STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 404500 337500 SK 04500 37500
Data Type	Point
Maximum Rainfall (mm/hr)	0
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.000
Maximum Backdrop Height (m)	0.000
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

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.323	4-8	0.224

Total Area Contributing (ha) = 0.547

Total Pipe Volume (m³) = 51.030

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)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	19.454	0.193	100.8	0.050	6.00	0.0	0.600	o	375	Pipe/Conduit	
1.001	23.215	0.341	68.1	0.135	0.00	0.0	0.600	o	375	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	0.00	6.18	110.800	0.050	0.0	0.0	0.0	1.80	199.3	0.0
1.001	0.00	6.36	110.607	0.185	0.0	0.0	0.0	2.20	242.8	0.0

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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)	HYD SECT	DIA (mm)	Section Type	Auto Design
2.000	8.887	0.015	592.5	0.133	6.00	0.0	0.600	o	825	Pipe/Conduit	
1.002	37.639	0.054	697.0	0.093	0.00	0.0	0.600	o	825	Pipe/Conduit	
1.003	35.390	0.051	693.9	0.056	0.00	0.0	0.600	o	825	Pipe/Conduit	
3.000	10.408	0.021	495.6	0.068	6.00	0.0	0.600	o	450	Pipe/Conduit	
1.004	12.345	0.049	251.9	0.012	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)
2.000	0.00	6.12	109.831	0.133	0.0	0.0	0.0	1.21	648.1	0.0
1.002	0.00	6.92	109.816	0.411	0.0	0.0	0.0	1.12	597.0	0.0
1.003	0.00	7.44	109.762	0.467	0.0	0.0	0.0	1.12	598.4	0.0
3.000	0.00	6.19	109.732	0.068	0.0	0.0	0.0	0.91	144.2	0.0
1.004	0.00	7.65	109.711	0.547	0.0	0.0	0.0	0.99	69.7	0.0

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Manhole Schedules for Storm

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)
10	112.825	2.025	Open Manhole	1350	1.000	110.800	375				
11	112.650	2.043	Open Manhole	1350	1.001	110.607	375	1.000	110.607	375	
12	112.250	2.419	Open Manhole	1800	2.000	109.831	825				
13	112.101	2.285	Open Manhole	1800	1.002	109.816	825	1.001	110.266	375	
								2.000	109.816	825	
14	112.300	2.538	Open Manhole	1800	1.003	109.762	825	1.002	109.762	825	
15	111.975	2.243	Open Manhole	1350	3.000	109.732	450				
FCC A	111.975	2.264	Open Manhole	3000	1.004	109.711	300	1.003	109.711	825	
								3.000	109.711	450	
headwall	111.000	1.338	Open Manhole	0		OUTFALL		1.004	109.662	300	

No coordinates have been specified, layout information cannot be produced.

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PIPELINE SCHEDULES for Storm

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	375	10	112.825	110.800	1.650	Open Manhole	1350
1.001	o	375	11	112.650	110.607	1.668	Open Manhole	1350
2.000	o	825	12	112.250	109.831	1.594	Open Manhole	1800
1.002	o	825	13	112.101	109.816	1.460	Open Manhole	1800
1.003	o	825	14	112.300	109.762	1.713	Open Manhole	1800
3.000	o	450	15	111.975	109.732	1.793	Open Manhole	1350
1.004	o	300	FCC A	111.975	109.711	1.964	Open Manhole	3000

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	19.454	100.8	11	112.650	110.607	1.668	Open Manhole	1350
1.001	23.215	68.1	13	112.101	110.266	1.460	Open Manhole	1800
2.000	8.887	592.5	13	112.101	109.816	1.460	Open Manhole	1800
1.002	37.639	697.0	14	112.300	109.762	1.713	Open Manhole	1800
1.003	35.390	693.9	FCC A	111.975	109.711	1.439	Open Manhole	3000
3.000	10.408	495.6	FCC A	111.975	109.711	1.814	Open Manhole	3000
1.004	12.345	251.9	headwall	111.000	109.662	1.038	Open Manhole	0

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)
1.004	headwall	111.000	109.662	0.000	0	0

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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	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	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.373		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: FCC A, DS/PN: 1.004, Volume (m³): 34.9

Unit Reference	MD-SHE-0295-5000-0950-5000
Design Head (m)	0.950
Design Flow (l/s)	50.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	295
Invert Level (m)	109.711
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.950	50.0
Flush-Flo™	0.438	49.9
Kick-Flo®	0.753	44.7
Mean Flow over Head Range	-	39.7

