KAVANAGH BURKE
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Drainage Design Report

for

Residential Development

at

Manor Avenue,
Wainsfort Grove,
Dublin 6W

Job No:	D1606-1
Client:	Sam Le Bas (for applicant Patricia Carmody)
Date:	April 2023
Local Authority:	South Dublin County Council
Revision:	PL2 Additional Information

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1. INTRODUCTION

This report details the site development works design for a residential development at Manor Avenue, Wainsfort Grove, Dublin 6W.

The land of the proposed development is bounded on all sides by residential properties. The development comprises 3 no. dwellings in total.

The site will be serviced primarily through the connection to the existing services in the area.

The provision of the new on-site surface water, foul sewer and watermain are described as follows with calculations appended.

2. SURFACE WATER

A new surface water drainage and various SuDS measures are proposed for this previously unattenuated brown field site.

To minimise surface water runoff from the site, only grass and permeable surfacing is incorporated both to the front and to the back of the dwellings and to the driveway and carpark area. The risk of debris ingress from the subject site will be low due to its relatively small size. However, any possible silts present on site can be intercepted through trapped gullies, washing out of the attenuation system StormTech isolator row and/or utilising the silt storage within the proprietary petrol interceptor. All private storm drainage will be connected through the private collector pipe located in the rear gardens of the proposed dwellings. This collector pipe will directly discharge to the manhole and petrol interceptor prior entering attenuation system.

"StormTech" or similar approved proprietary system consists of thermoplastic arches backfilled in specified stone and wrapped in a pervious geotextile. Prior to entering the system, the surface water runoff will pass through a proprietary petrol interceptor to ensure debris, silt particles and hydrocarbons are removed. Subsequently the surface runoff enters the attenuation facility through an "isolator row" whereby a row of void forming thermoplastic arches are wrapped in a pervious geotextile which provides a second level of suspended solid removal prior to the water entering the greater attenuation area.

A proprietary Petrol Interceptor provided will improve the quality of the discharge by capturing all possible hydrocarbons pollution from the proposed car parking.

Discharge form proposed development is proposed to the existing surface water manhole located at Manor Avenue, as shown on enclosed drg.ref. D1606-1-KB-XX--DW-DR-C-0001-PL2 - Drainage & Watermain Layout.

The following figures synopsise the surface water attenuation calculations:

Site area (red line)	*1,328 m²*
CATCHMENT AREA	892 m²
SAAR	729
SOIL VALUE	0.3

STRUCTURE TYPE	RUNOFF COEFFICIENTS	AREA (ha)
Roofs	1.0	0.0228
Green Roof	0.8	0.0077
Concrete footpath	1.0	0.0138
Permeable surfacing	0.8	0.0245
Contributing Landscaping	0.3	0.0205
TOTAL	-	**0.089**

Details of the surface water attenuation system including SuDS measures, interceptors, flow restrictions, volume and pipe designs are attached in this Drainage Design Report and on the accompanying Drainage details layout (drawing reference D1606-1-KB-XX--DW-DR-C-0001-PL2 - Drainage & Watermain Layout) for a review by the Local Authority.

SuDS Management Plan

Runoff from the hardstanding areas will be collected by various SuDS devices (such as green roof, tree pits, bioretention area and permeable paving) and rainwater goods and trapped road gullies throughout the development and directed to an on-site surface water attenuation facility. This facility is designed to attenuate 1 in 30-year storm event of any duration. Therefore, no flooding will occur on site for any duration events up to 30 year return period as per "Greater Dublin Strategic Drainage Study" (GDSDS) requirements. In addition to providing attenuation volume, temporary flood storage is check and provided where needed (as an integrated part of the attenuation system) for 100-year return events as per GDSDS requirements. The restricted discharge from site will be limited by a proprietary flow control device provided at the outfall manhole SW 03, designed to control the flow to 2 l/sec. The flow rate value of 2l/s is the practical minimum for an orifice size within the proprietary vortex flow control device, as advised by numerous flow control device manufactures).
All flows and runoffs for storm water network design and attenuation sizing are calculated incorporating 20% climate change factor for all rainfall intensities as per chapter 6.3.2.4 of GDSDS table 6.2 "Climate Change Factors". In addition, a computer analysis in the storm network modelling software was performed to confirm the sizing of the pipe network and underground attenuation storage for 1 in 100-year storms of all durations. This analysis includes a specific model of vortex flow control device with discharge of the calculated QBAR and 20% Climate Change Factor. The analysis indicated no on-site flooding (meaning that both the network and all proposed attenuation storage have sufficient capacities).

SuDS Treatment Train

The treatment train approach was applied to both the storm water network and the attenuation design to ascertain that both runoff quality and quantity are appropriately addressed. An array of techniques was used to fulfil requirements of each element of the treatment train:

- Pollution prevention –

To prevent chemicals and other pollutants from contaminating the rainfall runoff, a maintenance regime for the proposed development will be established. A proprietary petrol interceptor will be provided on the surface water drainage network to intercept debris, silts and hydrocarbons and prevent them from entering the attenuation system and from being discharged to the soil or receiving watercourse.

- Source control –

To detain and infiltrate the runoff as close as possible to the point of origin. The infiltration of the surface water, promoting water disposal at source and limiting the discharge to the SW network was proposed throughout the site, with the following measures being proposed in place:

  - Permeable paving,
  - Tree pits.

Permeable surfacing with integrated infiltration pit below is proposed to driveway and car parking bays. Any runoff from the permeable paving area will be discharged to the angular stone filled infiltration pit below the permeable paving blocks. This will ensure storing any storm water runoff with possibility of infiltration to the ground. In case of the rainfall event exceeding the capacity of the infiltration pit, runoff water will be collected by trap gullies and directed to the surface water pipe and attenuation facility provided on site. The same approach applies to tree pits.

- Site control –

To deal with as much of the runoff as possible within the site, it is proposed to use the green roof and soft landscaping on site for the interception storage. This interception storage is provided to capture first 5mm of any rainfall and store it until it will dissipate by infiltration to the soil beneath or evaporation. This will reduce the quantity of water that discharges from the site.

- Regional control –

To mimic the behaviour of the green field site and protect the receiving watercourse, the underground attenuation storage is designed to cater for all durations of rainfall up to 30-year return period with 20% climate change factor applied. These attenuation systems have also been designed to cater for 1 in 100-year storms of all durations exceeding the requirements of Greater Dublin Strategic Drainage Study (GDSDS).

