STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for REV A.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.400	Add Flow / Climate Change (%)	10
Ratio R	0.344	Minimum Backdrop Height (m)	0.200
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for REV A.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.048	4-8	0.024

Total Area Contributing (ha) = 0.072

Total Pipe Volume (m^3) = 33.017

Network Design Table for REV A.SWS

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	28.389	0.071	399.8	0.009	5.00	0.0	0.600	o	825	Pipe/Conduit	
2.000	13.772	0.138	99.8	0.010	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	21.421	0.214	100.1	0.006	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	5.32	86.237	0.009	0.0	0.0	0.1	1.48	790.4	1.3
2.000	50.00	5.23	87.896	0.010	0.0	0.0	0.1	1.01	17.8	1.5
2.001	50.00	5.58	87.758	0.016	0.0	0.0	0.2	1.00	17.7	2.4

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Network Design Table for REV A.SWS

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
2.002	50.322	0.503	100.0	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	27.391	1.321	20.7	0.007	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.003	15.517	0.200	77.6	0.017	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	28.737	0.072	399.1	0.013	0.00	0.0	0.600	o	825	Pipe/Conduit	
1.002	11.885	0.119	99.9	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)
2.002	50.00	6.42	87.544	0.026	0.0	0.0	0.4	1.00	17.8	3.9
3.000	50.00	5.21	88.362	0.007	0.0	0.0	0.1	2.22	39.3	1.0
2.003	50.00	6.64	87.041	0.050	0.0	0.0	0.7	1.14	20.2	7.4
1.001	50.00	6.97	86.166	0.072	0.0	0.0	1.0	1.48	791.1	10.7
1.002	50.00	7.17	86.094	0.072	0.0	0.0	1.0	1.01	17.8	10.7

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Manhole Schedules for REV A.SWS

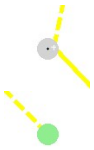
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	88.979	2.742	Open Manhole	1800	1.000	86.237	825				
5	88.646	0.750	Open Manhole	600	2.000	87.896	150				
6	88.762	1.004	Open Manhole	600	2.001	87.758	150	2.000	87.758	150	
7	89.184	1.640	Open Manhole	600	2.002	87.544	150	2.001	87.544	150	
9	89.112	0.750	Open Manhole	600	3.000	88.362	150				
8	89.149	2.108	Open Manhole	1200	2.003	87.041	150	2.002	87.041	150	
								3.000	87.041	150	
2	88.909	2.743	Open Manhole	1800	1.001	86.166	825	1.000	86.166	825	
								2.003	86.841	150	
3	88.787	2.693	Open Manhole	1800	1.002	86.094	150	1.001	86.094	825	
3	88.910	2.935	Open Manhole	0		OUTFALL		1.002	85.975	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	386767.303	402126.707	386767.303	402126.707	Required	
5	386762.899	402134.519	386762.899	402134.519	Required	
6	386765.848	402147.971	386765.848	402147.971	Required	
7	386786.868	402143.846	386786.868	402143.846	Required	
9	386770.424	402067.893	386770.424	402067.893	Required	
8	386776.209	402094.666	386776.209	402094.666	Required	
2	386761.298	402098.961	386761.298	402098.961	Required	

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Manhole Schedules for REV A.SWS

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
3	386755.296	402070.857	386755.433	402070.897	Required	
3	386763.538	402062.295			No Entry	



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PIPELINE SCHEDULES for REV A.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	825	1	88.979	86.237	1.917	Open Manhole	1800
2.000	o	150	5	88.646	87.896	0.600	Open Manhole	600
2.001	o	150	6	88.762	87.758	0.854	Open Manhole	600
2.002	o	150	7	89.184	87.544	1.490	Open Manhole	600
3.000	o	150	9	89.112	88.362	0.600	Open Manhole	600
2.003	o	150	8	89.149	87.041	1.958	Open Manhole	1200
1.001	o	825	2	88.909	86.166	1.918	Open Manhole	1800
1.002	o	150	3	88.787	86.094	2.543	Open Manhole	1800

