11.0 APPENDIX

Appendix 11.1

Micro Drainage Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.276	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
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.	1.000	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 1

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.492	4-8	0.309

Total Area Contributing (ha) = 0.801

Total Pipe Volume (m³) = 25.312

Area Summary for Catchment 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	60	0.012	0.007	0.007
	User	-	60	0.017	0.010	0.017
	User	-	71	0.052	0.037	0.054
	User	-	70	0.050	0.035	0.089
	User	-	40	0.004	0.001	0.091
	User	-	40	0.002	0.001	0.091
1.001	User	-	60	0.016	0.010	0.010
	User	-	71	0.036	0.026	0.035
	User	-	71	0.039	0.028	0.063
	User	-	70	0.034	0.024	0.087
	User	-	70	0.027	0.019	0.107
	User	-	40	0.011	0.004	0.111
	User	-	40	0.005	0.002	0.113
1.002	User	-	60	0.013	0.008	0.008
	User	-	70	0.019	0.014	0.022
	User	-	40	0.006	0.003	0.024
	User	-	40	0.022	0.009	0.033
	User	-	40	0.012	0.005	0.038
1.003	User	-	71	0.030	0.021	0.021
	User	-	70	0.014	0.010	0.031
1.004	User	-	60	0.013	0.008	0.008
	User	-	60	0.011	0.006	0.014
	User	-	70	0.020	0.014	0.028
	User	-	40	0.002	0.001	0.029
2.000	User	-	60	0.013	0.008	0.008
	User	-	60	0.006	0.004	0.012
	User	-	60	0.016	0.010	0.022
	User	-	60	0.006	0.004	0.025
	User	-	71	0.048	0.034	0.059
	User	-	71	0.053	0.038	0.097
	User	-	70	0.025	0.017	0.114
	User	-	40	0.002	0.001	0.115
	User	-	40	0.001	0.000	0.115
2.001	User	-	60	0.014	0.008	0.008
	User	-	60	0.011	0.007	0.015
	User	-	71	0.032	0.023	0.038
	User	-	70	0.024	0.017	0.055
	User	-	40	0.002	0.001	0.056
	User	-	40	0.028	0.011	0.067
	User	-	40	0.003	0.001	0.068
	User	-	95	0.014	0.013	0.081
2.002	User	-	71	0.025	0.018	0.018
	User	-	70	0.014	0.009	0.027
	User	-	40	0.008	0.003	0.031
	User	-	40	0.029	0.012	0.042
2.003	User	-	71	0.027	0.019	0.019
	User	-	40	0.011	0.004	0.024
	User	-	40	0.033	0.013	0.037
2.004	User	-	71	0.023	0.016	0.016
	User	-	40	0.019	0.008	0.024
2.005	User	-	70	0.038	0.027	0.027
3.000	User	-	60	0.022	0.013	0.013
	User	-	71	0.046	0.032	0.046
	User	-	70	0.069	0.048	0.094

Area Summary for Catchment 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	95	0.002	0.002	0.096
3.001	User	-	70	0.004	0.003	0.003
	User	-	40	0.002	0.001	0.004
4.000	-	-	100	0.000	0.000	0.000
4.001	User	-	40	0.011	0.004	0.004
1.005	User	-	40	0.171	0.068	0.068
1.006	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.322	0.801	0.801

Free Flowing Outfall Details for Catchment 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006		103.550	101.387	101.650	225	0

Simulation Criteria for Catchment 1

Volumetric Runoff Coeff	1.000	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	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for Catchment 1

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m^3): 5.4

Unit Reference	MD-SHE-0142-9400-1000-9400
Design Head (m)	1.000
Design Flow (l/s)	9.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	142
Invert Level (m)	101.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.4	Kick-Flo®	0.672	7.8
Flush-Flo™	0.302	9.4	Mean Flow over Head Range	-	8.1

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	5.1	0.800	8.5	2.000	13.0	4.000	18.1	7.000	23.7
0.200	9.1	1.000	9.4	2.200	13.6	4.500	19.2	7.500	24.5
0.300	9.4	1.200	10.2	2.400	14.2	5.000	20.2	8.000	25.3
0.400	9.3	1.400	11.0	2.600	14.8	5.500	21.1	8.500	26.1
0.500	9.0	1.600	11.7	3.000	15.8	6.000	22.0	9.000	26.8
0.600	8.6	1.800	12.4	3.500	17.0	6.500	22.9	9.500	27.5

Storage Structures for Catchment 1

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 101.650 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	0.0	1.500	500.0	0.0	1.501	0.0	0.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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 (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	15 minute 2 year Summer I+20%	107.690	106.269	-0.146	0.000	0.27		0.084
1.001	2	15 minute 2 year Summer I+20%	107.350	105.941	-0.104	0.000	0.55		0.195
1.002	3	15 minute 2 year Summer I+20%	107.000	105.321	-0.074	0.000	0.78		0.294
1.003	4	15 minute 2 year Summer I+20%	106.430	105.030	-0.115	0.000	0.48		0.177
1.004	5	15 minute 2 year Summer I+20%	105.250	103.629	-0.171	0.000	0.39		0.141
2.000	6	15 minute 2 year Summer I+20%	107.180	105.759	-0.146	0.000	0.27		0.083
2.001	7	15 minute 2 year Summer I+20%	106.220	104.798	-0.222	0.000	0.15		0.105
2.002	8	15 minute 2 year Summer I+20%	104.500	102.991	-0.149	0.000	0.50		0.215
2.003	9	15 minute 2 year Summer I+20%	104.000	102.761	-0.224	0.000	0.34		0.573
2.004	10	15 minute 2 year Summer I+20%	104.500	102.660	-0.205	0.000	0.42		0.454
2.005	11	15 minute 2 year Summer I+20%	104.220	102.460	-0.205	0.000	0.42		0.596
3.000	12	15 minute 2 year Summer I+20%	105.460	104.023	-0.162	0.000	0.17		0.065
3.001	13	15 minute 2 year Summer I+20%	104.350	102.579	-0.126	0.000	0.40		0.117
4.000	14	15 minute 2 year Summer I+20%	103.400	102.400	-0.225	0.000	0.00		0.000
4.001	15	15 minute 2 year Summer I+20%	104.000	102.325	-0.100	0.000	0.03		0.189
1.005	6	15 minute 2 year Summer I+20%	104.500	102.324	0.049	0.000	1.37		1.281
1.006	7	360 minute 2 year Summer I+20%	104.500	101.926	0.151	0.000	0.18		131.519

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.3	16.5	OK
1.001	2	1.6	35.2	OK
1.002	3	1.5	41.6	OK

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.003	4	2.4	46.7	OK
1.004	5	1.8	51.4	OK
2.000	6	1.7	20.8	OK
2.001	7	2.4	34.0	OK
2.002	8	1.2	41.0	OK
2.003	9	1.1	46.8	OK
2.004	10	1.0	50.1	OK
2.005	11	1.1	54.2	OK
3.000	12	1.9	17.3	OK
3.001	13	1.1	17.9	OK
4.000	14	0.0	0.0	OK
4.001	15	0.5	1.4	OK
1.005	6	1.2	132.9	SURCHARGED
1.006	7	1.1	9.4	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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 (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	15 minute 30 year Summer I+20%	107.690	106.422	0.007	0.000	0.52		0.257
1.001	2	15 minute 30 year Summer I+20%	107.350	106.342	0.297	0.000	1.01		1.386
1.002	3	15 minute 30 year Summer I+20%	107.000	105.653	0.258	0.000	1.43		1.398
1.003	4	15 minute 30 year Summer I+20%	106.430	105.087	-0.058	0.000	0.90		0.353
1.004	5	15 minute 30 year Summer I+20%	105.250	103.694	-0.106	0.000	0.74		0.214
2.000	6	30 minute 30 year Summer I+20%	107.180	105.792	-0.113	0.000	0.49		0.121
2.001	7	15 minute 30 year Summer I+20%	106.220	104.835	-0.185	0.000	0.31		0.168
2.002	8	15 minute 30 year Summer I+20%	104.500	103.158	0.018	0.000	1.03		0.584
2.003	9	15 minute 30 year Summer I+20%	104.000	102.848	-0.137	0.000	0.72		1.262
2.004	10	15 minute 30 year Summer I+20%	104.500	102.799	-0.066	0.000	0.86		1.023
2.005	11	15 minute 30 year Summer I+20%	104.220	102.689	0.024	0.000	0.84		3.169
3.000	12	30 minute 30 year Summer I+20%	105.460	104.047	-0.138	0.000	0.32		0.093
3.001	13	15 minute 30 year Summer I+20%	104.350	102.714	0.009	0.000	0.71		0.355
4.000	14	15 minute 30 year Summer I+20%	103.400	102.612	-0.013	0.000	0.04		0.234
4.001	15	15 minute 30 year Summer I+20%	104.000	102.622	0.197	0.000	0.26		1.137
1.005	6	15 minute 30 year Summer I+20%	104.500	102.622	0.347	0.000	2.56		3.801
1.006	7	480 minute 30 year Summer I+20%	104.500	102.228	0.453	0.000	0.18		276.447

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.5	32.0	SURCHARGED
1.001	2	1.8	64.6	SURCHARGED
1.002	3	1.9	76.4	SURCHARGED

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.003	4	2.8	87.0	OK
1.004	5	2.0	97.3	OK
2.000	6	2.0	37.8	OK
2.001	7	2.9	70.3	OK
2.002	8	1.3	85.3	SURCHARGED
2.003	9	1.3	98.8	OK
2.004	10	1.2	104.0	OK
2.005	11	1.2	108.1	SURCHARGED
3.000	12	2.2	31.7	OK
3.001	13	1.2	31.8	SURCHARGED
4.000	14	0.3	1.5	OK
4.001	15	0.5	10.7	SURCHARGED
1.005	6	2.3	249.0	SURCHARGED
1.006	7	1.1	9.4	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	16.000	Cv (Summer)	1.000
Region	Scotland and Ireland	Ratio R	0.276	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 (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	15 minute 100 year Summer I+20%	107.690	106.975	0.560	0.000	0.67		0.882
1.001	2	15 minute 100 year Summer I+20%	107.350	106.863	0.818	0.000	1.20		2.005
1.002	3	15 minute 100 year Summer I+20%	107.000	105.885	0.490	0.000	1.67		2.174
1.003	4	15 minute 100 year Summer I+20%	106.430	105.191	0.046	0.000	1.02		0.726
1.004	5	15 minute 100 year Summer I+20%	105.250	103.713	-0.087	0.000	0.84		0.236
2.000	6	30 minute 100 year Summer I+20%	107.180	105.812	-0.093	0.000	0.63		0.143
2.001	7	15 minute 100 year Summer I+20%	106.220	104.853	-0.167	0.000	0.40		0.207
2.002	8	15 minute 100 year Summer I+20%	104.500	103.475	0.335	0.000	1.28		1.389
2.003	9	15 minute 100 year Summer I+20%	104.000	103.149	0.164	0.000	0.81		3.152
2.004	10	15 minute 100 year Summer I+20%	104.500	103.065	0.200	0.000	0.99		1.675
2.005	11	15 minute 100 year Summer I+20%	104.220	102.914	0.249	0.000	0.99		4.332
3.000	12	30 minute 100 year Summer I+20%	105.460	104.061	-0.124	0.000	0.41		0.109
3.001	13	15 minute 100 year Summer I+20%	104.350	102.961	0.256	0.000	0.92		0.863
4.000	14	15 minute 100 year Summer I+20%	103.400	102.803	0.178	0.000	0.04		0.450
4.001	15	15 minute 100 year Summer I+20%	104.000	102.807	0.382	0.000	0.29		1.349
1.005	6	15 minute 100 year Summer I+20%	104.500	102.809	0.534	0.000	3.07		4.178
1.006	7	360 minute 100 year Winter I+20%	104.500	102.441	0.666	0.000	0.18		378.314

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.5	41.4	SURCHARGED
1.001	2	1.9	76.5	SURCHARGED
1.002	3	2.2	89.2	SURCHARGED

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.003	4	2.8	99.2	SURCHARGED
1.004	5	2.1	111.3	OK
2.000	6	2.1	49.4	OK
2.001	7	3.1	91.1	OK
2.002	8	1.5	105.3	SURCHARGED
2.003	9	1.4	111.2	SURCHARGED
2.004	10	1.2	118.8	SURCHARGED
2.005	11	1.2	126.9	SURCHARGED
3.000	12	2.4	41.3	OK
3.001	13	1.2	41.4	SURCHARGED
4.000	14	0.3	1.9	SURCHARGED
4.001	15	0.5	11.8	SURCHARGED
1.005	6	2.7	298.5	SURCHARGED
1.006	7	1.1	9.4	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.276	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
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.	1.000	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 2

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.606	4-8	0.237

Total Area Contributing (ha) = 0.843

Total Pipe Volume (m³) = 19.764

Area Summary for Catchment 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	60	0.025	0.015	0.015
	User	-	71	0.037	0.026	0.041
	User	-	70	0.049	0.034	0.075
	User	-	60	0.007	0.004	0.079
	User	-	60	0.013	0.008	0.088
	User	-	40	0.001	0.000	0.088
	User	-	40	0.010	0.004	0.092
	User	-	40	0.017	0.007	0.099
	User	-	83	0.005	0.004	0.103
	User	-	83	0.009	0.008	0.111
	User	-	83	0.022	0.018	0.129
	User	-	40	0.022	0.009	0.138
	User	-	70	0.035	0.025	0.162
2.000	User	-	60	0.010	0.006	0.006
	User	-	60	0.002	0.001	0.008
	User	-	70	0.005	0.004	0.011
	User	-	40	0.007	0.003	0.014
	User	-	70	0.009	0.006	0.020
	User	-	40	0.003	0.001	0.022
	User	-	70	0.003	0.002	0.023
	User	-	70	0.005	0.004	0.027
	User	-	40	0.005	0.002	0.029
	User	-	40	0.015	0.006	0.035
	User	-	40	0.016	0.006	0.041
	User	-	70	0.005	0.003	0.045
2.001	User	-	60	0.008	0.005	0.005
	User	-	70	0.037	0.026	0.031
	User	-	95	0.101	0.096	0.127
	User	-	70	0.004	0.003	0.130
1.001	User	-	60	0.037	0.022	0.022
	User	-	71	0.025	0.018	0.040
	User	-	70	0.035	0.025	0.065
	User	-	40	0.049	0.020	0.084
	User	-	70	0.007	0.005	0.089
	User	-	40	0.008	0.003	0.092
	User	-	40	0.009	0.004	0.096
	User	-	70	0.005	0.004	0.100
3.000	User	-	60	0.008	0.005	0.005
	User	-	60	0.010	0.006	0.011
	User	-	95	0.009	0.008	0.019
	User	-	83	0.012	0.010	0.029
	User	-	95	0.001	0.001	0.030
	User	-	40	0.003	0.001	0.032
	User	-	70	0.001	0.001	0.033
	User	-	83	0.010	0.008	0.041
	User	-	71	0.005	0.003	0.044
3.001	User	-	60	0.013	0.008	0.008
	User	-	60	0.025	0.015	0.022
	User	-	71	0.063	0.045	0.067
	User	-	70	0.026	0.018	0.085
	User	-	40	0.003	0.001	0.086
	User	-	40	0.010	0.004	0.090
	User	-	70	0.003	0.002	0.092
	User	-	40	0.002	0.001	0.093

Area Summary for Catchment 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	40	0.002	0.001	0.094
	User	-	40	0.027	0.011	0.105
	User	-	40	0.005	0.002	0.107
	User	-	71	0.021	0.015	0.122
	User	-	40	0.006	0.002	0.124
	User	-	83	0.011	0.009	0.133
	User	-	83	0.011	0.009	0.142
1.002	User	-	60	0.022	0.013	0.013
	User	-	70	0.023	0.016	0.030
	User	-	70	0.008	0.006	0.035
	User	-	70	0.022	0.015	0.051
	User	-	40	0.006	0.002	0.053
	User	-	40	0.005	0.002	0.055
	User	-	83	0.010	0.008	0.063
	User	-	71	0.004	0.003	0.066
1.003	User	-	40	0.016	0.006	0.006
	User	-	40	0.037	0.015	0.021
	User	-	95	0.044	0.041	0.062
	User	-	37	0.001	0.000	0.063
	User	-	71	0.043	0.030	0.093
	User	-	70	0.008	0.006	0.099
	User	-	70	0.001	0.001	0.100
	User	-	40	0.002	0.001	0.101
	User	-	100	0.010	0.010	0.110
	User	-	95	0.001	0.001	0.111
	User	-	71	0.003	0.002	0.113
1.004	User	-	95	0.010	0.010	0.010
	User	-	70	0.005	0.004	0.013
	User	-	40	0.010	0.004	0.017
	User	-	40	0.026	0.010	0.028
	User	-	40	0.002	0.001	0.029
	User	-	40	0.002	0.001	0.029
	User	-	40	0.003	0.001	0.030
	User	-	95	0.011	0.010	0.040
				Total	Total	Total
				1.284	0.843	0.843