Proposed SuDS elements

In considering the above surface water management solution, we considered all SuDS devices and a following range of measures are proposed to be incorporated into the development, as follows:

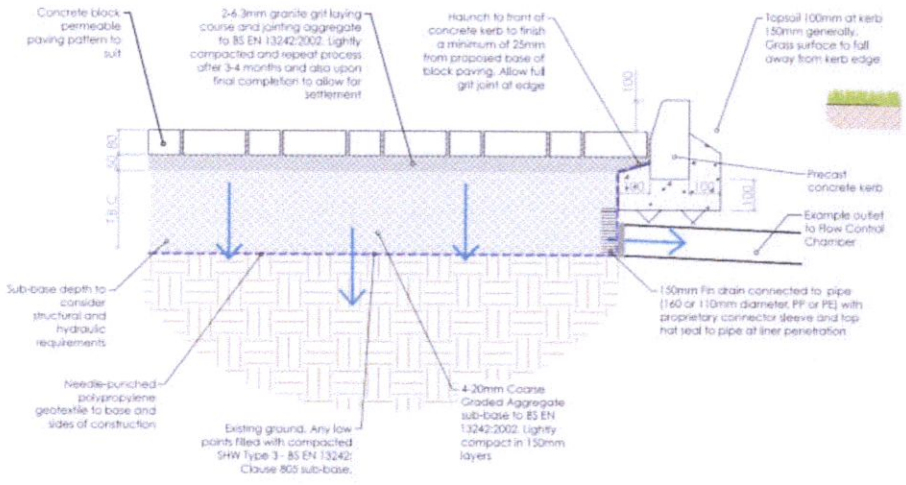
- Permeable surfacing,
- Green roof,
- Green walls,
- Tree pits,
- Bioretention area,
- Trapped Road Gullies (to collect run-off from concrete surfaces);
- Restricted discharge (to the outlets of all attenuation systems for regional control);

- Silt trap and petrol interceptor (to the inlets of all attenuation systems for pollution prevention).
- Underground attenuation system,

Permeable surfacing

Proposed pervious surfacing will allow for infiltration of the storm water runoff from it into the underlying stone and soil. This system not only reduces the quantity of runoff, but it also has a positive impact on water quality. Due to the shallow nature of the underlying build-up, permeable paving can be utilised even on sites with high ground water levels where other deeper infiltration devices would not work.

Detail 2 - Permeable Paving (System B) with Partial Infiltration



Green Roof

An extensive (sedum type) green roof is proposed to some portion of the proposed dwellings roofs. The roof substrate will be made up of fabric mats sown with sedum planting. This roof type allows for storm water interception and disposal through transpiration and evaporation. In addition to quantity reduction, the green roofs will improve the quality of the runoff and will become a wildlife habitat, improve biodiversity and boost the environmental credentials of the development. According to CIRIA 697 SUDS Manual, typical green roofs should attenuate storms up to a two-year return period event.

Green Walls

Green walls will create more visually appealing and dynamic facades that sway in the breeze and change with the seasons. These dense facade coverings will not only help to break the monotony of cladding surfaces but will also help to create efficient building envelope, minimizing heat loss and cooling loads, reducing rainwater runoff and filtering pollutants out of the air.

Tree Pits

Tree pits will be provided with overflow pipes discharging excess runoff to the proposed on-site storage system from which the storm water will be discharged to the existing storm water network at green field runoff rate.

Bioretention Area

Bioretention area (or rain gardens) use soil, plants and microbes to treat stormwater before it is infiltrated or discharged. Stormwater runoff flows into the bioretention area, percolates through the soil (which acts as a filter) and eventually drains into the groundwater; some of the water is also absorbed by the plants. They are usually designed to allow ponded water and with an overflow outlet to prevent flooding during larger storm events. Where soils have low permeability or where faster drainage is desired, designers may incorporate a perforated underdrain that routes to a storm drain system. Bioretention areas can provide excellent pollutant removal and recharge for the "first flush" of stormwater runoff. Properly designed bioretention areas will remove suspended solids, metals, and nutrients. Distributed around a property, bioretention areas can enhance site aesthetics.

3. FOUL SEWER

A new foul sewer has been designed to collect the discharge both from the proposed dwellings and from the existing properties in vicinity of the proposed foul network, and discharge to an existing foul sewer manhole located at Manor Avenue/Wainsfort Grove. Connection to the existing foul sewer network is proposed to an existing manhole at the junction of Wainsfort Grove and Manor Avenue, the exact connection location and discharge route is shown on accompanying drawing reference D1606-1-KB-XX--DW-DR-C-0001-PL2 - Drainage & Watermain Layout.

An average of 6 discharge units per dwelling is used in the design of the network (the method of calculating the total discharge units from the development is carried out in accordance with BS EN 752-4:1998 "Drain and sewer systems outside buildings", refer to insert below for the relative tabulated extract).

Table C.1 — Typical frequency factors (k_{DU})

Type of building	k_{DU}
Dwelling, guesthouse, office (intermittent use)	0.5
Hospital, school, restaurant, hotel (frequent use)	0.7
Toilets and/or shower open to the public (congested use)	1.0
Laboratory buildings (special use)	1.2

Table C.2 — Typical values of discharge units (DU)

Type of appliance	DU
Washbasin, shower	0.3 to 0.6
Urinal	0.3 to 0.8
Bath, kitchen sink	0.8 to 1.3
Dishwasher	0.2 to 0.8
Household washing machine	0.5 to 0.8
Commercial washing machine	1.0 to 1.5
WCs (4.0 l to 9.0 l cistern)	1.2 to 2.5
Floor drains (DN 50 to DN 100)	0.6 to 2.0
The discharge unit will depend on the type of drainage system inside the building and the size of the appliance. Where no specific information is available, the higher value should be used.	

The proposed foul sewer including manholes and service connections will be constructed in compliance with design standards set out by Irish Water in the IW Code of Practice for Wastewater Infrastructure and Wastewater Infrastructure Standard Details.

Foul sewer drainage calculations are enclosed in the chapter "Foul Network Design", demonstrating the design flows and pipe capacities of the proposal, for a review of the Local Authority.

4. WATERMAIN

Water supply to 3 No. proposed dwellings will be provided through a new 100ø watermain connection to the existing Local Authority watermain in Manor Avenue/Wainsfort Grove.

New 100mm dia. HDPE watermain within the site will be provided with adequate sluice valves, bulk water meter & fire hydrants. Hydrants will not be placed within 6.0m of a building or structure and at a maximum 46.0m from proposed buildings. All associated details including watermain pipe material will be in accordance with the current Irish Water guidelines. Guidelines set out in the Irish Water Publications IW-CDS_5020-1 & IW-CDS-5030-1 have been consulted and adopted within the design of the proposed drainage & watermain networks.

BCAR system of inspections and certification will be adopted to ensure all fire safety elements are designed and implemented as per Part B of Technical Guidance Documents as well.

