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)	1	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.423	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

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)	Auto Design
S3.000	20.708	0.259	80.0	0.011	5.00	0.0	0.600	o	150	
S3.001	6.761	0.066	102.4	0.015	0.00	0.0	0.600	o	150	
S4.000	14.525	0.097	150.0	0.004	5.00	0.0	0.600	o	150	
S4.001	15.878	0.106	150.0	0.001	0.00	0.0	0.600	o	150	
S4.002	13.929	0.093	150.0	0.014	0.00	0.0	0.600	o	150	
S5.000	15.179	0.101	150.0	0.008	5.00	0.0	0.600	o	150	
S5.001	18.990	0.127	150.0	0.005	0.00	0.0	0.600	o	150	
S3.002	3.343	0.054	62.0	0.003	0.00	0.0	0.600	o	150	
S3.003	6.494	0.110	59.0	0.000	0.00	0.0	0.600	o	150	

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)
S3.000	50.00	5.31	98.600	0.011	0.0	0.0	0.0	1.12	19.9	1.5
S3.001	50.00	5.42	97.400	0.026	0.0	0.0	0.0	0.99	17.5	3.5
S4.000	50.00	5.30	97.630	0.004	0.0	0.0	0.0	0.82	14.5	0.6
S4.001	50.00	5.62	97.533	0.005	0.0	0.0	0.0	0.82	14.5	0.7
S4.002	50.00	5.90	97.427	0.019	0.0	0.0	0.0	0.82	14.5	2.5
S5.000	50.00	5.31	97.630	0.008	0.0	0.0	0.0	0.82	14.5	1.1
S5.001	50.00	5.70	97.529	0.013	0.0	0.0	0.0	0.82	14.5	1.8
S3.002	50.00	5.95	97.334	0.061	0.0	0.0	0.0	1.28	22.6	8.3
S3.003	50.00	6.03	97.280	0.061	0.0	0.0	0.0	1.31	23.2	8.3

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S7	99.650	1.050	Open Manhole	450	S3.000	98.600	150				
S8	98.900	1.500	Open Manhole	450	S3.001	97.400	150	S3.000	98.341	150	941
S1	98.080	0.450	Open Manhole	450	S4.000	97.630	150				
S2	98.080	0.547	Open Manhole	450	S4.001	97.533	150	S4.000	97.533	150	
S3	98.080	0.653	Open Manhole	450	S4.002	97.427	150	S4.001	97.427	150	
S5	98.080	0.450	Open Manhole	450	S5.000	97.630	150				
S6	98.080	0.551	Open Manhole	450	S5.001	97.529	150	S5.000	97.529	150	
S7	98.030	0.696	Open Manhole	1200	S3.002	97.334	150	S3.001	97.334	150	
								S4.002	97.334	150	
								S5.001	97.402	150	68
S8	97.920	0.640	Open Manhole	1200	S3.003	97.280	150	S3.002	97.280	150	
S	97.400	0.230	Open Manhole	225		OUTFALL		S3.003	97.170	150	

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
3.000	User	-	100	0.011	0.011	0.011
3.001	-	-	100	0.015	0.015	0.015
4.000	User	-	100	0.004	0.004	0.004
4.001	User	-	100	0.001	0.001	0.001
4.002	User	-	100	0.002	0.002	0.002
	User	-	100	0.008	0.008	0.010
	User	-	100	0.003	0.003	0.014
5.000	User	-	100	0.004	0.004	0.004
	User	-	100	0.001	0.001	0.006
	User	-	100	0.003	0.003	0.008
5.001	User	-	100	0.005	0.005	0.005
3.002	User	-	100	0.003	0.003	0.003
3.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.061	0.061	0.061

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)
S3.003	S	97.400	97.170	97.000	225	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 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)	20.000	Storm Duration (mins)	30
Ratio R	0.423		

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: S7, DS/PN: S3.002, Volume (m³): 1.4

Unit Reference	MD-SHE-0085-3200-1000-3200
Design Head (m)	1.000
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	85
Invert Level (m)	97.334
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.2	Kick-Flo®	0.624	2.6
Flush-Flo™	0.298	3.2	Mean Flow over Head Range	-	2.8

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	2.5	0.800	2.9	2.000	4.4	4.000	6.1	7.000	7.9
0.200	3.1	1.000	3.2	2.200	4.6	4.500	6.4	7.500	8.2
0.300	3.2	1.200	3.5	2.400	4.8	5.000	6.7	8.000	8.4
0.400	3.1	1.400	3.7	2.600	5.0	5.500	7.0	8.500	8.7
0.500	3.0	1.600	4.0	3.000	5.3	6.000	7.3	9.000	8.9
0.600	2.7	1.800	4.2	3.500	5.7	6.500	7.6	9.500	9.1

