STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SURFACE WATER NETWORK

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	30	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.355	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	3.000
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.	0.850	Min Slope for Optimisation (1:X)	400

Designed with Level Soffits

Network Design Table for SURFACE WATER NETWORK

« - 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	62.925	0.157	400.8	0.158	5.00	0.0	0.600	o	750	Pipe/Conduit	
1.001	25.930	0.065	398.9	0.039	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.002	21.090	0.053	397.9	0.126	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.003	7.462	0.584	12.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

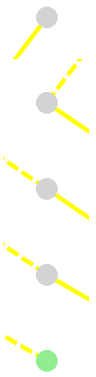
PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	100.00	5.75	54.379	0.158	0.0	0.0	0.0	1.39	614.8	48.5
1.001	100.00	6.06	54.222	0.197	0.0	0.0	0.0	1.39	616.3	60.5
1.002	99.06	6.29	54.007	0.323	0.0	0.0	0.0	1.56	995.3	98.2
1.003	98.77	6.33	53.954	0.323	0.0	0.0	0.0	2.83	50.1«	98.2

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Manhole Schedules for SURFACE WATER NETWORK

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)
SW3	56.568	2.189	Open Manhole	1800	1.000	54.379	750				
SW4	56.673	2.451	Open Manhole	2100	1.001	54.222	750	1.000	54.222	750	
SW5	56.612	2.605	Open Manhole	2400	1.002	54.007	900	1.001	54.157	750	
SW6	56.512	2.558	Open Manhole	2100	1.003	53.954	150	1.002	53.954	900	
SW7	56.561	3.191	Open Manhole	1200		OUTFALL		1.003	53.370	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SW3	385379.400	399749.645	385379.400	399749.645	Required	
SW4	385341.559	399699.369	385341.559	399699.369	Required	
SW5	385363.011	399684.803	385363.011	399684.803	Required	
SW6	385380.388	399672.852	385380.388	399672.852	Required	
SW7	385386.848	399669.118			No Entry	



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PIPELINE SCHEDULES for SURFACE WATER NETWORK

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	750	SW3	56.568	54.379	1.439	Open Manhole	1800
1.001	o	750	SW4	56.673	54.222	1.701	Open Manhole	2100
1.002	o	900	SW5	56.612	54.007	1.705	Open Manhole	2400
1.003	o	150	SW6	56.512	53.954	2.408	Open Manhole	2100

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	62.925	400.8	SW4	56.673	54.222	1.701	Open Manhole	2100
1.001	25.930	398.9	SW5	56.612	54.157	1.705	Open Manhole	2400
1.002	21.090	397.9	SW6	56.512	53.954	1.658	Open Manhole	2100
1.003	7.462	12.8	SW7	56.561	53.370	3.041	Open Manhole	1200

Surcharged Outfall Details for SURFACE WATER NETWORK

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	SW7	56.561	53.370	0.000	1200	0

Datum (m) 53.220 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
10	1.300	30	1.300	50	1.300	70	1.300	90	1.300	110	1.300
20	1.300	40	1.300	60	1.300	80	1.300	100	1.300	120	1.300

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Simulation Criteria for SURFACE WATER NETWORK

Volumetric Runoff Coeff	0.850	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
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)	30	Cv (Summer)	0.850
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.355		

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Online Controls for SURFACE WATER NETWORK

Hydro-Brake® Optimum Manhole: SW6, DS/PN: 1.003, Volume (m³): 20.8

Unit Reference	MD-SHE-0104-7000-2450-7000
Design Head (m)	2.450
Design Flow (l/s)	7.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	104
Invert Level (m)	53.954
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)	2.450	7.0	Kick-Flo®	0.928	4.5
Flush-Flo™	0.455	5.6	Mean Flow over Head Range	-	5.5

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	3.5	1.200	5.0	3.000	7.7	7.000	11.5
0.200	5.0	1.400	5.4	3.500	8.3	7.500	11.9
0.300	5.4	1.600	5.7	4.000	8.8	8.000	12.3
0.400	5.6	1.800	6.1	4.500	9.3	8.500	12.6
0.500	5.6	2.000	6.4	5.000	9.8	9.000	13.0
0.600	5.5	2.200	6.7	5.500	10.3	9.500	13.3
0.800	5.1	2.400	6.9	6.000	10.7		
1.000	4.6	2.600	7.2	6.500	11.1		

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Storage Structures for SURFACE WATER NETWORK

Cellular Storage Manhole: SW6, DS/PN: 1.003

Invert Level (m) 55.320 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)
0.000	78.1	0.0	0.661	0.0	0.0
0.660	78.1	0.0			

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Summary of Critical Results by Maximum Level (Rank 1) for SURFACE WATER NETWORK

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 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	Ratio R	0.357
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240
Return Period(s) (years)	2
Climate Change (%)	0

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	SW3	180 Winter	2	+0%					54.686
1.001	SW4	180 Winter	2	+0%					54.687
1.002	SW5	180 Winter	2	+0%					54.688
1.003	SW6	180 Winter	2	+0%	2/15 Summer				54.688

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW3	-0.443	0.000	0.01			5.8	OK	
1.001	SW4	-0.285	0.000	0.01			3.3	OK	
1.002	SW5	-0.219	0.000	0.01			5.8	OK	
1.003	SW6	0.584	0.000	0.12		111	5.4	SURCHARGED	

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