Free Flowing Outfall Details for Catchment 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	S	100.750	97.740	97.000	225	0

Simulation Criteria for Catchment 2

Volumetric Runoff Coeff	1.000	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	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for Catchment 2

Hydro-Brake® Optimum Manhole: S5, DS/PN: S1.004, Volume (m³): 8.8

Unit Reference	MD-SHE-0144-9700-1000-9700
Design Head (m)	1.000
Design Flow (l/s)	9.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	144
Invert Level (m)	97.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.7	Kick-Flo®	0.675	8.1
Flush-Flo™	0.305	9.7	Mean Flow over Head Range	-	8.3

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)	Depth (m)	Flow (l/s)
0.100	5.2	0.800	8.7	2.000	13.5	4.000	18.7	7.000	24.5
0.200	9.4	1.000	9.7	2.200	14.1	4.500	19.8	7.500	25.3
0.300	9.7	1.200	10.6	2.400	14.7	5.000	20.8	8.000	26.1
0.400	9.6	1.400	11.4	2.600	15.2	5.500	21.8	8.500	26.9
0.500	9.3	1.600	12.1	3.000	16.3	6.000	22.7	9.000	27.6
0.600	8.9	1.800	12.8	3.500	17.6	6.500	23.6	9.500	28.4

Storage Structures for Catchment 2

Cellular Storage Manhole: S5, DS/PN: S1.004

Invert Level (m) 98.200 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	450.0	0.0	1.500	450.0	0.0	1.501	0.0	0.0

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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 (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	15 minute 2 year Summer I+20%	104.770	103.350	-0.145	0.000	0.28		0.085
S2.000	S2	15 minute 2 year Summer I+20%	104.330	102.406	-0.179	0.000	0.09		0.047
S2.001	S3	15 minute 2 year Summer I+20%	102.870	101.464	-0.206	0.000	0.21		0.510
S1.001	S2	15 minute 2 year Summer I+20%	102.650	101.277	-0.248	0.000	0.25		0.458
S3.000	S5	15 minute 2 year Summer I+20%	102.800	101.512	-0.163	0.000	0.17		0.065
S3.001	S5	15 minute 2 year Summer I+20%	102.730	101.366	-0.129	0.000	0.37		0.166
S1.002	S3	15 minute 2 year Summer I+20%	101.010	99.600	-0.185	0.000	0.50		0.304
S1.003	S4	15 minute 2 year Summer I+20%	100.750	98.650	-0.150	0.000	0.78		0.423
S1.004	S5	360 minute 2 year Summer I+20%	100.750	98.465	0.440	0.000	0.28		115.837

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.3	29.3	OK
S2.000	S2	1.4	8.1	OK
S2.001	S3	1.6	29.9	OK
S1.001	S2	2.3	75.4	OK
S3.000	S5	0.9	8.0	OK
S3.001	S5	2.0	31.6	OK
S1.002	S3	2.1	118.2	OK
S1.003	S4	1.2	136.7	OK
S1.004	S5	1.0	9.6	SURCHARGED

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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 (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	30 minute 30 year Summer I+20%	104.770	103.384	-0.111	0.000	0.50		0.123
S2.000	S2	30 minute 30 year Summer I+20%	104.330	102.423	-0.162	0.000	0.17		0.066
S2.001	S3	15 minute 30 year Summer I+20%	102.870	101.517	-0.153	0.000	0.48		0.641
S1.001	S2	15 minute 30 year Summer I+20%	102.650	101.345	-0.180	0.000	0.52		0.686
S3.000	S5	30 minute 30 year Summer I+20%	102.800	101.536	-0.139	0.000	0.31		0.092
S3.001	S5	15 minute 30 year Summer I+20%	102.730	101.432	-0.063	0.000	0.84		0.395
S1.002	S3	15 minute 30 year Summer I+20%	101.010	99.850	0.065	0.000	1.09		1.458
S1.003	S4	15 minute 30 year Summer I+20%	100.750	99.013	0.213	0.000	1.68		0.942
S1.004	S5	240 minute 30 year Winter I+20%	100.750	98.799	0.774	0.000	0.28		262.079

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.7	53.3	OK
S2.000	S2	1.6	14.7	OK
S2.001	S3	2.0	68.1	OK
S1.001	S2	2.8	159.2	OK
S3.000	S5	1.0	14.6	OK
S3.001	S5	2.4	71.8	OK
S1.002	S3	2.4	256.1	SURCHARGED
S1.003	S4	1.9	296.2	SURCHARGED
S1.004	S5	1.0	9.7	SURCHARGED

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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 (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	30 minute 100 year Summer I+20%	104.770	103.405	-0.090	0.000	0.66		0.147
S2.000	S2	30 minute 100 year Summer I+20%	104.330	102.433	-0.152	0.000	0.23		0.076
S2.001	S3	15 minute 100 year Summer I+20%	102.870	101.543	-0.127	0.000	0.63		0.703
S1.001	S2	15 minute 100 year Summer I+20%	102.650	101.380	-0.145	0.000	0.68		0.810
S3.000	S5	15 minute 100 year Summer I+20%	102.800	101.726	0.051	0.000	0.51		0.307
S3.001	S5	15 minute 100 year Summer I+20%	102.730	101.691	0.196	0.000	0.96		1.145
S1.002	S3	15 minute 100 year Summer I+20%	101.010	100.083	0.298	0.000	1.36		3.038
S1.003	S4	15 minute 100 year Summer I+20%	100.750	99.208	0.408	0.000	2.10		1.272
S1.004	S5	360 minute 100 year Winter I+20%	100.750	99.034	1.009	0.000	0.31		362.623

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.8	69.6	OK
S2.000	S2	1.8	19.2	OK
S2.001	S3	2.1	88.2	OK
S1.001	S2	3.0	206.2	OK
S3.000	S5	1.0	23.7	SURCHARGED
S3.001	S5	2.4	81.6	SURCHARGED
S1.002	S3	2.9	319.0	SURCHARGED
S1.003	S4	2.3	369.5	SURCHARGED
S1.004	S5	1.0	10.7	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.276	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
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.	1.000	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for Catchment 1

Outfall Pipe Number	**Outfall Name**	**C. Level (m)**	**I. Level (m)**	**Min I. Level (m)**	**D,L (mm)**	**W (mm)**
1.006		103.550	101.387	101.650	225	0

Simulation Criteria for Catchment 1

Volumetric Runoff Coeff	1.000	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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for Catchment 1

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m³): 5.4

Unit Reference	MD-SHE-0013-1000-1000-1000
Design Head (m)	1.000
Design Flow (l/s)	0.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	13
Invert Level (m)	101.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	0.1	Kick-Flo®	0.120	0.0
Flush-Flo™	0.052	0.0	Mean Flow over Head Range	-	0.1

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	0.0	0.800	0.1	2.000	0.1	4.000	0.2	7.000	0.2
0.200	0.1	1.000	0.1	2.200	0.1	4.500	0.2	7.500	0.2
0.300	0.1	1.200	0.1	2.400	0.1	5.000	0.2	8.000	0.2
0.400	0.1	1.400	0.1	2.600	0.1	5.500	0.2	8.500	0.2
0.500	0.1	1.600	0.1	3.000	0.2	6.000	0.2	9.000	0.3
0.600	0.1	1.800	0.1	3.500	0.2	6.500	0.2	9.500	0.3

Storage Structures for Catchment 1

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 101.650 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	0.0	1.500	500.0	0.0	1.501	0.0	0.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	16.000	Cv (Summer)	1.000
Region	Scotland and Ireland	Ratio R	0.276	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)	120
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	120 minute 2 year Summer I+20%	107.690	106.248	-0.167	0.000	0.15		0.060
1.001	2	120 minute 2 year Summer I+20%	107.350	105.908	-0.137	0.000	0.32		0.127
1.002	3	120 minute 2 year Summer I+20%	107.000	105.277	-0.118	0.000	0.45		0.173
1.003	4	120 minute 2 year Summer I+20%	106.430	105.002	-0.143	0.000	0.28		0.123
1.004	5	120 minute 2 year Summer I+20%	105.250	103.598	-0.202	0.000	0.23		0.105
2.000	6	120 minute 2 year Summer I+20%	107.180	105.738	-0.167	0.000	0.15		0.060
2.001	7	120 minute 2 year Summer I+20%	106.220	104.780	-0.240	0.000	0.09		0.080
2.002	8	120 minute 2 year Summer I+20%	104.500	102.951	-0.189	0.000	0.29		0.141
2.003	9	120 minute 2 year Summer I+20%	104.000	102.725	-0.260	0.000	0.20		0.333
2.004	10	120 minute 2 year Summer I+20%	104.500	102.618	-0.247	0.000	0.24		0.297
2.005	11	120 minute 2 year Summer I+20%	104.220	102.419	-0.246	0.000	0.25		0.333
3.000	12	120 minute 2 year Summer I+20%	105.460	104.007	-0.178	0.000	0.10		0.048
3.001	13	120 minute 2 year Summer I+20%	104.350	102.552	-0.153	0.000	0.22		0.084
4.000	14	120 minute 2 year Summer I+20%	103.400	102.400	-0.225	0.000	0.00		0.000
4.001	15	120 minute 2 year Summer I+20%	104.000	102.212	-0.213	0.000	0.01		0.009
1.005	6	120 minute 2 year Summer I+20%	104.500	102.164	-0.111	0.000	0.81		0.431
1.006	7	120 minute 2 year Winter I+20%	104.500	101.998	0.223	0.000	0.00		166.048

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.1	9.3	OK
1.001	2	1.4	20.5	OK
1.002	3	1.3	24.3	OK
1.003	4	2.1	27.2	OK

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.004	5	1.5	29.9	OK
2.000	6	1.5	11.7	OK
2.001	7	2.0	19.9	OK
2.002	8	1.0	23.8	OK
2.003	9	1.0	27.4	OK
2.004	10	0.9	29.4	OK
2.005	11	1.0	31.9	OK
3.000	12	1.6	9.7	OK
3.001	13	0.9	10.0	OK
4.000	14	0.0	0.0	OK
4.001	15	0.4	0.4	OK
1.005	6	1.0	78.5	OK
1.006	7	0.1	0.1	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	16.000	Cv (Summer)	1.000
Region	Scotland and Ireland	Ratio R	0.276	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)	120
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	120 minute 30 year Summer I+20%	107.690	106.269	-0.146	0.000	0.27		0.084
1.001	2	120 minute 30 year Summer I+20%	107.350	105.943	-0.102	0.000	0.58		0.202
1.002	3	120 minute 30 year Summer I+20%	107.000	105.326	-0.069	0.000	0.82		0.307
1.003	4	120 minute 30 year Summer I+20%	106.430	105.034	-0.111	0.000	0.51		0.188
1.004	5	120 minute 30 year Summer I+20%	105.250	103.634	-0.166	0.000	0.41		0.146
2.000	6	120 minute 30 year Summer I+20%	107.180	105.759	-0.146	0.000	0.27		0.084
2.001	7	120 minute 30 year Summer I+20%	106.220	104.799	-0.221	0.000	0.16		0.107
2.002	8	120 minute 30 year Summer I+20%	104.500	102.994	-0.146	0.000	0.52		0.221
2.003	9	120 minute 30 year Summer I+20%	104.000	102.767	-0.218	0.000	0.36		0.610
2.004	10	120 minute 30 year Summer I+20%	104.500	102.666	-0.199	0.000	0.44		0.479
2.005	11	120 minute 30 year Summer I+20%	104.220	102.469	-0.196	0.000	0.45		0.650
3.000	12	120 minute 30 year Summer I+20%	105.460	104.023	-0.162	0.000	0.17		0.065
3.001	13	120 minute 30 year Summer I+20%	104.350	102.579	-0.126	0.000	0.40		0.117
4.000	14	120 minute 30 year Summer I+20%	103.400	102.400	-0.225	0.000	0.00		0.000
4.001	15	120 minute 30 year Summer I+20%	104.000	102.347	-0.078	0.000	0.03		0.256
1.005	6	120 minute 30 year Summer I+20%	104.500	102.345	0.070	0.000	1.47		1.460
1.006	7	120 minute 30 year Winter I+20%	104.500	102.266	0.491	0.000	0.00		294.818

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.3	16.5	OK
1.001	2	1.7	36.8	OK
1.002	3	1.5	43.6	OK
1.003	4	2.5	49.1	OK

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.004	5	1.8	54.2	OK
2.000	6	1.7	20.8	OK
2.001	7	2.4	35.5	OK
2.002	8	1.2	42.8	OK
2.003	9	1.1	49.4	OK
2.004	10	1.1	53.4	OK
2.005	11	1.1	58.2	OK
3.000	12	1.9	17.3	OK
3.001	13	1.1	17.9	OK
4.000	14	0.0	0.0	OK
4.001	15	0.4	1.2	OK
1.005	6	1.3	142.7	SURCHARGED
1.006	7	0.1	0.1	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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) 120
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
1.000	1	120 minute 100 year Summer I+20%	107.690	106.282	-0.133	0.000	0.35		0.098
1.001	2	120 minute 100 year Summer I+20%	107.350	105.966	-0.079	0.000	0.74		0.263
1.002	3	120 minute 100 year Summer I+20%	107.000	105.416	0.021	0.000	1.05		0.584
1.003	4	120 minute 100 year Summer I+20%	106.430	105.053	-0.092	0.000	0.65		0.248
1.004	5	120 minute 100 year Summer I+20%	105.250	103.656	-0.144	0.000	0.53		0.171
2.000	6	120 minute 100 year Summer I+20%	107.180	105.771	-0.134	0.000	0.34		0.098
2.001	7	120 minute 100 year Summer I+20%	106.220	104.811	-0.209	0.000	0.20		0.124
2.002	8	120 minute 100 year Summer I+20%	104.500	103.021	-0.119	0.000	0.67		0.270
2.003	9	120 minute 100 year Summer I+20%	104.000	102.791	-0.194	0.000	0.47		0.773
2.004	10	120 minute 100 year Summer I+20%	104.500	102.696	-0.169	0.000	0.57		0.590
2.005	11	120 minute 100 year Summer I+20%	104.220	102.498	-0.167	0.000	0.58		0.860
3.000	12	120 minute 100 year Summer I+20%	105.460	104.032	-0.153	0.000	0.22		0.076
3.001	13	120 minute 100 year Summer I+20%	104.350	102.595	-0.110	0.000	0.51		0.142
4.000	14	120 minute 100 year Winter I+20%	103.400	102.442	-0.183	0.000	0.00		0.042
4.001	15	120 minute 100 year Summer I+20%	104.000	102.442	0.017	0.000	0.05		0.596
1.005	6	120 minute 100 year Summer I+20%	104.500	102.442	0.167	0.000	1.88		2.334
1.006	7	120 minute 100 year Winter I+20%	104.500	102.441	0.666	0.000	0.00		378.309

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.000	1	1.4	21.3	OK
1.001	2	1.8	47.5	OK
1.002	3	1.5	56.0	SURCHARGED
1.003	4	2.6	63.1	OK

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
1.004	5	1.9	69.8	OK
2.000	6	1.8	26.9	OK
2.001	7	2.5	45.7	OK
2.002	8	1.3	55.3	OK
2.003	9	1.2	63.8	OK
2.004	10	1.1	69.0	OK
2.005	11	1.2	75.1	OK
3.000	12	2.0	22.4	OK
3.001	13	1.1	23.0	OK
4.000	14	0.0	0.0	OK
4.001	15	0.4	2.2	SURCHARGED
1.005	6	1.7	183.1	SURCHARGED
1.006	7	0.1	0.1	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.276	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
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.	1.000	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for Catchment 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	S	100.750	97.740	97.000	225	0

Simulation Criteria for Catchment 2

Volumetric Runoff Coeff	1.000	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	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for Catchment 2

Hydro-Brake® Optimum Manhole: S5, DS/PN: S1.004, Volume (m^3): 8.8

Unit Reference	MD-SHE-0013-1000-1000-1000
Design Head (m)	1.000
Design Flow (l/s)	0.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	13
Invert Level (m)	97.800
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	0.1	Kick-Flo®	0.120	0.0
Flush-Flo™	0.052	0.0	Mean Flow over Head Range	-	0.1

