



Date 14/03/2020
File (2020-03-14).MDX

Designed by MM
Checked by

Innovyze

Network 2018.1.1

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)	20.100	Add Flow / Climate Change (%)	0
Ratio R	0.294	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	0.076	4-8	0.016

Total Area Contributing (ha) = 0.092

Total Pipe Volume (m³) = 12.983

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	11.400	0.195	58.5	0.007	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	5.100	0.195	26.2	0.018	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	6.600	0.113	58.4	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	16.800	0.337	49.9	0.036	0.00	0.0	0.600	[]	-22	Pipe/Conduit	
3.000	25.500	0.595	42.9	0.021	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	8.700	0.070	124.3	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)
1.000	46.56	5.14	122.740	0.007	0.0	0.0	0.0	1.32	23.3	0.9
2.000	46.92	5.04	122.740	0.018	0.0	0.0	0.0	1.98	34.9	2.3
1.001	46.26	5.23	122.545	0.035	0.0	0.0	0.0	1.32	23.3	4.4
1.002	46.01	5.30	122.432	0.071	0.0	0.0	0.0	3.94	2805.2	8.8
3.000	46.09	5.28	122.740	0.021	0.0	0.0	0.0	1.54	27.2	2.6
1.003	45.46	5.46	122.095	0.092	0.0	0.0	0.0	0.90	15.9	11.3



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Conduit Sections for Storm

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \ / open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m ²)
-22	[]	1425	500	90.0		0.740	0.713



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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)
S1	124.040	1.300	Open Manhole	600	1.000	122.740	150				
S2	124.040	1.300	Open Manhole	600	2.000	122.740	150				
S3	124.040	1.495	Open Manhole	600	1.001	122.545	150	1.000	122.545	150	
								2.000	122.545	150	
S4	124.040	1.608	Open Manhole	600	1.002	122.432	-22	1.001	122.432	150	
S5	124.040	1.300	Open Manhole	600	3.000	122.740	150				
S7	123.900	1.805	Open Manhole	2400	1.003	122.095	150	1.002	122.095	-22	
								3.000	122.145	150	50
	124.300	2.275	Open Manhole	0		OUTFALL		1.003	122.025	150	



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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	150	S1	124.040	122.740	1.150	Open Manhole	600
2.000	o	150	S2	124.040	122.740	1.150	Open Manhole	600
1.001	o	150	S3	124.040	122.545	1.345	Open Manhole	600
1.002	[]	-22	S4	124.040	122.432	1.108	Open Manhole	600
3.000	o	150	S5	124.040	122.740	1.150	Open Manhole	600
1.003	o	150	S7	123.900	122.095	1.655	Open Manhole	2400

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	11.400	58.5	S3	124.040	122.545	1.345	Open Manhole	600
2.000	5.100	26.2	S3	124.040	122.545	1.345	Open Manhole	600
1.001	6.600	58.4	S4	124.040	122.432	1.458	Open Manhole	600
1.002	16.800	49.9	S7	123.900	122.095	1.305	Open Manhole	2400
3.000	25.500	42.9	S7	123.900	122.145	1.605	Open Manhole	2400
1.003	8.700	124.3		124.300	122.025	2.125	Open Manhole	0



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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.007	0.007	0.007
2.000	-	-	100	0.018	0.018	0.018
1.001	-	-	100	0.010	0.010	0.010
1.002	-	-	100	0.036	0.036	0.036
3.000	-	-	100	0.021	0.021	0.021
1.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.092	0.092	0.092



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Network Classifications for Storm

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	1.150	1.345	Unclassified	600	0	1.150	Unclassified
2.000	S2	150	1.150	1.345	Unclassified	600	0	1.150	Unclassified
1.001	S3	150	1.345	1.458	Unclassified	600	0	1.345	Unclassified
1.002	S4	-22	1.108	1.305	Unclassified	600	0	1.108	Unclassified
3.000	S5	150	1.150	1.605	Unclassified	600	0	1.150	Unclassified
1.003	S7	150	1.655	2.125	Unclassified	2400	0	1.655	Unclassified

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall C. Level Name (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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1.003	124.300	122.025	122.000	0	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 * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	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	0	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)	20.100	Storm Duration (mins)	30
Ratio R	0.294		



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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S7, DS/PN: 1.003, Volume (m³): 19.5

Unit Reference MD-SHE-0111-6700-1700-6700
Design Head (m) 1.700
Design Flow (l/s) 6.7
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 111
Invert Level (m) 122.095
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)	1.700	6.7	Kick-Flo®	0.989	5.2
Flush-Flo™	0.486	6.5	Mean Flow over Head Range	-	5.8

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	3.8	0.800	6.1	2.000	7.2	4.000	10.0	7.000	13.1
0.200	5.7	1.000	5.2	2.200	7.5	4.500	10.6	7.500	13.5
0.300	6.3	1.200	5.7	2.400	7.9	5.000	11.1	8.000	13.9
0.400	6.5	1.400	6.1	2.600	8.2	5.500	11.6	8.500	14.3
0.500	6.5	1.600	6.5	3.000	8.7	6.000	12.1	9.000	14.7
0.600	6.5	1.800	6.9	3.500	9.4	6.500	12.6	9.500	15.1

