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	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	19.700	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.321	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

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)	Section Type	Auto Design
S1.000	16.523	0.420	39.3	0.038	5.00	0.0	0.600	o	225	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)
S1.000	47.75	5.13	49.655	0.038	0.0	0.0	0.0	2.09	83.2	4.9

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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
S1.001	18.765	0.386	48.6	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	21.147	0.213	99.3	0.014	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	15.708	0.461	34.1	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	13.723	0.595	23.1	0.026	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	13.570	0.100	135.7	0.032	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	21.099	0.212	99.5	0.041	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	20.740	0.284	73.0	0.024	0.00	0.0	0.600	o	225	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)
S1.001	47.13	5.30	49.235	0.069	0.0	0.0	0.0	1.88	74.8	8.8
S1.002	46.16	5.57	48.799	0.083	0.0	0.0	0.0	1.31	52.2	10.4
S2.000	47.67	5.15	49.833	0.024	0.0	0.0	0.0	1.73	30.6	3.1
S1.003	45.87	5.65	48.587	0.134	0.0	0.0	0.0	2.74	108.8	16.6
S3.000	47.48	5.20	48.589	0.032	0.0	0.0	0.0	1.12	44.6	4.1
S3.001	46.50	5.47	48.489	0.073	0.0	0.0	0.0	1.31	52.1	9.2
S3.002	45.72	5.70	48.276	0.098	0.0	0.0	0.0	1.53	60.9	12.1

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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
S1.004	11.584	0.069	167.9	0.040	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	3.922	0.023	170.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S4.000	3.216	0.100	32.2	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
S1.006	5.010	0.030	167.0	0.000	0.00	0.0	0.600	o	300	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)
S1.004	45.18	5.86	47.992	0.272	0.0	0.0	0.0	1.21	85.6	33.2
S1.005	45.00	5.91	47.923	0.272	0.0	0.0	0.0	1.20	84.9	33.2
S4.000	48.10	5.04	48.000	0.000	0.0	0.0	0.0	1.37	10.7	0.0
S1.006	44.77	5.98	47.900	0.272	0.0	0.0	0.0	1.21	85.8	33.2

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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	50.955	1.300	Open Manhole	1200	S1.000	49.655	225				
S2	50.535	1.300	Open Manhole	1200	S1.001	49.235	225	S1.000	49.235	225	
S3	50.604	1.805	Open Manhole	1200	S1.002	48.799	225	S1.001	48.849	225	50
S4	51.133	1.300	Open Manhole	1200	S2.000	49.833	150				
S5	50.672	2.086	Open Manhole	1200	S1.003	48.587	225	S1.002	48.586	225	
								S2.000	49.372	150	710
S6	49.760	1.171	Open Manhole	1500	S3.000	48.589	225				
S7	50.105	1.616	Open Manhole	1500	S3.001	48.489	225	S3.000	48.489	225	
S8	50.213	1.937	Open Manhole	1500	S3.002	48.276	225	S3.001	48.277	225	1
S9	50.041	2.049	Open Manhole	1800	S1.004	47.992	300	S1.003	47.992	225	
								S3.002	47.992	225	
S10	49.798	1.875	Open Manhole	1800	S1.005	47.923	300	S1.004	47.923	300	
S11	49.638	1.638	Open Manhole	1200	S4.000	48.000	100				
S12	49.523	1.623	Open Manhole	1500	S1.006	47.900	300	S1.005	47.900	300	
								S4.000	47.900	100	
S	49.540	1.670	Open Manhole	0		OUTFALL		S1.006	47.870	300	

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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)
S1.000	o	225	S1	50.955	49.655	1.075	Open Manhole	1200
S1.001	o	225	S2	50.535	49.235	1.075	Open Manhole	1200
S1.002	o	225	S3	50.604	48.799	1.580	Open Manhole	1200
S2.000	o	150	S4	51.133	49.833	1.150	Open Manhole	1200
S1.003	o	225	S5	50.672	48.587	1.860	Open Manhole	1200
S3.000	o	225	S6	49.760	48.589	0.946	Open Manhole	1500

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)
S1.000	16.523	39.3	S2	50.535	49.235	1.075	Open Manhole	1200
S1.001	18.765	48.6	S3	50.604	48.849	1.530	Open Manhole	1200
S1.002	21.147	99.3	S5	50.672	48.586	1.861	Open Manhole	1200
S2.000	15.708	34.1	S5	50.672	49.372	1.150	Open Manhole	1200
S1.003	13.723	23.1	S9	50.041	47.992	1.824	Open Manhole	1800
S3.000	13.570	135.7	S7	50.105	48.489	1.391	Open Manhole	1500

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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)
S3.001	o	225	S7	50.105	48.489	1.391	Open Manhole	1500
S3.002	o	225	S8	50.213	48.276	1.712	Open Manhole	1500
S1.004	o	300	S9	50.041	47.992	1.749	Open Manhole	1800
S1.005	o	300	S10	49.798	47.923	1.575	Open Manhole	1800
S4.000	o	100	S11	49.638	48.000	1.538	Open Manhole	1200
S1.006	o	300	S12	49.523	47.900	1.323	Open Manhole	1500

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)
S3.001	21.099	99.5	S8	50.213	48.277	1.711	Open Manhole	1500
S3.002	20.740	73.0	S9	50.041	47.992	1.824	Open Manhole	1800
S1.004	11.584	167.9	S10	49.798	47.923	1.575	Open Manhole	1800
S1.005	3.922	170.5	S12	49.523	47.900	1.323	Open Manhole	1500
S4.000	3.216	32.2	S12	49.523	47.900	1.523	Open Manhole	1500
S1.006	5.010	167.0	S	49.540	47.870	1.370	Open Manhole	0