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	0.0	0.800	0.1	2.000	0.1	4.000	0.2	7.000	0.2
0.200	0.1	1.000	0.1	2.200	0.1	4.500	0.2	7.500	0.2
0.300	0.1	1.200	0.1	2.400	0.1	5.000	0.2	8.000	0.2
0.400	0.1	1.400	0.1	2.600	0.1	5.500	0.2	8.500	0.2
0.500	0.1	1.600	0.1	3.000	0.2	6.000	0.2	9.000	0.3
0.600	0.1	1.800	0.1	3.500	0.2	6.500	0.2	9.500	0.3

Storage Structures for Catchment 2

Cellular Storage Manhole: S5, DS/PN: S1.004

Invert Level (m) 98.200 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	450.0	0.0	1.500	450.0	0.0	1.501	0.0	0.0

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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) 120
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	120 minute 2 year Summer I+20%	104.770	103.329	-0.166	0.000	0.16		0.061
S2.000	S2	120 minute 2 year Summer I+20%	104.330	102.393	-0.192	0.000	0.05		0.032
S2.001	S3	120 minute 2 year Summer I+20%	102.870	101.440	-0.230	0.000	0.13		0.453
S1.001	S2	120 minute 2 year Summer I+20%	102.650	101.245	-0.280	0.000	0.14		0.364
S3.000	S5	120 minute 2 year Summer I+20%	102.800	101.497	-0.178	0.000	0.10		0.047
S3.001	S5	120 minute 2 year Summer I+20%	102.730	101.342	-0.153	0.000	0.22		0.122
S1.002	S3	120 minute 2 year Summer I+20%	101.010	99.550	-0.235	0.000	0.30		0.209
S1.003	S4	120 minute 2 year Winter I+20%	100.750	98.595	-0.205	0.000	0.32		0.344
S1.004	S5	120 minute 2 year Winter I+20%	100.750	98.595	0.570	0.000	0.00		173.207

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.0	16.4	OK
S2.000	S2	1.2	4.5	OK
S2.001	S3	1.4	17.7	OK
S1.001	S2	2.0	43.9	OK
S3.000	S5	0.8	4.5	OK
S3.001	S5	1.7	18.8	OK
S1.002	S3	1.9	69.6	OK
S1.003	S4	1.0	57.0	OK
S1.004	S5	0.1	0.1	SURCHARGED

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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) 120
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	120 minute 30 year Summer I+20%	104.770	103.351	-0.144	0.000	0.28		0.086
S2.000	S2	120 minute 30 year Summer I+20%	104.330	102.406	-0.179	0.000	0.09		0.047
S2.001	S3	120 minute 30 year Summer I+20%	102.870	101.466	-0.204	0.000	0.22		0.515
S1.001	S2	120 minute 30 year Summer I+20%	102.650	101.279	-0.246	0.000	0.26		0.465
S3.000	S5	120 minute 30 year Summer I+20%	102.800	101.512	-0.163	0.000	0.17		0.065
S3.001	S5	120 minute 30 year Summer I+20%	102.730	101.368	-0.127	0.000	0.40		0.170
S1.002	S3	120 minute 30 year Summer I+20%	101.010	99.605	-0.180	0.000	0.53		0.314
S1.003	S4	120 minute 30 year Summer I+20%	100.750	98.909	0.109	0.000	0.82		0.794
S1.004	S5	120 minute 30 year Summer I+20%	100.750	98.908	0.883	0.000	0.00		308.843

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.3	29.2	OK
S2.000	S2	1.4	8.1	OK
S2.001	S3	1.6	31.6	OK
S1.001	S2	2.3	78.7	OK
S3.000	S5	0.9	7.9	OK
S3.001	S5	2.0	33.8	OK
S1.002	S3	2.2	124.5	OK
S1.003	S4	1.2	144.2	SURCHARGED
S1.004	S5	0.1	0.1	SURCHARGED

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

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 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.000 Cv (Summer) 1.000
Region Scotland and Ireland Ratio R 0.276 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) 120
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S1.000	S1	120 minute 100 year Summer I+20%	104.770	103.363	-0.132	0.000	0.36		0.100
S2.000	S2	120 minute 100 year Summer I+20%	104.330	102.412	-0.173	0.000	0.12		0.053
S2.001	S3	120 minute 100 year Summer I+20%	102.870	101.480	-0.190	0.000	0.29		0.549
S1.001	S2	120 minute 100 year Summer I+20%	102.650	101.299	-0.226	0.000	0.33		0.532
S3.000	S5	120 minute 100 year Summer I+20%	102.800	101.522	-0.153	0.000	0.22		0.075
S3.001	S5	120 minute 100 year Summer I+20%	102.730	101.384	-0.111	0.000	0.51		0.219
S1.002	S3	120 minute 100 year Summer I+20%	101.010	99.639	-0.146	0.000	0.69		0.421
S1.003	S4	120 minute 100 year Summer I+20%	100.750	99.120	0.320	0.000	1.05		1.106
S1.004	S5	120 minute 100 year Summer I+20%	100.750	99.118	1.093	0.000	0.00		398.727

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	S1	2.4	37.7	OK
S2.000	S2	1.5	10.4	OK
S2.001	S3	1.7	40.8	OK
S1.001	S2	2.5	101.5	OK
S3.000	S5	1.0	10.3	OK
S3.001	S5	2.2	43.6	OK
S1.002	S3	2.3	160.7	OK
S1.003	S4	1.2	185.8	SURCHARGED
S1.004	S5	0.1	0.1	SURCHARGED

Appendix 11.2

Interception/Swale/Tree Pit Calculations

Roger Mullarkey & Associates Duncreevan Kilcock Co.Kildare	Project Glenamuck North A Stage 3				Job Ref. 2411	
	Section Example Swale 1				Sheet no./rev. 1	
	Calc. by RM	Date 18/11/2025	Chk'd by	Date	App'd by	Date

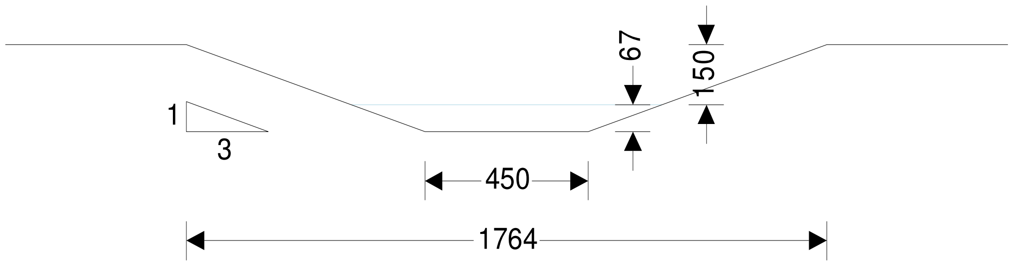
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.450** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.330**
Manning number	n = **0.25**
Length of swale	L = **27** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **50** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **1** hr
Return period	Period = **100** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.272**
5-year return period rainfall of 60 minutes duration	M5_60min = **17.7** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **20** %
Factor Z1 (Wallingford procedure)	Z1 = **1.00**
Rainfall for 1hr storm with 5 year return period	$M5\_1hr_i = Z1 \times M5\_60min \times (1 + p_{climate})$ = **21.2** mm
Factor Z2 (Wallingford procedure)	Z2 = **1.92**
Rainfall for 1hr storm with 100 year return period	$M100\_1hr = Z2 \times M5\_1hr_i$ = **40.8** mm
Design rainfall intensity	$I_{max} = M100\_1hr / D$ = **40.8** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **323** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **3.3** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **67** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.044** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **0.876** m
Hydraulic radius	$R = A / P$ = **0.050** m
Check flow using Manning equation	$Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n$ = **3.3** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.076** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **1.764** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **11.9** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **12.2** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.6** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **11.3** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.3** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

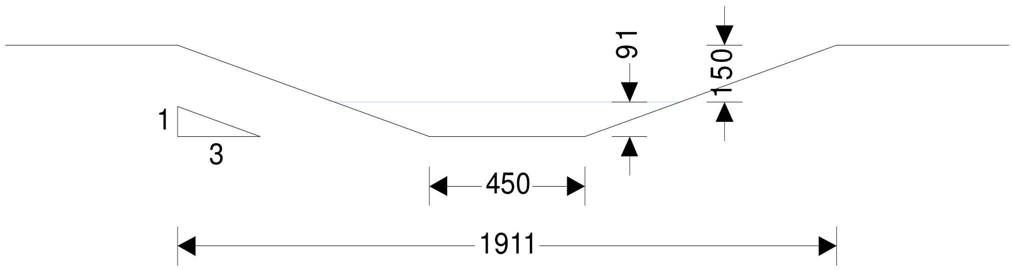
Width of swale base — w = **0.450** m

Longitudinal gradient of swale — S = **0.020**

Side slope gradient of swale — s = **0.330**

Manning number — n = **0.25**

Length of swale — L = **66** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert — d_{outlet} = **50** mm

Design rainfall intensity

Location of catchment area — Other

Storm duration — D = **1** hr

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.272**

5-year return period rainfall of 60 minutes duration — M5_60min = **17.7** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **20** %

Factor Z1 (Wallingford procedure) — Z1 = **1.00**

Rainfall for 1hr storm with 5 year return period — $M5\_1hr_i = Z1 \times M5\_60min \times (1 + p_{climate})$ = **21.2** mm

Factor Z2 (Wallingford procedure) — Z2 = **1.92**

Rainfall for 1hr storm with 100 year return period — $M100\_1hr = Z2 \times M5\_1hr_i$ = **40.8** mm

Design rainfall intensity — $I_{max} = M100\_1hr / D$ = **40.8** mm/hr

Maximum surface water runoff

Catchment area — A_{catch} = **582** m^2

Percentage of area that is impermeable — p = **90** %

Maximum surface water runoff — $Q_{max} = A_{catch} \times p \times I_{max}$ = **5.9** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow — x = **91** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow — $A = (w + x / s) \times x$ = **0.066** m^2

Perimeter of flow — $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.031** m

Hydraulic radius — $R = A / P$ = **0.064** m

Check flow using Manning equation — $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n$ = **6.0** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.090** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **1.911** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **21.4** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **29.7** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **1.5** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **19.9** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.7** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

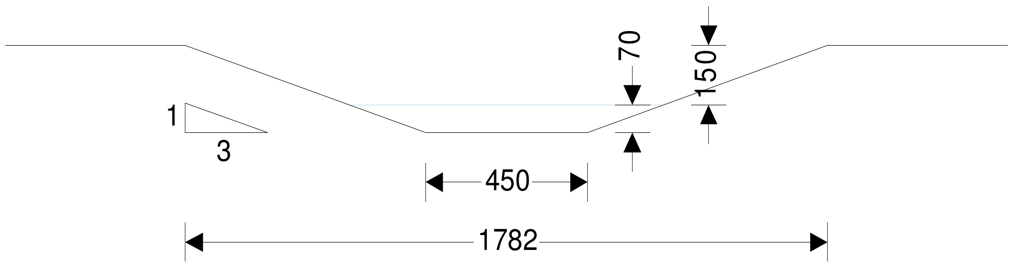
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.450** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.330**
Manning number	n = **0.25**
Length of swale	L = **45** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **50** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **1** hr
Return period	Period = **100** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.272**
5-year return period rainfall of 60 minutes duration	M5_60min = **17.7** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **20** %
Factor Z1 (Wallingford procedure)	Z1 = **1.00**
Rainfall for 1hr storm with 5 year return period	$M5\_1hr_i = Z1 \times M5\_60min \times (1 + p_{climate})$ = **21.2** mm
Factor Z2 (Wallingford procedure)	Z2 = **1.92**
Rainfall for 1hr storm with 100 year return period	$M100\_1hr = Z2 \times M5\_1hr_i$ = **40.8** mm
Design rainfall intensity	$I_{max} = M100\_1hr / D$ = **40.8** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **351** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **3.6** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **70** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.046** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **0.896** m
Hydraulic radius	$R = A / P$ = **0.052** m
Check flow using Manning equation	$Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n$ = **3.6** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A = \mathbf{0.077}$ m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} = \mathbf{150}$ mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w = \mathbf{1.782}$ m

Storage

Infiltration capacity of the base $f = \mathbf{0.000014}$ m/s

Flow into swale $V_{in} = Q_{max} \times D = \mathbf{12.9}$ m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w = \mathbf{20.3}$ m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} = \mathbf{1.0}$ m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} = \mathbf{11.9}$ m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 = \mathbf{0.5}$ m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

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Address
web:

Project	Glenamuck Nth		
Ref	2411		
Sheet	1		
Date	Mar'25		
By	RM	Revised	

Tree Pit Interception Volume No.1

Length	5	m	
Width	3.5	m	
Storage depth	0.1	m	
Interception Volume Available	**1.75**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	260	m^2	
Rainfall depth (i)	5	mm	
Interception Volume Required	**1.04**	m^3	
Volume Required =	1.040		**PASS**
Volume Provided =	1.750		

** GDSDS E2.1.1*

Tree Pit Interception Volume No.2

Length	5	m	
Width	3.5	m	
Storage depth	0.1	m	
Interception Volume Available	**1.75**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	130	m^2	
Rainfall depth (i)	5	mm	
Interception Volume Required	**0.52**	m^3	
Volume Required =	0.52		**PASS**
Volume Provided =	1.75		

** GDSDS E2.1.1*

Tree Pit Interception Volume No.3

Length	13.000	m	
Width	3.000	m	
Storage depth	0.100	m	
Interception Volume Available	**3.900**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	554.000	m^2	
Rainfall depth (i)	5.000	mm	
Interception Volume Required	**2.216**	m^3	
Volume Required =	2.216		**PASS**
Volume Provided =	3.900		

** GDSDS E2.1.1*

Tree Pit Interception Volume No.4

Length	12.000	m	
Width	2.500	m	
Storage depth	0.100	m	
Interception Volume Available	**3.000**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	334.000	m^2	
Rainfall depth (i)	5.000	mm	
Interception Volume Required	**1.336**	m^3	
Volume Required =	1.336		**PASS**
Volume Provided =	3.000		

** GDSDS E2.1.1*

Tree Pit Interception Volume No.5

Length	5.000	m	
Width	1.500	m	
Storage depth	0.100	m	
Interception Volume Available	**0.750**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	83.000	m^2	
Rainfall depth (i)	5.000	mm	
Interception Volume Required	**0.332**	m^3	
Volume Required =	0.332		**PASS**
Volume Provided =	0.750		

** GDSDS E2.1.1*

Tree Pit Interception Volume No.6

Length	5.000	m	
Width	6.000	m	
Storage depth	0.100	m	
Interception Volume Available	**3.000**	m^3	
Interception Volume Required *	A x 0.8 x I		
Drained Impermeable Area (A)	300.000	m^2	
Rainfall depth (i)	5.000	mm	
Interception Volume Required	**1.200**	m^3	
Volume Required =	1.200		**PASS**
Volume Provided =	3.000		

** GDSDS E2.1.1*

INTERCEPTION - Glenamuck Nth Site A - CATCHMENT A

Paved Surfaces connected to the drainage system (Ha) =	0.935	Volume of Interception Required (m³)	37.4	Gross Paved Area x 5mm x 0.8 (GDSDS E2.1.1 - Criterion 1)

Volume of Interception Provided (m³)	Length	Width (m)	Area (m²)	Quantity	Depth (mm)	Void Ratio	Volume (m³)
Voids of stone below Permeable Paving overflow			1,250		0.2	0.3	75.0
Voids of stone below Filter Drains	287	0.75		1	0.15	0.4	12.9
Voids of stone below Swale overflow	119	0.75			0.15	0.4	5.4
Tree Pits	2	5		3	0.1	1	3.0
Green Roof (Intensive)			0	1	0.2	0.35	0.0
Bio Retention			217	1	0.1	1	21.7
Voids of stone below Storage areas			510		0.3	0.4	61.2

Volume of Interception Provided (m³) =	**179.2**
Volume of Interception Required (m³) =	**37.4**
Interception provided > Required	**OK**

INTERCEPTION - Glenamuck Nth Site A - CATCHMENT B

Paved Surfaces connected to the drainage system (Ha) =	0.954	Volume of Interception Required (m³)	38.2	Gross Paved Area x 5mm x 0.8 (GDSDS E2.1.1 - Criterion 1)

Volume of Interception Provided (m³)	Length	Width (m)	Area (m²)	Quantity	Depth (mm)	Void Ratio	Volume (m³)
Voids of stone below Permeable Paving overflow			1,255		0.2	0.3	75.3
Voids of stone below Filter Drains	109	0.75		1	0.15	0.4	4.9
Voids of stone below Swale overflow	116	0.45			0.15	0.4	3.1
Tree Pits	0.6	5	29	7	0.1	1	5.0
Green Roof (Intensive)			1,007	1	0.2	0.35	70.5
Bio Retention			154	1	0.1	1	15.4
Voids of stone below Storage areas			448		0.3	0.4	53.8

