STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm South

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.300	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)	500

Designed with Level Soffits

Time Area Diagram for Storm South

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.080	4-8	0.007

Total Area Contributing (ha) = 0.087

Total Pipe Volume (m³) = 1.035

Network Design Table for Storm South

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	30.779	0.537	57.3	0.020	4.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	9.075	0.500	18.2	0.025	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	12.525	0.113	110.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	1.934	0.025	77.4	0.042	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	4.269	0.082	52.1	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	4.39	76.400	0.020	0.0	0.0	0.0	1.33	23.5	2.7
S1.001	50.00	4.45	75.863	0.045	0.0	0.0	0.0	2.38	42.0	6.1
S1.002	50.00	4.67	75.363	0.045	0.0	0.0	0.0	0.95	16.9	6.1
S1.003	50.00	4.70	75.250	0.087	0.0	0.0	0.0	1.14	20.2	11.8
S1.004	50.00	4.75	75.225	0.087	0.0	0.0	0.0	1.40	24.7	11.8

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Manhole Schedules for Storm South

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)	Bac
S1	77.700	1.300	Open Manhole	450	S1.000	76.400	150				
S2	77.500	1.637	Open Manhole	450	S1.001	75.863	150	S1.000	75.863	150	
S3 - CP MH	77.400	2.037	Open Manhole	450	S1.002	75.363	150	S1.001	75.363	150	
S4 - HB	77.250	2.000	Open Manhole	1500	S1.003	75.250	150	S1.002	75.250	150	
S5	77.200	1.975	Open Manhole	450	S1.004	75.225	150	S1.003	75.225	150	
SS12 - New Outfall MH	77.120	1.977	Open Manhole	0		OUTFALL		S1.004	75.143	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	386471.977	401654.572	386471.977	401654.572	Required	
S2	386441.701	401649.027	386441.701	401649.027	Required	
S3 - CP MH	386432.779	401647.368	386432.779	401647.368	Required	
S4 - HB	386420.465	401645.079	386420.465	401645.079	Required	
S5	386420.099	401646.978	386420.099	401646.978	Required	
SS12 - New Outfall MH	386419.291	401651.170			No Entry	

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PIPELINE SCHEDULES for Storm South

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	77.700	76.400	1.150	Open Manhole	450
S1.001	o	150	S2	77.500	75.863	1.487	Open Manhole	450
S1.002	o	150	S3 - CP MH	77.400	75.363	1.887	Open Manhole	450
S1.003	o	150	S4 - HB	77.250	75.250	1.850	Open Manhole	1500
S1.004	o	150	S5	77.200	75.225	1.825	Open Manhole	450

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	30.779	57.3	S2	77.500	75.863	1.487	Open Manhole	450
S1.001	9.075	18.2	S3 - CP MH	77.400	75.363	1.887	Open Manhole	450
S1.002	12.525	110.8	S4 - HB	77.250	75.250	1.850	Open Manhole	1500
S1.003	1.934	77.4	S5	77.200	75.225	1.825	Open Manhole	450
S1.004	4.269	52.1	SS12 - New Outfall MH	77.120	75.143	1.827	Open Manhole	0

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Setting Out Information - True Coordinates (Storm South)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S1	450		386471.977	401654.572	386471.977	401654.572	
S1.001	S2	450		386441.701	401649.027	386441.701	401649.027	
S1.002	S3 - CP MH	450		386432.779	401647.368	386432.779	401647.368	
S1.003	S4 - HB	1500		386420.465	401645.079	386420.465	401645.079	
S1.004	S5	450		386420.099	401646.978	386420.099	401646.978	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.004	SS12 - New Outfall MH	0		386419.291	401651.170	

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Area Summary for Storm South

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.020	0.020	0.020
1.001	-	-	100	0.025	0.025	0.025
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.042	0.042	0.042
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.087	0.087	0.087

Free Flowing Outfall Details for Storm South

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	SS12 - New Outfall MH	77.120	75.143	0.000	0	0

