


Barnsley Marshall		Page 1
1 Birch Court Blackpole East Worcester, WR3 8SG		
Date 20/07/2023 08:24 File 472m3 Pond @ 2.0 lps - ...	Designed by AlexMavhunga Checked by	
Innovyze		Network 2020.1.3

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes Alex003

FSR Rainfall Model - England and Wales			
Return Period (years)	3	PIMP (%)	100
M5-60 (mm)	18.500	Add Flow / Climate Change (%)	40
Ratio R	0.334	Minimum Backdrop Height (m)	4.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	4.000
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.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm





Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.264	8-12	0.340	12-16	0.001

Total Area Contributing (ha) = 0.604

Total Pipe Volume (m³) = 34.511

Network Design Table for Storm











« - 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
S1.000	51.808	0.310	167.1	0.082	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.001	53.261	0.318	167.5	0.065	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	18.299	0.109	167.9	0.054	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	51.694	0.309	167.3	0.107	5.00	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)
S1.000	50.00	5.71	104.616	0.082	0.0	0.0	4.4	1.21	85.8	15.5
S1.001	50.00	6.44	104.306	0.147	0.0	0.0	8.0	1.21	85.7	27.9
S1.002	50.00	6.70	103.988	0.201	0.0	0.0	10.9	1.21	85.6	38.0
S2.000	50.00	5.71	104.616	0.107	0.0	0.0	5.8	1.21	85.7	20.2

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
S2.001	53.305	0.429	124.3	0.097	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	18.300	0.057	321.0	0.043	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.000	51.810	0.310	167.1	0.068	5.00	0.0	0.600	o	300	Pipe/Conduit	
S3.001	53.421	0.485	110.1	0.061	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	20.574	0.064	321.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	16.057	0.054	296.1	0.029	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	26.778	0.090	297.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.007	113.978	0.996	114.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.008	18.090	0.200	90.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.009	116.390	2.341	49.7	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)
S2.001	50.00	6.34	104.307	0.204	0.0	0.0	11.0	1.41	99.6	38.6
S1.003	50.00	7.00	103.803	0.447	0.0	0.0	24.2	1.01	111.1	84.7
S3.000	50.00	5.71	104.616	0.068	0.0	0.0	3.7	1.21	85.8	12.8
S3.001	50.00	6.31	104.306	0.128	0.0	0.0	7.0	1.50	105.9	24.4
S1.004	50.00	7.34	103.746	0.575	0.0	0.0	31.2	1.01	111.1	109.1
S1.005	50.00	7.60	103.682	0.604	0.0	0.0	32.7	1.05	115.7	114.5
S1.006	50.00	8.37	103.628	0.604	0.0	0.0	32.7	0.58	10.2<	114.5
S1.007	48.19	10.39	103.537	0.604	0.0	0.0	32.7	0.94	16.6<	114.5
S1.008	47.54	10.68	102.541	0.604	0.0	0.0	32.7	1.06	18.7<	114.5
S1.009	44.69	12.03	102.341	0.604	0.0	0.0	32.7	1.43	25.3<	114.5

