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	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.394	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 Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.016	4-8	0.002

Total Area Contributing (ha) = 0.018

Total Pipe Volume (m³) = 0.569

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	10.400	0.178	58.4	0.003	4.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	6.000	0.060	100.0	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	6.000	0.103	58.5	0.003	4.00	0.0	0.600	o	100	Pipe/Conduit	
3.000	6.000	0.103	58.5	0.003	4.00	0.0	0.600	o	100	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	4.17	167.200	0.003	0.0	0.0	0.0	1.01	7.9	0.4
1.001	50.00	4.27	167.022	0.006	0.0	0.0	0.0	1.00	17.8	0.8
2.000	50.00	4.10	166.983	0.003	0.0	0.0	0.0	1.01	7.9	0.4
3.000	50.00	4.10	166.983	0.003	0.0	0.0	0.0	1.01	7.9	0.4

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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
1.002	8.500	0.090	94.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.000	10.400	0.178	58.5	0.003	5.00	0.0	0.600	o	100	Pipe/Conduit	
4.001	3.700	0.132	28.0	0.003	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.003	1.500	0.020	75.0	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)
1.002	50.00	4.41	166.880	0.012	0.0	0.0	0.0	1.03	18.3	1.6
4.000	50.00	5.17	167.100	0.003	0.0	0.0	0.0	1.01	7.9	0.4
4.001	50.00	5.21	166.922	0.006	0.0	0.0	0.0	1.46	11.5	0.8
1.003	50.00	5.24	166.740	0.018	0.0	0.0	0.0	1.16	20.5	2.4

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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)
Rodding Eye	168.400	1.200	Open Manhole	300	1.000	167.200	100			
1	168.120	1.098	Open Manhole	450	1.001	167.022	150	1.000	167.022	100
tr1	168.100	1.117	Open Manhole	450	2.000	166.983	100			
TR2	168.000	1.017	Open Manhole	450	3.000	166.983	100			
2	168.100	1.220	Open Manhole	1200	1.002	166.880	150	1.001	166.962	150
								2.000	166.880	100
								3.000	166.880	100
Rodding Eye	168.400	1.300	Open Manhole	300	4.000	167.100	100			
3	168.400	1.478	Open Manhole	1200	4.001	166.922	100	4.000	166.922	100
Control Chamber	168.100	1.360	Open Manhole	1200	1.003	166.740	150	1.002	166.790	150
								4.001	166.790	100
to adopted 150	168.000	1.280	Open Manhole	150		OUTFALL		1.003	166.720	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	100	Rodding Eye	168.400	167.200	1.100	Open Manhole	300
1.001	o	150	1	168.120	167.022	0.998	Open Manhole	450
2.000	o	100	tr1	168.100	166.983	1.017	Open Manhole	450
3.000	o	100	TR2	168.000	166.983	0.917	Open Manhole	450
1.002	o	150	2	168.100	166.880	1.120	Open Manhole	1200
4.000	o	100	Rodding Eye	168.400	167.100	1.200	Open Manhole	300
4.001	o	100	3	168.400	166.922	1.378	Open Manhole	1200
1.003	o	150	Control Chamber	168.100	166.740	1.210	Open Manhole	1200

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	10.400	58.4	1	168.120	167.022	0.998	Open Manhole	450
1.001	6.000	100.0	2	168.100	166.962	1.038	Open Manhole	1200
2.000	6.000	58.5	2	168.100	166.880	1.120	Open Manhole	1200
3.000	6.000	58.5	2	168.100	166.880	1.120	Open Manhole	1200
1.002	8.500	94.4	Control Chamber	168.100	166.790	1.210	Open Manhole	1200
4.000	10.400	58.5	3	168.400	166.922	1.378	Open Manhole	1200
4.001	3.700	28.0	Control Chamber	168.100	166.790	1.210	Open Manhole	1200
1.003	1.500	75.0	to adopted 150	168.000	166.720	1.130	Open Manhole	150

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	to adopted 150	168.000	166.720	166.720	150	0

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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	1
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	0.386		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: Control Chamber, DS/PN: 1.003, Volume (m³): 1.7

Unit Reference	MD-SHE-0020-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	20
Invert Level (m)	166.740
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	0.2
Flush-Flo™	0.084	0.1
Kick-Flo®	0.175	0.1
Mean Flow over Head Range	-	0.1

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)
0.100	0.1	1.200	0.2	3.000	0.3	7.000	0.5
0.200	0.1	1.400	0.2	3.500	0.3	7.500	0.5
0.300	0.1	1.600	0.2	4.000	0.4	8.000	0.5
0.400	0.1	1.800	0.3	4.500	0.4	8.500	0.5
0.500	0.1	2.000	0.3	5.000	0.4	9.000	0.5
0.600	0.2	2.200	0.3	5.500	0.4	9.500	0.5
0.800	0.2	2.400	0.3	6.000	0.4		
1.000	0.2	2.600	0.3	6.500	0.4		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.002