Refer to a drawing ref D1606-1-KB-XX--DW-DR-C-0001-PL2 for details of the proposal enclosed for a Local Authority review.

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Surface Water Attenuation Design

- StormTech Cumulative Spreadsheet of proposed system

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Surface Water Attenuation Calculation

1) Areas for Attenuation Calculation

Site Area (red line)	1328 m² (0.133 ha)
Catchment Area (*as shown in dashed line at enclosed drg. ref. D1602-1-KB-XX-DW-DR-C-0001-PL2*)	892 m² (0.089 ha)

	Runoff coefficient	Areas
Contributing Landscaping:	*0.3*	205 m²
Green Roof	*0.8*	76.5 m²
Roofs (impervious area)	*1.0*	227.5 m²
Footpaths	*1.0*	138 m²
Permeable surfacing (driveway, carparking bays)	*0.8*	245 m²
TOTAL IMPERV. AREAS:		687 m²

2) Interception Storage

Calculate runoff from 5mm of rainfall on developed area.
For this calculation only hardstanding areas are assumed to provide 80% runoff, and non-hardstanding areas are assumed to provide 0% runoff.

The equivalent volume of Interception Storage should be provided on site as no discharge from site should occur for this initial 5mm depth of rainfall. The Interception Storage on this subject site will be provided through the base of attenuation tank located in the concrete yard.

Design Impermeable Areas: 687 m² x 0.80 = 549.6 m²

Total volume for 5mm rainfall: 5mm x 549.6 m² = **2.75 m³**

Therefore, a minimum Interception Storage volume of 2.75 m³ should be provided. This will prevent discharge from the site during rainfall events of up to 5mm rainfall. It is proposed to use the green roof and soft landscaping on site for interception storage for 5mm and smaller rainfall events.

Research from around the world indicates that Green Roofs reduce annual run-off from roofs by at least 50%, and more usually by 60-70% - contributing to urban drainage and flood alleviation schemes. Moreover, the rate of release following heavy rainfall is slowed, reducing the problems associated with

storm surges. With an increasing need for developments to have limited water runoff, the UK's Environment Agency now highlight the use of green roofing in their May 2003 publication "Sustainable Drainage Systems (SUDS) – an introduction."

Proposed sedum blanket type roof thickness varies from 25mm to 45mm and it is installed on 80mm multi-layer roof substrate composed of mineral bulk mixture with a proportion of mineral and organic matter. Maximum water capacity of roof substrate layer is ≥35%.

Max Water Capacity for subject roof: 76.5m2 x 80mm x 35% = 2.14 m3

Max water capacity of the substrate will limit the water runoff from consecutive rainfall events since water from interception storage will not infiltrate to the subsoil but will be dealt with primarily by evaporation and to some extent used by the green roof plants.

Rainfall runoff from roofs can contain pollutants for example, from bird droppings and atmospheric pollution. As well, a standard roof covering such as bitumen will give off a range of pollutants under heat stress, which then are carried along with the runoff. One of the roles of a sustainable urban drainage system is to remove some if not all of this pollution. Green roofs can retain and bind contaminants that fall on their surface either as dust or dissolved in rainwater. Research by (Johnston et al, 2004) found that 95% of heavy metals are removed from runoff by green roofs and nitrogen levels can be reduced.

Interception will be also facilitated by other pre-treatment SuDS devices: permeable paving, bio-retention areas and pervious asphalt/open texture macadam to the access road to the development.

To provide an opportunity for surface water to infiltrate to ground prior to being attenuated, bioretention area and permeable surfacing to development's driveway and carparking bays have been provided. Any surface water not infiltrating will enter the SW pipe network and will be attenuated prior to discharge to the existing surface network in Manor Avenue.

3) Greenfield Runoff Rate – QBAR, (mean annual flood flow):

$Q_{BARrural}$ (m^3/sec) = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$

SAAR (E 313000, N 229800): 729 mm (*as per Met Eireann data*)

Soil Index:
S1 (very low runoff)
S2
S3 (moderate runoff)
S4
S5 (very high runoff)

Soil = 0.1($Soil_1$) + 0.3($Soil_2$) + 0.37($Soil_3$) + 0.47($Soil_4$) + 0.53($Soil_5$)

As the site is relatively small in catchment terms the soil class will be 100% Soil2 as per online Wallingford Procedure Greenfield runoff estimation tool on www.uksuds.com (*refer to chapter: Surface Water Design for the HR Wallingford Greenfield runoff rate estimation report and details*).

Soil Class: $Soil_2$
Runoff Potential: Low
Soil Value: 0.3

Q_{BAR}:
As the site area is less than 50 hectares, QBAR for 50 hectares is firstly calculated:

Q_{BAR} (m^3/sec) = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$ =
0.00108 x $(0.5)^{0.89}$ x $(729)^{1.17}$ x $(0.3)^{2.17}$ =
95.55 l/sec =
1.91 l/sec/ha

Q_{BAR} for the subject site area (overall catchment area):

1.91 l/sec/ha x 0.133ha =
Q_{BAR} = 0.25 l/sec

According to GDSDS chapter 6.3.1.4 if the separate long-term storage cannot be provided and temporary flood storage forms part of the single attenuation system, all the runoff from the site should be discharged at either a rate of 2.0 l/s/ha or the average annual peak flow rate Q_{BAR}, whichever is greater.

Minimum achievable hydro brake flow rate is 2 l/sec therefore allowable discharge will be set at 2 l/sec (i.e. flow rate of 2l/s is the practical minimum for an orifice size within the proprietary vortex flow control device, as advised by numerous flow control device manufactures).

4) Attenuation Storage Volume

Refer to enclosed Surface Water Network Design chapter in this Design Report for detailed storm water network modelling and attenuation storages volumes check with a specific Hydrobrake flow control devices included in the analysis. Storages were checked for storm durations up to 3 days for 1 year, 2 years, 30 years and 100 years return period including 20% CCF.

In summary:

INTERCEPTION STORAGE:

2.75m³ – to be provided by various SuDS devices

ATTENUATION VOLUME REQUIRED:

18.2m³ to be provided within the underground attenuation system on site.

TEMPORARY FLOOD STORAGE:

The proposed attenuation storage will accommodate all rainfall events of all durations up to 1 in 100 years return. Therefore, no separate flood storage is required.

TOTAL ATTENUATION VOLUME PROVIDED: 19 m³

Storm Water Network analysis and Attenuation Tank Size checks were performed using a computer hydraulic analysis software. The analysis did not highlight any ponding for any storm durations up to 1:100y return therefore the network and attenuation capacity calculated above are satisfactory.
The results of the analysis are included in this report.