Volume of Interception Provided (m³) =	**228.0**
Volume of Interception Required (m³) =	**38.2**
Interception provided > Required	**OK**

Appendix 11.3

Attenuation Storage Calculations

CubicM3 Stormwater Management System Design Tool

Ver: June 2025

PROJECT REF:	Glenamuck North Site A -2411
PROJECT:	TANK 1
DATE:	03-Dec-25
CREATED BY:	RM

SYSTEM PARAMETERS

Required Total Storage	416	m^3
Attenuation Chamber Model	RT-1140	
Filtration Permeable Geo or Impermeable Geo	Filter geo - TS1000	
Number of Separator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	45%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.45	m	0.15
Stone Below Chambers	0.35	m	0.2 if cover <= 2.5m or 0.25 for bigger cover
In-between Row Spacing	0.15	m	0.15
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Perp to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		7	ea
Number of units per Row		10	ea
System Installed Storage Depth (effective storage depth)	1.940		m
Tank overall installed Width at base	15.55	15.5	m
Tank overall installed Length at Base	20.842	21	m
Total Effective System Storage	431.1	432.4	m^3

SYSTEM DETAIL

Chamber Model	RT-1140	
Unit Width	1.95	m
Unit Length	1.88	m
Unit Height	1.14	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	4	m
Chamber Internal Storage Vol.	2.67	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	716	m^3
Width at base	15.50	m
Width at top	17.74	m
Length at base	21.00	m
Length at top	23.24	m
Depth Of System	1.94	m
Area of Dig at Base of System	326	m^2
Area of Dig at Top of System	412	m^2
Void Ratio	60%	
Stone Requirement - m3	523	m^3
Stone Requirement - tonne	792	tonne

SYSTEM ITEM LIST

Item	Product	Calculated	Adopted	unit	€/unit	Total	Comments
Storage							
Chamber Type	RT-1140	70	70	ea	€ -	€ -	
Endcap Type	RT-1140 ec	14	14	ea	€ -	€ -	

CubicM3 Stormwater Management System Design Tool

Ver: June 2025

PROJECT REF:	Glenamuck North Site A -2411
PROJECT:	TANK 2
DATE:	03-Dec-25
CREATED BY:	RM

CUBICM3

SYSTEM PARAMETERS

Required Total Storage	398	m^3
Attenuation Chamber Model	RT-1140	
Filtration Permeable Geo or Impermeable Geo	Filter geo - TS1000	
Number of Separator Rows (IR)	1	

SITE PARAMETERS

Stone Porosity	45%		
Excavation Batter Angle (degrees)	60	°	*Minimum Requirement*
Stone Above Chambers	0.45	m	*0.15*
Stone Below Chambers	0.35	m	*0.2 if cover <= 2.5m or 0.25 for bigger cover*
In-between Row Spacing	0.15	m	*0.15*
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Perp to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		5	ea
Number of units per Row		13	ea
System Installed Storage Depth (effective storage depth)	1.940		m
Tank overall installed Width at base	11.35	11.5	m
Tank overall installed Length at Base	26.482	26.5	m
Total Effective System Storage	403.6	407.4	m^3

SYSTEM DETAIL

Chamber Model	RT-1140	
Unit Width	1.95	m
Unit Length	1.88	m
Unit Height	1.14	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	4	m
Chamber Internal Storage Vol.	2.67	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	679	m^3
Width at base	11.50	m
Width at top	13.74	m
Length at base	26.50	m
Length at top	28.74	m
Depth Of System	1.94	m
Area of Dig at Base of System	305	m^2
Area of Dig at Top of System	395	m^2
Void Ratio	60%	
Stone Requirement - m3	500	m^3
Stone Requirement - tonne	757	tonne

SYSTEM ITEM LIST

Item	Product	Calculated	Adopted	unit	€/unit	Total	Comments
Storage							
Chamber Type	RT-1140	65	65	ea	€ -	€ -	
Endcap Type	RT-1140 ec	10	10	ea	€ -	€ -	

RAINSAFE™
STORMWATER MANAGEMENT SYSTEMS

STORMWATER MANAGEMENT SYSTEMS

PRODUCT BROCHURE

CUBICM³
SUSTAINABLE ENGINEERING SOLUTIONS

RainSafe Stormwater Management Systems

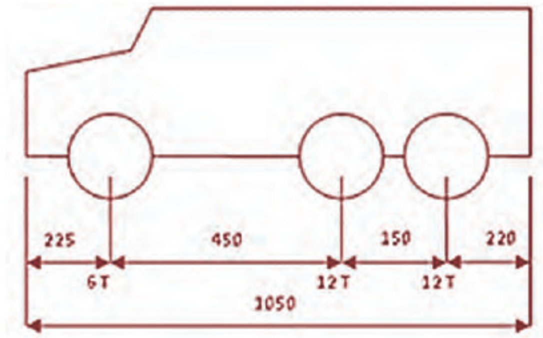
CUBICM3

CubicM3, a leader in sustainable stormwater management with over two decades of international expertise, introduces RainSafe, an innovative range of attenuation chambers crafted for sustainable and efficient stormwater management. With thousands of systems installed across three continents, CubicM3 has leveraged its extensive experience to develop RainSafe in collaboration with top-tier global specialists in geotechnical engineering, structural analysis, design for manufacture, and product testing. Utilizing cutting-edge Finite Element modeling, the chambers are optimized for structural efficiency and durability.

Manufactured in Europe through precision injection molding, RainSafe ensures uniform wall thickness and exceptional quality, meeting or surpassing stringent European and national standards such as Eurocode, ASTM, and CIRIA. The product has undergone exhaustive independent material and performance testing to secure CSTB certification, affirming its reliability.

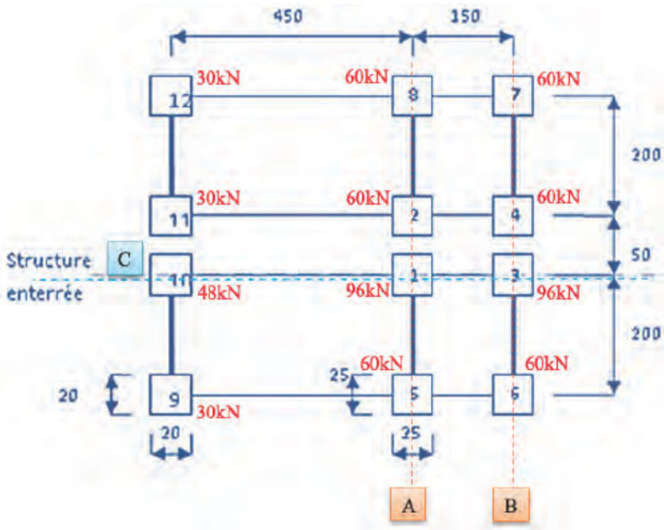
Rainsafe Chambers Key Features :

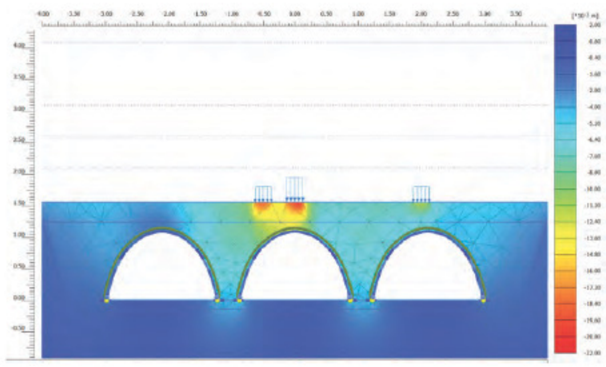
- ***Industry-leading structural capacity*** for both live traffic loads (e.g., heavy vehicles) and long-term dead loads in deep cover scenarios.
- ***CSTB certification ensure full compliance with relevant European*** and local regulatory codes.
- ***Modular design with innovative button-tab features*** enables rapid, adaptable assembly on-site, saving time and labor.
- ***Environmentally conscious European production*** reduces carbon footprint, with optimized sizing for containerized shipping and compact storage.
- ***Lightweight design (RT-1140 weighs under 50 kg)*** with integrated handles ensures compliance with European health and safety manual handling regulations, allowing safe lifting by two operatives.
- ***A dedicated Filtration and Maintenance Row captures suspended solids,*** offering easy access for cost-effective maintenance to maintain tank performance and enhance discharge water quality.
- ***Built-in vents prevent air entrapment,*** ensuring maximum storage capacity is always available.
- ***Swift lead times,*** with delivery possible within as little as one week from order placement.

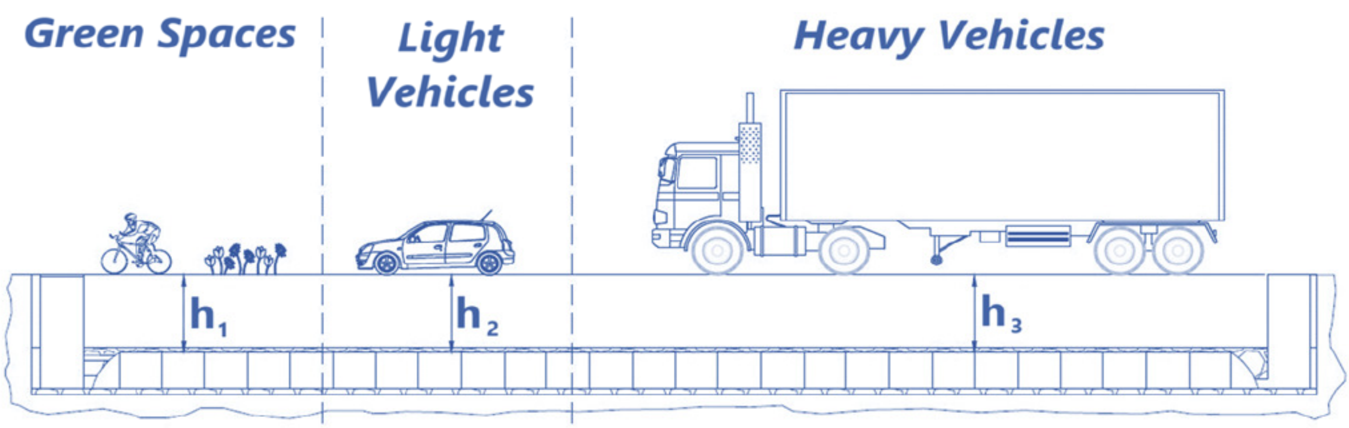


Structural Performance:

RainSafe is engineered to excel under the most rigorous structural demands, adhering to the strictest interpretation of Eurocode LM1 and LM2 vehicle loading scenarios, as outlined in the French Fascicule F70 Standard. This includes simulations of multiple vehicles exerting simultaneous vertical and horizontal forces, as well as traffic moving in varied directions—factors often overlooked in less comprehensive guidelines like ASTM and CIRIA. These alternative standards typically impose lower surface pressure requirements, yet RainSafe's unique design surpasses them all. Independently evaluated and certified by CSTB, RainSafe significantly exceeds these loading benchmarks, making it an ideal solution for high-traffic areas such as roadways and logistics parks, as well as deep-burial installations.





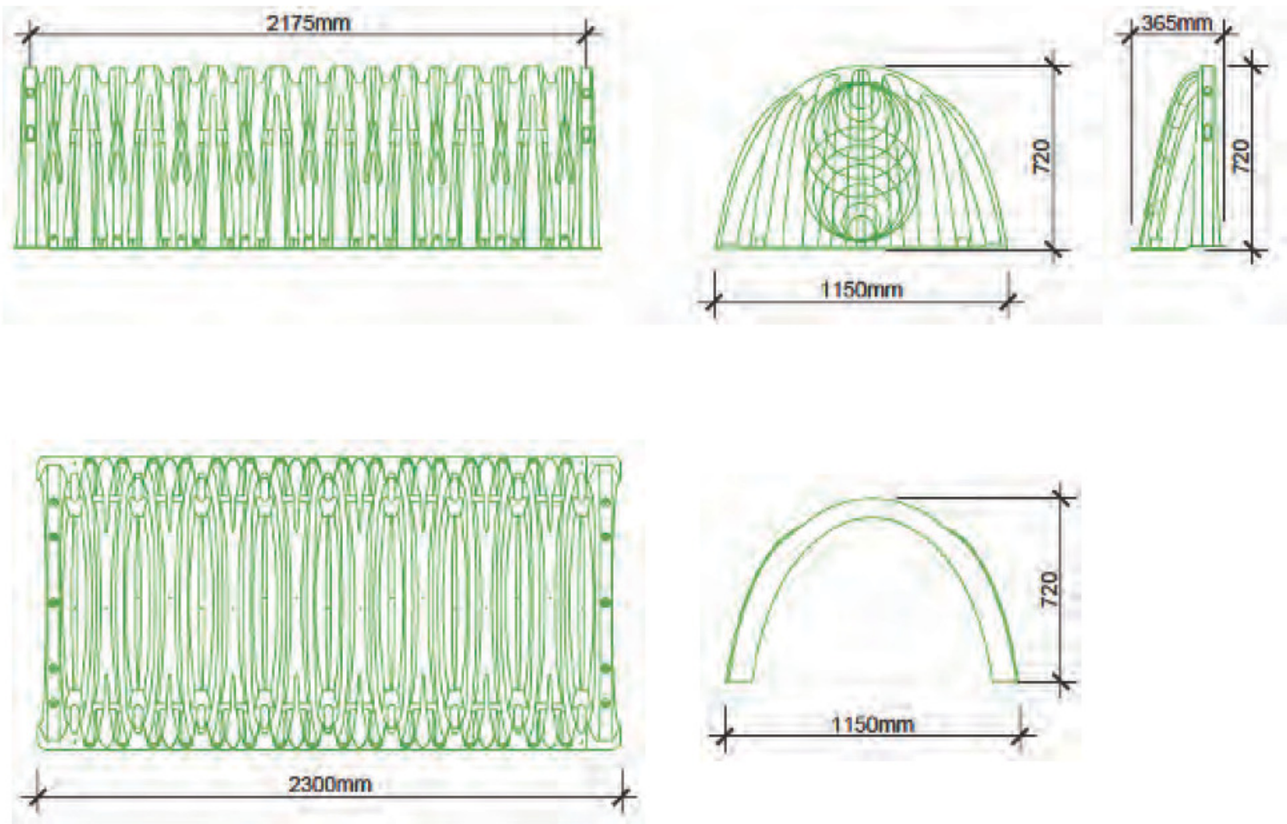


RainSafe RT-720 Chamber Specifications

CUBICM³

RainSafe RT-720 chambers were developed by CubicM3 to provide the ideal solution for managing stormwater in virtually all scenarios faced by developers, engineers and contractors. Designed to exceed the most demanding European industry standards, RainSafe RT-720 chambers combine market-leading structural performance with cost-efficiency and ease of use. Capability of supporting HGV traffic (LM1 and LM2) and deep cover loads requirements make RainSafe chambers the best in the market.