Infiltration Trench

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	0.6
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	12.0
Safety Factor	2.0	Slope (1:X)	58.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	166.880	Cap Infiltration Depth (m)	0.000

Cellular Storage

Invert Level (m)	166.880	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	8.0	8.0	0.600	0.0	17.0
0.500	8.0	17.0			

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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 Storage Structures	1
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 0.356
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.200	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, 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
1.000	Rodding Eye	15 Winter	1	+0%	100/30 Winter		
1.001	1	15 Winter	1	+0%	30/120 Winter		
2.000	tr1	240 Winter	1	+0%	30/30 Summer		
3.000	TR2	240 Winter	1	+0%	30/30 Summer		
1.002	2	240 Winter	1	+0%	30/15 Summer		
4.000	Rodding Eye	15 Winter	1	+0%	30/120 Winter		
4.001	3	240 Winter	1	+0%	30/15 Summer		
1.003	Control Chamber	240 Winter	1	+0%	1/15 Summer		

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
1.000	Rodding Eye		167.215	-0.085	0.000	0.06		
1.001	1		167.043	-0.129	0.000	0.05		
2.000	tr1		167.005	-0.077	0.000	0.01		
3.000	TR2		167.005	-0.077	0.000	0.01		
1.002	2		167.005	-0.025	0.000	0.01		162

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

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
4.000	Rodding Eye		167.115	-0.085	0.000	0.05		
4.001	3		167.005	-0.017	0.000	0.02		
1.003	Control Chamber		167.005	0.115	0.000	0.01		

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
1.000	Rodding Eye	0.4	OK	
1.001	1	0.7	OK	
2.000	tr1	0.1	OK	
3.000	TR2	0.1	OK	
1.002	2	0.1	OK	
4.000	Rodding Eye	0.4	OK	
4.001	3	0.2	OK	
1.003	Control Chamber	0.1	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	1
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 0.356
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.200	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, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow
1.000	Rodding Eye	240 Winter	30	+0%	100/30 Winter		
1.001	1	240 Winter	30	+0%	30/120 Winter		
2.000	tr1	240 Winter	30	+0%	30/30 Summer		
3.000	TR2	240 Winter	30	+0%	30/30 Summer		
1.002	2	240 Winter	30	+0%	30/15 Summer		
4.000	Rodding Eye	240 Winter	30	+0%	30/120 Winter		
4.001	3	240 Winter	30	+0%	30/15 Summer		
1.003	Control Chamber	240 Winter	30	+0%	1/15 Summer		

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
1.000	Rodding Eye		167.225	-0.075	0.000	0.03		
1.001	1		167.224	0.052	0.000	0.02		

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

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
2.000	tr1		167.224	0.142	0.000	0.03		
3.000	TR2		167.224	0.142	0.000	0.03		
1.002	2		167.224	0.194	0.000	0.01		
4.000	Rodding Eye		167.224	0.024	0.000	0.03		
4.001	3		167.224	0.202	0.000	0.03		
1.003	Control Chamber		167.224	0.334	0.000	0.01		

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
1.000	Rodding Eye	0.2	OK	
1.001	1	0.4	SURCHARGED	
2.000	tr1	0.2	SURCHARGED	
3.000	TR2	0.2	SURCHARGED	
1.002	2	0.1	SURCHARGED	
4.000	Rodding Eye	0.2	SURCHARGED	
4.001	3	0.3	SURCHARGED	
1.003	Control Chamber	0.1	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	1
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 0.356
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.200	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, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow
1.000	Rodding Eye	360 Winter	100	+40%	100/30 Winter		
1.001	1	360 Winter	100	+40%	30/120 Winter		
2.000	tr1	360 Winter	100	+40%	30/30 Summer		
3.000	TR2	360 Winter	100	+40%	30/30 Summer		
1.002	2	360 Winter	100	+40%	30/15 Summer		
4.000	Rodding Eye	360 Winter	100	+40%	30/120 Winter		
4.001	3	360 Winter	100	+40%	30/15 Summer		
1.003	Control Chamber	360 Winter	100	+40%	1/15 Summer		

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
1.000	Rodding Eye		167.806	0.506	0.000	0.03		
1.001	1		167.806	0.634	0.000	0.03		

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

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
2.000	tr1		167.806	0.723	0.000	0.03		
3.000	TR2		167.806	0.723	0.000	0.03		
1.002	2		167.806	0.776	0.000	0.01		
4.000	Rodding Eye		167.806	0.606	0.000	0.03		
4.001	3		167.805	0.783	0.000	0.04		
1.003	Control Chamber		167.805	0.915	0.000	0.02		

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
1.000	Rodding Eye	0.2	SURCHARGED	
1.001	1	0.5	SURCHARGED	
2.000	tr1	0.2	FLOOD RISK	
3.000	TR2	0.2	FLOOD RISK	
1.002	2	0.2	FLOOD RISK	
4.000	Rodding Eye	0.2	SURCHARGED	
4.001	3	0.4	SURCHARGED	
1.003	Control Chamber	0.2	FLOOD RISK	

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