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)	1	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.359	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	0.041	4-8	0.014

Total Area Contributing (ha) = 0.055

Total Pipe Volume (m³) = 0.595

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
1.000	8.332	0.950	8.8	0.055	5.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.001	5.696	0.050	113.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.002	3.665	0.050	73.3	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.003	10.443	0.625	16.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.004	5.537	0.565	9.8	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)
1.000	46.58	5.04	46.100	0.055	0.0	0.0	0.0	3.42	60.5	6.9
1.001	46.19	5.14	45.150	0.055	0.0	0.0	0.0	0.94	16.6	6.9
1.002	45.99	5.19	45.100	0.055	0.0	0.0	0.0	1.18	20.8	6.9
1.003	45.73	5.26	45.050	0.055	0.0	0.0	0.0	2.48	43.8	6.9
1.004	45.63	5.29	44.425	0.055	0.0	0.0	0.0	3.24	57.2	6.9

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Manhole Schedules for Surface Network 1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	46.650	0.550	Open Manhole	450	1.000	46.100	150				
S2	46.650	1.500	Open Manhole	1200	1.001	45.150	150	1.000	45.150	150	
S3	46.650	1.550	Open Manhole	450	1.002	45.100	150	1.001	45.100	150	
S4	46.650	1.600	Open Manhole	450	1.003	45.050	150	1.002	45.050	150	
S5	46.650	2.225	Open Manhole	450	1.004	44.425	150	1.003	44.425	150	
S6	45.450	1.590	Open Manhole	1500		OUTFALL		1.004	43.860	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	385013.320	398250.072	385013.320	398250.072	Required	
S2	385005.225	398252.044	385005.225	398252.044	Required	
S3	385008.109	398247.132	385008.109	398247.132	Required	
S4	385011.731	398247.689	385011.731	398247.689	Required	
S5	385017.234	398238.814	385017.234	398238.814	Required	
S6	385021.488	398235.269			No Entry	

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PIPELINE SCHEDULES for Surface Network 1

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	150	S1	46.650	46.100	0.400	Open Manhole	450
1.001	o	150	S2	46.650	45.150	1.350	Open Manhole	1200
1.002	o	150	S3	46.650	45.100	1.400	Open Manhole	450
1.003	o	150	S4	46.650	45.050	1.450	Open Manhole	450
1.004	o	150	S5	46.650	44.425	2.075	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	8.332	8.8	S2	46.650	45.150	1.350	Open Manhole	1200
1.001	5.696	113.9	S3	46.650	45.100	1.400	Open Manhole	450
1.002	3.665	73.3	S4	46.650	45.050	1.450	Open Manhole	450
1.003	10.443	16.7	S5	46.650	44.425	2.075	Open Manhole	450
1.004	5.537	9.8	S6	45.450	43.860	1.440	Open Manhole	1500

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Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1	150	0.400	1.350	Unclassified	450	0	0.400	Unclassified
1.001	S2	150	1.350	1.400	Unclassified	1200	0	1.350	Unclassified
1.002	S3	150	1.400	1.450	Unclassified	450	0	1.400	Unclassified
1.003	S4	150	1.450	2.075	Unclassified	450	0	1.450	Unclassified
1.004	S5	150	1.440	2.075	Unclassified	450	0	2.075	Unclassified

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)
1.004	S6	45.450	43.860	0.000	1500	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	2.000
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)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.359		

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S2, DS/PN: 1.001, Volume (m³): 1.8

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	45.150
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Storage Structures for Surface Network 1

Cellular Storage Manhole: S2, DS/PN: 1.001

Invert Level (m) 45.150 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)
0.000	11.0	11.0	0.900	0.0	23.0
0.800	11.0	23.0			

Manhole Headloss for Surface Network 1

PN	US/MH Name	US/MH Headloss
1.000	S1	0.500
1.001	S2	0.500
1.002	S3	0.500
1.003	S4	0.500
1.004	S5	0.500

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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	2.000
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)	18.000
Region	England and Wales	Ratio R	0.359
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

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)
1.000	S1	15 Winter	1	+0%	100/30 Winter				46.135	-0.115
1.001	S2	15 Winter	1	+0%	30/15 Summer				45.282	-0.018
1.002	S3	15 Winter	1	+0%					45.151	-0.099
1.003	S4	15 Winter	1	+0%					45.080	-0.120
1.004	S5	15 Winter	1	+0%					44.452	-0.123

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.000	0.13		6.6	OK	
1.001	S2	0.000	0.26		3.6	OK	
1.002	S3	0.000	0.26		3.6	OK	
1.003	S4	0.000	0.09		3.6	OK	
1.004	S5	0.000	0.08		3.6	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	2.000
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)	18.000
Region	England and Wales	Ratio R	0.359
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

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)
1.000	S1	15 Winter	30	+0%	100/30 Winter				46.157	-0.093
1.001	S2	30 Winter	30	+0%	30/15 Summer				45.574	0.274
1.002	S3	30 Winter	30	+0%					45.161	-0.089
1.003	S4	30 Winter	30	+0%					45.085	-0.115
1.004	S5	30 Winter	30	+0%					44.457	-0.118

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.000	0.31		16.2	OK	
1.001	S2	0.000	0.35		4.9	SURCHARGED	
1.002	S3	0.000	0.35		4.9	OK	
1.003	S4	0.000	0.12		4.9	OK	
1.004	S5	0.000	0.10		4.9	OK	

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100 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	2.000
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)	18.000
Region	England and Wales	Ratio R	0.359
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

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)
1.000	S1	30 Winter	100	+40%	100/30 Winter				46.605	0.355
1.001	S2	30 Winter	100	+40%	30/15 Summer				46.590	1.290
1.002	S3	60 Winter	100	+40%					45.161	-0.089
1.003	S4	60 Winter	100	+40%					45.085	-0.115
1.004	S5	30 Winter	100	+40%					44.457	-0.118

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.000	0.44		23.4	FLOOD RISK	
1.001	S2	0.000	0.35		4.9	FLOOD RISK	
1.002	S3	0.000	0.35		4.9	OK	
1.003	S4	0.000	0.12		4.9	OK	
1.004	S5	0.000	0.10		4.9	OK	

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