RainSafe RT-720 Nominal Specifications:	
Dimensions(L x W x H)	2175 x 1150 x 720 mm
Chamber Capacity	1.16 m^3
Weight	25.2 kg
Min. Base Stone*	150 - 200 mm
Min. Stone Above	150 mm
Min. Row Spacing	150 mm
Min. Total Cover**	450 mm
Max. Total Cover	4500 mm
*Base stone depth varies with total cover depth **Min cover is to support HGV traffic	

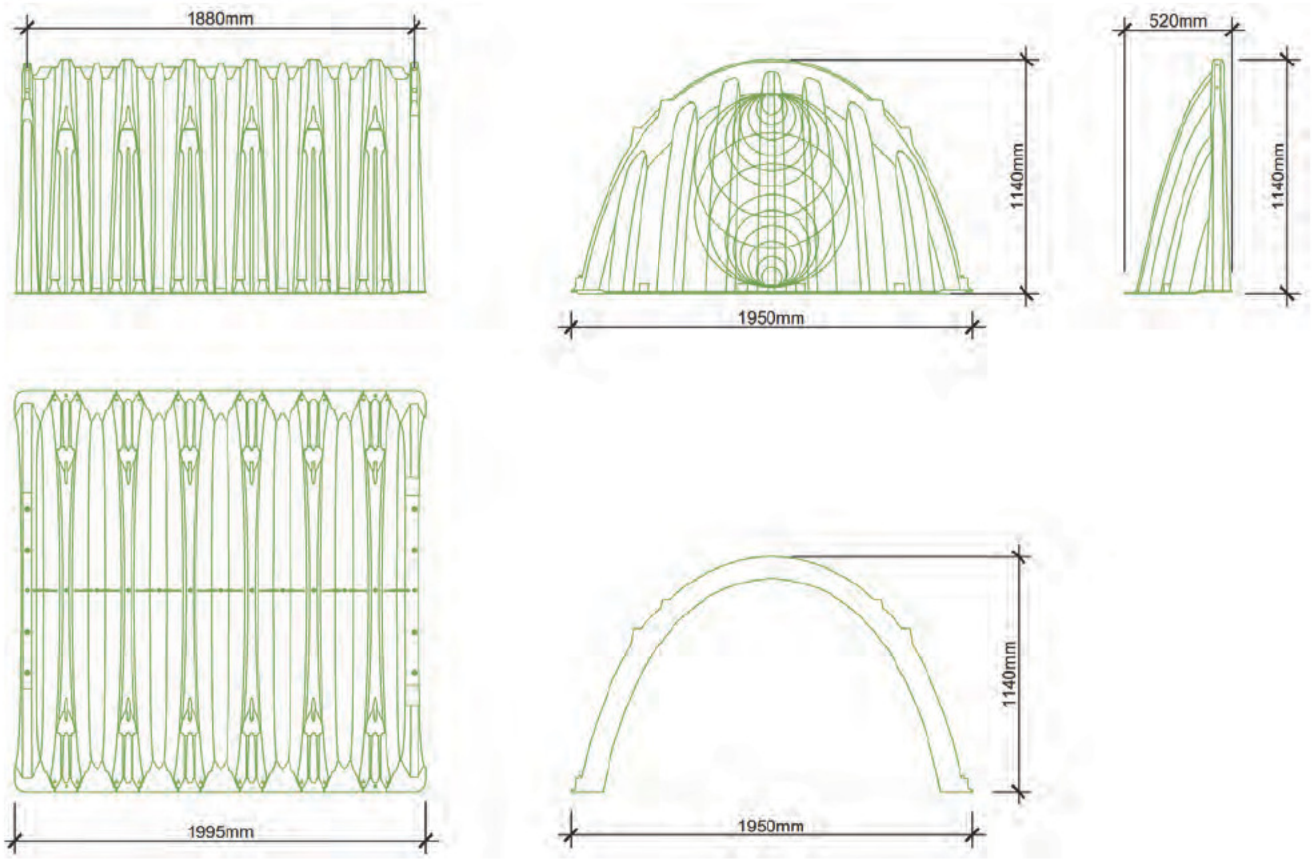


RainSafe RT-1140 Chamber Specifications

RainSafe RT-1140 chambers were developed by CubicM3 to provide the ideal solution for managing stormwater in virtually all scenarios faced by developers, engineers and contractors. Designed to exceed the most demanding European industry standards, RainSafe RT-720 chambers combine market-leading structural performance with cost-efficiency and ease of use. Capability of supporting HGV traffic (LM1 and LM2) and deep cover loads requirements make RainSafe chambers the best in the market.

RainSafe RT-1140 Nominal Specifications:	
Dimensions(L x W x H)	1880 x 1950 x 1140 mm
Chamber Capacity	2.67 m^3
Weight	48.75 kg
Min. Base Stone*	200 - 250 mm
Min. Stone Above	150 mm
Min. Row Spacing	300 mm
Min. Total Cover**	450 mm
Max. Total Cover	4000 mm

*Base stone depth varies with total cover depth
**Min cover is to support HGV traffic



Structural rigidity and maximum allowable construction loads

Rainsafe storm attenuation systems from Cubic M3 are engineered for strength and durability, offering exceptional load-bearing performance in even the most demanding environments. Designed to withstand the weight of heavy machinery and traffic, Rainsafe is ideal for installation beneath car parks, roadways, and commercial yards.

Whether exposed to occasional HGV movements or constant industrial operations, the system's **robust modular structure** ensures long-term stability without compromise. Independent load testing confirms that Rainsafe meets and exceeds relevant structural standards, giving you **peace of mind and flexibility** in project planning.

With Rainsafe, there's no need to limit your surface usage—**functionality above ground doesn't come at the expense of performance below.**

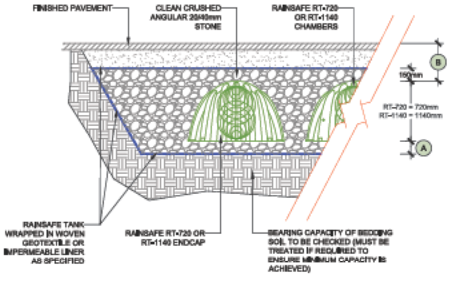
Zone	Fill Depth over Chambers	Maximum Allowable Wheel Loads		Maximum Allowable Track Loads		Max Allowable Roller Loads
		Max Axle Load Kg(kN)	Max Wheel Loads	Track Width	Max Ground Pressure (kPa)	Max Drum Weight or Dynamic Force Kg(kPa)
Surround Stone	Upto 150mm	3,500 (35)	Not Allowed	Not Allowed	Not Allowed	Not Allowed
Surround Stone	150mm to 300mm	7,000 (70)	Not Allowed	300 450 600 750	55 35 35 30	Drum weight no to exceed 1,350 kgs Max allowable pressure 55 kPa
Initial Fill Material	300mm to 450mm	15,000 (150)	7,000 (70)	300 450 600 750	100 75 60 55	Drum weight no to exceed 2,500 kgs Max allowable pressure 104 kPa
Initial Fill Material	450mm to 600mm Loose	15,000 (150)	7,000 (70)	300 450 600 750 900	110 80 65 55 50	Drum weight no to exceed 8,000 kgs Max allowable pressure 182 kPa
Initial Fill Material	450mm to 600mm Compacted	15,000 (150)	7,000 (70)	300 450 600 750 900	120 85 70 60 55	Drum weight no to exceed 10,000 kgs Max allowable pressure 233 kPa
Final Fill Material	450mm to 900mm Compacted	15,000 (150)	7,000 (70)	300 450 600 750 900	165 115 90 75 65	17,500 (170)

Easy Inspection & Efficient Cleaning

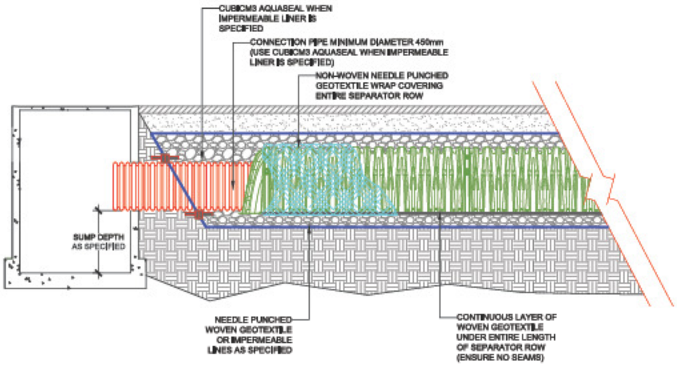
CUBICM³

Cubic M3's **Rainsafe system** is designed with **quick, visual inspections and access for maintenance** in mind—allowing users to assess sediment build-up easily without the need for invasive procedures. When maintenance is needed, the **straightforward jetting process** makes cleaning simple, effective, and fast. Using a self-propelling jetting unit, silt and debris are efficiently flushed and removed, ensuring optimal system performance.

Photographic records and maintenance logs help track system condition over time, making it easier to **optimise inspection schedules** and **reduce unnecessary servicing**. With clear guidance and minimal disruption, Rainsafe helps keep your stormwater system operating smoothly and compliantly.



BED AND COVER DEPTHS			
REQUIREMENT	RT-720	RT-1140	DRAWING REFERENCE
TOTAL COVER UP TO 2500mm	150mm	200mm	A
TOTAL COVER OVER 2500mm	200mm	250mm	
MIN. COVER (GREEN AREA)	450mm		B
MIN. COVER (TRAFFICABLE AREA)	600mm		
MAX. COVER	4500mm	4000mm	

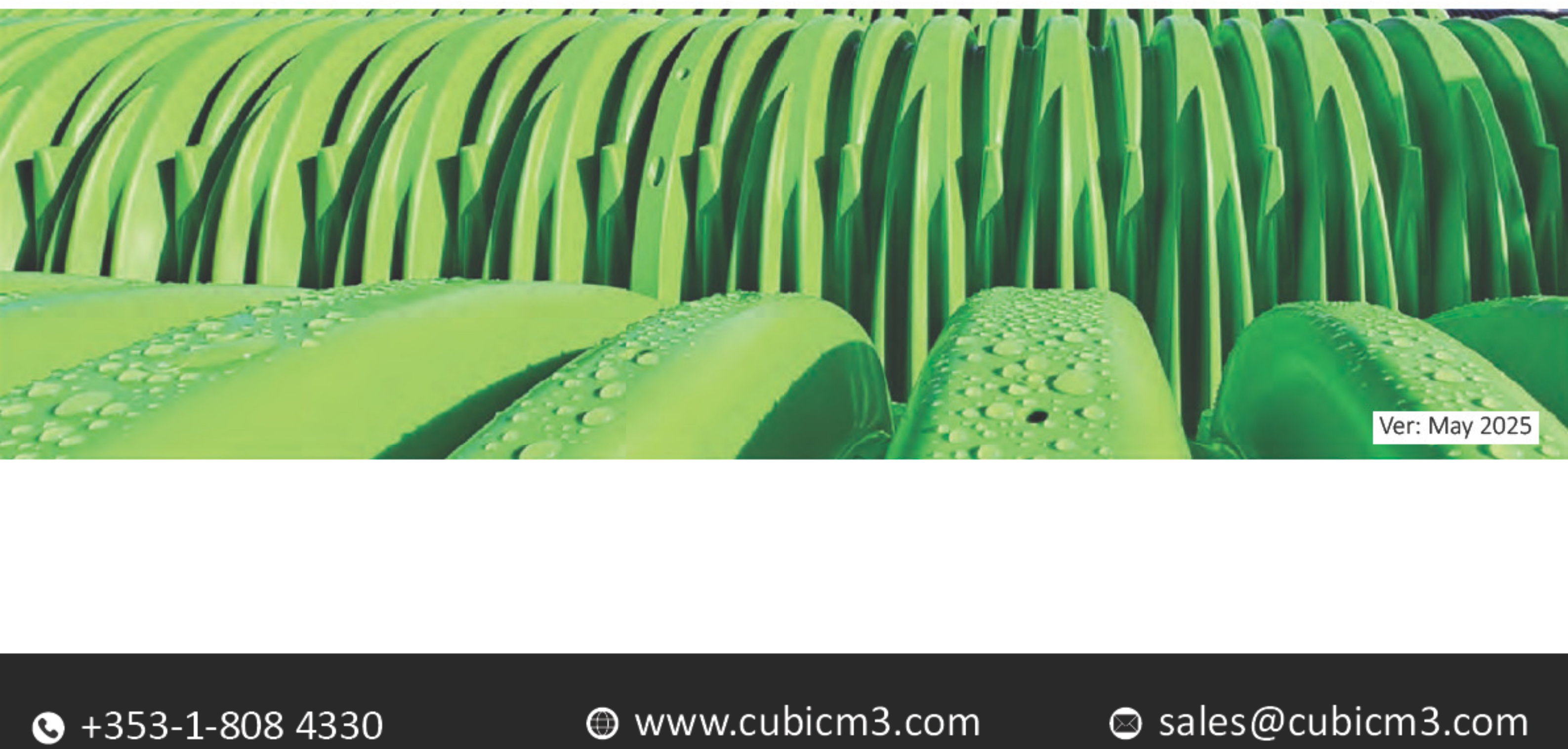


RAINSAFE™
STORMWATER MANAGEMENT SYSTEMS

Full Engineering Design Support

CUBICM³
SUSTAINABLE ENGINEERING SOLUTIONS

ENGINEERS IRELAND
REGISTERED TRAINING PROVIDER 2021



Ver: May 2025

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RainSafe Technical Notice and FAQs

June 2025

To Whom it May Concern,

CubicM3 is the leading provider of products and solutions in the Stormwater management sector in Ireland. We are very proud to present RainSafe, our own range of attenuation chambers, to the Irish market.

For over 20 years we have been sourcing and promoting leading products from reputable suppliers and over that time we have built up considerable expertise in the sector. This was recognised in 2019 when CubicM3 was asked to review BS 9298 prior to its publication in 2020. In 2022 we decided to develop our own product range with the intent of incorporating various innovations and improvements and providing a superior solution specifically designed for and manufactured in Europe. As you may be aware, earlier this year CubicM3 began offering RainSafe chambers for stormwater management systems.

We developed RainSafe from the outset with several objectives:

- Improve structural efficiency and performance;
- Design in Europe to European codes and standards (in particular the updated application of LM1 and LM2, which is significantly more stringent than the old interpretations);
- Manufacture in Europe for reduced carbon footprint;
- Optimise sizing for transport and handling.

This development process was carried undertaken in the context of the new ISO-4982 and working closely in conjunction with CSTB who from prior experience are the most experienced and stringent national standards authority for stormwater management products. For reference, the CSTB approval was the underpinning approval, under which we marketed Stormtech for years and was the base approval for Stormtech's BBA and DIBt certificates. We also worked closely with Ireland's leading geotechnical firm, Advanced Geotechnics Ltd, to provide finite element modelling and independent analysis of the structural performance of RainSafe chambers.

CSTB's review of RainSafe generally made reference to the testing and performance requirements detailed in ISO-4982, except where their existing requirements were already more stringent and included:

- Raw material testing for both short and long term properties,
- Product testing per ISO-4982,
- Detailed review of structural analyses and modelling,
- Production facilities and quality control measures,
- Installation and Maintenance guidelines.

RainSafe meets or exceeds all the necessary specifications and outperforms other comparable products in all relevant parameters. We are confident the testing and analyses of our products has been more thorough and in compliance with the latest standards than other products on the market today.

We recognise that given RainSafe is a new product, our clients and their consultant engineers will have questions and will need to carry out due diligence to satisfy themselves as to RainSafe suitability for use on their projects. To assist in this, in addition to the standard material we are issuing with our proposals – CSTB cert, Product Brochure, Installation and Maintenance Guidelines, etc we are providing the following answers to some frequently asked questions (FAQs) appended below.

CubicM3 is extremely proud of the RainSafe and if you have a query or concern that is not addressed below, please contact us and we would be happy to address this directly with you.

Yours sincerely,

Justin Elliott,
Managing Director, CubicM3 and RainSafe
CEng, MBA, BA, BAI

RAINSAFE™ STORMWATER MANAGEMENT SYSTEMS

CUBICM³ SUSTAINABLE ENGINEERING SOLUTIONS

Frequently Asked Questions

Is RainSafe able to take Traffic Loading?

RainSafe is the strongest attenuation system in the market and is suitable for use in areas subject to Heavy Goods Vehicle traffic and Emergency Vehicle loading. There are numerous design codes and standards that apply to assessing structural capacities of buried structures. We had RainSafe independently assessed by AGL Consulting who demonstrated compliance with French Bc Convoi Loading (as specified in Fascicules 61 & 70). We selected the French standard because it is more realistic in that it assesses multiple wheel loads simultaneously and in un-balanced configurations, significantly exceeding the loading regimes under the pan-European LM1 and LM2 loading regimes. RainSafe complies with all these standards with significant factors of safety when installed correctly.

What plant can be used above RainSafe tanks during construction?

In general once the specified minimum levels of cover are in place RainSafe can take typical construction traffic loading. However, if construction traffic is expected to transit a RainSafe tank in advance of final surfacing being in place it may be necessary to provide a means to prevent rutting impacting effective cover during wet periods. Similarly, suitable measures may be required for construction plant that use outriggers or generate abnormally concentrated loads. CubicM3 has extensive experience in this area and can provide assistance with for non-standard loading situations.

How deep can you bury RainSafe chambers?

RainSafe was specifically designed to provide market-leading structural performance. RainSafe RT-720s is approved to carry up to 4.5m and up to 4.0m of cover at a minimum chamber spacing of 150mm for RT-1140s.

Are RainSafe chamber walls thinner than some other chambers and is this a problem?

Yes, some other chambers have thicker walls than RainSafe. However, wall thickness is not a relevant engineering consideration in its own right. It is included as a criteria in certain design codes, originally drafted nearly 20 years ago. Since then it has ceased to be relevant under engineering consideration.

Wall thickness is a contributing factor to both structural capacity and impact resistance but is not the only metric that should be taken into consideration. CSTB do not consider wall thickness in isolation in their evaluation of attenuation arches. RainSafe has been determined to meet and exceed the requirements for both structural capacity and impact resistance.

RainSafe's structural performance was independently evaluated by Advanced Geotechnics Ltd (Ireland's leading geotechnical consulting engineers) and verified by CSTB to meet Eurocode 1 traffic loads (LM1 and LM2) meaning it considerably exceeds the structural capacity of other chambers on the market both for live loading and deep burial. AGL used Eurocode 7 in their evaluation which is more onerous than the ASTM code F2787.

