STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Warrenby 3A

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
3A-1.000	126.573	0.400	316.4	0.170	1.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-1.001	126.573	0.253	500.0	0.355	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-2.000	130.844	1.271	102.9	0.237	1.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-1.002	59.601	13.530	4.4	0.343	0.00	0.0	0.600		o	300	Pipe/Conduit	
3A-1.003	52.664	2.483	21.2	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
3A-3.000	66.495	0.389	170.9	0.464	1.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.001	66.495	0.230	289.1	0.513	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.002	37.476	0.761	49.2	0.337	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.003	119.782	0.240	499.1	0.000	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.004	119.782	0.240	499.1	0.523	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.005	34.753	0.070	496.5	0.000	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-4.000	109.345	0.219	499.3	0.575	1.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-4.001	109.345	0.219	500.0	0.855	0.00	0.0		0.018	1.5 _/	500	1:1.5 Ditch	
3A-3.006	50.182	11.285	4.4	0.458	0.00	0.0	0.600		o	300	Pipe/Conduit	
3A-3.007	46.985	3.948	11.9	0.000	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)
3A-1.000	210.85	3.12	18.145	0.170	0.0	0.0	0.0	1.00	284.0	97.1
3A-1.001	137.63	5.78	17.745	0.525	0.0	0.0	0.0	0.79	225.9	195.6
3A-2.000	250.00	2.25	18.960	0.237	0.0	0.0	0.0	1.75	497.8	160.5
3A-1.002	135.50	5.91	17.492	1.105	0.0	0.0	0.0	7.54	533.0	405.6
3A-1.003	131.59	6.17	3.414	1.105	0.0	0.0	0.0	3.43	242.4«	405.6
3A-3.000	250.00	1.82	18.150	0.464	0.0	0.0	0.0	1.36	386.3	314.4
3A-3.001	222.66	2.88	17.761	0.977	0.0	0.0	0.0	1.04	297.1«	589.4
3A-3.002	210.34	3.13	17.531	1.314	0.0	0.0	0.0	2.53	719.8«	748.7
3A-3.003	139.89	5.64	16.770	1.314	0.0	0.0	0.0	0.79	226.1«	748.7
3A-3.004	108.42	8.16	16.530	1.837	0.0	0.0	0.0	0.79	226.1«	748.7
3A-3.005	102.20	8.89	16.290	1.837	0.0	0.0	0.0	0.80	226.7«	748.7
3A-4.000	202.81	3.30	18.740	0.575	0.0	0.0	0.0	0.79	226.1«	315.8
3A-4.001	140.71	5.60	18.521	1.430	0.0	0.0	0.0	0.79	225.9«	544.8
3A-3.006	101.33	9.00	16.220	3.725	0.0	0.0	0.0	7.50	530.5«	1022.1
3A-3.007	100.19	9.15	4.935	3.725	0.0	0.0	0.0	5.28	582.8«	1022.1

Area Summary for Warrenby 3A

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.170	0.170	0.170
1.001	User	-	100	0.355	0.355	0.355
2.000	User	-	100	0.237	0.237	0.237
1.002	User	-	100	0.343	0.343	0.343
1.003	-	-	100	0.000	0.000	0.000
3.000	User	-	100	0.464	0.464	0.464
3.001	User	-	100	0.513	0.513	0.513
3.002	User	-	100	0.337	0.337	0.337
3.003	-	-	100	0.000	0.000	0.000
3.004	User	-	100	0.523	0.523	0.523
3.005	-	-	100	0.000	0.000	0.000
4.000	User	-	100	0.575	0.575	0.575
4.001	User	-	100	0.855	0.855	0.855
3.006	User	-	100	0.458	0.458	0.458
3.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				4.830	4.830	4.830

Free Flowing Outfall Details for Warrenby 3A

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
3A-1.003	3A-	2.756	0.931	0.000	0	0

Free Flowing Outfall Details for Warrenby 3A

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
3A-3.007	3A-	2.137	0.987	0.000	0	0

