1.400	3.7	3.500	5.6	7.500	8.1
0.300	3.5	1.600	3.9	4.000	6.0	8.000	8.3
0.400	3.5	1.800	4.1	4.500	6.3	8.500	8.6
0.500	3.4	2.000	4.3	5.000	6.7	9.000	8.8
0.600	3.3	2.200	4.5	5.500	7.0	9.500	9.0
0.800	2.8	2.400	4.7	6.000	7.3		
1.000	3.2	2.600	4.9	6.500	7.5		

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Offline Controls for Surface Network 2

Pipe Manhole: MH 06, DS/PN: 1.005, Loop to PN: 2.001

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	58.835

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Storage Structures for Surface Network 2

Tank or Pond Manhole: S9, DS/PN: 2.000

Invert Level (m) 57.126

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	22.5	0.400	22.5	0.800	22.5	1.200	22.5
0.100	22.5	0.500	22.5	0.900	22.5	1.300	22.5
0.200	22.5	0.600	22.5	1.000	22.5	1.400	22.5
0.300	22.5	0.700	22.5	1.100	22.5	1.500	22.5

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

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 Storage Structures	1
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.360
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	18.000	Cv (Winter)	1.000

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	MH 01	15 Summer	2	+0%					57.026
1.001	MH 02	240 Winter	2	+0%					57.022
1.002	MH 03	240 Winter	2	+0%					57.022
1.003	MH 04	240 Winter	2	+0%					57.023
1.004	MH 05	240 Winter	2	+0%					57.023
2.000	S9	15 Summer	2	+0%					57.126
2.001	S8	15 Summer	2	+0%					57.085
1.005	MH 06	240 Winter	2	+0%				0	57.023
1.006	MH 07	240 Winter	2	+0%					57.023
1.007	MH 08	240 Winter	2	+0%	2/15 Summer				57.024

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	MH 01	-1.050	0.000	0.03			41.5	OK	
1.001	MH 02	-0.992	0.000	0.01			9.9	OK	
1.002	MH 03	-0.846	0.000	0.01			12.3	OK	
1.003	MH 04	-0.791	0.000	0.01			12.8	OK	

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	MH 05	-0.765	0.000	0.01			11.8	OK	
2.000	S9	-0.150	0.000	0.00			0.0	OK	
2.001	S8	-0.150	0.000	0.00			0.0	OK	
1.005	MH 06	-0.660	0.000	0.01	0.0		8.0	OK	
1.006	MH 07	-0.580	0.000	0.01			5.9	OK	
1.007	MH 08	0.514	0.000	0.25			3.5	SURCHARGED	

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