Project: **Wainsfort Grove PL2 AI**

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model -	SC-740	
Units -	**Metric**	Click Here for Imperial
Number of chambers -	8	
Voids in the stone (porosity) -	43	%
Base of Stone Elevation -	47.47	m
Amount of Stone Above Chambers -	155	mm
Amount of Stone Below Chambers -	155	mm
Area of system -	30	sq.meters

☑ Include Perimeter Stone in Calculations

Min. Area - 25.124 sq.meters

StormTech SC-740 Cumulative Storage Volumes

Height of System *(mm)*	Incremental Single Chamber *(cubic meters)*	Incremental Total Chamber *(cubic meters)*	Incremental Stone *(cubic meters)*	Incremental Ch & St *(cubic meters)*	Cumulative Chamber *(cubic meters)*	Elevation *(meters)*
1067	0.00	0.00	0.33	0.33	19.699	48.54
1041	0.00	0.00	0.33	0.33	19.371	48.51
1016	0.00	0.00	0.33	0.33	19.043	48.49
991	0.00	0.00	0.33	0.33	18.715	48.46
965	0.00	0.00	0.33	0.33	18.388	48.44
940	0.00	0.00	0.33	0.33	18.060	48.41
914	0.00	0.01	0.32	0.33	17.732	48.38
889	0.00	0.04	0.31	0.35	17.397	48.36
864	0.01	0.06	0.30	0.36	17.049	48.33
838	0.02	0.14	0.27	0.41	16.684	48.31
813	0.02	0.18	0.25	0.43	16.279	48.28
787	0.03	0.22	0.24	0.45	15.847	48.26
762	0.03	0.24	0.22	0.47	15.397	48.23
737	0.03	0.27	0.21	0.48	14.930	48.21
711	0.04	0.29	0.20	0.49	14.450	48.18
686	0.04	0.31	0.20	0.50	13.959	48.16
660	0.04	0.33	0.19	0.52	13.456	48.13
635	0.04	0.35	0.18	0.52	12.941	48.11
610	0.04	0.36	0.17	0.53	12.416	48.08
584	0.05	0.37	0.17	0.54	11.884	48.05
559	0.05	0.38	0.16	0.55	11.344	48.03
533	0.05	0.40	0.16	0.55	10.797	48.00
508	0.05	0.41	0.15	0.56	10.243	47.98
483	0.05	0.42	0.15	0.57	9.683	47.95
457	0.05	0.43	0.14	0.57	9.115	47.93
432	0.05	0.44	0.14	0.58	8.543	47.90
406	0.06	0.45	0.14	0.58	7.966	47.88
381	0.06	0.46	0.13	0.59	7.383	47.85
356	0.06	0.46	0.13	0.59	6.796	47.83
330	0.06	0.47	0.13	0.60	6.204	47.80
305	0.06	0.48	0.12	0.60	5.608	47.77
279	0.06	0.48	0.12	0.60	5.009	47.75
254	0.06	0.49	0.12	0.61	4.406	47.72
229	0.06	0.49	0.12	0.61	3.800	47.70
203	0.06	0.50	0.11	0.61	3.191	47.67
178	0.06	0.50	0.11	0.61	2.579	47.65
152	0.00	0.00	0.33	0.33	1.966	47.62
127	0.00	0.00	0.33	0.33	1.639	47.60
102	0.00	0.00	0.33	0.33	1.311	47.57
76	0.00	0.00	0.33	0.33	0.983	47.55
51	0.00	0.00	0.33	0.33	0.655	47.52
25	0.00	0.00	0.33	0.33	0.328	47.50

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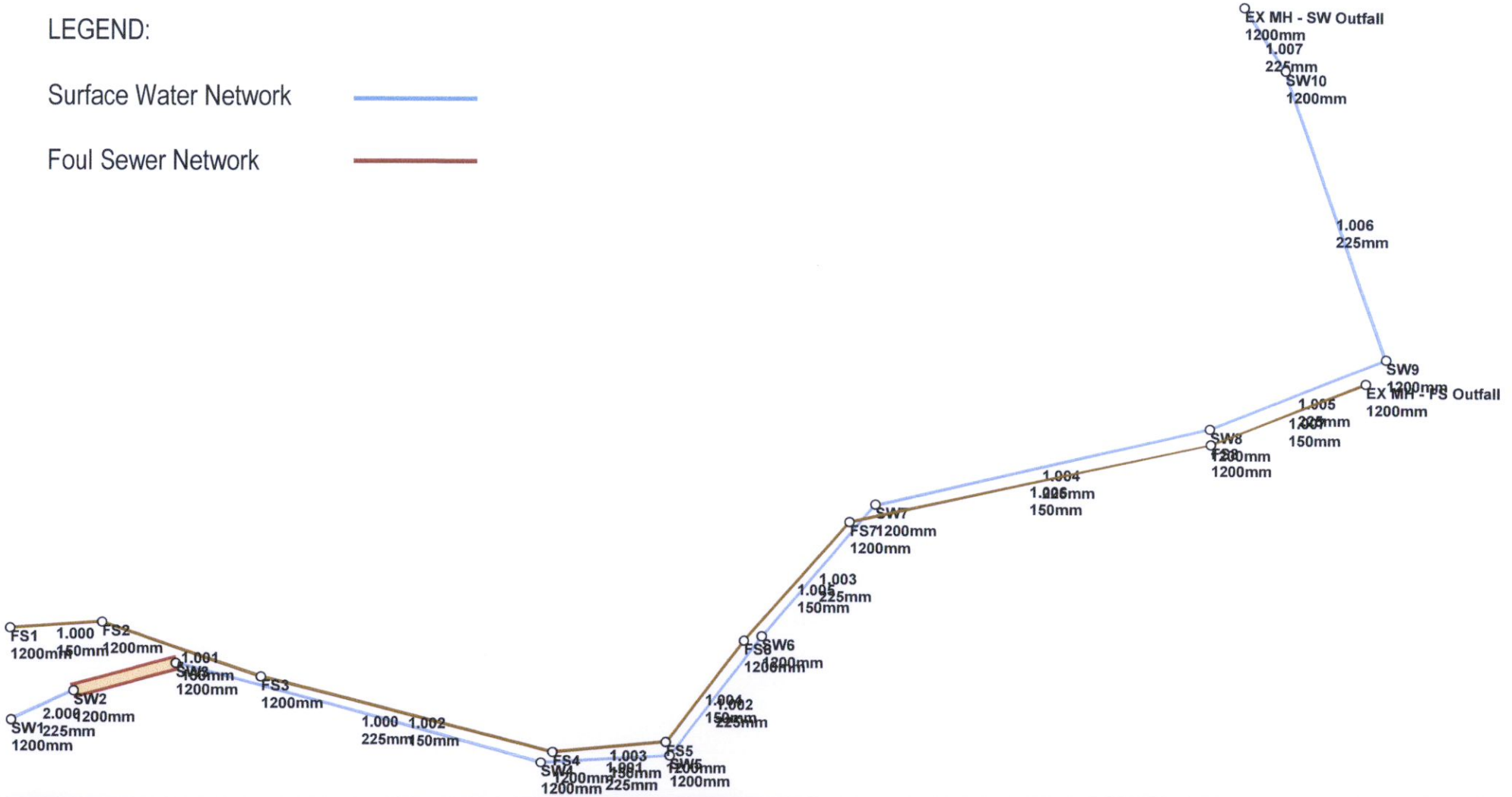
Surface Water Network Design

