


Woods Hardwick		Page 0
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 17694\_STORM1.SWS

Pipe Sizes SW NETWORK 1 Manhole Sizes SW NETWORK 1

FSR Rainfall Model - England and Wales			
Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.385	Maximum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	0	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	0.75
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits






Time Area Diagram for 17694\_STORM1.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.261	4-8	0.143

Total Area Contributing (ha) = 0.404


Total Pipe Volume (m³) = 10.186

Network Design Table for 17694\_STORM1.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)	Auto Design
1.000	40.731	0.155	263.0	0.100	5.00	0.0	0.600	o	300	
1.001	10.356	0.039	263.0	0.030	0.00	0.0	0.600	o	300	
1.002	75.045	0.285	263.0	0.106	0.00	0.0	0.600	o	300	
1.003	13.157	0.050	263.0	0.157	0.00	0.0	0.600	o	300	
1.004	8.564	0.060	142.7	0.011	0.00	0.0	0.600	o	225	

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	5.70	36.490	0.100	0.0	0.0	0.0	0.96	68.2	0.0
1.001	0.00	5.88	36.335	0.130	0.0	0.0	0.0	0.96	68.2	0.0
1.002	0.00	7.18	36.296	0.236	0.0	0.0	0.0	0.96	68.2	0.0
1.003	0.00	7.41	36.010	0.393	0.0	0.0	0.0	0.96	68.2	0.0
1.004	0.00	5.13	35.960	0.000	4.8	0.0	0.0	1.09	43.4	4.8

Woods Hardwick		Page 1
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

Manhole Schedules for 17694\_STORM1.SWS

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out			Pipes In			Backdrop (mm)
					PN	Invert Level (m)	Diameter (mm)	PN	Invert Level (m)	Diameter (mm)	
SA1	37.690	1.200	Open Manhole	1500	1.000	36.490	300				
SA2	38.018	1.683	Open Manhole	1500	1.001	36.335	300	1.000	36.335	300	
SA3	37.927	1.631	Open Manhole	1500	1.002	36.296	300	1.001	36.296	300	
SA4	37.528	1.518	Open Manhole	1500	1.003	36.010	300	1.002	36.010	300	
SA5	37.230	1.270	Open Manhole	2400	1.004	35.960	225	1.003	35.960	300	
SA6	37.031	1.131	Open Manhole	1500		OUTFALL		1.004	35.900	225	

Free Flowing Outfall Details for 17694\_STORM1.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004	SA6	37.031	35.900	0.000	1500	0


Simulation Criteria for 17694\_STORM1.SWS

Volumetric Runoff Coeff 0.750      Additional Flow - % of Total Flow 0.000  
Areal Reduction Factor 1.000      MADD Factor \* 10m<sup>3</sup>/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 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)      2      Cv (Summer) 0.750  
Region England and Wales      Cv (Winter) 0.840  
M5-60 (mm)      20.000      Storm Duration (mins) 30  
Ratio R      0.385

Woods Hardwick		Page 2
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions	Network 2015.1	

Online Controls for 17694\_STORM1.SWS


Hydro-Brake Optimum® Manhole: SA5, DS/PN: 1.004, Volume (m³): 6.5

Unit Reference	MD-SHE-0100-4800-1200-4800
Design Head (m)	1.200
Design Flow (l/s)	4.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	100
Invert Level (m)	35.960
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.8
Flush-Flo™	0.358	4.8
Kick-Flo®	0.748	3.8
Mean Flow over Head Range	-	4.2

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	4.8	3.000	7.3	7.000	11.0
0.200	4.5	1.400	5.1	3.500	7.9	7.500	11.3
0.300	4.7	1.600	5.5	4.000	8.4	8.000	11.7
0.400	4.8	1.800	5.8	4.500	8.9	8.500	12.0
0.500	4.7	2.000	6.1	5.000	9.3	9.000	12.3
0.600	4.5	2.200	6.3	5.500	9.8	9.500	12.7
0.800	4.0	2.400	6.6	6.000	10.2		
1.000	4.4	2.600	6.9	6.500	10.6		

Woods Hardwick		Page 3
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

Storage Structures for 17694\_STORM1.SWS

Cellular Storage Manhole: SA3, DS/PN: 1.002


Invert Level (m) 36.596 Safety Factor 2.0  
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95  
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )
0.000	137.0	112.0	0.801	0.0	148.8
0.800	137.0	148.8			

Cellular Storage Manhole: SA4, DS/PN: 1.003

Invert Level (m) 36.310 Safety Factor 2.0  
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95  
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )
0.000	225.0	225.0	0.401	0.0	287.4
0.400	225.0	287.4			

