STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 459550 219500 SP 59550 19500
Data Type	Catchment
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

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)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	66.218	0.123	538.4	0.099	5.00	0.0	0.600		o	600	Pipe/Conduit	
S2.000	31.238	0.089	351.0	0.048	5.00	0.0	0.600		o	600	Pipe/Conduit	
S1.001	37.823	0.071	532.7	0.036	0.00	0.0	0.600		o	600	Pipe/Conduit	
S3.000	20.139	0.066	305.1	0.043	5.00	0.0	0.600		o	600	Pipe/Conduit	
S4.000	21.501	0.050	430.0	0.031	5.00	0.0	0.600		o	600	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	6.06	68.799	0.099	0.0	0.0	0.0	1.04	294.8	17.9
S2.000	50.00	5.40	68.765	0.048	0.0	0.0	0.0	1.29	365.9	8.7
S1.001	50.00	6.66	68.676	0.183	0.0	0.0	0.0	1.05	296.3	33.0
S3.000	50.00	5.24	68.800	0.043	0.0	0.0	0.0	1.39	392.7	7.8
S4.000	50.00	5.31	68.850	0.031	0.0	0.0	0.0	1.17	330.2	5.6

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)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
S4.001	31.078	0.066	470.9	0.062	0.00	0.0	0.600		o	600	Pipe/Conduit	
S3.001	68.465	0.129	530.7	0.017	0.00	0.0	0.600		o	600	Pipe/Conduit	
S5.000	45.620	0.105	434.5	0.061	5.00	0.0	0.600		o	600	Pipe/Conduit	
S1.002	5.808	0.012	484.0	0.036	0.00	0.0	0.600		o	600	Pipe/Conduit	
S6.000	41.898	0.089	470.8	0.047	5.00	0.0	0.600		o	600	Pipe/Conduit	
S7.000	55.030	0.285	193.1	0.055	5.00	0.0		0.045	3 \=/	225	1:3 Swale	
S8.000	35.075	0.185	189.6	0.034	5.00	0.0		0.045	3 \=/	225	1:3 Swale	
S7.001	21.376	0.847	25.2	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
S1.003	14.786	0.148	99.9	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)
S4.001	50.00	5.77	68.800	0.093	0.0	0.0	0.0	1.12	315.4	16.8
S3.001	50.00	6.86	68.734	0.153	0.0	0.0	0.0	1.05	296.9	27.6
S5.000	50.00	5.65	68.710	0.061	0.0	0.0	0.0	1.16	328.5	11.0
S1.002	50.00	6.95	68.605	0.433	0.0	0.0	0.0	1.10	311.1	78.2
S6.000	50.00	5.63	68.682	0.047	0.0	0.0	0.0	1.12	315.5	8.5
S7.000	50.00	7.94	70.100	0.055	0.0	0.0	0.0	0.31	31.6	9.9
S8.000	50.00	6.86	70.000	0.034	0.0	0.0	0.0	0.32	31.9	6.1
S7.001	50.00	8.05	69.740	0.089	0.0	0.0	0.0	3.14	222.1	16.1
S1.003	50.00	8.21	68.593	0.569	0.0	0.0	0.0	1.57	111.2	102.7

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)
S1.003	SHW1	69.500	68.445	67.850	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.900	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 Storage Structures	2
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	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 459550 219500 SP 59550 19500
Data Type	Catchment
Summer Storms	Yes
Winter Storms	No
Cv (Summer)	0.900
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S4, DS/PN: S1.003, Volume (m³): 18.3

Unit Reference	MD-SHE-0254-3530-1000-3530
Design Head (m)	1.000
Design Flow (l/s)	35.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	254
Invert Level (m)	68.593
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	35.3
Flush-Flo™	0.401	35.3
Kick-Flo®	0.759	30.9
Mean Flow over Head Range	-	28.9

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	8.2	1.200	38.5	3.000	59.9	7.000	90.5
0.200	26.0	1.400	41.5	3.500	64.6	7.500	93.5
0.300	34.7	1.600	44.2	4.000	68.9	8.000	96.5
0.400	35.3	1.800	46.8	4.500	72.9	8.500	99.4
0.500	34.9	2.000	49.2	5.000	76.8	9.000	102.3
0.600	34.1	2.200	51.6	5.500	80.4	9.500	105.0
0.800	31.7	2.400	53.8	6.000	83.9		
1.000	35.3	2.600	55.9	6.500	87.2		

Storage Structures for Storm

Swale Manhole: SIC13, DS/PN: S7.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	55.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.500
Invert Level (m)	70.100	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: SIC14, DS/PN: S8.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	35.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.500
Invert Level (m)	70.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

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

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 Storage Structures	2
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 0.400
Region	England and Wales	Cv (Summer)	0.900
M5-60 (mm)		20.000 Cv (Winter)	0.900

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, 240, 360, 480, 960, 1440
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.
S1.000	S1	120 Summer	100	+40%	100/15 Summer			
S2.000	S5	120 Summer	100	+40%	100/15 Summer			
S1.001	S2	120 Winter	100	+40%	100/15 Summer			
S3.000	S6	120 Summer	100	+40%	100/15 Summer			
S4.000	S8	120 Summer	100	+40%	100/15 Summer	100/30 Summer		
S4.001	S9	120 Winter	100	+40%	100/15 Summer	100/120 Summer		
S3.001	S7	120 Winter	100	+40%	100/15 Summer			
S5.000	S10	120 Summer	100	+40%	100/15 Summer			
S1.002	S3	120 Winter	100	+40%	100/15 Summer			
S6.000	S11	120 Summer	100	+40%	100/15 Summer			
S7.000	SIC13	15 Summer	100	+40%				
S8.000	SIC14	60 Summer	100	+40%				
S7.001	SS12	60 Summer	100	+40%	100/15 Summer			
S1.003	S4	120 Winter	100	+40%	100/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	70.338	0.939	0.000	0.10			26.9	SURCHARGED
S2.000	S5	70.345	0.980	0.000	0.04			12.2	SURCHARGED

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.001	S2	70.332	1.056	0.000	0.10			24.7	SURCHARGED
S3.000	S6	70.308	0.908	0.000	0.04			10.9	SURCHARGED
S4.000	S8	70.212	0.762	7.655	0.03			7.5	FLOOD
S4.001	S9	70.332	0.932	3.089	0.08			21.5	FLOOD
S3.001	S7	70.332	0.998	0.000	0.07			17.8	SURCHARGED
S5.000	S10	70.308	0.998	0.000	0.06			15.9	SURCHARGED
S1.002	S3	70.372	1.167	0.000	0.26			55.7	SURCHARGED
S6.000	S11	70.328	1.046	0.000	0.04			11.8	SURCHARGED
S7.000	SIC13	70.249	-0.545	0.000	0.03		6	31.7	OK
S8.000	SIC14	70.201	-0.394	0.000	0.02		18	14.3	OK
S7.001	SS12	70.201	0.161	0.000	0.19			36.8	SURCHARGED
S1.003	S4	70.386	1.493	0.000	0.47			44.1	SURCHARGED

PN	US/MH Name	Level Exceeded
S1.000	S1	
S2.000	S5	
S1.001	S2	
S3.000	S6	
S4.000	S8	6
S4.001	S9	
S3.001	S7	
S5.000	S10	
S1.002	S3	
S6.000	S11	
S7.000	SIC13	
S8.000	SIC14	
S7.001	SS12	
S1.003	S4	