LEGEND:

Surface Water Network

Foul Sewer Network



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	20	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.600	Minimum Backdrop Height (m)	0.200
Ratio-R	0.276	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Equivalent Runoff Areas used for network design and analysis including 100% impermeable areas + 30% landscaping

Nodes

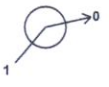
Name	Area (ha)	T of E (mins)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Easting (m)	Northing (m)
SW1	0.075	5.00	49.450	Manhole	Storm MH	1200	712958.211	729786.821
SW2			49.550	Manhole	Storm MH	1200	712966.333	729790.698
SW3		5.00	49.500	Manhole	Storm MH	1200	712977.837	729794.858
SW4	0.020	5.00	49.500	Manhole	Storm MH	1200	713028.013	729781.208
SW5			49.750	Manhole	Storm MH	1200	713044.982	729782.246
SW6	0.034	5.00	49.550	Manhole	Storm MH	1200	713057.112	729798.147
SW7			49.450	Manhole	Storm MH	1200	713071.916	729815.750
SW8			49.400	Manhole	Storm MH	1200	713115.747	729825.941
SW9			48.650	Manhole	Storm MH	1200	713138.932	729835.292
SW10			48.100	Manhole	Storm MH	1200	713125.451	729873.642
EX MH - SW Outfall			48.100	Manhole	Storm MH	1200	713119.968	729882.005

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	SW1	SW2	9.000	1.500	48.050	48.000	0.050	180.0	225	5.18	50.0
1.000	SW3	SW4	52.000	1.500	47.470	47.250	0.220	236.4	225	6.16	48.9
1.001	SW4	SW5	17.001	1.500	47.250	47.170	0.080	212.5	225	6.52	47.8
1.002	SW5	SW6	19.999	1.500	47.170	47.080	0.090	222.2	225	6.96	46.5
1.003	SW6	SW7	23.001	1.500	47.080	46.980	0.100	230.0	225	7.47	45.1
1.004	SW7	SW8	45.000	1.500	46.980	46.780	0.200	225.0	225	8.45	42.7
1.005	SW8	SW9	25.000	1.500	46.780	46.670	0.110	227.3	225	9.00	41.5
1.006	SW9	SW10	40.650	1.500	46.670	46.490	0.180	225.8	225	9.89	39.8
1.007	SW10	EX MH - SW Outfall	10.000	1.500	46.490	46.440	0.050	200.0	225	10.09	39.4

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Add Inflow (l/s)	Pro Velocity (m/s)
2.000	0.854	34.0	12.2	1.175	1.325	1.175	1.325	0.0	0.786
1.000	0.745	29.6	0.0	1.805	2.025	1.805	2.025	0.0	0.000
1.001	0.786	31.2	3.1	2.025	2.355	2.025	2.355	0.0	0.499
1.002	0.768	30.5	3.0	2.355	2.245	2.245	2.355	0.0	0.488
1.003	0.755	30.0	7.9	2.245	2.245	2.245	2.245	0.0	0.636
1.004	0.763	30.4	7.5	2.245	2.395	2.245	2.395	0.0	0.632
1.005	0.760	30.2	7.3	2.395	1.755	1.755	2.395	0.0	0.625
1.006	0.762	30.3	7.0	1.755	1.385	1.385	1.755	0.0	0.619
1.007	0.810	32.2	6.9	1.385	1.435	1.385	1.435	0.0	0.645

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW1	49.450	1.400	1200		0	2.000	48.050	225
SW2	49.550	2.047	1200		1	2.000	48.000	225
SW3	49.500	2.030	1200		0	1.000	47.470	225
SW4	49.500	2.250	1200		1	1.000	47.250	225
					0	1.001	47.250	225
SW5	49.750	2.580	1200		1	1.001	47.170	225
					0	1.002	47.170	225
SW6	49.550	2.470	1200		1	1.002	47.080	225
					0	1.003	47.080	225
SW7	49.450	2.470	1200		1	1.003	46.980	225
					0	1.004	46.980	225
SW8	49.400	2.620	1200		1	1.004	46.780	225
					0	1.005	46.780	225
SW9	48.650	1.980	1200		1	1.005	46.670	225
					0	1.006	46.670	225
SW10	48.100	1.610	1200		1	1.006	46.490	225
					0	1.007	46.490	225
EX MH - SW Outfall	48.100	1.660	1200		1	1.007	46.440	225

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	Scotland and Ireland	Skip Steady State	x
M5-60 (mm)	17.600	Drain Down Time (mins)	240
Ratio-R	0.276	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200
30	120	240	480	720	1440	2880	5760	

20% CCF used

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	0	0
2	20	0	0
10	20	0	0
30	20	0	0
100	20	0	0

Node SW3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	47.550	Product Number	CTL-SHE-0067-2000-0990-2000
Design Depth (m)	0.990	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Qbar for the overall site. Refer to calculations in this report.

Node SW3 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	10.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	47.470	Main Channel Slope (1:X)	300.0
Safety Factor	2.0	Time to half empty (mins)	140	Main Channel n	0.015

Inlets
SW2

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	17.0	0.0	1.070	17.0	0.0	1.080	0.5	0.0

Proposed attenuation storage: 1.07m x 17m2 = 18.2m3

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year +20% CC 15 minute summer	113.520	32.122
1 year +20% CC 15 minute winter	79.663	32.122
1 year +20% CC 30 minute summer	77.976	22.065
1 year +20% CC 30 minute winter	54.720	22.065
1 year +20% CC 60 minute summer	55.559	14.683
1 year +20% CC 60 minute winter	36.912	14.683
1 year +20% CC 120 minute summer	36.356	9.608