Simulation Criteria for Warrenby 3A

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

Synthetic Rainfall Details

Rainfall Model	FEH	E (1km)	0.282
Return Period (years)	30	F (1km)	2.353
FEH Rainfall Version	1999	Summer Storms	Yes
Site Location	GB 457250 524500 NZ 57250 24500	Winter Storms	Yes
C (1km)	-0.021	Cv (Summer)	0.750
D1 (1km)	0.380	Cv (Winter)	0.840
D2 (1km)	0.382	Storm Duration (mins)	30
D3 (1km)	0.245		

Online Controls for Warrenby 3A

Hydro-Brake® Optimum Manhole: 3A-3, DS/PN: 3A-1.003, Volume (m³): 6.1

Unit Reference	MD-SHE-0223-2620-1000-2620
Design Head (m)	1.000
Design Flow (l/s)	26.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	223
Invert Level (m)	3.414
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	26.2	Kick-Flo®	0.739	22.7
Flush-Flo™	0.367	26.2	Mean Flow over Head Range	-	21.8

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)	Depth (m)	Flow (l/s)
0.100	7.5	0.800	23.6	2.000	36.5	4.000	51.0	7.000	67.0
0.200	22.2	1.000	26.2	2.200	38.2	4.500	54.0	7.500	69.3
0.300	26.0	1.200	28.6	2.400	39.9	5.000	56.9	8.000	71.5
0.400	26.2	1.400	30.8	2.600	41.4	5.500	59.6	8.500	73.6
0.500	25.8	1.600	32.8	3.000	44.4	6.000	62.1	9.000	75.7
0.600	25.1	1.800	34.7	3.500	47.8	6.500	64.6	9.500	77.7

Hydro-Brake® Optimum Manhole: 3A-10, DS/PN: 3A-3.007, Volume (m³): 4.6

Unit Reference	MD-SCL-0356-9750-1000-9750
Design Head (m)	1.000
Design Flow (l/s)	97.5
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	356
Invert Level (m)	4.935
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	97.5	Kick-Flo®	0.754	85.0
Flush-Flo™	0.431	97.2	Mean Flow over Head Range	-	72.8

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)	Depth (m)	Flow (l/s)
0.100	11.3	0.800	87.5	2.000	136.4	4.000	191.3	7.000	251.6
0.200	39.5	1.000	97.5	2.200	142.9	4.500	202.7	7.500	260.3
0.300	73.2	1.200	106.4	2.400	149.1	5.000	213.4	8.000	268.7
0.400	97.1	1.400	114.7	2.600	155.0	5.500	223.6	8.500	276.8
0.500	96.6	1.600	122.4	3.000	166.2	6.000	233.3	9.000	284.7
0.600	93.7	1.800	129.6	3.500	179.2	6.500	242.6	9.500	292.3

Storage Structures for Warrenby 3A

Tank or Pond Manhole: 3A-3, DS/PN: 3A-1.003

Invert Level (m) 3.414

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	277.3	1.000	277.3

Tank or Pond Manhole: 3A-10, DS/PN: 3A-3.007

Invert Level (m) 4.935

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	934.9	1.000	934.9

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

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

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.245
FEH Rainfall Version	1999	E (1km)	0.282
Site Location	GB 457250 524500 NZ 57250 24500	F (1km)	2.353
C (1km)	-0.021	Cv (Summer)	0.600
D1 (1km)	0.380	Cv (Winter)	0.600
D2 (1km)	0.382		