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backd (mm)
S01	106.000	1.384	Open Manhole	1200	S1.000	104.616	300				
S02	106.000	1.694	Open Manhole	1200	S1.001	104.306	300	S1.000	104.306	300	
S03	106.000	2.012	Open Manhole	1200	S1.002	103.988	300	S1.001	103.988	300	
S04	106.000	1.384	Open Manhole	1200	S2.000	104.616	300				
S05	106.000	1.693	Open Manhole	1200	S2.001	104.307	300	S2.000	104.307	300	
S06	106.000	2.197	Open Manhole	1500	S1.003	103.803	375	S1.002	103.879	300	
								S2.001	103.878	300	
S07	106.000	1.384	Open Manhole	1200	S3.000	104.616	300				
S08	106.000	1.694	Open Manhole	1200	S3.001	104.306	300	S3.000	104.306	300	
S09	106.000	2.254	Open Manhole	1500	S1.004	103.746	375	S1.003	103.746	375	
								S3.001	103.821	300	
S10	105.800	2.118	Open Manhole	1500	S1.005	103.682	375	S1.004	103.682	375	
S11	105.700	2.072	Open Manhole	1500	S1.006	103.628	150	S1.005	103.628	375	
S12	105.200	1.663	Open Manhole	1200	S1.007	103.537	150	S1.006	103.538	150	
S13	104.000	1.459	Junction		S1.008	102.541	150	S1.007	102.541	150	
S14	103.800	1.459	Junction		S1.009	102.341	150	S1.008	102.341	150	
SexDitch	101.000	1.000	Open Manhole	0		OUTFALL		S1.009	100.000	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
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S01	360036.501	440289.729	360036.501	440289.729	Required	
S02	360072.874	440326.622	360072.874	440326.622	Required	
S03	360110.315	440364.501	360110.315	440364.501	Required	
S04	360049.533	440276.959	360049.533	440276.959	Required	
S05	360085.878	440313.719	360085.878	440313.719	Required	
S06	360123.337	440351.644	360123.337	440351.644	Required	

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MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S07	360062.487	440264.025	360062.487	440264.025	Required	
S08	360098.876	440300.905	360098.876	440300.905	Required	
S09	360136.449	440338.879	360136.449	440338.879	Required	
S10	360151.001	440324.335	360151.001	440324.335	Required	
S11	360166.812	440327.133	360166.812	440327.133	Required	
S12	360190.915	440338.800	360190.915	440338.800	Required	
S13	360266.740	440423.897			No Entry	
S14	360269.279	440441.808			No Entry	
SexDitch	360286.336	440556.942			No Entry	


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)
S1.000	o	300	S01	106.000	104.616	1.084	Open Manhole	1200
S1.001	o	300	S02	106.000	104.306	1.394	Open Manhole	1200
S1.002	o	300	S03	106.000	103.988	1.712	Open Manhole	1200
S2.000	o	300	S04	106.000	104.616	1.084	Open Manhole	1200
S2.001	o	300	S05	106.000	104.307	1.393	Open Manhole	1200
S1.003	o	375	S06	106.000	103.803	1.822	Open Manhole	1500
S3.000	o	300	S07	106.000	104.616	1.084	Open Manhole	1200
S3.001	o	300	S08	106.000	104.306	1.394	Open Manhole	1200
S1.004	o	375	S09	106.000	103.746	1.879	Open Manhole	1500
S1.005	o	375	S10	105.800	103.682	1.743	Open Manhole	1500
S1.006	o	150	S11	105.700	103.628	1.922	Open Manhole	1500
S1.007	o	150	S12	105.200	103.537	1.513	Open Manhole	1200
S1.008	o	150	S13	104.000	102.541	1.309	Junction	
S1.009	o	150	S14	103.800	102.341	1.309	Junction	

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)
S1.000	51.808	167.1	S02	106.000	104.306	1.394	Open Manhole	1200
S1.001	53.261	167.5	S03	106.000	103.988	1.712	Open Manhole	1200
S1.002	18.299	167.9	S06	106.000	103.879	1.821	Open Manhole	1500
S2.000	51.694	167.3	S05	106.000	104.307	1.393	Open Manhole	1200
S2.001	53.305	124.3	S06	106.000	103.878	1.822	Open Manhole	1500
S1.003	18.300	321.0	S09	106.000	103.746	1.879	Open Manhole	1500
S3.000	51.810	167.1	S08	106.000	104.306	1.394	Open Manhole	1200
S3.001	53.421	110.1	S09	106.000	103.821	1.879	Open Manhole	1500
S1.004	20.574	321.0	S10	105.800	103.682	1.743	Open Manhole	1500
S1.005	16.057	296.1	S11	105.700	103.628	1.697	Open Manhole	1500
S1.006	26.778	297.5	S12	105.200	103.538	1.512	Open Manhole	1200
S1.007	113.978	114.4	S13	104.000	102.541	1.309	Junction	
S1.008	18.090	90.5	S14	103.800	102.341	1.309	Junction	
S1.009	116.390	49.7	SexDitch	101.000	100.000	0.850	Open Manhole	0