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year +20% CC 120 minute winter	24.154	9.608
1 year +20% CC 180 minute summer	29.024	7.469
1 year +20% CC 180 minute winter	18.866	7.469
1 year +20% CC 240 minute summer	23.620	6.242
1 year +20% CC 240 minute winter	15.692	6.242
1 year +20% CC 360 minute summer	18.787	4.835
1 year +20% CC 360 minute winter	12.212	4.835
1 year +20% CC 480 minute summer	15.252	4.031
1 year +20% CC 480 minute winter	10.133	4.031
1 year +20% CC 600 minute summer	12.799	3.501
1 year +20% CC 600 minute winter	8.745	3.501
1 year +20% CC 720 minute summer	11.705	3.137
1 year +20% CC 720 minute winter	7.866	3.137
1 year +20% CC 960 minute summer	9.910	2.610
1 year +20% CC 960 minute winter	6.565	2.610
1 year +20% CC 1440 minute summer	7.510	2.013
1 year +20% CC 1440 minute winter	5.047	2.013
1 year +20% CC 2160 minute summer	5.615	1.552
1 year +20% CC 2160 minute winter	3.869	1.552
1 year +20% CC 2880 minute summer	4.818	1.291
1 year +20% CC 2880 minute winter	3.238	1.291
1 year +20% CC 4320 minute summer	3.809	0.996
1 year +20% CC 4320 minute winter	2.509	0.996
1 year +20% CC 5760 minute summer	3.229	0.826
1 year +20% CC 5760 minute winter	2.090	0.826
1 year +20% CC 7200 minute summer	2.804	0.715
1 year +20% CC 7200 minute winter	1.810	0.715
2 year +20% CC 15 minute summer	136.954	38.753
2 year +20% CC 15 minute winter	96.108	38.753
2 year +20% CC 30 minute summer	93.872	26.562
2 year +20% CC 30 minute winter	65.875	26.562
2 year +20% CC 60 minute summer	66.748	17.639
2 year +20% CC 60 minute winter	44.346	17.639
2 year +20% CC 120 minute summer	43.293	11.441
2 year +20% CC 120 minute winter	28.763	11.441
2 year +20% CC 180 minute summer	34.320	8.832
2 year +20% CC 180 minute winter	22.309	8.832
2 year +20% CC 240 minute summer	27.897	7.372
2 year +20% CC 240 minute winter	18.534	7.372
2 year +20% CC 360 minute summer	22.113	5.690
2 year +20% CC 360 minute winter	14.374	5.690
2 year +20% CC 480 minute summer	17.897	4.730
2 year +20% CC 480 minute winter	11.890	4.730
2 year +20% CC 600 minute summer	14.980	4.097
2 year +20% CC 600 minute winter	10.235	4.097
2 year +20% CC 720 minute summer	13.597	3.644
2 year +20% CC 720 minute winter	9.138	3.644
2 year +20% CC 960 minute summer	11.503	3.029
2 year +20% CC 960 minute winter	7.620	3.029

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +20% CC 1440 minute summer	8.693	2.330
2 year +20% CC 1440 minute winter	5.842	2.330
2 year +20% CC 2160 minute summer	6.470	1.788
2 year +20% CC 2160 minute winter	4.458	1.788
2 year +20% CC 2880 minute summer	5.530	1.482
2 year +20% CC 2880 minute winter	3.716	1.482
2 year +20% CC 4320 minute summer	4.348	1.137
2 year +20% CC 4320 minute winter	2.863	1.137
2 year +20% CC 5760 minute summer	3.670	0.939
2 year +20% CC 5760 minute winter	2.375	0.939
2 year +20% CC 7200 minute summer	3.176	0.810
2 year +20% CC 7200 minute winter	2.050	0.810
10 year +20% CC 15 minute summer	198.836	56.264
10 year +20% CC 15 minute winter	139.534	56.264
10 year +20% CC 30 minute summer	135.628	38.378
10 year +20% CC 30 minute winter	95.178	38.378
10 year +20% CC 60 minute summer	95.045	25.118
10 year +20% CC 60 minute winter	63.146	25.118
10 year +20% CC 120 minute summer	60.928	16.102
10 year +20% CC 120 minute winter	40.479	16.102
10 year +20% CC 180 minute summer	47.958	12.341
10 year +20% CC 180 minute winter	31.174	12.341
10 year +20% CC 240 minute summer	38.604	10.202
10 year +20% CC 240 minute winter	25.648	10.202
10 year +20% CC 360 minute summer	30.263	7.788
10 year +20% CC 360 minute winter	19.672	7.788
10 year +20% CC 480 minute summer	24.310	6.424
10 year +20% CC 480 minute winter	16.151	6.424
10 year +20% CC 600 minute summer	20.223	5.531
10 year +20% CC 600 minute winter	13.817	5.531
10 year +20% CC 720 minute summer	18.260	4.894
10 year +20% CC 720 minute winter	12.272	4.894
10 year +20% CC 960 minute summer	15.315	4.033
10 year +20% CC 960 minute winter	10.145	4.033
10 year +20% CC 1440 minute summer	11.453	3.069
10 year +20% CC 1440 minute winter	7.697	3.069
10 year +20% CC 2160 minute summer	8.448	2.335
10 year +20% CC 2160 minute winter	5.821	2.335
10 year +20% CC 2880 minute summer	7.172	1.922
10 year +20% CC 2880 minute winter	4.820	1.922
10 year +20% CC 4320 minute summer	5.587	1.461
10 year +20% CC 4320 minute winter	3.679	1.461
10 year +20% CC 5760 minute summer	4.695	1.202
10 year +20% CC 5760 minute winter	3.039	1.202
10 year +20% CC 7200 minute summer	4.050	1.033
10 year +20% CC 7200 minute winter	2.614	1.033
30 year +20% CC 15 minute summer	252.443	71.433
30 year +20% CC 15 minute winter	177.153	71.433
30 year +20% CC 30 minute summer	172.992	48.951