Margin for Flood Risk Warning (mm)	0.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
3A-1.000	3A-1	15 Summer	1	+0%					18.224	-0.326
3A-1.001	3A-2	15 Summer	1	+0%					17.860	-0.440
3A-2.000	3A-2	15 Summer	1	+0%					19.029	-0.331
3A-1.002	3A-2	15 Summer	1	+0%					17.570	-0.222
3A-1.003	3A-3	120 Summer	1	+0%	30/15 Summer				3.590	-0.124
3A-3.000	3A-5	15 Summer	1	+0%					18.264	-0.286
3A-3.001	3A-7	15 Summer	1	+0%					17.906	-0.330
3A-3.002	3A-6	15 Summer	1	+0%					17.631	-0.299
3A-3.003	3A-7	15 Summer	1	+0%	100/15 Summer	100/15 Summer			16.960	-0.210
3A-3.004	3A-10	15 Summer	1	+0%					16.730	-0.520
3A-3.005	3A-8	30 Summer	1	+0%					16.483	-1.873
3A-4.000	3A-9	15 Summer	1	+0%	100/15 Summer	100/15 Summer			18.902	-0.238
3A-4.001	3A-13	30 Summer	1	+0%	100/15 Summer	100/15 Summer			18.700	-0.240
3A-3.006	3A-9	30 Summer	1	+0%	30/15 Summer				16.349	-0.171
3A-3.007	3A-10	240 Summer	1	+0%	30/30 Summer				5.156	-0.154

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-1.000	3A-1	0.000	0.03		15.4	OK	
3A-1.001	3A-2	0.000	0.04		32.8	OK	
3A-2.000	3A-2	0.000	0.03		29.4	OK	
3A-1.002	3A-2	0.000	0.15		76.6	OK	
3A-1.003	3A-3	0.000	0.08		18.9	OK	
3A-3.000	3A-5	0.000	0.08		52.3	OK	
3A-3.001	3A-7	0.000	0.09		70.7	OK	
3A-3.002	3A-6	0.000	0.07		92.8	OK	
3A-3.003	3A-7	0.000	0.19		77.5	OK	4
3A-3.004	3A-10	0.000	0.07		96.6	OK	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-3.005	3A-8	0.000	0.01		96.5	OK	
3A-4.000	3A-9	0.000	0.12		47.1	OK	1
3A-4.001	3A-13	0.000	0.18		82.8	OK	2
3A-3.006	3A-9	0.000	0.38		190.9	OK	
3A-3.007	3A-10	0.000	0.09		46.5	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

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

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.245
FEH Rainfall Version	1999	E (1km)	0.282
Site Location	GB 457250 524500 NZ 57250 24500	F (1km)	2.353
C (1km)	-0.021	Cv (Summer)	0.600
D1 (1km)	0.380	Cv (Winter)	0.600
D2 (1km)	0.382		

Margin for Flood Risk Warning (mm)	0.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
3A-1.000	3A-1	15 Summer	30	+0%					18.290	-0.260
3A-1.001	3A-2	15 Summer	30	+0%					17.972	-0.328
3A-2.000	3A-2	15 Summer	30	+0%					19.088	-0.272
3A-1.002	3A-2	15 Summer	30	+0%					17.642	-0.150
3A-1.003	3A-3	120 Summer	30	+0%	30/15 Summer				3.884	0.170
3A-3.000	3A-5	15 Summer	30	+0%					18.360	-0.190
3A-3.001	3A-7	15 Summer	30	+0%					18.032	-0.204
3A-3.002	3A-6	15 Summer	30	+0%					17.729	-0.201
3A-3.003	3A-7	15 Summer	30	+0%	100/15 Summer	100/15 Summer			17.120	-0.050
3A-3.004	3A-10	15 Summer	30	+0%					16.878	-0.372
3A-3.005	3A-8	15 Summer	30	+0%					16.644	-1.712
3A-4.000	3A-9	15 Summer	30	+0%	100/15 Summer	100/15 Summer			19.043	-0.097
3A-4.001	3A-13	15 Summer	30	+0%	100/15 Summer	100/15 Summer			18.846	-0.094
3A-3.006	3A-9	15 Summer	30	+0%	30/15 Summer				16.565	0.045
3A-3.007	3A-10	120 Summer	30	+0%	30/30 Summer				5.423	0.113

