STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW NETWORK.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.357	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
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

Network Design Table for SW NETWORK.SWS

« - Indicates pipe capacity < flow

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	20.197	0.808	25.0	0.150	4.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	19.227	0.760	25.3	0.110	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	19.558	0.782	25.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	14.822	0.593	25.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	22.537	0.901	25.0	0.140	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	14.838	0.568	26.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	17.655	0.090	196.2	0.054	0.00	0.0	0.600	[]	-1	Pipe/Conduit	
1.007	26.569	0.133	199.8	0.120	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.008	10.636	1.044	10.2	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.009	7.860	0.786	10.0	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)
1.000	50.00	4.11	136.500	0.150	0.0	0.0	0.0	3.16	223.2	20.3
1.001	50.00	4.21	135.692	0.260	0.0	0.0	0.0	3.14	221.9	35.2
1.002	50.00	4.31	134.932	0.260	0.0	0.0	0.0	3.16	223.1	35.2
1.003	50.00	4.39	134.150	0.260	0.0	0.0	0.0	3.16	223.2	35.2
1.004	50.00	4.51	133.557	0.400	0.0	0.0	0.0	3.16	223.1	54.2
1.005	50.00	4.59	132.656	0.400	0.0	0.0	0.0	3.09	218.3	54.2
1.006	50.00	4.65	129.998	0.454	0.0	0.0	0.0	5.20	88985.1	61.5
1.007	50.00	4.81	129.908	0.574	0.0	0.0	0.0	2.64	2989.7	77.7
1.008	50.00	4.87	129.725	0.574	0.0	0.0	0.0	3.18	56.1«	77.7
1.009	50.00	4.91	128.681	0.574	0.0	0.0	0.0	3.20	56.6«	77.7

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Conduit Sections for SW NETWORK.SWS

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)
-1	[]	7136	2400	90.0		3.592	17.126

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Manhole Schedules for SW NETWORK.SWS

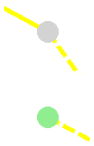
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	138.000	1.500	Open Manhole	1500	1.000	136.500	300				
S2	137.398	1.706	Open Manhole	1500	1.001	135.692	300	1.000	135.692	300	
S3	136.815	1.883	Open Manhole	1200	1.002	134.932	300	1.001	134.932	300	
S4	136.250	2.100	Open Manhole	1200	1.003	134.150	300	1.002	134.150	300	
S5	135.802	2.245	Open Manhole	1200	1.004	133.557	300	1.003	133.557	300	
S6	135.113	2.457	Open Manhole	1200	1.005	132.656	300	1.004	132.656	300	
S7	134.895	4.897	Open Manhole	1800	1.006	129.998	-1	1.005	132.088	300	
S8	134.450	4.542	Open Manhole	1800	1.007	129.908	1200	1.006	129.908	-1	
S9	132.780	3.055	Open Manhole	2100	1.008	129.725	150	1.007	129.775	1200	1100
S10	132.107	3.426	Open Manhole	1200	1.009	128.681	150	1.008	128.681	150	
EX MH	131.608	3.713	Open Manhole	0		OUTFALL		1.009	127.895	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	434266.028	400150.999	434266.028	400150.999	Required	
S2	434283.520	400161.095	434283.520	400161.095	Required	
S3	434297.469	400174.328	434297.469	400174.328	Required	
S4	434314.944	400183.110	434314.944	400183.110	Required	
S5	434327.810	400190.470	434327.810	400190.470	Required	
S6	434343.211	400206.924	434343.211	400206.924	Required	
S7	434357.130	400212.065	434357.130	400212.065	Required	
S8	434373.565	400205.681	434373.565	400205.681	Required	
S9	434385.393	400229.472	434385.393	400229.472	Required	

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Manhole Schedules for SW NETWORK.SWS

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	434379.167	400238.095	434379.167	400238.095	Required	
EX MH	434372.250	400241.828			No Entry	



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PIPELINE SCHEDULES for SW NETWORK.SWS

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	300	S1	138.000	136.500	1.200	Open Manhole	1500
1.001	o	300	S2	137.398	135.692	1.406	Open Manhole	1500
1.002	o	300	S3	136.815	134.932	1.583	Open Manhole	1200
1.003	o	300	S4	136.250	134.150	1.800	Open Manhole	1200
1.004	o	300	S5	135.802	133.557	1.945	Open Manhole	1200
1.005	o	300	S6	135.113	132.656	2.157	Open Manhole	1200
1.006	[]	-1	S7	134.895	129.998	2.497	Open Manhole	1800
1.007	o	1200	S8	134.450	129.908	3.342	Open Manhole	1800
1.008	o	150	S9	132.780	129.725	2.905	Open Manhole	2100
1.009	o	150	S10	132.107	128.681	3.276	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	20.197	25.0	S2	137.398	135.692	1.406	Open Manhole	1500
1.001	19.227	25.3	S3	136.815	134.932	1.583	Open Manhole	1200
1.002	19.558	25.0	S4	136.250	134.150	1.800	Open Manhole	1200
1.003	14.822	25.0	S5	135.802	133.557	1.945	Open Manhole	1200
1.004	22.537	25.0	S6	135.113	132.656	2.157	Open Manhole	1200
1.005	14.838	26.1	S7	134.895	132.088	2.507	Open Manhole	1800
1.006	17.655	196.2	S8	134.450	129.908	2.142	Open Manhole	1800
1.007	26.569	199.8	S9	132.780	129.775	1.805	Open Manhole	2100
1.008	10.636	10.2	S10	132.107	128.681	3.276	Open Manhole	1200
1.009	7.860	10.0	EX MH	131.608	127.895	3.563	Open Manhole	0