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
1.000	S1	0.500
2.000	S2	0.500
1.001	S3	0.500
1.002	S4	0.500
3.000	S5	0.500
1.003	S7	0.500



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CASDeF Controller for Storm

PN	US/MH	Level	Not	Modify	Modify	Max Pipe	No. Pipe	Add	No. Storage	Use
	Name	Exceeded	Control	Pipe	Size	Diameter	Failures	Storage	Failures	CASDeF
1.000	S1	124.040		Yes	No	1150	0	Yes	0	Yes
2.000	S2	124.040		Yes	No	1150	0	Yes	0	Yes
1.001	S3	124.040		Yes	No	1345	0	Yes	0	Yes
1.002	S4	124.040		Yes	No	1458	0	Yes	0	Yes
3.000	S5	124.040		Yes	No	1150	0	Yes	0	Yes
1.003	S7	123.900		Yes	No	1655	0	Yes	0	Yes

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe	USMH	Manhole	Pipe	Storage	Total
Number	Name	Volume (m³)	Volume (m³)	Structure Volume (m³)	Volume (m³)
1.000	S1	0.368	0.201	0.000	0.569
2.000	S2	0.368	0.090	0.000	0.458
1.001	S3	0.423	0.117	0.000	0.539
1.002	S4	0.455	11.970	0.000	12.425
3.000	S5	0.368	0.451	0.000	0.818
1.003	S7	8.166	0.154	0.000	8.319
Total		10.146	12.983	0.000	23.128

Volume Summary (Static)

Length Calculations based on True Length

Pipe	USMH	Manhole	Pipe	Storage	Total
Number	Name	Volume (m³)	Volume (m³)	Structure Volume (m³)	Volume (m³)
1.000	S1	0.368	0.191	0.000	0.558
2.000	S2	0.368	0.080	0.000	0.447
1.001	S3	0.423	0.106	0.000	0.529
1.002	S4	0.455	10.901	0.000	11.356
3.000	S5	0.368	0.424	0.000	0.792
1.003	S7	8.166	0.133	0.000	8.298
Total		10.146	11.834	0.000	21.980



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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 Coefficient 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 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 0.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)

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) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level	Surcharged Depth	Flooded Volume
									(m)	(m)	(m³)
1.000	S1 15	Winter	1	+0%	100/15	Summer			122.760	-0.130	0.000
2.000	S2 15	Winter	1	+0%	100/15	Summer			122.768	-0.122	0.000
1.001	S3 15	Winter	1	+0%	100/15	Summer			122.592	-0.103	0.000
1.002	S4 15	Winter	1	+0%	100/15	Winter			122.436	-0.496	0.000
3.000	S5 15	Winter	1	+0%	100/15	Summer			122.772	-0.118	0.000
1.003	S7 15	Winter	1	+0%	1/15	Summer			122.293	0.048	0.000

PN	US/MH Name	Flow / Cap.	Pipe Flow (l/s)	Level Exceeded
1.000	S1	0.04	0.9	OK
2.000	S2	0.08	2.2	OK
1.001	S3	0.21	4.1	OK
1.002	S4	0.01	7.9	OK
3.000	S5	0.10	2.6	OK
1.003	S7	0.41	5.7	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 Coefficient 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 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 0.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)

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	Surcharged	Flooded
									Level (m)	Depth (m)	Volume (m ³)
1.000	S1 15	Winter	30	+0%	100/15	Summer			122.772	-0.118	0.000
2.000	S2 15	Winter	30	+0%	100/15	Summer			122.785	-0.105	0.000
1.001	S3 15	Winter	30	+0%	100/15	Summer			122.625	-0.070	0.000
1.002	S4 30	Winter	30	+0%	100/15	Winter			122.577	-0.355	0.000
3.000	S5 15	Winter	30	+0%	100/15	Summer			122.790	-0.100	0.000
1.003	S7 30	Winter	30	+0%	1/15	Summer			122.577	0.332	0.000

PN	US/MH Name	Flow / Cap.	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.10	2.1	OK	
2.000	S2	0.20	5.5	OK	
1.001	S3	0.54	10.7	OK	
1.002	S4	0.01	17.4	OK	
3.000	S5	0.24	6.3	OK	
1.003	S7	0.47	6.5	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 Coefficient 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 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 0.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)

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	Surcharged	Flooded
									Level (m)	Depth (m)	Volume (m³)
1.000	S1	60 Winter	100	+40%	100/15 Summer				123.890	1.000	0.000
2.000	S2	60 Winter	100	+40%	100/15 Summer				123.890	1.000	0.000
1.001	S3	60 Winter	100	+40%	100/15 Summer				123.888	1.193	0.000
1.002	S4	60 Winter	100	+40%	100/15 Winter				123.881	0.949	0.000
3.000	S5	60 Winter	100	+40%	100/15 Summer				123.889	0.999	0.000
1.003	S7	60 Winter	100	+40%	1/15 Summer				123.880	1.635	0.000

Pipe

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level
						Exceeded
1.000	S1	0.10		2.2	SURCHARGED	
2.000	S2	0.20		5.5	SURCHARGED	
1.001	S3	0.51		10.0	SURCHARGED	
1.002	S4	0.01		19.8	SURCHARGED	
3.000	S5	0.25		6.5	SURCHARGED	
1.003	S7	0.49		6.8	SURCHARGED	