Simulation Criteria for Storm South

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
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)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.300	Storm Duration (mins)	30
Ratio R	0.348		

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Online Controls for Storm South

Hydro-Brake® Optimum Manhole: S4 - HB, DS/PN: S1.003, Volume (m³): 3.7

Unit Reference	MD-SHE-0075-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	75.250
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)	1.500	3.0	Kick-Flo®	0.671	2.1
Flush-Flo™	0.329	2.6	Mean Flow over Head Range	-	2.4

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	2.1	0.800	2.2	2.000	3.4	4.000	4.7	7.000	6.1
0.200	2.5	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.3
0.300	2.6	1.200	2.7	2.400	3.7	5.000	5.2	8.000	6.5
0.400	2.6	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.7
0.500	2.5	1.600	3.1	3.000	4.1	6.000	5.7	9.000	6.9
0.600	2.3	1.800	3.3	3.500	4.4	6.500	5.9	9.500	7.1

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Storage Structures for Storm South

Cellular Storage Manhole: S4 - HB, DS/PN: S1.003

Invert Level (m) 75.363 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	35.0	35.0	1.200	35.0	67.4	1.210	0.0	67.4

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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)	18.300
Region	England and Wales	Ratio R	0.350
Cv (Summer)	1.000		
Cv (Winter)	1.000		

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

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, 45

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)
S1.000	S1	15 Summer	1	+0%	100/15 Summer				76.439	-0.111
S1.001	S2	15 Summer	1	+0%	100/15 Summer				75.906	-0.107
S1.002	S3 - CP MH	60 Summer	1	+0%	30/15 Summer				75.482	-0.031
S1.003	S4 - HB	60 Summer	1	+0%	1/15 Summer				75.476	0.076
S1.004	S5	60 Summer	1	+0%					75.262	-0.113

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.15			3.5	OK	
S1.001	S2	0.000	0.18			6.7	OK	
S1.002	S3 - CP MH	0.000	0.30			4.5	OK	
S1.003	S4 - HB	0.000	0.23		30	2.5	SURCHARGED	
S1.004	S5	0.000	0.14			2.5	OK	

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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) 18.300	Cv (Summer) 1.000
Region	England and Wales	Ratio R 0.350	Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

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, 45

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)
S1.000	S1	15 Summer	30	+0%	100/15 Summer				76.464	-0.086
S1.001	S2	15 Summer	30	+0%	100/15 Summer				75.939	-0.074
S1.002	S3 - CP MH	60 Winter	30	+0%	30/15 Summer				75.819	0.306
S1.003	S4 - HB	60 Winter	30	+0%	1/15 Summer				75.814	0.414
S1.004	S5	30 Winter	30	+0%					75.263	-0.112

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.37			8.4	OK	
S1.001	S2	0.000	0.51			19.0	OK	
S1.002	S3 - CP MH	0.000	0.55			8.4	SURCHARGED	
S1.003	S4 - HB	0.000	0.24		58	2.6	SURCHARGED	
S1.004	S5	0.000	0.14			2.6	OK	

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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) 18.300	Cv (Summer) 1.000
Region	England and Wales	Ratio R 0.350	Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

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, 45

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)
S1.000	S1	15 Summer	100	+45%	100/15 Summer				76.970	0.420
S1.001	S2	15 Summer	100	+45%	100/15 Summer				76.728	0.715
S1.002	S3 - CP MH	120 Winter	100	+45%	30/15 Summer				76.494	0.981
S1.003	S4 - HB	120 Winter	100	+45%	1/15 Summer				76.488	1.088
S1.004	S5	120 Winter	100	+45%					75.264	-0.111

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.65			14.7	SURCHARGED	
S1.001	S2	0.000	0.86			31.8	SURCHARGED	
S1.002	S3 - CP MH	0.000	0.64			9.8	SURCHARGED	
S1.003	S4 - HB	0.000	0.25		148	2.7	SURCHARGED	
S1.004	S5	0.000	0.15			2.7	OK	

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