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	9.1	1.200	55.9	3.000	87.2	7.000	131.8
0.200	30.3	1.400	60.3	3.500	94.0	7.500	136.4
0.300	48.5	1.600	64.3	4.000	100.3	8.000	140.8
0.400	49.8	1.800	68.1	4.500	106.3	8.500	145.0
0.500	49.7	2.000	71.6	5.000	111.9	9.000	149.1
0.600	48.7	2.200	75.0	5.500	117.2	9.500	153.1
0.800	46.0	2.400	78.2	6.000	122.3		
1.000	51.2	2.600	81.4	6.500	127.2		

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Storage Structures for Storm

Porous Car Park Manhole: 13, DS/PN: 1.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	120.0
Max Percolation (l/s)	200.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	0
Porosity	0.30	Evaporation (mm/day)	0
Invert Level (m)	109.816	Cap Volume Depth (m)	0.350

Tank or Pond Manhole: 15, DS/PN: 3.000

Invert Level (m) 109.850

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	100.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	100.0	0.801	0.0	1.600	0.0	2.300	0.0
0.300	100.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	100.0	1.100	0.0	1.800	0.0	2.500	0.0
0.401	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

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1 year Return Period 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 0.373
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 ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 40

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	10	15 Winter	1	+0%					110.846
1.001	11	15 Winter	1	+0%					110.686
2.000	12	15 Winter	1	+0%					109.947
1.002	13	60 Winter	1	+0%					109.929
1.003	14	60 Winter	1	+0%					109.886
3.000	15	60 Winter	1	+0%	100/30 Winter				109.851
1.004	FCC A	60 Winter	1	+0%	100/15 Summer				109.850

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	10	-0.329	0.000	0.04		6.0	OK	
1.001	11	-0.296	0.000	0.10		20.6	OK	
2.000	12	-0.709	0.000	0.05		15.9	OK	
1.002	13	-0.712	0.000	0.03		12.7	OK	
1.003	14	-0.701	0.000	0.03		14.4	OK	
3.000	15	-0.331	0.000	0.06		4.6	OK	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	FCC A	-0.161	0.000	0.29		16.5	OK	

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2 year Return Period 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 0.373
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 ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 40

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	10	15 Winter	2	+0%					110.852
1.001	11	15 Winter	2	+0%					110.697
2.000	12	15 Winter	2	+0%					109.965
1.002	13	60 Winter	2	+0%					109.952
1.003	14	60 Winter	2	+0%					109.909
3.000	15	60 Winter	2	+0%	100/30 Winter				109.871
1.004	FCC A	60 Winter	2	+0%	100/15 Summer				109.871

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	10	-0.323	0.000	0.05		7.7	OK	
1.001	11	-0.285	0.000	0.13		26.6	OK	
2.000	12	-0.691	0.000	0.06		20.5	OK	
1.002	13	-0.689	0.000	0.04		17.8	OK	
1.003	14	-0.678	0.000	0.04		20.1	OK	
3.000	15	-0.311	0.000	0.07		5.7	OK	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	FCC A	-0.140	0.000	0.37		21.0	OK	

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30 year Return Period 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 0.373
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 ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 40

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	10	15 Winter	30	+0%					110.875
1.001	11	15 Winter	30	+0%					110.744
2.000	12	30 Winter	30	+0%					110.041
1.002	13	30 Winter	30	+0%					110.037
1.003	14	60 Winter	30	+0%					109.999
3.000	15	60 Winter	30	+0%	100/30 Winter				109.974
1.004	FCC A	60 Winter	30	+0%	100/15 Summer				109.973

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	10	-0.300	0.000	0.09		14.6	OK	
1.001	11	-0.238	0.000	0.29		59.7	OK	
2.000	12	-0.615	0.000	0.10		31.5	OK	
1.002	13	-0.604	0.000	0.10		45.0	OK	
1.003	14	-0.588	0.000	0.10		46.2	OK	
3.000	15	-0.208	0.000	0.11		8.8	OK	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	FCC A	-0.038	0.000	0.75		42.4	OK	

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100 year Return Period 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 0.373
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 ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 40

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	10	15 Winter	100	+40%					110.899
1.001	11	15 Winter	100	+40%					110.800
2.000	12	60 Winter	100	+40%					110.284
1.002	13	60 Winter	100	+40%					110.282
1.003	14	60 Winter	100	+40%					110.255
3.000	15	60 Winter	100	+40%	100/30 Winter				110.230
1.004	FCC A	60 Winter	100	+40%	100/15 Summer				110.228

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	10	-0.276	0.000	0.16		26.5	OK	
1.001	11	-0.182	0.000	0.52		108.2	OK	
2.000	12	-0.372	0.000	0.12		39.7	OK	
1.002	13	-0.359	0.000	0.18		85.5	OK	
1.003	14	-0.332	0.000	0.18		83.4	OK	
3.000	15	0.048	0.000	0.26		20.4	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	FCC A	0.217	0.000	0.88		49.7	SURCHARGED	

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