STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.280	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)	0.300
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 Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.155	4-8	0.029

Total Area Contributing (ha) = 0.184

Total Pipe Volume (m³) = 33.158

Network Design Table for Storm

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	31.600	0.080	395.0	0.067	5.00	0.0	0.600	o	900	Pipe/Conduit	
1.001	10.000	0.025	400.0	0.032	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.002	10.000	0.025	400.0	0.032	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.003	18.752	0.920	20.4	0.053	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	50.00	5.34	167.600	0.067	0.0	0.0	0.0	1.57	999.0	9.1
1.001	50.00	5.44	167.520	0.099	0.0	0.0	0.0	1.56	992.7	13.4
1.002	50.00	5.55	167.495	0.131	0.0	0.0	0.0	1.56	992.7	17.7
1.003	50.00	5.69	167.420	0.184	0.0	0.0	0.0	2.24	39.6	24.9

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Manhole Schedules for Storm

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	172.120	4.520	Open Manhole	3000	1.000	167.600	900				
S1A	170.620	3.100	Open Manhole	3000	1.001	167.520	900	1.000	167.520	900	
S1B	170.120	2.625	Open Manhole	3000	1.002	167.495	900	1.001	167.495	900	
S2	169.455	2.035	Open Manhole	3000	1.003	167.420	150	1.002	167.470	900	800
	168.000	1.500	Open Manhole	1200		OUTFALL		1.003	166.500	150	

No coordinates have been specified, layout information cannot be produced.

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PIPELINE SCHEDULES for Storm

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	900	S1	172.120	167.600	3.620	Open Manhole	3000
1.001	o	900	S1A	170.620	167.520	2.200	Open Manhole	3000
1.002	o	900	S1B	170.120	167.495	1.725	Open Manhole	3000
1.003	o	150	S2	169.455	167.420	1.885	Open Manhole	3000

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	31.600	395.0	S1A	170.620	167.520	2.200	Open Manhole	3000
1.001	10.000	400.0	S1B	170.120	167.495	1.725	Open Manhole	3000
1.002	10.000	400.0	S2	169.455	167.470	1.085	Open Manhole	3000
1.003	18.752	20.4		168.000	166.500	1.350	Open Manhole	1200

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		168.000	166.500	0.000	1200	0

Simulation Criteria for Storm

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.280		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S2, DS/PN: 1.003, Volume (m³): 18.8

Unit Reference	MD-SHE-0075-3500-2100-3500
Design Head (m)	2.100
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	167.420
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.100	3.5
Flush-Flo™	0.332	2.6
Kick-Flo®	0.674	2.1
Mean Flow over Head Range	-	2.7

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	2.1	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.5	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.6	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.6	1.800	3.3	4.500	5.0	8.500	6.7
0.500	2.5	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.3	2.200	3.6	5.500	5.5	9.500	7.1
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.9	6.500	5.9		

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

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	S1	120 Winter	1	+0%	100/60 Summer				167.779
1.001	S1A	120 Winter	1	+0%	100/30 Winter				167.779
1.002	S1B	120 Winter	1	+0%	100/30 Winter				167.779
1.003	S2	120 Winter	1	+0%	1/15 Summer				167.779

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	S1	-0.721	0.000	0.00			2.2	OK	
1.001	S1A	-0.641	0.000	0.00			1.9	OK	
1.002	S1B	-0.616	0.000	0.00			2.0	OK	
1.003	S2	0.209	0.000	0.07			2.6	SURCHARGED	

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

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	S1	180 Winter	30	+0%	100/60 Summer				168.262
1.001	S1A	180 Winter	30	+0%	100/30 Winter				168.262
1.002	S1B	180 Winter	30	+0%	100/30 Winter				168.262
1.003	S2	180 Winter	30	+0%	1/15 Summer				168.262

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	S1	-0.238	0.000	0.01			4.2	OK	
1.001	S1A	-0.158	0.000	0.00			1.6	OK	
1.002	S1B	-0.133	0.000	0.00			2.0	OK	
1.003	S2	0.692	0.000	0.07			2.6	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

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	S1	240 Winter	100	+30%	100/60 Summer				169.448
1.001	S1A	240 Winter	100	+30%	100/30 Winter				169.448
1.002	S1B	240 Winter	100	+30%	100/30 Winter				169.448
1.003	S2	240 Winter	100	+30%	1/15 Summer				169.448

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	S1	0.948	0.000	0.01			5.5	SURCHARGED	
1.001	S1A	1.028	0.000	0.00			2.2	SURCHARGED	
1.002	S1B	1.053	0.000	0.01			2.5	SURCHARGED	
1.003	S2	1.878	0.000	0.09			3.4	FLOOD RISK	

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