Where is RainSafe made?

RainSafe was designed in Ireland and is manufactured by injection moulding in France in one of the most advanced manufacturing facilities of its kind in Europe. Manufacturing in France enables us to serve the European market with a much smaller carbon footprint and a significantly reduced lead-time than competing products in the market being imported from Asia and the US

Is RainSafe manufactured in an ISO certified factory?

ISO QA systems are one of many systems that may be used for controlling and measuring quality in manufacturing. CSTB has assessed the RainSafe quality assurance program that is in place for the manufacture for RainSafe (in exactly the same way they would in an ISO facility) and deemed it to be appropriate and adequate to ensure the necessary quality and performance criteria are maintained. Under CSTB certification this quality plan is subject to regular audit by QB.

If RainSafe is a new product, how can we be sure of its long term capabilities?

Long term deep burial was a requirement when design codes for corrugated arches were originally drafted nearly 20 years ago. Over the years, testing methods have been developed to enable highly accurate prediction of long-term structural performance of polymers. The high-quality virgin polypropylene material qualified for use in RainSafe underwent rigorous testing as required under ISO 4982 (ISO 899-2) the new International Standard governing Arch-shaped, corrugated wall chambers and also under ASTM 6992, a well-established methodology, relied on for years by other leading products in the industry, including Stormtech and recycled polymer pipe products. Again, the results of these tests were evaluated and accepted by CSTB.

Has RainSafe been used before in Ireland?

RainSafe has been approved by consulting engineers and adopted in over 200 projects to date in Ireland and the UK. These include installations for county councils and other public sector clients, on projects multinationals and other mission-critical installations such as at airports and power stations.

What is the Design Life of RainSafe chambers

The standard design is the same as for plastic pipes where the Factor of Safety for RainSafe is verified as sufficient at 50 years. Please contact CubicM3 if your project requires an extended design life.

How easy is it to install RainSafe tanks?

RainSafe chambers were designed for ease of use and handling. Their modular design means tanks can be designed to meet virtually any site layout. The chambers come stacked on pallets for compact storage on site. For installation the chambers fit together to from storage tunnels within the tank. Based on years of experience of installing attenuation tanks we included features to help make installation easier and more accurate such as lifting handles on the larger RT-1140 model, which we also kept under 50kg to allow a safe two-man lift and locating buttons on the overlap joins to ensure a firm connection.

Can RainSafe tanks be used for Soakaways?

Yes, this is a very common application also known as *detention* storage. Simply wrapping a RainSafe tank in a permeable geotextile will allow Stormwater held in the tank to permeate into the surrounding soil. Thanks to RainSafe's Separator Row stormwater can infiltrate through the floor of the tank as well as the walls. This is different to and an improvement over traditional methods where infiltration through the floor is excluded from consideration due to potential silt build-up.

Can RainSafe tanks be made to be impermeable?

RainSafe tanks can be designed for *retention* storage where it is required to prevent stormwater from infiltrating into the surrounding ground. This can be achieved using Geo-synthetic Clay Liners (GCLs) or High-density Polyethylene (HDPE) liners. CubicM3 has extensive experience working with both types of liners but in general our customers have a preference for GCLs due to their ease of use.

How close can RainSafe be installed to buildings and structures?

As with all buried stormwater management systems, due care needs to be taken for installations in close proximity to buildings and structures. For tanks with permeable outer membranes (ie soakaway-type systems), these should be kept a minimum of 5m from the nearest structural elements that are founded in the surrounding soil. It is possible to install closer than this with impermeable membranes with appropriate design consideration.

Do RainSafe Tanks provide any water treatment?

Yes. Our Separator Row provides a means of capturing any remaining water-borne silt or suspended solids that have not been removed by upstream measures, retaining them and preventing them from reducing the hydraulic performance of the tank. The Separator Row enables easy access for inspection and maintenance and removal of any build of material that accumulates over time. CubicM3 previously commissioned the Scottish Environmental Protection Agency to carry out an independent evaluation of a similar system that concluded that over 90% of suspended solids are captured in this way. Please refer to the RainSafe Operation and Maintenance manual for further information.

Is RainSafe CE certified?

There is no CE in place yet for corrugated arch chambers so it is not yet possible to provide a CE mark for RainSafe. In these cases where CE marking is not available, products intended for use in the Irish Construction Industry must be evaluated by a recognized EU national standards authority. Therefore, the CSTB provide the necessary Technical Opinion that RainSafe complies with their requirements and is suitable for use .

Does RainSafe carry BBA Certification?

No. As we developed RainSafe after Brexit had occurred we opted to use CSTB for certification as they provide EU recognized standards and are the most experienced national standards authority at evaluating corrugated arch attenuation systems and carry out the most rigorous evaluations.

Whats the difference between CSTB and NSAI?

Both organisations are national standards authorities. We decided to work with CSTB from the outset for two reasons. First, from our experience of working with CSTB on Stormtech, we knew that CSTB have extensive experience working with corrugated arch attenuation chambers and provide the most stringent assessment requirements for certification and we wanted to use this to demonstrate RainSafe's superior performance. Second, it made sense to work with CSTB as we manufacture RainSafe in France and it is easier for them to carry out quality audits on our manufacturing facilities.

If RainSafe is new, how can we be sure of its long-term performance?

Over the years testing methods have been developed to enable highly accurate prediction of long-term structural performance of polymers. The polypropylene material qualified for use in RainSafe underwent rigorous testing as required under ISO 4982 (ISO 899-2)the new International Standard governing Arch-shaped, corrugated wall chambers and also under ASTM 6992, a well-established methodology, relied on for years by other leading products in the industry, including Stormtech.

Has RainSafe undergone a 10,000 hour test?

This is not required under ISO 4982. By using the methodology prescribed in that standard and others such as ASTM 6992, the certifying national and European standards authorities, such as CSTB, can evaluate long-term structural performance with confidence and without the need for extended sites testing.

What is the Design Life of RainSafe chambers

The standard design life for RainSafe is 50 years. However, it is possible to extend this up to 120 years based on project-specific information. Please contact CubicM3 if your project requires and extended design life.

What is ISO 4982 and why is it important?

ISO 4982 was introduced in 2023 to provide clarity on the requirements for injection moulded corrugated arch-shaped chambers to be used in underground systems for retention, detention, transportation and storage of non-potable water (eg stormwater). While these types of stormwater products have been used for many years there has been a lack of such a unified standard and ISO 4982 is seen as a first step towards being able to introduce a CE mark for this type of product.

Why doesn't RainSafe have a CE mark?

At present CE marking is not available for arch-shaped attenuation systems as there has not been a unified standard in place against which to certify them. With the introduction of ISO-4982 in 2023 we expect that this situation will change in the near future. However, in the absence of a CE mark, CubicM3 developed RainSafe in compliance with all the relevant European and US standards and obtained the French CSTB certification as this is generally accepted as the most stringent assessment available for these types of products.

What warranty does CubicM3 offer for RainSafe installations

We provide a standard limited 10-year warranty on all installations.

Does CubicM3 carry out its own design and does it have Professional Indemnity cover?

We have a dedicated team of qualified and experienced engineers and technicians and over the years we have developed a reputation for value engineering and reliability. This is why over 70% of our business is with repeat customers. We carry our own Professional Indemnity cover of €1.5m.

What are the dimensions and storage capacity of RainSafe chambers?

RainSafe currently offers two chamber types as follows:

- RT-720 L: 2175mm x W: 1150mm x H: 720mm, providing 1.16m^3 storage and weighing 26.4kg,
- RT-1140 L: 1880mm x W: 1950mm x H: 1140mm, providing 2.67m^3 storage and weighing 48.5kg.

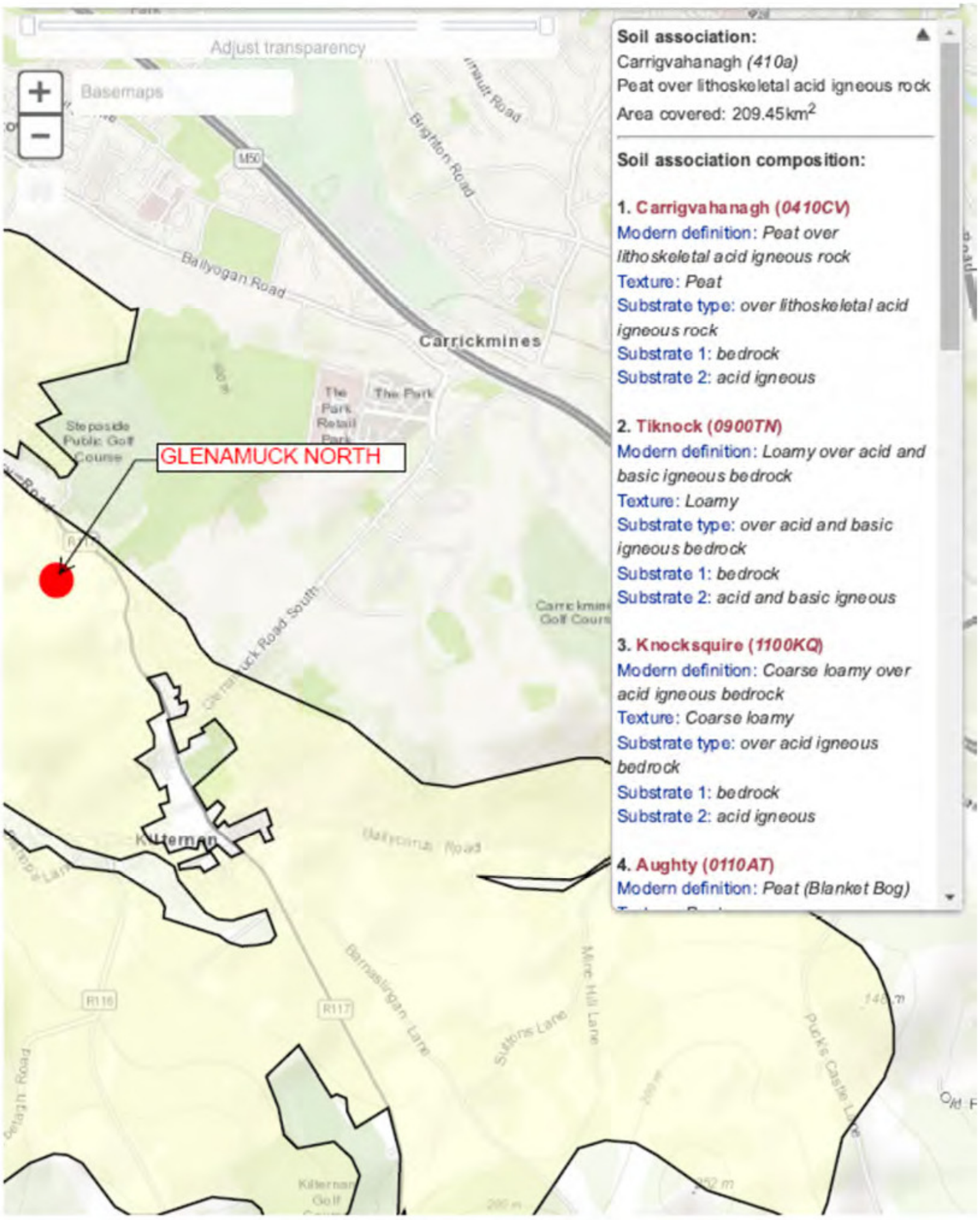
(Please refer to the RainSafe website at www.rainsafe.ue for product literature and further information)

Does CubicM3 do CPDs for RainSafe?

Yes – we are a Registered CPD Training Provider with Engineers Ireland and would be glad to set up a CPD with your team. This can be arranged by contacting sales@cubicm3.com

Appendix 11.4

SPR Soil Derivation Data



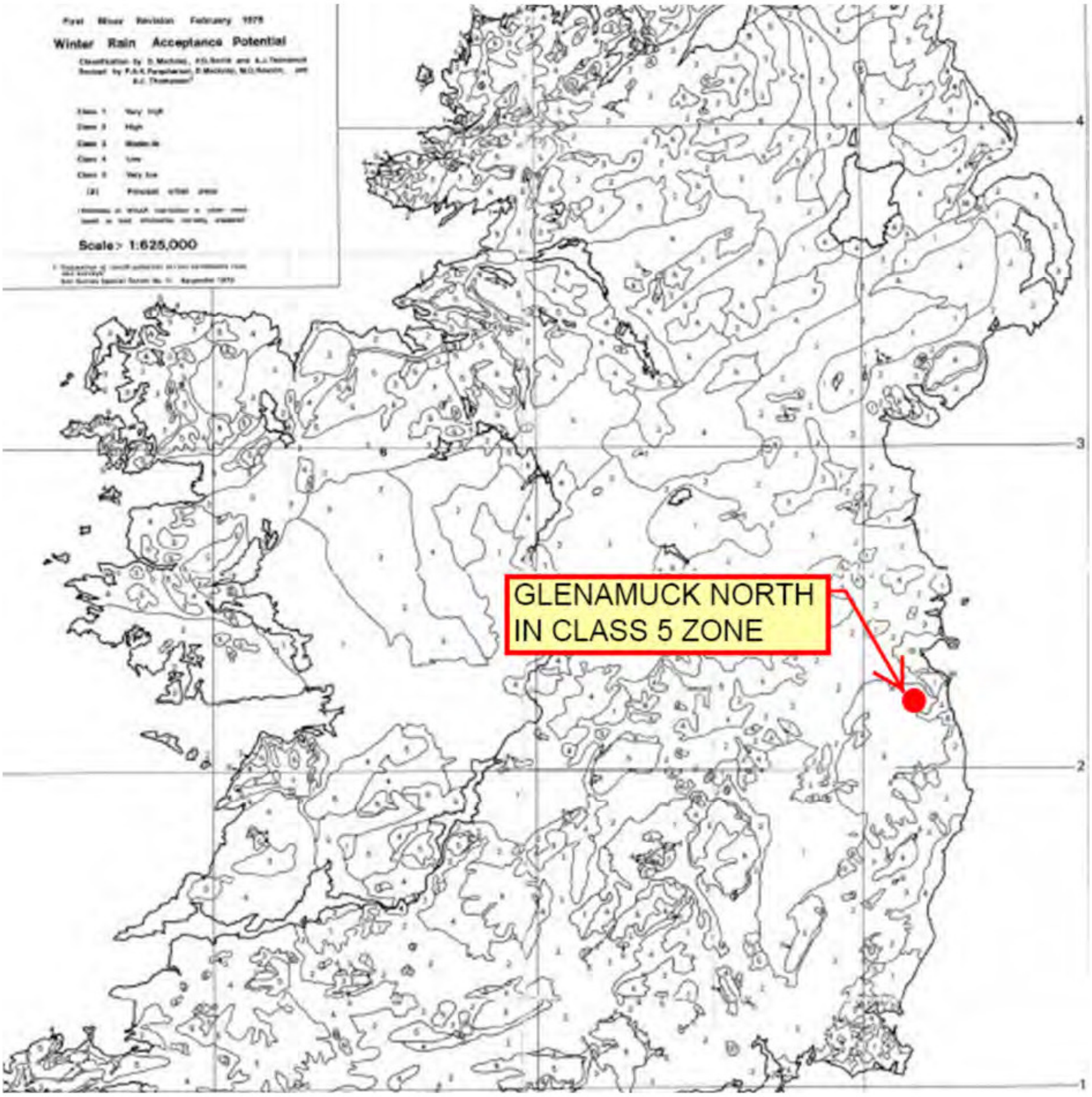
GSI/Teagasc Soil Data

Using the results of the site investigation trial holes as well as the Teagasc data sets noted previously, a Soil class of S4 could be interpolated.

FSR Soil Indices	
Soil Type 1	Well drained permeable sandy or loamy soils and shallower analogues over highly permeable limestone, chalk, sandstone, and related drifts. Earth peat soils drained by dykes and pumps Less permeable loamy over clayey soils on plateaux adjacent to very permeable soils in valleys
Soil Type 2	Very permeable soils with shallow ground water Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils. Moderately permeable soils, some with slowly permeable sub-soils
Soil Type 3	Relatively impermeable soils in boulder and sedimentary clays, and in alluvium. Permeable soils with shallow ground water in low lying areas. Mixed areas of impermeable and permeable soils in approximately equal proportions.
Soil Type 4	Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.
Soil Type 5	Soils of wet uplands with peaty or humose surface horizons and impermeable layers at shallow depth Deep raw peat associated with gentle upland slopes or basin sites Bare rock cliffs and screes (iv) shallow, permeable rocky soils on steep slopes.