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +20% CC 30 minute winter	121.398	48.951
30 year +20% CC 60 minute summer	120.498	31.844
30 year +20% CC 60 minute winter	80.056	31.844
30 year +20% CC 120 minute summer	76.613	20.247
30 year +20% CC 120 minute winter	50.900	20.247
30 year +20% CC 180 minute summer	59.958	15.429
30 year +20% CC 180 minute winter	38.974	15.429
30 year +20% CC 240 minute summer	48.051	12.699
30 year +20% CC 240 minute winter	31.924	12.699
30 year +20% CC 360 minute summer	37.426	9.631
30 year +20% CC 360 minute winter	24.328	9.631
30 year +20% CC 480 minute summer	29.920	7.907
30 year +20% CC 480 minute winter	19.878	7.907
30 year +20% CC 600 minute summer	24.796	6.782
30 year +20% CC 600 minute winter	16.942	6.782
30 year +20% CC 720 minute summer	22.319	5.982
30 year +20% CC 720 minute winter	15.000	5.982
30 year +20% CC 960 minute summer	18.629	4.905
30 year +20% CC 960 minute winter	12.340	4.905
30 year +20% CC 1440 minute summer	13.835	3.708
30 year +20% CC 1440 minute winter	9.298	3.708
30 year +20% CC 2160 minute summer	10.132	2.800
30 year +20% CC 2160 minute winter	6.981	2.800
30 year +20% CC 2880 minute summer	8.554	2.293
30 year +20% CC 2880 minute winter	5.749	2.293
30 year +20% CC 4320 minute summer	6.610	1.728
30 year +20% CC 4320 minute winter	4.353	1.728
30 year +20% CC 5760 minute summer	5.523	1.414
30 year +20% CC 5760 minute winter	3.574	1.414
30 year +20% CC 7200 minute summer	4.741	1.210
30 year +20% CC 7200 minute winter	3.060	1.210
100 year +20% CC 15 minute summer	327.924	92.791
100 year +20% CC 15 minute winter	230.122	92.791
100 year +20% CC 30 minute summer	225.859	63.910
100 year +20% CC 30 minute winter	158.497	63.910
100 year +20% CC 60 minute summer	156.285	41.301
100 year +20% CC 60 minute winter	103.832	41.301
100 year +20% CC 120 minute summer	98.475	26.024
100 year +20% CC 120 minute winter	65.425	26.024
100 year +20% CC 180 minute summer	76.581	19.707
100 year +20% CC 180 minute winter	49.780	19.707
100 year +20% CC 240 minute summer	61.080	16.142
100 year +20% CC 240 minute winter	40.580	16.142
100 year +20% CC 360 minute summer	47.237	12.156
100 year +20% CC 360 minute winter	30.705	12.156
100 year +20% CC 480 minute summer	37.566	9.928
100 year +20% CC 480 minute winter	24.958	9.928
100 year +20% CC 600 minute summer	31.003	8.480
100 year +20% CC 600 minute winter	21.183	8.480

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +20% CC 720 minute summer	27.812	7.454
100 year +20% CC 720 minute winter	18.691	7.454
100 year +20% CC 960 minute summer	23.088	6.080
100 year +20% CC 960 minute winter	15.294	6.080
100 year +20% CC 1440 minute summer	17.018	4.561
100 year +20% CC 1440 minute winter	11.437	4.561
100 year +20% CC 2160 minute summer	12.364	3.417
100 year +20% CC 2160 minute winter	8.520	3.417
100 year +20% CC 2880 minute summer	10.377	2.781
100 year +20% CC 2880 minute winter	6.974	2.781
100 year +20% CC 4320 minute summer	7.949	2.078
100 year +20% CC 4320 minute winter	5.234	2.078
100 year +20% CC 5760 minute summer	6.598	1.689
100 year +20% CC 5760 minute winter	4.270	1.689
100 year +20% CC 7200 minute summer	5.635	1.438
100 year +20% CC 7200 minute winter	3.637	1.438

Results for 1 year +20% CC Critical Storm Duration. Lowest mass balance: 97.42%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW1	10	48.143	0.093	11.0	0.2047	0.0000	OK
60 minute winter	SW2	47	47.790	0.287	6.3	0.3242	0.0000	OK
60 minute winter	SW3	47	47.790	0.320	4.1	0.3615	0.0000	SURCHARGED
15 minute winter	SW4	11	47.307	0.057	4.2	0.0747	0.0000	OK
15 minute winter	SW5	12	47.226	0.056	4.1	0.0632	0.0000	OK
30 minute summer	SW6	19	47.163	0.083	8.2	0.1169	0.0000	OK
15 minute winter	SW7	12	47.062	0.082	8.2	0.0923	0.0000	OK
15 minute winter	SW8	13	46.862	0.082	8.2	0.0929	0.0000	OK
15 minute winter	SW9	14	46.751	0.081	8.1	0.0913	0.0000	OK
15 minute winter	SW10	14	46.569	0.079	8.0	0.0899	0.0000	OK
15 minute winter	EX MH - SW Outfall	15	46.512	0.072	7.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SW1	2.000	SW2	10.8	0.739	0.317	0.1311	
60 minute winter	SW2	Flow through pond	SW3	4.1	0.107	0.001	5.1563	
60 minute winter	SW3	Hydro-Brake®	SW4	2.0				
15 minute winter	SW4	1.001	SW5	4.1	0.540	0.131	0.1313	
15 minute winter	SW5	1.002	SW6	4.1	0.413	0.134	0.2095	
30 minute summer	SW6	1.003	SW7	8.2	0.629	0.272	0.2992	
15 minute winter	SW7	1.004	SW8	8.2	0.638	0.269	0.5778	
15 minute winter	SW8	1.005	SW9	8.1	0.628	0.268	0.3216	
15 minute winter	SW9	1.006	SW10	8.0	0.635	0.265	0.5146	
15 minute winter	SW10	1.007	EX MH - SW Outfall	7.8	0.669	0.243	0.1170	7.4

Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 97.42%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW1	10	48.153	0.103	13.2	0.2273	0.0000	OK
120 minute winter	SW2	86	47.867	0.364	5.0	0.4116	0.0000	OK
120 minute winter	SW3	86	47.867	0.397	3.5	0.4489	0.0000	SURCHARGED
15 minute winter	SW4	11	47.313	0.063	5.0	0.0824	0.0000	OK
15 minute winter	SW5	12	47.231	0.061	5.0	0.0688	0.0000	OK
15 minute winter	SW6	11	47.174	0.094	10.3	0.1318	0.0000	OK
15 minute winter	SW7	12	47.071	0.091	10.1	0.1034	0.0000	OK
15 minute winter	SW8	13	46.872	0.092	10.1	0.1039	0.0000	OK
15 minute winter	SW9	13	46.760	0.090	9.9	0.1017	0.0000	OK
15 minute winter	SW10	14	46.579	0.089	9.8	0.1011	0.0000	OK
15 minute winter	EX MH - SW Outfall	14	46.520	0.080	9.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SW1	2.000	SW2	12.9	0.778	0.381	0.1499	
120 minute winter	SW2	Flow through pond	SW3	3.5	0.058	0.001	6.4707	
120 minute winter	SW3	Hydro-Brake®	SW4	2.0				
15 minute winter	SW4	1.001	SW5	5.0	0.566	0.159	0.1493	
15 minute winter	SW5	1.002	SW6	4.8	0.418	0.159	0.2414	
15 minute winter	SW6	1.003	SW7	10.1	0.666	0.335	0.3501	
15 minute winter	SW7	1.004	SW8	10.1	0.673	0.332	0.6746	
15 minute winter	SW8	1.005	SW9	9.9	0.662	0.329	0.3753	
15 minute winter	SW9	1.006	SW10	9.8	0.670	0.323	0.5974	
15 minute winter	SW10	1.007	EX MH - SW Outfall	9.7	0.706	0.300	0.1368	9.2