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Storage Structures for Storm

Cellular Storage Manhole: S8, DS/PN: S3.001

Invert Level (m) 97.400 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	25.0	25.0	0.750	25.0	41.0	0.751	0.0	41.0

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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 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)	20.000
Region	England and Wales	Ratio R	0.410
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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
S3.000	15 Winter	1	0%					
S3.001	30 Winter	1	0%	30/15 Summer				
S4.000	15 Winter	1	0%	100/15 Summer	100/120 Winter			
S4.001	15 Winter	1	0%	100/15 Summer				
S4.002	15 Winter	1	0%	30/15 Summer				
S5.000	15 Winter	1	0%	100/15 Summer	100/120 Winter			
S5.001	15 Winter	1	0%	100/15 Summer				
S3.002	15 Winter	1	0%	30/15 Summer				
S3.003	15 Winter	1	0%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
S3.000	S7	98.629	-0.121	0.000	0.08	0.0	1.5	OK
S3.001	S8	97.473	-0.077	0.000	0.13	0.0	1.9	OK
S4.000	S1	97.651	-0.129	0.000	0.05	0.0	0.6	OK
S4.001	S2	97.555	-0.128	0.000	0.05	0.0	0.7	OK
S4.002	S3	97.488	-0.089	0.000	0.16	0.0	2.1	OK
S5.000	S5	97.660	-0.120	0.000	0.09	0.0	1.2	OK
S5.001	S6	97.565	-0.114	0.000	0.13	0.0	1.8	OK
S3.002	S7	97.481	-0.003	0.000	0.20	0.0	2.9	OK
S3.003	S8	97.318	-0.112	0.000	0.15	0.0	2.9	OK

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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 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) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.410 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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
S3.000	15 Winter	30	0%					
S3.001	30 Winter	30	0%	30/15 Summer				
S4.000	30 Winter	30	0%	100/15 Summer	100/120 Winter			
S4.001	30 Winter	30	0%	100/15 Summer				
S4.002	30 Winter	30	0%	30/15 Summer				
S5.000	15 Winter	30	0%	100/15 Summer	100/120 Winter			
S5.001	30 Winter	30	0%	100/15 Summer				
S3.002	30 Winter	30	0%	30/15 Summer				
S3.003	30 Winter	30	0%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
S3.000	S7	98.646	-0.104	0.000	0.20	0.0	3.8	OK
S3.001	S8	97.667	0.117	0.000	0.16	0.0	2.4	SURCHARGED
S4.000	S1	97.670	-0.110	0.000	0.09	0.0	1.2	OK
S4.001	S2	97.669	-0.014	0.000	0.09	0.0	1.2	OK
S4.002	S3	97.669	0.092	0.000	0.33	0.0	4.4	SURCHARGED
S5.000	S5	97.677	-0.103	0.000	0.21	0.0	2.9	OK
S5.001	S6	97.668	-0.011	0.000	0.25	0.0	3.4	OK
S3.002	S7	97.665	0.181	0.000	0.22	0.0	3.2	SURCHARGED
S3.003	S8	97.320	-0.110	0.000	0.16	0.0	3.2	OK

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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 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) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.410 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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
S3.000	15 Winter	100	+40%					
S3.001	60 Winter	100	+40%	30/15 Summer				
S4.000	60 Winter	100	+40%	100/15 Summer	100/120 Winter			
S4.001	60 Winter	100	+40%	100/15 Summer				
S4.002	60 Winter	100	+40%	30/15 Summer				
S5.000	60 Winter	100	+40%	100/15 Summer	100/120 Winter			
S5.001	60 Winter	100	+40%	100/15 Summer				
S3.002	60 Winter	100	+40%	30/15 Summer				
S3.003	15 Summer	100	+40%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
S3.000	S7	98.663	-0.087	0.000	0.37	0.0	6.9	OK
S3.001	S8	98.031	0.481	0.000	0.21	0.0	3.1	SURCHARGED
S4.000	S1	98.042	0.262	0.000	0.09	0.0	1.2	FLOOD RISK
S4.001	S2	98.039	0.356	0.000	0.09	0.0	1.2	FLOOD RISK
S4.002	S3	98.036	0.458	0.000	0.38	0.0	5.1	FLOOD RISK
S5.000	S5	98.040	0.260	0.000	0.17	0.0	2.3	FLOOD RISK
S5.001	S6	98.034	0.355	0.000	0.26	0.0	3.6	FLOOD RISK
S3.002	S7	98.028	0.544	0.000	0.22	0.0	3.2	FLOOD RISK
S3.003	S8	97.320	-0.110	0.000	0.16	0.0	3.2	OK

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