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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)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.350	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)	400

Designed with Level Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.017	4-8	0.005

Total Area Contributing (ha) = 0.022

Total Pipe Volume (m³) = 0.950

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	17.240	0.180	95.8	0.006	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	10.048	0.100	100.5	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	17.240	0.280	61.6	0.010	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	5.342	0.570	9.4	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)
S1.000	50.00	5.28	87.650	0.006	0.0	0.0	0.0	1.03	18.1	0.8
S1.001	50.00	5.45	87.470	0.009	0.0	0.0	0.0	1.00	17.7	1.2
S2.000	50.00	5.22	87.650	0.010	0.0	0.0	0.0	1.28	22.7	1.4
S1.002	50.00	5.47	87.370	0.019	0.0	0.0	0.0	3.31	58.5	2.6

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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)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	88.150	0.500	Open Manhole	300	S1.000	87.650	150				
S2	88.150	0.680	Open Manhole	300	S1.001	87.470	150	S1.000	87.470	150	
S3	88.150	0.500	Open Manhole	300	S2.000	87.650	150				
S3	88.150	0.780	Open Manhole	300	S1.002	87.370	150	S1.001	87.370	150	
								S2.000	87.370	150	
S5	87.800	0.505	Open Manhole	300	S3.000	87.295	150				
S4	87.850	1.050	Open Manhole	300	S1.003	86.800	150	S1.002	86.800	150	
								S3.000	86.800	150	
S5	87.900	1.170	Junction		S1.004	86.730	150	S1.003	86.790	150	60
S	87.900	1.180	Open Manhole	0		OUTFALL		S1.004	86.720	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	449551.298	418567.634	449551.298	418567.634	Required	
S2	449534.172	418569.609	449534.172	418569.609	Required	
S3	449552.450	418577.616	449552.450	418577.616	Required	
S3	449535.323	418579.591	449535.323	418579.591	Required	
S5	449535.952	418586.812	449535.952	418586.812	Required	
S4	449535.935	418584.898	449535.935	418584.898	Required	
S5	449536.929	418584.783			No Entry	
S	449537.922	418584.668			No Entry	

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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	150	S1	88.150	87.650	0.350	Open Manhole	300
S1.001	o	150	S2	88.150	87.470	0.530	Open Manhole	300
S2.000	o	150	S3	88.150	87.650	0.350	Open Manhole	300
S1.002	o	150	S3	88.150	87.370	0.630	Open Manhole	300
S3.000	o	150	S5	87.800	87.295	0.355	Open Manhole	300
S1.003	o	150	S4	87.850	86.800	0.900	Open Manhole	300
S1.004	o	150	S5	87.900	86.730	1.020	Junction	

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	17.240	95.8	S2	88.150	87.470	0.530	Open Manhole	300
S1.001	10.048	100.5	S3	88.150	87.370	0.630	Open Manhole	300
S2.000	17.240	61.6	S3	88.150	87.370	0.630	Open Manhole	300
S1.002	5.342	9.4	S4	87.850	86.800	0.900	Open Manhole	300
S3.000	1.915	3.9	S4	87.850	86.800	0.900	Open Manhole	300
S1.003	1.000	100.0	S5	87.900	86.790	0.960	Junction	
S1.004	1.000	100.0	S	87.900	86.720	1.030	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	0.006	0.006	0.006
1.001	-	-	100	0.003	0.003	0.003
2.000	-	-	100	0.010	0.010	0.010
1.002	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.003	0.003	0.003
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.022	0.022	0.022

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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
S1.000	S1	150	0.350	0.530	Unclassified	300	0	0.350	Unclassified
S1.001	S2	150	0.530	0.630	Unclassified	300	0	0.530	Unclassified
S2.000	S3	150	0.350	0.630	Unclassified	300	0	0.350	Unclassified
S1.002	S3	150	0.630	0.900	Unclassified	300	0	0.630	Unclassified
S3.000	S5	150	0.355	0.900	Unclassified	300	0	0.355	Unclassified
S1.003	S4	150	0.900	0.960	Unclassified	300	0	0.900	Unclassified
S1.004	S5	150	1.020	1.030	Unclassified				Junction

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)
S1.004	S	87.900	86.720	0.000	0	0

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	0.000
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 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)	18.000	Storm Duration (mins)	30
Ratio R	0.350		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S5, DS/PN: S1.004, Volume (m³): 0.0

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	86.730
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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Storage Structures for Storm

Cellular Storage Manhole: S5, DS/PN: S1.004

Invert Level (m) 86.730 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	7.5	0.0	0.551	0.0	0.0
0.550	7.5	0.0			

Manhole Headloss for Storm

PN	US/MH	US/MH
	Name	Headloss
S1.000	S1	0.500
S1.001	S2	0.500
S2.000	S3	0.500
S1.002	S3	0.500
S3.000	S5	0.500
S1.003	S4	0.500
S1.004	S5	0.000

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

PN	US/MH Name	Surcharged		Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)			
S1.003	S4	0.405	0.000	0.58		6.3		SURCHARGED	
S1.004	S5	0.401	0.000	0.19		2.0		SURCHARGED*	