Flood Studies Report

Based on the above definitions a SOIL Type 3 or 4 could be chosen for the Glenamuck North development site



Winter Rain Acceptance Potential (WRAP) Map

Based on the WRAP map a SOIL value of 5 could be interpreted but is not applied for this site. It is noted that SOIL type 5 is rarely applied and is more associated with exposed rock or peat wetlands.

Drainage Class	Depth to impermeable layer (cm)	Slope Classes 0-2° Rapid (1)	0-2° Medium (2)	0-2° Slow (3)	2-8° Rapid (1)	2-8° Medium (2)	2-8° Slow (3)	>8° Rapid (1)	>8° Medium (2)	>8° Slow (3)
		Peremability rates above impermeable layers								
1	>80	1			1			1	2	3
	40-80					2		3		4
	<40	--------	--------	--------	--------	--------	--------	--------	--------	--------
2	>80	2						--------		
	40-80				3		4			
	<40	3								
3	>80							--------		
	40-80						5	--------		
	<40									

Winter rain acceptance indices:1, very high; 2, high; 3, moderate; 4, low; 5, very low Upland peat and peaty soils are in Class 5. Urban areas are unclassified.

Flood Studies Report (FSR)

From the FSR table, reproduced above showing the noted drainage and slope classes, the Soil type could be interpolated between a type 4 and a type 3.

General soil description	Runoff potential	Soil class
Well drained sandy, loamy or earthy peat soils Less permeable loamy soils over clayey soils on plateaux adjacent to very permeable soils in valleys	Very low	S_1
Very permeable soils (e.g. gravel, sand) with shallow groundwater Permeable soils over rocks Moderately permeable soils some with slowly permeable subsoils	Low	S_2
Very fine sands, silts and sedimentary clays Permeable soils (e.g. gravel, sand) with shallow groundwater in low lying areas Mixed areas of permeable and impermeable soils in similar proportions	Moderate	S_3
Clayey or loamy soils	High	S4
Soils of the wet uplands: Bare rocks or cliffs Shallow, permeable rocky soils on steep slopes Peats with impermeable layers at shallow depth	Very high	S_5

Transport Infrastructure Ireland -TII publication Drainage of Runoff from Natural Catchments 2015, Volume 4 Sections 2 of the Design Manual for Roads and Bridges (DMRB)

Appendix 11.5

HRWallingford Qbar Calculations

Greenfield runoff rate estimation tool

www.uksuds.com | Greenfield runoff rate estimation tool (https://www.uksuds.com/)

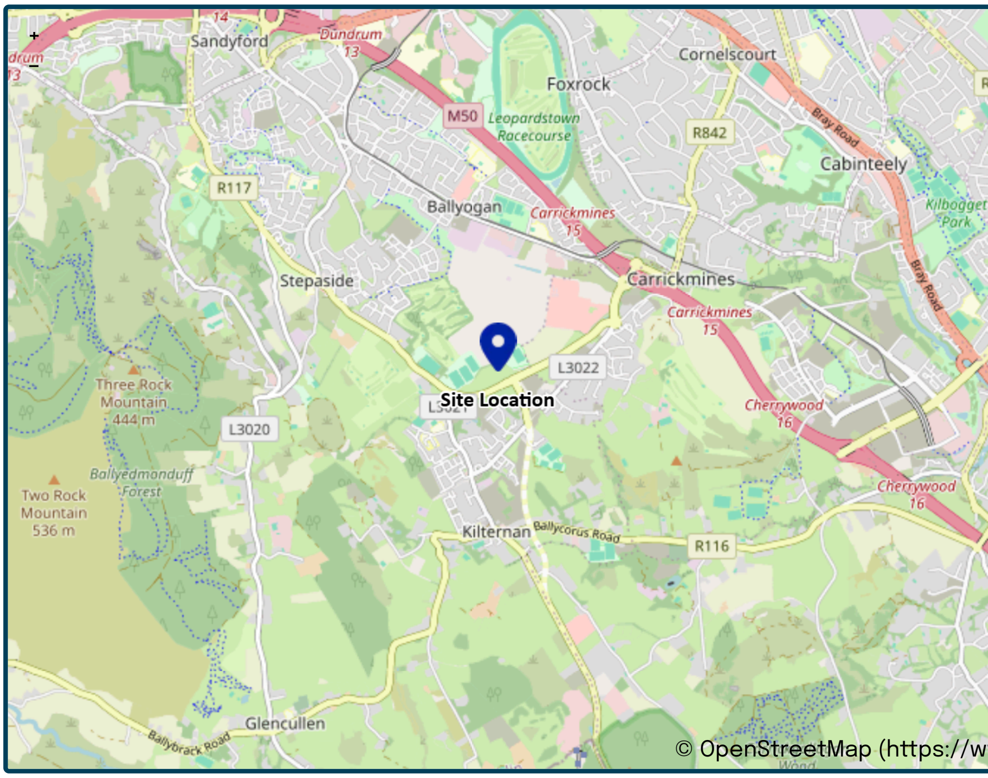
This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Project details

Date	03/12/2025
Calculated by	Roger Mullarkey
Reference	2411A
Model version	2.2.2

Location

Site name	Glenamuck North
Site location	Site A



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Site easting (Irish Grid)	320658
Site northing (Irish Grid)	223140
Site easting (Irish Transverse Mercator)	720583
Site northing (Irish Transverse Mercator)	723169

Site details

Total site area (ha)	2.62 ha

Greenfield runoff

Method

Method	IH124	

IH124

	My value	Map value
SAAR (mm)	994 mm	1021
How should SPR be derived?	WRAP soil type	
WRAP soil type	4	2
SPR	0.47	
QBar (IH124) (l/s)	19.1 l/s	

Growth curve factors

	My value	Map value
Hydrological region	12	12
1 year growth factor	0.85	
2 year growth factor	0.95	
10 year growth factor	1.72	
30 year growth factor	2.13	
100 year growth factor	2.61	
200 year growth factor	2.86	

Results

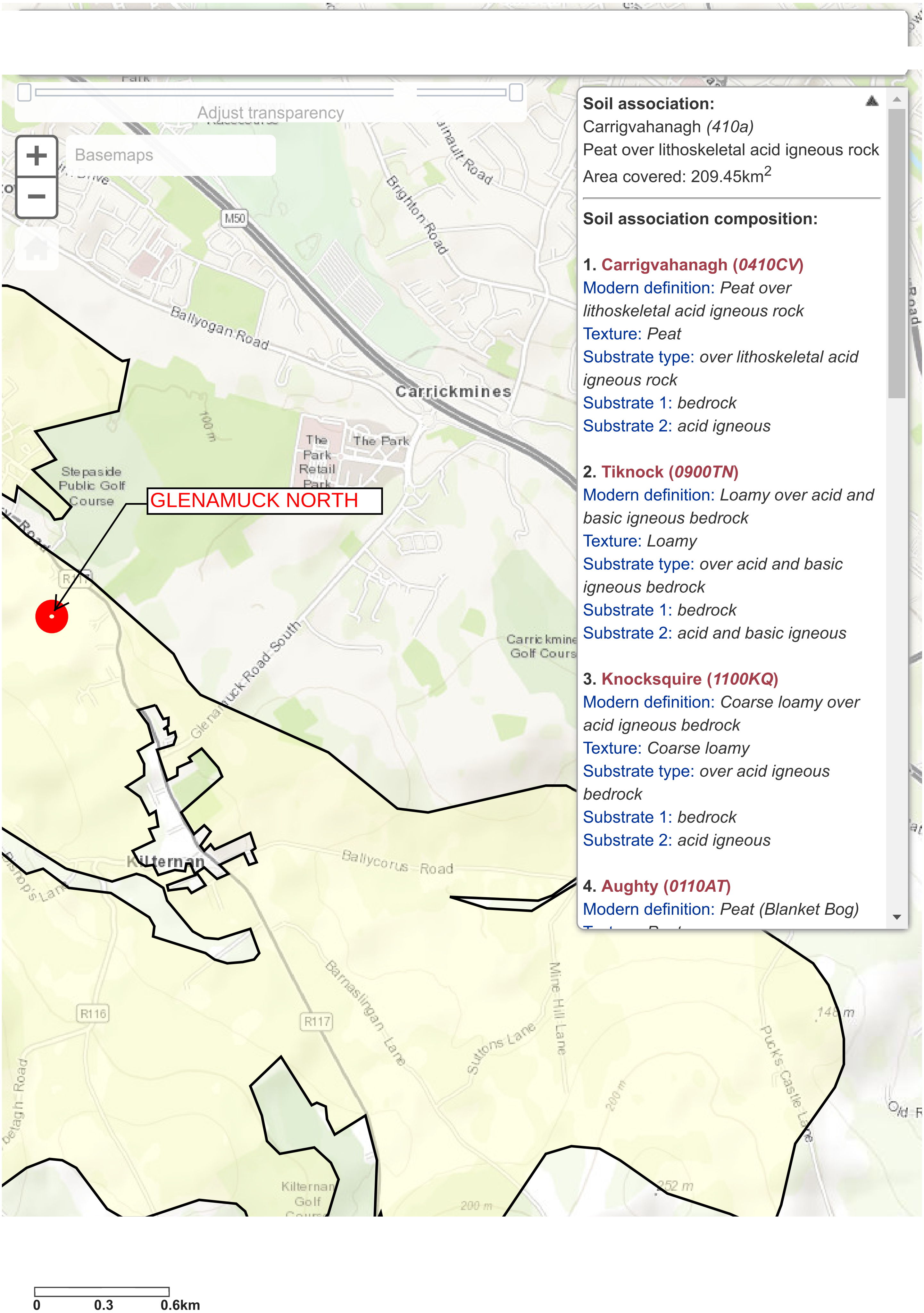
Method	IH124
Flow rate 1 year (l/s)	16.2 l/s
Flow rate 2 year (l/s)	18.1 l/s
Flow rate 10 years (l/s)	32.8 l/s
Flow rate 30 years (l/s)	40.6 l/s
Flow rate 100 years (l/s)	49.8 l/s
Flow rate 200 years (l/s)	54.5 l/s

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent 'zero' figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

Disclaimer

Appendix 11.6

GSI Data


Adjust transparency
Basemaps
M50
Brighton Road
Ballyogan Road
Carrickmines
The Park
The Park Retail Park
Stepaside Public Golf Course
100 m
GLENAMUCK NORTH
Glenamuck Road South
Kilternan
Ballycorus Road
Barnaslingan Lane
Mine Hill Lane
Suttons Lane
Pucks Castle Lane
R116
R117
148 m
200 m
252 m
Soil association:
Carrigvahanagh (410a)
Peat over lithoskeletal acid igneous rock
Area covered: 209.45km2
Soil association composition:
1. Carrigvahanagh (0410CV)
Modern definition: Peat over lithoskeletal acid igneous rock
Texture: Peat
Substrate type: over lithoskeletal acid igneous rock
Substrate 1: bedrock
Substrate 2: acid igneous
2. Tiknock (0900TN)
Modern definition: Loamy over acid and basic igneous bedrock
Texture: Loamy
Substrate type: over acid and basic igneous bedrock
Substrate 1: bedrock
Substrate 2: acid and basic igneous
3. Knocksquire (1100KQ)
Modern definition: Coarse loamy over acid igneous bedrock
Texture: Coarse loamy
Substrate type: over acid igneous bedrock
Substrate 1: bedrock
Substrate 2: acid igneous
4. Aughty (0110AT)
Modern definition: Peat (Blanket Bog)
0 0.3 0.6km

Water

WATER, LAND & SOIL ▾ PROTECTED AREAS ▾ MONITORING & FLOW ▾ STATUS & RISK ▾ PRESSURES & ACTIVITIES ▾ TAKING ACTION ▾ HELP

Results

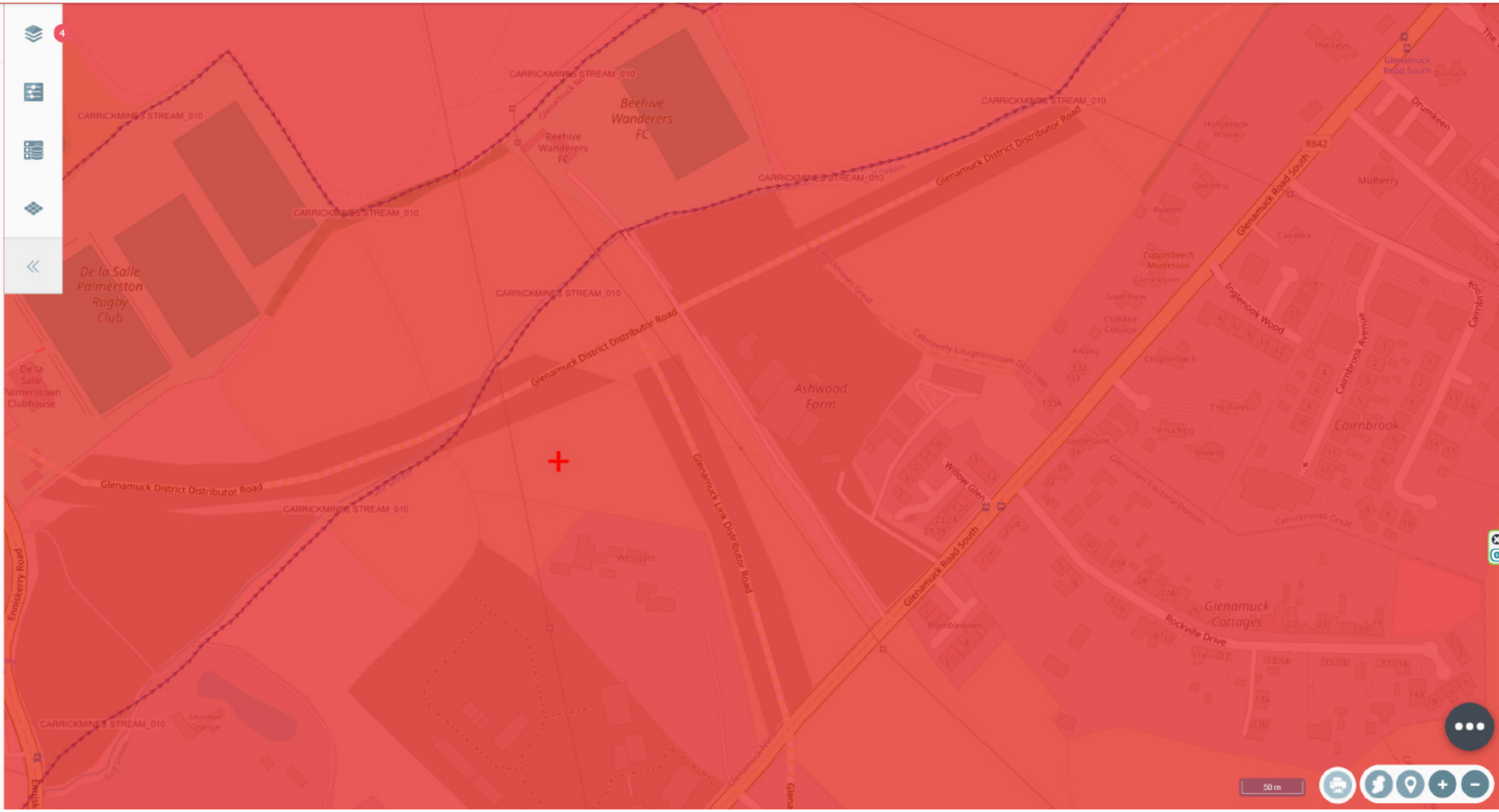
Keep Previous Results

GSI Bedrock Polygons 100k

Type 3 muscovite porphyritic

UnitName	Type 3 muscovite porphyritic
NewCode	IDNLGR3
SheetNumber	16
StratigraphicCode	Nt3
LithologicalCode	
Description	Granite with muscovite phenocrysts
Label	Nt3
AreaKm2	33.93640136
PerimeterM	28466.40039062