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.082	0.082	0.082
1.001	User	-	100	0.065	0.065	0.065
1.002	User	-	100	0.054	0.054	0.054
2.000	User	-	100	0.107	0.107	0.107
2.001	User	-	100	0.097	0.097	0.097
1.003	User	-	100	0.043	0.043	0.043
3.000	User	-	100	0.068	0.068	0.068
3.001	User	-	100	0.061	0.061	0.061
1.004	-	-	100	0.000	0.000	0.000
1.005	User	-	50	0.058	0.029	0.029
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.633	0.604	0.604

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)
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S1.009 SexDitch 101.000 100.000 100.000 0 0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	0.000
Hot Start (mins)	0	Inlet Coefficient	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	1
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)	3	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Storm Duration (mins)	30
Ratio R	0.334		

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Online Controls for Storm


Hydro-Brake® Optimum Manhole: S10, DS/PN: S1.005, Volume (m³): 5.8

Unit Reference	MD-SHE-0073-3000-1750-3000
Design Head (m)	1.750
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	103.682
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.750	3.0
Flush-Flo™	0.318	2.4
Kick-Flo®	0.650	1.9
Mean Flow over Head Range	-	2.3

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	1.9	1.200	2.5	3.000	3.8	7.000	5.7
0.200	2.3	1.400	2.7	3.500	4.1	7.500	5.9
0.300	2.4	1.600	2.9	4.000	4.4	8.000	6.1
0.400	2.3	1.800	3.0	4.500	4.6	8.500	6.3
0.500	2.3	2.000	3.2	5.000	4.9	9.000	6.4
0.600	2.1	2.200	3.3	5.500	5.1	9.500	6.6
0.800	2.1	2.400	3.5	6.000	5.3		
1.000	2.3	2.600	3.6	6.500	5.5		

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Storage Structures for Storm

Tank or Pond Manhole: S10, DS/PN: S1.005


Invert Level (m) 103.682

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	140.0	1.700	444.0	2.118	533.3

1 year Return Period 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 / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S01	104.700	-0.216	0.000	0.17		13.5	OK
S1.001	S02	104.414	-0.192	0.000	0.27		22.1	OK
S1.002	S03	104.275	-0.013	0.000	0.06		4.2	OK
S2.000	S04	104.712	-0.204	0.000	0.22		17.6	OK
S2.001	S05	104.427	-0.180	0.000	0.33		30.7	OK
S1.003	S06	104.274	0.096	0.000	0.10		8.8	SURCHARGED
S3.000	S07	104.691	-0.225	0.000	0.14		11.2	OK
S3.001	S08	104.397	-0.209	0.000	0.20		19.6	OK
S1.004	S09	104.273	0.152	0.000	0.12		10.9	SURCHARGED
S1.005	S10	104.272	0.215	0.000	0.03		2.4	SURCHARGED
S1.006	S11	103.678	-0.100	0.000	0.24		2.4	OK
S1.007	S12	103.575	-0.112	0.000	0.14		2.4	OK
S1.008	S13	102.576	-0.115	0.000	0.13		2.4	OK*
S1.009	S14	102.372	-0.119	0.000	0.09		2.4	OK*

PN	US/MH Name	Level Exceeded
S1.000	S01	
S1.001	S02	
S1.002	S03	
S2.000	S04	
S2.001	S05	
S1.003	S06	
S3.000	S07	
S3.001	S08	
S1.004	S09	
S1.005	S10	
S1.006	S11	
S1.007	S12	
S1.008	S13	
S1.009	S14	

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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 0.000
Hot Start Level (mm) 0 Inlet Coefficient 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 1
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 0.337
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.500 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 0.0 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) 1, 30, 100
Climate Change (%) 40, 40, 40


PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S01	960 Winter	30	+40%	100/15 Summer			
S1.001	S02	960 Winter	30	+40%	30/15 Winter			
S1.002	S03	960 Winter	30	+40%	30/15 Summer			
S2.000	S04	960 Winter	30	+40%	100/15 Summer			
S2.001	S05	960 Winter	30	+40%	30/15 Summer			
S1.003	S06	960 Winter	30	+40%	1/180 Winter			
S3.000	S07	960 Winter	30	+40%	100/180 Winter			
S3.001	S08	960 Winter	30	+40%	30/120 Winter			
S1.004	S09	960 Winter	30	+40%	1/120 Winter			
S1.005	S10	960 Winter	30	+40%	1/60 Winter			
S1.006	S11	960 Winter	30	+40%				
S1.007	S12	960 Winter	30	+40%				
S1.008	S13	960 Winter	30	+40%				
S1.009	S14	960 Winter	30	+40%				

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30 year Return Period 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 / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S01	104.914	-0.002	0.000	0.03		2.6	OK
S1.001	S02	104.914	0.308	0.000	0.05		4.4	SURCHARGED
S1.002	S03	104.913	0.625	0.000	0.08		5.6	SURCHARGED
S2.000	S04	104.914	-0.002	0.000	0.04		3.4	OK
S2.001	S05	104.914	0.307	0.000	0.07		6.2	SURCHARGED
S1.003	S06	104.912	0.734	0.000	0.14		12.7	SURCHARGED
S3.000	S07	104.911	-0.005	0.000	0.03		2.2	OK
S3.001	S08	104.911	0.305	0.000	0.04		3.9	SURCHARGED
S1.004	S09	104.911	0.790	0.000	0.17		16.1	SURCHARGED
S1.005	S10	104.909	0.852	0.000	0.03		2.5	SURCHARGED
S1.006	S11	103.680	-0.098	0.000	0.26		2.5	OK
S1.007	S12	103.576	-0.111	0.000	0.16		2.5	OK
S1.008	S13	102.578	-0.113	0.000	0.14		2.5	OK*
S1.009	S14	102.373	-0.118	0.000	0.10		2.5	OK*

PN	US/MH Name	Level Exceeded
S1.000	S01	
S1.001	S02	
S1.002	S03	
S2.000	S04	
S2.001	S05	
S1.003	S06	
S3.000	S07	
S3.001	S08	
S1.004	S09	
S1.005	S10	
S1.006	S11	
S1.007	S12	
S1.008	S13	
S1.009	S14	

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Innovyze		Network 2020.1.3

100 year Return Period 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 / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S01	105.203	0.287	0.000	0.04		3.3	SURCHARGED
S1.001	S02	105.203	0.597	0.000	0.07		5.3	SURCHARGED
S1.002	S03	105.202	0.914	0.000	0.10		7.3	SURCHARGED
S2.000	S04	105.246	0.330	0.000	0.63		51.3	SURCHARGED
S2.001	S05	105.202	0.595	0.000	0.08		7.5	SURCHARGED
S1.003	S06	105.201	1.022	0.000	0.18		16.4	SURCHARGED
S3.000	S07	105.200	0.284	0.000	0.03		2.7	SURCHARGED
S3.001	S08	105.200	0.594	0.000	0.04		4.5	SURCHARGED
S1.004	S09	105.199	1.078	0.000	0.22		20.8	SURCHARGED
S1.005	S10	105.198	1.141	0.000	0.03		2.8	SURCHARGED
S1.006	S11	103.683	-0.095	0.000	0.29		2.8	OK
S1.007	S12	103.578	-0.109	0.000	0.17		2.8	OK
S1.008	S13	102.579	-0.112	0.000	0.15		2.8	OK*
S1.009	S14	102.374	-0.117	0.000	0.11		2.8	OK*

PN	US/MH Name	Level Exceeded
S1.000	S01	
S1.001	S02	
S1.002	S03	
S2.000	S04	
S2.001	S05	
S1.003	S06	
S3.000	S07	
S3.001	S08	
S1.004	S09	
S1.005	S10	
S1.006	S11	
S1.007	S12	
S1.008	S13	
S1.009	S14	