STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 525554 280998 TL 25554 80998
Data Type	Point
Maximum Rainfall (mm/hr)	50
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)	0.200
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

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.170	4-8	0.088

Total Area Contributing (ha) = 0.258

Total Pipe Volume (m³) = 1.747

Network Design Table for Surface Network 1

« - 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	38.789	1.077	36.0	0.192	5.00	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	5.38	24.324	0.192	0.0	0.0	0.0	1.68	29.7	26.0

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Network Design Table for Surface Network 1

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	14.710	0.059	249.3	0.050	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	33.431	0.936	35.7	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	6.539	0.280	23.4	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	5.410	0.338	16.0	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)
2.000	50.00	5.39	23.303	0.050	0.0	0.0	0.0	0.63	11.2	6.8
1.001	50.00	5.72	23.244	0.243	0.0	0.0	0.0	1.69	29.9«	32.9
1.002	50.00	5.77	22.308	0.258	0.0	0.0	0.0	2.09	37.0	34.9
1.003	50.00	5.81	22.028	0.258	0.0	0.0	0.0	2.53	44.7	34.9

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Manhole Schedules for Surface Network 1

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	26.567	2.243	Open Manhole	1350	1.000	24.324	150				
S6	25.201	1.898	Open Manhole	1050	2.000	23.303	150				
S2	25.244	2.000	Open Manhole	1350	1.001	23.244	150	1.000	23.247	150	3
								2.000	23.244	150	
S3	23.675	1.367	Open Manhole	1350	1.002	22.308	150	1.001	22.308	150	
S4	23.450	1.422	Open Manhole	1050	1.003	22.028	150	1.002	22.028	150	
S6	23.450	1.760	Open Manhole	1350		OUTFALL		1.003	21.690	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	525587.459	280996.715	525587.459	280996.715	Required	
S2	525557.190	281020.970	525557.190	281020.970	Required	
S3	525575.671	281048.829	525575.671	281048.829	Required	
S4	525571.075	281053.481	525571.075	281053.481	Required	
S6	525576.485	281053.481			No Entry	

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PIPELINE SCHEDULES for Surface Network 1

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	150	S1	26.567	24.324	2.093	Open Manhole	1350
2.000	o	150	S6	25.201	23.303	1.748	Open Manhole	1050
1.001	o	150	S2	25.244	23.244	1.850	Open Manhole	1350
1.002	o	150	S3	23.675	22.308	1.217	Open Manhole	1350
1.003	o	150	S4	23.450	22.028	1.272	Open Manhole	1050

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	38.789	36.0	S2	25.244	23.247	1.847	Open Manhole	1350
2.000	14.710	249.3	S2	25.244	23.244	1.850	Open Manhole	1350
1.001	33.431	35.7	S3	23.675	22.308	1.217	Open Manhole	1350
1.002	6.539	23.4	S4	23.450	22.028	1.272	Open Manhole	1050
1.003	5.410	16.0	S6	23.450	21.690	1.610	Open Manhole	1350

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	S6	23.450	21.690	0.000	1350	0

Simulation Criteria for Surface Network 1

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	3
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)	100

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Synthetic Rainfall Details

FEH Rainfall Version	2013
Site Location	GB 525554 280998 TL 25554 80998
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S2, DS/PN: 1.001, Volume (m³): 3.8

Unit Reference	MD-SHE-0066-2100-1200-2100
Design Head (m)	1.200
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	66
Invert Level (m)	23.244
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.1
Flush-Flo™	0.288	1.9
Kick-Flo®	0.587	1.5
Mean Flow over Head Range	-	1.7

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	1.6	1.200	2.1	3.000	3.2	7.000	4.7
0.200	1.8	1.400	2.2	3.500	3.4	7.500	4.9
0.300	1.9	1.600	2.4	4.000	3.6	8.000	5.0
0.400	1.8	1.800	2.5	4.500	3.9	8.500	5.2
0.500	1.7	2.000	2.6	5.000	4.0	9.000	5.3
0.600	1.5	2.200	2.8	5.500	4.2	9.500	5.5
0.800	1.7	2.400	2.9	6.000	4.4		
1.000	1.9	2.600	3.0	6.500	4.6		