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-1.000	3A-1	0.000	0.09		45.9	OK	
3A-1.001	3A-2	0.000	0.13		109.9	OK	
3A-2.000	3A-2	0.000	0.10		89.5	OK	
3A-1.002	3A-2	0.000	0.50		252.7	OK	
3A-1.003	3A-3	0.000	0.11		26.2	SURCHARGED	
3A-3.000	3A-5	0.000	0.23		157.6	OK	
3A-3.001	3A-7	0.000	0.29		222.0	OK	
3A-3.002	3A-6	0.000	0.24		309.8	OK	
3A-3.003	3A-7	0.000	0.61		246.8	OK	4

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-3.004	3A-10	0.000	0.20		286.8	OK	
3A-3.005	3A-8	0.000	0.02		290.0	OK	
3A-4.000	3A-9	0.000	0.35		143.1	OK	1
3A-4.001	3A-13	0.000	0.59		262.7	OK	2
3A-3.006	3A-9	0.000	1.00		500.9	SURCHARGED	
3A-3.007	3A-10	0.000	0.18		97.2	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

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

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.245
FEH Rainfall Version	1999	E (1km)	0.282
Site Location	GB 457250 524500 NZ 57250 24500	F (1km)	2.353
C (1km)	-0.021	Cv (Summer)	0.600
D1 (1km)	0.380	Cv (Winter)	0.600
D2 (1km)	0.382		

Margin for Flood Risk Warning (mm)	0.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
3A-1.000	3A-1	15 Summer	100	+20%					18.341	-0.209
3A-1.001	3A-2	15 Summer	100	+20%					18.049	-0.251
3A-2.000	3A-2	15 Summer	100	+20%					19.133	-0.227
3A-1.002	3A-2	15 Summer	100	+20%					17.708	-0.084
3A-1.003	3A-3	120 Summer	100	+20%	30/15 Summer				4.310	0.596
3A-3.000	3A-5	15 Summer	100	+20%					18.431	-0.119
3A-3.001	3A-7	15 Summer	100	+20%					18.122	-0.114
3A-3.002	3A-6	15 Summer	100	+20%					17.796	-0.134
3A-3.003	3A-7	30 Summer	100	+20%	100/15 Summer	100/15 Summer			17.235	0.065
3A-3.004	3A-10	15 Summer	100	+20%					17.250	0.000
3A-3.005	3A-8	15 Summer	100	+20%					17.135	-1.221
3A-4.000	3A-9	15 Summer	100	+20%	100/15 Summer	100/15 Summer			19.140	0.000
3A-4.001	3A-13	15 Summer	100	+20%	100/15 Summer	100/15 Summer			18.944	0.004
3A-3.006	3A-9	15 Summer	100	+20%	30/15 Summer				17.118	0.598
3A-3.007	3A-10	180 Summer	100	+20%	30/30 Summer				5.849	0.539

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-1.000	3A-1	0.000	0.16		81.3	OK	
3A-1.001	3A-2	0.000	0.24		192.2	OK	
3A-2.000	3A-2	0.000	0.18		160.2	OK	
3A-1.002	3A-2	0.000	0.86		434.6	OK	
3A-1.003	3A-3	0.000	0.11		26.2	SURCHARGED	
3A-3.000	3A-5	0.000	0.40		277.4	OK	
3A-3.001	3A-7	0.000	0.51		394.2	OK	
3A-3.002	3A-6	0.000	0.42		545.6	OK	
3A-3.003	3A-7	65.643	0.89		361.8	FLOOD	4

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Warrenby 3A

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3A-3.004	3A-10	0.000	0.27		389.1	OK	
3A-3.005	3A-8	0.000	0.02		280.2	OK	
3A-4.000	3A-9	0.044	0.62		253.3	FLOOD	1
3A-4.001	3A-13	4.037	1.05		472.2	FLOOD	2
3A-3.006	3A-9	0.000	1.03		512.5	SURCHARGED	
3A-3.007	3A-10	0.000	0.18		97.2	SURCHARGED	