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	28.389	399.8	2	88.909	86.166	1.918	Open Manhole	1800
2.000	13.772	99.8	6	88.762	87.758	0.854	Open Manhole	600
2.001	21.421	100.1	7	89.184	87.544	1.490	Open Manhole	600
2.002	50.322	100.0	8	89.149	87.041	1.958	Open Manhole	1200
3.000	27.391	20.7	8	89.149	87.041	1.958	Open Manhole	1200
2.003	15.517	77.6	2	88.909	86.841	1.918	Open Manhole	1800
1.001	28.737	399.1	3	88.787	86.094	1.868	Open Manhole	1800
1.002	11.885	99.9	3	88.910	85.975	2.785	Open Manhole	0

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Network Classifications for REV A.SWS

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
1.000	1	825	1.914	1.918	Unclassified	1800	0	1.917	Unclassified
2.000	5	150	0.600	0.896	Unclassified	600	0	0.600	Unclassified
2.001	6	150	0.854	1.490	Unclassified	600	0	0.854	Unclassified
2.002	7	150	1.490	1.958	Unclassified	600	0	1.490	Unclassified
3.000	9	150	0.600	1.958	Unclassified	600	0	0.600	Unclassified
2.003	8	150	1.918	2.192	Unclassified	1200	0	1.958	Unclassified
1.001	2	825	1.868	1.953	Unclassified	1800	0	1.918	Unclassified
1.002	3	150	2.543	2.785	Unclassified	1800	0	2.543	Unclassified

Free Flowing Outfall Details for REV A.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002	3	88.910	85.975	0.000	0	0

Simulation Criteria for REV A.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	10.000
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 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)	18.400	Storm Duration (mins)	30
Ratio R	0.344		

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Online Controls for REV A.SWS

Hydro-Brake® Optimum Manhole: 3, DS/PN: 1.002, Volume (m³): 21.3

Unit Reference	MD-SHE-0100-5000-1400-5000
Design Head (m)	1.400
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	100
Invert Level (m)	86.094
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)	1.400	5.0	Kick-Flo®	0.855	4.0
Flush-Flo™	0.416	5.0	Mean Flow over Head Range	-	4.4

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)
0.100	3.3	1.200	4.7	3.000	7.1	7.000	10.7
0.200	4.6	1.400	5.0	3.500	7.7	7.500	11.0
0.300	4.9	1.600	5.3	4.000	8.2	8.000	11.4
0.400	5.0	1.800	5.6	4.500	8.6	8.500	11.7
0.500	5.0	2.000	5.9	5.000	9.1	9.000	12.0
0.600	4.9	2.200	6.2	5.500	9.5	9.500	12.3
0.800	4.3	2.400	6.4	6.000	9.9		
1.000	4.3	2.600	6.7	6.500	10.3		

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Summary of Critical Results by Maximum Level (Rank 1) for REV A.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
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 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.345
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	18.300	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	OFF
Inertia 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)
1.000	1	60 Winter	100	+45%					86.825
2.000	5	15 Summer	100	+45%	100/15 Summer				88.153
2.001	6	15 Summer	100	+45%	100/15 Summer				88.127
2.002	7	15 Summer	100	+45%	100/15 Summer				88.047
3.000	9	15 Summer	100	+45%					88.400
2.003	8	15 Summer	100	+45%	30/15 Summer				87.570
1.001	2	60 Winter	100	+45%					86.825
1.002	3	60 Winter	100	+45%	1/15 Summer				86.826

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.237	0.000	0.00		2.4	OK	
2.000	5	0.107	0.000	0.44		7.2	SURCHARGED	

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Summary of Critical Results by Maximum Level (Rank 1) for REV A.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
2.001	6	0.219	0.000	0.66		11.1	SURCHARGED	
2.002	7	0.353	0.000	0.93		16.2	SURCHARGED	
3.000	9	-0.112	0.000	0.14		5.4	OK	
2.003	8	0.379	0.000	1.68		31.4	SURCHARGED	
1.001	2	-0.166	0.000	0.03		16.2	OK	
1.002	3	0.582	0.000	0.31		5.0	SURCHARGED	

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