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Storage Structures for Surface Network 1

Porous Car Park Manhole: S1, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	275.0	Slope (1:X)	30.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	25.000	Membrane Depth (mm)	0

Porous Car Park Manhole: S6, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	83.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	24.700	Membrane Depth (mm)	0

Cellular Storage Manhole: S2, DS/PN: 1.001

Invert Level (m)	23.244	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	240.0	240.0	1.300	0.0	317.5
0.100	240.0	246.2	1.400	0.0	317.5
0.200	240.0	252.4	1.500	0.0	317.5
0.300	240.0	258.6	1.600	0.0	317.5
0.400	240.0	264.8	1.700	0.0	317.5
0.500	240.0	271.0	1.800	0.0	317.5
0.600	240.0	277.2	1.900	0.0	317.5
0.700	240.0	283.4	2.000	0.0	317.5
0.800	240.0	289.6	2.100	0.0	317.5
0.900	240.0	295.8	2.200	0.0	317.5
1.000	240.0	302.0	2.300	0.0	317.5
1.100	240.0	308.2	2.400	0.0	317.5
1.200	240.0	314.4	2.500	0.0	317.5

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

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	3
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
FEH Rainfall Version	2013
Site Location	GB 525554 280998 TL 25554 80998
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	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, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 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	S1	15 Summer	2	+0%	2/15 Summer				24.880
2.000	S6	15 Summer	2	+0%	30/15 Summer				23.435
1.001	S2	480 Summer	2	+0%	2/180 Summer				23.426
1.002	S3	30 Summer	2	+0%					22.339
1.003	S4	30 Summer	2	+0%					22.056

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	S1	0.406	0.000	1.17		4	33.6	SURCHARGED	
2.000	S6	-0.018	0.000	1.00		5	10.3	OK	
1.001	S2	0.032	0.000	0.06		312	1.8	SURCHARGED	
1.002	S3	-0.119	0.000	0.09			2.9	OK	
1.003	S4	-0.122	0.000	0.08			2.9	OK	

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

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	3
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
FEH Rainfall Version	2013
Site Location	GB 525554 280998 TL 25554 80998
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	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, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 40

WARNING: Half Drain Time has not been calculated as the structure is too full.

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 Summer	30	+35%	2/15 Summer				25.442
2.000	S6	15 Summer	30	+35%	30/15 Summer				24.118
1.001	S2	480 Winter	30	+35%	2/180 Summer				24.015
1.002	S3	15 Summer	30	+35%					22.377
1.003	S4	15 Summer	30	+35%					22.091

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	S1	0.968	0.000	1.38		10	39.7	SURCHARGED	
2.000	S6	0.665	0.000	3.50		4	36.1	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.001	S2	0.621	0.000	0.06			1.9	SURCHARGED	
1.002	S3	-0.081	0.000	0.43			13.4	OK	
1.003	S4	-0.087	0.000	0.37			13.4	OK	

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

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	3
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
FEH Rainfall Version	2013
Site Location	GB 525554 280998 TL 25554 80998
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	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, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 40

WARNING: Half Drain Time has not been calculated as the structure is too full.

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	30 Summer	100	+40%	2/15 Summer				25.592
2.000	S6	15 Summer	100	+40%	30/15 Summer				24.701
1.001	S2	600 Winter	100	+40%	2/180 Summer				24.424
1.002	S3	15 Summer	100	+40%					22.393
1.003	S4	15 Summer	100	+40%					22.105

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	S1	1.118	0.000	1.40		19	40.3	SURCHARGED	
2.000	S6	1.248	0.000	4.69		3	48.3	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.001	S2	1.030	0.000	0.07			2.1	SURCHARGED	
1.002	S3	-0.065	0.000	0.60			18.7	OK	
1.003	S4	-0.073	0.000	0.51			18.7	OK	

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