


Ardent Consulting Engineers		Page 0
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions		Network 2020.1

STORM SEWER DESIGN by the Modified Rational Method











Design Criteria for 2105140-SWS-NT1_V5.SWS

Pipe Sizes 2105140-NT1-V1 Manhole Sizes 2105140-NT1-V1

FSR Rainfall Model - England and Wales			
Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	20.000
Maximum Rainfall (mm/hr)	90	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500


Designed with Level Inverts

Network Design Table for 2105140-SWS-NT1_V5.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
S1.000	12.366	0.050	247.3	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.001	17.336	0.089	194.8	0.056	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	25.515	0.104	245.3	0.056	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	15.804	0.070	225.8	0.056	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	28.643	0.123	232.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	17.332	0.988	17.5	0.056	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	15.595	0.050	311.9	0.056	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	23.860	0.060	397.7	0.056	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.007	21.495	0.053	405.6	0.046	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.008	7.242	0.021	344.9	0.017	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	90.00	5.21	27.530	0.000	0.0	0.0	0.0	1.00	70.3	0.0
S1.001	90.00	5.46	27.480	0.056	0.0	0.0	0.0	1.12	79.4	13.6
S1.002	90.00	5.89	27.391	0.112	0.0	0.0	0.0	1.00	70.6	27.3
S1.003	90.00	6.14	27.287	0.168	0.0	0.0	0.0	1.04	73.7	40.9
S1.004	90.00	6.61	27.217	0.168	0.0	0.0	0.0	1.03	72.5	40.9
S2.000	90.00	5.09	28.157	0.056	0.0	0.0	0.0	3.14	124.8	13.6
S1.005	90.00	6.86	27.019	0.280	0.0	0.0	0.0	1.02	112.7	68.2
S1.006	90.00	7.30	26.969	0.336	0.0	0.0	0.0	0.90	99.7	81.9
S1.007	90.00	7.66	26.834	0.382	0.0	0.0	0.0	1.00	159.6	93.1
S1.008	90.00	7.77	26.781	0.399	0.0	0.0	0.0	1.09	173.2	97.3

Ardent Consulting Engineers		Page 1
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

Free Flowing Outfall Details for 2105140-SWS-NT1_V5.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
------------------------	-----------------	-----------------	-----------------	------------------------	-------------	-----------


S1.008	S8	28.480	26.760	26.760	300	0
--------	----	--------	--------	--------	-----	---

Simulation Criteria for 2105140-SWS-NT1_V5.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
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	3
Number of Online Controls	2	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)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

Ardent Consulting Engineers		Page 2
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions		Network 2020.1

Online Controls for 2105140-SWS-NT1_V5.SWS

Hydro-Brake® Optimum Manhole: S6, DS/PN: S1.007, Volume (m³): 13.5

Unit Reference	MD-SHE-0067-3000-2461-3000
Design Head (m)	2.461
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	26.834
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200


Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.461	3.0
Flush-Flo™	0.291	1.9
Kick-Flo®	0.597	1.6
Mean Flow over Head Range	-	2.2

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	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.0
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.8	5.500	4.4	9.500	5.6
0.800	1.8	2.400	3.0	6.000	4.5		
1.000	2.0	2.600	3.1	6.500	4.7		

Hydro-Brake® Optimum Manhole: S7, DS/PN: S1.008, Volume (m³): 10.4

Unit Reference	MD-SHE-0074-3000-1619-3000
Design Head (m)	1.619
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	74
Invert Level (m)	26.781
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200


Ardent Consulting Engineers		Page 3
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

Hydro-Brake® Optimum Manhole: S7, DS/PN: S1.008, Volume (m³): 10.4

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.619	3.0
Flush-Flo™	0.324	2.5
Kick-Flo®	0.659	2.0
Mean Flow over Head Range	-	2.4

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	2.0	1.200	2.6	3.000	4.0	7.000	5.9
0.200	2.4	1.400	2.8	3.500	4.3	7.500	6.1
0.300	2.5	1.600	3.0	4.000	4.6	8.000	6.3
0.400	2.4	1.800	3.1	4.500	4.8	8.500	6.5
0.500	2.4	2.000	3.3	5.000	5.1	9.000	6.7
0.600	2.2	2.200	3.4	5.500	5.3	9.500	6.8
0.800	2.2	2.400	3.6	6.000	5.5		
1.000	2.4	2.600	3.7	6.500	5.7		