Free Flowing Outfall Details for SW NETWORK.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009	EX MH	131.608	127.895	0.000	0	0

Simulation Criteria for SW NETWORK.SWS

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 Online Controls 1 Number of Storage Structures 0

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Simulation Criteria for SW NETWORK.SWS

Number of Time/Area Diagrams 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	0.357		

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Online Controls for SW NETWORK.SWS

Hydro-Brake® Optimum Manhole: S9, DS/PN: 1.008, Volume (m³): 38.4

Unit Reference	MD-SHE-0084-5000-2800-5000
Design Head (m)	2.800
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	84
Invert Level (m)	129.725
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.800	5.0
Flush-Flo™	0.371	3.4
Kick-Flo®	0.756	2.7
Mean Flow over Head Range	-	3.7

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	2.5	1.200	3.4	3.000	5.2	7.000	7.7
0.200	3.2	1.400	3.6	3.500	5.5	7.500	8.0
0.300	3.4	1.600	3.9	4.000	5.9	8.000	8.2
0.400	3.4	1.800	4.1	4.500	6.2	8.500	8.4
0.500	3.3	2.000	4.3	5.000	6.6	9.000	8.7
0.600	3.2	2.200	4.5	5.500	6.9	9.500	8.9
0.800	2.8	2.400	4.7	6.000	7.2		
1.000	3.1	2.600	4.8	6.500	7.4		

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

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 Storage Structures	0
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 0.357
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	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	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)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Winter	1	+0%					136.565
1.001	S2	15 Winter	1	+0%					135.774
1.002	S3	15 Winter	1	+0%					135.014
1.003	S4	15 Winter	1	+0%	100/15 Summer				134.234
1.004	S5	15 Winter	1	+0%	100/15 Summer				133.657
1.005	S6	15 Winter	1	+0%	100/15 Summer				132.760
1.006	S7	180 Winter	1	+0%	100/360 Winter				130.465
1.007	S8	180 Winter	1	+0%	30/120 Winter				130.466
1.008	S9	180 Winter	1	+0%	1/15 Summer				130.465
1.009	S10	600 Summer	1	+0%					128.707

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.235	0.000	0.10		20.4	OK	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.001	S2	-0.218	0.000	0.17		32.3	OK	
1.002	S3	-0.218	0.000	0.17		32.2	OK	
1.003	S4	-0.216	0.000	0.17		32.1	OK	
1.004	S5	-0.200	0.000	0.24		47.0	OK	
1.005	S6	-0.196	0.000	0.26		47.2	OK	
1.006	S7	-1.933	0.000	0.00		15.2	OK	
1.007	S8	-0.642	0.000	0.00		7.8	OK	
1.008	S9	0.590	0.000	0.07		3.4	SURCHARGED	
1.009	S10	-0.124	0.000	0.07		3.4	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

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 Storage Structures	0
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 0.357
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	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	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)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Winter	30	+0%					136.603
1.001	S2	15 Winter	30	+0%					135.833
1.002	S3	15 Summer	30	+0%					135.073
1.003	S4	15 Summer	30	+0%	100/15 Summer				134.295
1.004	S5	15 Summer	30	+0%	100/15 Summer				133.740
1.005	S6	15 Winter	30	+0%	100/15 Summer				132.847
1.006	S7	240 Winter	30	+0%	100/360 Winter				131.243
1.007	S8	240 Winter	30	+0%	30/120 Winter				131.243
1.008	S9	240 Winter	30	+0%	1/15 Summer				131.261
1.009	S10	240 Winter	30	+0%					128.708

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.197	0.000	0.26		50.0	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.001	S2	-0.159	0.000	0.45		86.7	OK	
1.002	S3	-0.159	0.000	0.45		86.8	OK	
1.003	S4	-0.155	0.000	0.47		86.8	OK	
1.004	S5	-0.117	0.000	0.68		133.1	OK	
1.005	S6	-0.109	0.000	0.72		132.3	OK	
1.006	S7	-1.155	0.000	0.00		28.5	OK	
1.007	S8	0.135	0.000	0.01		10.1	SURCHARGED	
1.008	S9	1.386	0.000	0.07		3.7	SURCHARGED	
1.009	S10	-0.123	0.000	0.08		3.7	OK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

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 Storage Structures	0
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	0.357
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	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	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)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Winter	100	+30%					136.637
1.001	S2	15 Winter	100	+30%					135.888
1.002	S3	15 Summer	100	+30%					135.128
1.003	S4	15 Winter	100	+30%	100/15 Summer				134.531
1.004	S5	15 Winter	100	+30%	100/15 Summer				134.195
1.005	S6	15 Winter	100	+30%	100/15 Summer				133.133
1.006	S7	480 Winter	100	+30%	100/360 Winter				132.478
1.007	S8	480 Winter	100	+30%	30/120 Winter				132.478
1.008	S9	480 Winter	100	+30%	1/15 Summer				132.497
1.009	S10	480 Winter	100	+30%					128.713

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.163	0.000	0.43		84.1	OK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SW NETWORK.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.001	S2	-0.104	0.000	0.76		145.8	OK	
1.002	S3	-0.104	0.000	0.75		145.9	OK	
1.003	S4	0.081	0.000	0.76		141.0	SURCHARGED	
1.004	S5	0.338	0.000	1.07		211.6	SURCHARGED	
1.005	S6	0.177	0.000	1.16		211.3	SURCHARGED	
1.006	S7	0.080	0.000	0.00		28.5	SURCHARGED	
1.007	S8	1.370	0.000	0.01		10.4	SURCHARGED	
1.008	S9	2.622	0.000	0.10		4.9	FLOOD RISK	
1.009	S10	-0.118	0.000	0.10		4.9	OK	

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