EXPORT



Water

WATER, LAND & SOIL · PROTECTED AREAS · MONITORING & FLOW · STATUS & RISK · PRESSURES & ACTIVITIES · TAKING ACTION · HELP

Results

Keep Previous Results

GSI Bedrock Polygons 100k

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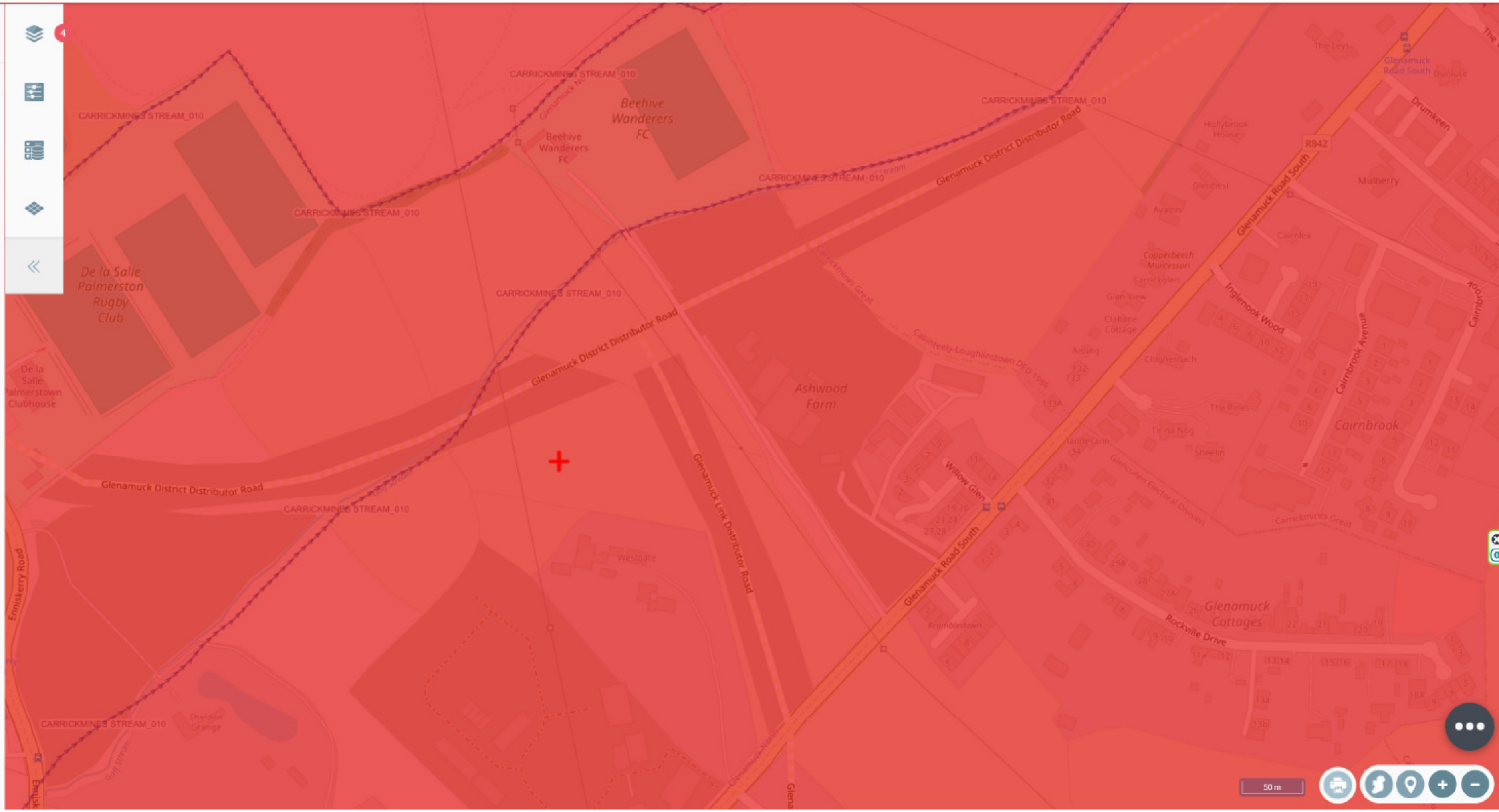
PerimeterM	28466.40039062

EXPORT



Water

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Results

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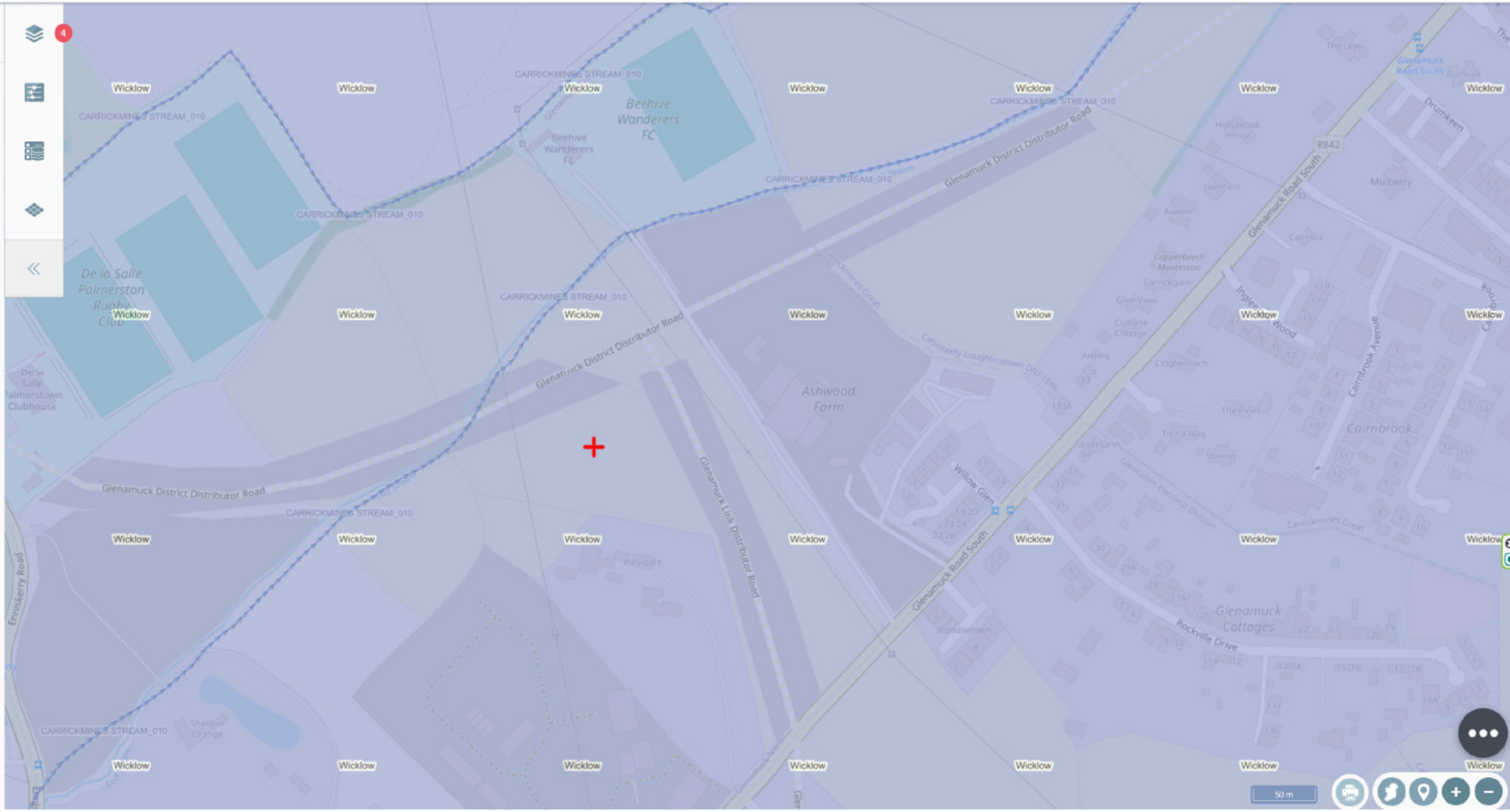
Ground Waterbodies

IE_EA_G_076

EU_CD	IE_EA_G_076
NAME	Wicklow
URL	View the Data Page
MS_CD	EA_G_076
Description	Poorly productive bedrock
EdenCode	<Null>
LOCALAUTHORITY	3400
AreaHectare	116876.63813407
AreaKm2	1168.76638134
Easting	318245.11
Northing	195048.95

EXPORT



Water

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Results

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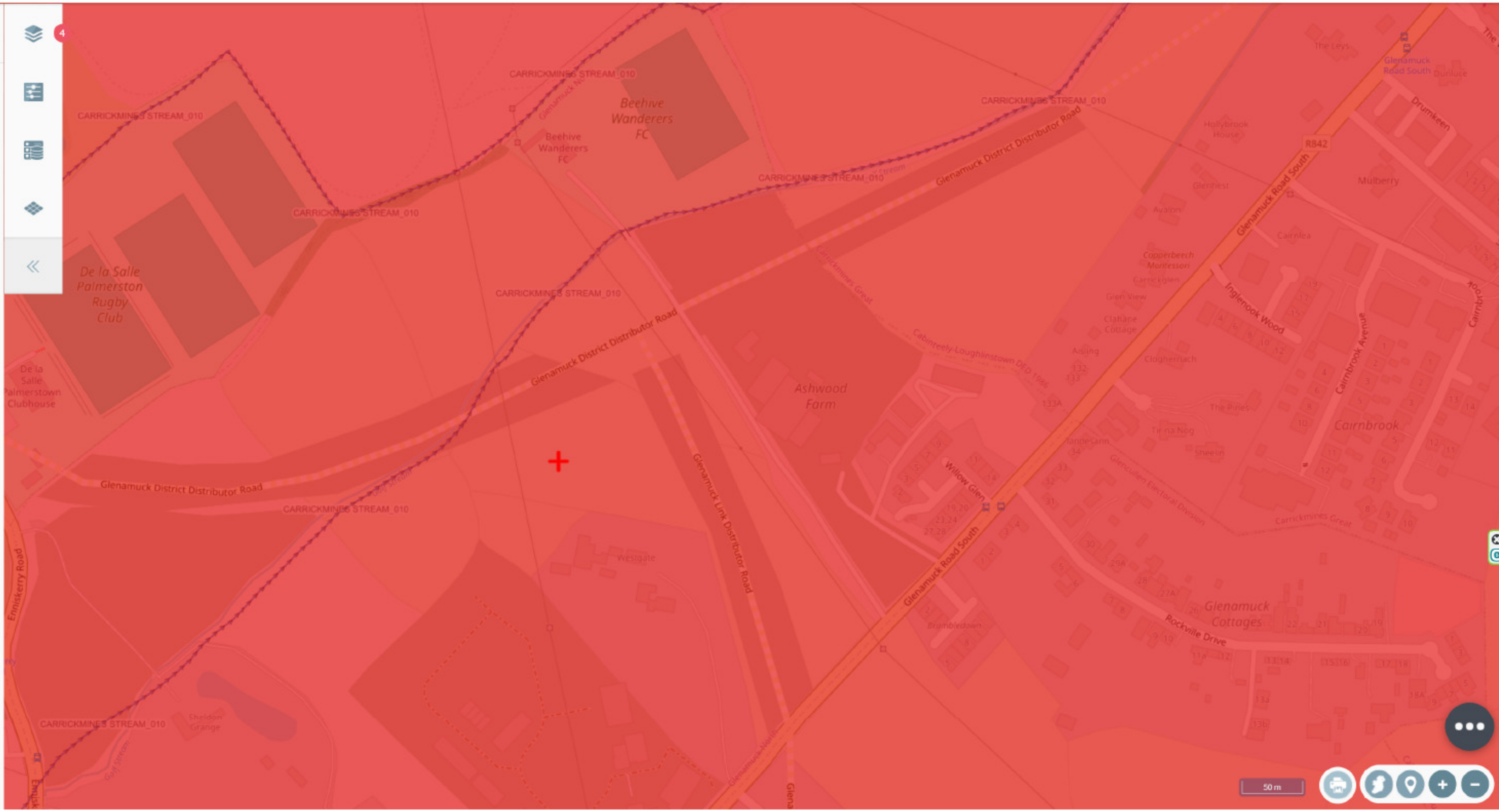
GSI Bedrock Polygons 100k

Type 3 muscovite porphyritic

UnitName	Type 3 muscovite porphyritic
NewCode	IDNLGR3
SheetNumber	16
StratigraphicCode	Nt3
LithologicalCode	
Description	Granite with muscovite phenocrysts
Label	Nt3
AreaKm2	33.93640136
PerimeterM	28466.40039062

EXPORT



Water

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Results

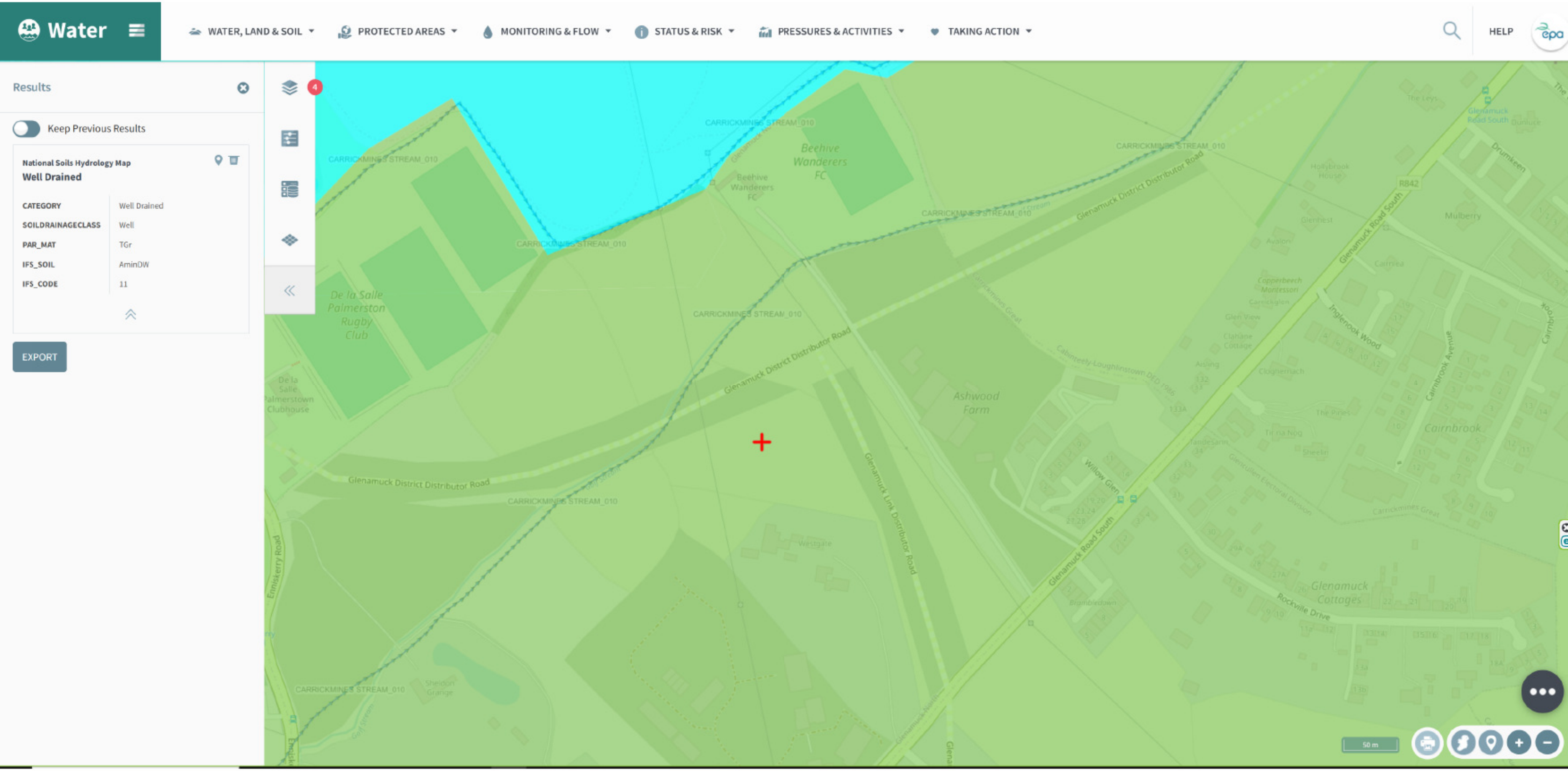
Keep Previous Results

National Soils Hydrology Map

Well Drained

CATEGORY	Well Drained
SOILDRAINAGECLASS	Well
PAR_MAT	TGr
IFS_SOIL	AminDW
IFS_CODE	11

EXPORT



Water
WATER, LAND & SOIL
PROTECTED AREAS
MONITORING & FLOW
STATUS & RISK
PRESSURES & ACTIVITIES
TAKING ACTION
HELP
Results
Keep Previous Results
National Soils Hydrology Map
Well Drained
CATEGORY Well Drained
SOILDRAINAGECLASS Well
PAR_MAT TGr
IFS_SOIL AminDW
IFS_CODE 11
EXPORT
Beehive Wanderers FC
De la Salle Palmerston Rugby Club
Ashwood Farm
CARRICKMINES STREAM_010
Glenamuck District Distributor Road
Glenamuck Link Distributor Road
Glenamuck Road South
Glenamuck Cottages
Rockville Drive
Cairnbrook
Cairnbrook Avenue
Inglenook Wood
Willow Glen
Drumkeen
Mulberry
Westgate
Enniskerry Road
50 m