Ardent Consulting Engineers		Page 4
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

Storage Structures for 2105140-SWS-NT1_V5.SWS

Cellular Storage Manhole: S1A, DS/PN: S1.000

Invert Level (m) 27.550 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 ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	100.0	100.0	1.700	0.0	166.0
1.600	100.0	164.0			

Cellular Storage Manhole: S2, DS/PN: S1.002


Invert Level (m) 27.400 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 ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	10.0	10.0	1.700	0.0	30.9
1.600	10.0	30.2			

Cellular Storage Manhole: S3, DS/PN: S1.003

Invert Level (m) 27.300 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 ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	25.5	25.5	1.700	0.0	58.8
1.600	25.5	57.8			

Ardent Consulting Engineers		Page 5
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 2105140-SWS-NT1_V5.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
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	3
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details


Rainfall Model	FEH D1 (1km)	0.347	F (1km)	2.339
FEH Rainfall Version	1999 D2 (1km)	0.441	Cv (Summer)	0.750
Site Location	D3 (1km)	0.263	Cv (Winter)	0.840
C (1km)	-0.027	E (1km)	0.296	

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)	2, 30, 100
Climate Change (%)	0, 0, 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) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1A	240 Winter	2	+0%	30/30 Winter				27.657
S1.001	S1	240 Winter	2	+0%	30/15 Summer				27.662
S1.002	S2	120 Winter	2	+0%	30/15 Summer				27.682
S1.003	S3	120 Winter	2	+0%	2/30 Winter				27.691
S1.004	S3a	120 Winter	2	+0%	2/15 Winter				27.694
S2.000	S9	15 Winter	2	+0%	100/15 Summer				28.197
S1.005	S4	120 Winter	2	+0%	2/15 Summer				27.699
S1.006	S5	120 Winter	2	+0%	2/15 Summer				27.699
S1.007	S6	120 Winter	2	+0%	2/15 Summer				27.698
S1.008	S7	120 Winter	2	+0%	100/15 Summer				26.998

Ardent Consulting Engineers		Page 6
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions		Network 2020.1

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 2105140-SWS-NT1_V5.SWS

PN	US/MH Name	Surcharged		Flooded		Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)				
S1.000	S1A	-0.173	0.000	0.02		90	1.1	OK	
S1.001	S1	-0.118	0.000	0.02			1.6	OK	
S1.002	S2	-0.009	0.000	0.07			4.3	OK	
S1.003	S3	0.104	0.000	0.07			4.3	SURCHARGED	
S1.004	S3a	0.177	0.000	0.06			3.7	SURCHARGED	
S2.000	S9	-0.185	0.000	0.07			8.1	OK	
S1.005	S4	0.305	0.000	0.05			4.6	SURCHARGED	
S1.006	S5	0.355	0.000	0.05			4.0	SURCHARGED	
S1.007	S6	0.414	0.000	0.01			1.9	SURCHARGED	
S1.008	S7	-0.233	0.000	0.02			2.3	OK	

Ardent Consulting Engineers		Page 7
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 2105140-SWS-NT1_V5.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
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	3
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details


Rainfall Model	FEH D1 (1km)	0.347	F (1km)	2.339
FEH Rainfall Version	1999 D2 (1km)	0.441	Cv (Summer)	0.750
Site Location	D3 (1km)	0.263	Cv (Winter)	0.840
C (1km)	-0.027	E (1km)	0.296	

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)	2, 30, 100
Climate Change (%)	0, 0, 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) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1A	360 Winter	30	+0%	30/30 Winter				28.078
S1.001	S1	360 Winter	30	+0%	30/15 Summer				28.078
S1.002	S2	360 Winter	30	+0%	30/15 Summer				28.079
S1.003	S3	360 Winter	30	+0%	2/30 Winter				28.078
S1.004	S3a	30 Winter	30	+0%	2/15 Winter				28.097
S2.000	S9	15 Winter	30	+0%	100/15 Summer				28.221
S1.005	S4	30 Winter	30	+0%	2/15 Summer				28.169
S1.006	S5	30 Winter	30	+0%	2/15 Summer				28.183
S1.007	S6	30 Winter	30	+0%	2/15 Summer				28.189
S1.008	S7	120 Winter	30	+0%	100/15 Summer				27.128