Woods Hardwick		Page 4
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)  
for 17694\_STORM1.SWS

Simulation Criteria

Areal Reduction Factor 1.000      Additional Flow - % of Total Flow 0.000  
Hot Start (mins)                      0                      MADD Factor \* 10m<sup>3</sup>/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 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 0.385  
Region England and Wales Cv (Summer) 0.750  
M5-60 (mm)                      20.000 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, 30, 100  
Climate Change (%)                      0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SA1	15 Winter	1	+0%	100/15 Summer			
1.001	SA2	15 Winter	1	+0%	30/15 Summer			
1.002	SA3	15 Winter	1	+0%	30/15 Summer			
1.003	SA4	60 Winter	1	+0%	1/15 Summer			
1.004	SA5	60 Winter	1	+0%	1/15 Summer	100/60 Winter		

PN	US/MH Name	Water			Surcharged		Flooded		Pipe		Level Exceeded
		Level (m)	Depth (m)	Volume (m <sup>3</sup> )	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status			
1.000	SA1	36.585	-0.205	0.000	0.21		13.4			OK	
1.001	SA2	36.459	-0.176	0.000	0.31		16.5			OK	
1.002	SA3	36.434	-0.162	0.000	0.41		26.6			OK	
1.003	SA4	36.405	0.095	0.000	0.13		7.3		SURCHARGED		
1.004	SA5	36.410	0.225	0.000	0.14		4.8		SURCHARGED	4	

Woods Hardwick		Page 5
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)  
for 17694\_STORM1.SWS

Simulation Criteria

Areal Reduction Factor 1.000      Additional Flow - % of Total Flow 0.000  
Hot Start (mins)                    0    MADD Factor \* 10m<sup>3</sup>/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 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 0.385  
Region England and Wales Cv (Summer) 0.750  
M5-60 (mm)    20.000 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, 30, 100  
Climate Change (%)    0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SA1	15 Winter	30	+0%	100/15 Summer			
1.001	SA2	15 Winter	30	+0%	30/15 Summer			
1.002	SA3	120 Winter	30	+0%	30/15 Summer			
1.003	SA4	120 Winter	30	+0%	1/15 Summer			
1.004	SA5	120 Winter	30	+0%	1/15 Summer	100/60 Winter		

PN	US/MH Name	Water			Surcharged		Flooded		Pipe		Level Exceeded
		Level (m)	Depth (m)	Volume (m <sup>3</sup> )	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status			
1.000	SA1	36.737	-0.053	0.000	0.50		31.5			OK	
1.001	SA2	36.684	0.049	0.000	0.76		40.6			SURCHARGED	
1.002	SA3	36.658	0.063	0.000	0.34		22.4			SURCHARGED	
1.003	SA4	36.653	0.343	0.000	0.11		6.0			SURCHARGED	
1.004	SA5	36.663	0.477	0.000	0.14		4.8			SURCHARGED	

Woods Hardwick		Page 6
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:02 File 17694_STORM1.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 17694\_STORM1.SWS

Simulation Criteria

Areal Reduction Factor 1.000      Additional Flow - % of Total Flow 0.000  
Hot Start (mins)                      0                      MADD Factor \* 10m<sup>3</sup>/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 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 0.385  
Region England and Wales Cv (Summer) 0.750  
M5-60 (mm)                      20.000 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, 30, 100  
Climate Change (%)                      0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SA1	240 Winter	100	+40%	100/15 Summer			
1.001	SA2	240 Winter	100	+40%	30/15 Summer			
1.002	SA3	240 Winter	100	+40%	30/15 Summer			
1.003	SA4	240 Winter	100	+40%	1/15 Summer			
1.004	SA5	240 Winter	100	+40%	1/15 Summer	100/60 Winter		

PN	US/MH Name	Water			Flow / Overflow Cap. (l/s)	Pipe		Level Exceeded
		Level (m)	Depth (m)	Volume (m <sup>3</sup> )		Flow (l/s)	Status	
1.000	SA1	37.264	0.474	0.000	0.18	11.7	SURCHARGED	
1.001	SA2	37.261	0.626	0.000	0.27	14.3	SURCHARGED	
1.002	SA3	37.259	0.664	0.000	0.31	20.4	SURCHARGED	
1.003	SA4	37.252	0.941	0.000	0.26	14.8	FLOOD RISK	
1.004	SA5	37.246	1.061	16.423	0.14	4.8	FLOOD	4