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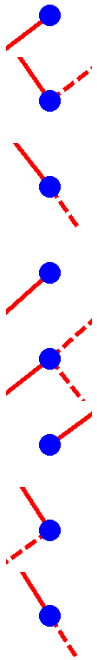
Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
S1.000	S1	1200		468204.859	109385.921	
S1.001	S2	1200		468191.759	109375.851	
S1.002	S3	1200		468181.103	109391.297	
S2.000	S4	1200		468179.699	109418.416	
S1.003	S5	1200		468168.020	109407.912	
S3.000	S6	1500		468168.687	109356.104	
S3.001	S7	1500		468179.637	109364.120	
S3.002	S8	1500		468168.296	109381.912	



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Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
S1.004	S9	1800		468157.219	109399.447	
S1.005	S10	1800		468148.459	109391.866	
S4.000	S11	1200		468145.183	109392.826	
S1.006	S12	1500		468145.251	109389.611	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.006	S	0		468140.328	109388.677	

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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	User	-	100	0.038	0.038	0.038
1.001	User	-	100	0.031	0.031	0.031
1.002	User	-	100	0.014	0.014	0.014
2.000	User	-	100	0.020	0.020	0.020
	User	-	100	0.004	0.004	0.024
1.003	User	-	100	0.026	0.026	0.026
3.000	User	-	100	0.022	0.022	0.022
	User	-	100	0.010	0.010	0.032
3.001	User	-	100	0.019	0.019	0.019
	User	-	100	0.022	0.022	0.041
3.002	User	-	100	0.015	0.015	0.015
	User	-	100	0.009	0.009	0.024
1.004	User	-	100	0.030	0.030	0.030
	User	-	100	0.011	0.011	0.040
1.005	-	-	100	0.000	0.000	0.000
4.000	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.272	0.272	0.272

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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)
S1.006	S	49.540	47.870	47.870	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	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	M5-60 (mm)	19.700	Cv (Summer)	0.750
Return Period (years)	1	Ratio R	0.321	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S12, DS/PN: S1.006, Volume (m³): 3.0

Unit Reference	MD-SHE-0284-4740-1323-4740	Sump Available	Yes
Design Head (m)	1.323	Diameter (mm)	284
Design Flow (l/s)	47.4	Invert Level (m)	47.900
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	300
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1800
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.323	47.4	Kick-Flo®	0.963	40.7
Flush-Flo™	0.471	47.4	Mean Flow over Head Range	-	39.6

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)	Depth (m)	Flow (l/s)
0.100	8.9	0.600	46.9	1.600	51.9	2.600	65.7	5.000	90.2	7.500	109.9
0.200	29.3	0.800	45.0	1.800	55.0	3.000	70.4	5.500	94.5	8.000	113.4
0.300	45.7	1.000	41.4	2.000	57.8	3.500	75.8	6.000	98.6	8.500	116.9
0.400	47.1	1.200	45.2	2.200	60.6	4.000	80.9	6.500	102.5	9.000	120.2
0.500	47.3	1.400	48.7	2.400	63.2	4.500	85.7	7.000	106.3	9.500	123.4

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Storage Structures for Storm

Tank or Pond Manhole: S11, DS/PN: S4.000

Invert Level (m) 48.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	11.0	0.900	11.0	0.901	0.0

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

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 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) 19.800 Cv (Summer) 0.750
Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0 DTS Status ON Inertia Status OFF
Analysis Timestep Fine DVD Status OFF

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) 100
Climate Change (%) 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)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)
S1.000	S1	15 Winter	100	+40%	100/15 Winter				49.890	0.010	0.000	0.30		22.1
S1.001	S2	15 Winter	100	+40%	100/15 Summer				49.863	0.403	0.000	0.57		38.5

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

PN	US/MH Name	Status	Level Exceeded
S1.000	S1	SURCHARGED	
S1.001	S2	SURCHARGED	

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

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)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)
S1.002	S3	15 Winter	100	+40%	100/15 Summer				49.813	0.789	0.000	0.77		36.8
S2.000	S4	15 Winter	100	+40%					49.908	-0.075	0.000	0.50		14.1
S1.003	S5	15 Winter	100	+40%	100/15 Summer				49.745	0.933	0.000	0.58		54.6
S3.000	S6	15 Winter	100	+40%	100/15 Summer				49.754	0.940	0.000	0.32		12.6
S3.001	S7	15 Winter	100	+40%	100/15 Summer				49.737	1.023	0.000	0.57		27.0
S3.002	S8	15 Winter	100	+40%	100/15 Summer				49.695	1.194	0.000	0.48		26.5
S1.004	S9	15 Winter	100	+40%	100/15 Summer				49.636	1.344	0.000	1.32		87.1
S1.005	S10	15 Winter	100	+40%	100/15 Summer				49.544	1.321	0.000	1.50		78.3
S4.000	S11	30 Winter	100	+40%	100/15 Summer				49.481	1.381	0.000	1.84		16.2
S1.006	S12	30 Winter	100	+40%	100/15 Summer				49.496	1.296	0.000	0.91		51.6

PN	US/MH Name	Status	Level Exceeded
S1.002	S3	SURCHARGED	
S2.000	S4	OK	
S1.003	S5	SURCHARGED	
S3.000	S6	FLOOD RISK	
S3.001	S7	FLOOD RISK	
S3.002	S8	SURCHARGED	
S1.004	S9	FLOOD RISK	
S1.005	S10	FLOOD RISK	
S4.000	S11	FLOOD RISK	

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

PN	US/MH Name	Status	Level Exceeded
S1.006	S12	FLOOD RISK	

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