Ardent Consulting Engineers		Page 8
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 2105140-SWS-NT1_V5.SWS

PN	US/MH Name	Surcharged		Flooded		Flow / Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap.	Flow / Overflow (l/s)					
S1.000	S1A	0.248	0.000	0.02			339	1.4	SURCHARGED	
S1.001	S1	0.298	0.000	0.02				1.7	SURCHARGED	
S1.002	S2	0.388	0.000	0.03				2.1	SURCHARGED	
S1.003	S3	0.491	0.000	0.03				2.1	SURCHARGED	
S1.004	S3a	0.580	0.000	0.13				8.7	SURCHARGED	
S2.000	S9	-0.161	0.000	0.18				19.9	OK	
S1.005	S4	0.775	0.000	0.12				10.8	SURCHARGED	
S1.006	S5	0.839	0.000	0.10				8.7	SURCHARGED	
S1.007	S6	0.905	0.000	0.02				2.1	SURCHARGED	
S1.008	S7	-0.103	0.000	0.02				2.5	OK	

Ardent Consulting Engineers		Page 9
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions	Network 2020.1	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2105140-SWS-NT1_V5.SWS

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 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 3
Number of Online Controls 2 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details


Rainfall Model FEH D1 (1km) 0.347 F (1km) 2.339
FEH Rainfall Version 1999 D2 (1km) 0.441 Cv (Summer) 0.750
Site Location D3 (1km) 0.263 Cv (Winter) 0.840
C (1km) -0.027 E (1km) 0.296

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) 2, 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.	Water Level (m)
S1.000	S1A	960 Winter	100	+40%	30/30 Winter				28.953
S1.001	S1	960 Winter	100	+40%	30/15 Summer				28.954
S1.002	S2	960 Winter	100	+40%	30/15 Summer				28.953
S1.003	S3	960 Winter	100	+40%	2/30 Winter				28.953
S1.004	S3a	960 Winter	100	+40%	2/15 Winter				28.952
S2.000	S9	15 Winter	100	+40%	100/15 Summer				29.261
S1.005	S4	15 Winter	100	+40%	2/15 Summer				29.178
S1.006	S5	15 Winter	100	+40%	2/15 Summer				29.227
S1.007	S6	15 Winter	100	+40%	2/15 Summer				29.252
S1.008	S7	120 Winter	100	+40%	100/15 Summer				27.806

PN	US/MH Name	Depth (m)	Volume (m ³)	Flow / Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1A	1.123	0.000	0.03		817	1.6 SURCHARGED	
S1.001	S1	1.174	0.000	0.02			1.6 SURCHARGED	

Ardent Consulting Engineers		Page 10
Suite 207 One Alie Street London E1 8DE	Falfield South Gloucestershire	
Date 25/08/2023 File 2105140-SWS-NT1_V6.MDX	Designed by AMC Checked by	
XP Solutions		Network 2020.1

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2105140-SWS-NT1_V5.SWS

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Cap.	(l/s)	Time (mins)	Flow (l/s)		
S1.002	S2	1.262	0.000	0.03		967	1.8	SURCHARGED	
S1.003	S3	1.366	0.000	0.04		1014	2.2	SURCHARGED	
S1.004	S3a	1.435	0.000	0.03			2.2	SURCHARGED	
S2.000	S9	0.879	0.000	0.29			32.8	FLOOD RISK	
S1.005	S4	1.784	0.000	0.19			17.3	SURCHARGED	
S1.006	S5	1.883	0.000	0.19			16.6	SURCHARGED	
S1.007	S6	1.968	0.000	0.02			2.7	FLOOD RISK	
S1.008	S7	0.575	0.000	0.02			2.5	SURCHARGED	