Results for 10 year +20% CC Critical Storm Duration. Lowest mass balance: 97.42%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW1	10	48.179	0.129	19.2	0.2845	0.0000	OK
120 minute winter	SW2	94	48.102	0.599	7.0	0.6769	0.0000	OK
120 minute winter	SW3	96	48.100	0.630	5.0	0.7130	0.0000	SURCHARGED
15 minute winter	SW4	10	47.324	0.074	6.9	0.0970	0.0000	OK
15 minute winter	SW5	11	47.242	0.072	6.8	0.0816	0.0000	OK
15 minute winter	SW6	11	47.198	0.118	14.9	0.1658	0.0000	OK
15 minute winter	SW7	11	47.093	0.113	15.0	0.1282	0.0000	OK
15 minute winter	SW8	12	46.895	0.115	14.8	0.1300	0.0000	OK
15 minute winter	SW9	13	46.783	0.113	14.4	0.1279	0.0000	OK
15 minute winter	SW10	14	46.601	0.111	14.5	0.1257	0.0000	OK
15 minute winter	EX MH - SW Outfall	14	46.538	0.098	14.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SW1	2.000	SW2	18.9	0.864	0.556	0.1966	
120 minute winter	SW2	Flow through pond	SW3	5.0	0.090	0.002	10.4512	
120 minute winter	SW3	Hydro-Brake®	SW4	2.0				
15 minute winter	SW4	1.001	SW5	6.8	0.617	0.217	0.1893	
15 minute winter	SW5	1.002	SW6	6.8	0.427	0.221	0.3203	
15 minute winter	SW6	1.003	SW7	15.0	0.731	0.500	0.4726	
15 minute winter	SW7	1.004	SW8	14.8	0.742	0.489	0.9080	
15 minute winter	SW8	1.005	SW9	14.4	0.731	0.478	0.5003	
15 minute winter	SW9	1.006	SW10	14.5	0.737	0.478	0.7983	
15 minute winter	SW10	1.007	EX MH - SW Outfall	14.3	0.789	0.443	0.1809	13.9

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 97.42%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	SW1	98	48.297	0.247	8.8	0.5436	0.0000	SURCHARGED
120 minute winter	SW2	98	48.298	0.795	8.8	0.8991	0.0000	OK
120 minute winter	SW3	98	48.296	0.826	8.6	0.9340	0.0000	SURCHARGED
15 minute winter	SW4	10	47.333	0.083	8.4	0.1082	0.0000	OK
15 minute winter	SW5	11	47.250	0.080	8.2	0.0906	0.0000	OK
15 minute winter	SW6	11	47.216	0.136	19.0	0.1915	0.0000	OK
15 minute winter	SW7	11	47.112	0.132	18.8	0.1488	0.0000	OK
15 minute winter	SW8	12	46.913	0.133	18.5	0.1508	0.0000	OK
15 minute winter	SW9	13	46.800	0.130	18.3	0.1472	0.0000	OK
15 minute winter	SW10	13	46.618	0.128	18.3	0.1445	0.0000	OK
15 minute winter	EX MH - SW Outfall	13	46.551	0.111	17.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute winter	SW1	2.000	SW2	8.8	0.701	0.259	0.3579	
120 minute winter	SW2	Flow through pond	SW3	8.5	0.089	0.003	13.7842	
120 minute winter	SW3	Hydro-Brake®	SW4	2.0				
15 minute winter	SW4	1.001	SW5	8.2	0.647	0.264	0.2179	
15 minute winter	SW5	1.002	SW6	8.2	0.437	0.270	0.3778	
15 minute winter	SW6	1.003	SW7	18.8	0.772	0.627	0.5661	
15 minute winter	SW7	1.004	SW8	18.5	0.782	0.610	1.0823	
15 minute winter	SW8	1.005	SW9	18.3	0.768	0.608	0.5974	
15 minute winter	SW9	1.006	SW10	18.3	0.776	0.602	0.9564	
15 minute winter	SW10	1.007	EX MH - SW Outfall	17.9	0.840	0.555	0.2133	18.0

Max water level in the attenuation and drainage network for storms up to 1:30y return. Critical event duration 98min. Maximum achieved water level during this event does not exceed the High Water Level in the proposed attenuation tank (48.54m) therefore proposed attenuation has sufficient capacity to accommodate storms up to 1in30 years return. See drawing ref. D1602-1-KB-XX-DW-DR-C-0001-PL2 for attenuation base and high water level.

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 97.42%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	SW1	86	48.533	0.483	11.3	1.0627	0.0000	SURCHARGED
120 minute winter	SW2	86	48.537	1.034	11.2	1.1692	0.0000	OK
240 minute winter	SW3	176	48.533	1.063	18.5	1.2017	0.0000	SURCHARGED
15 minute winter	SW4	10	47.343	0.093	10.4	0.1218	0.0000	OK
15 minute winter	SW5	11	47.261	0.091	10.2	0.1031	0.0000	OK
15 minute winter	SW6	11	47.241	0.161	24.3	0.2265	0.0000	OK
15 minute winter	SW7	11	47.135	0.155	23.8	0.1753	0.0000	OK
15 minute winter	SW8	12	46.938	0.158	23.5	0.1781	0.0000	OK
15 minute winter	SW9	13	46.823	0.153	23.3	0.1731	0.0000	OK
15 minute winter	SW10	13	46.639	0.149	23.1	0.1685	0.0000	OK
15 minute winter	EX MH - SW Outfall	13	46.566	0.126	22.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute winter	SW1	2.000	SW2	11.2	0.745	0.331	0.3579	
120 minute winter	SW2	Flow through pond	SW3	12.1	0.081	0.004	17.6600	
240 minute winter	SW3	Hydro-Brake®	SW4	2.0				
15 minute winter	SW4	1.001	SW5	10.2	0.682	0.327	0.2563	
15 minute winter	SW5	1.002	SW6	10.1	0.445	0.330	0.4548	
15 minute winter	SW6	1.003	SW7	23.8	0.809	0.792	0.6852	
15 minute winter	SW7	1.004	SW8	23.5	0.818	0.775	1.3095	
15 minute winter	SW8	1.005	SW9	23.3	0.806	0.772	0.7263	
15 minute winter	SW9	1.006	SW10	23.1	0.816	0.762	1.1514	
15 minute winter	SW10	1.007	EX MH - SW Outfall	22.9	0.901	0.710	0.2535	23.7

Max water level in the attenuation and drainage network for storms up to 1:100y return. Critical event duration 176min. Maximum achieved water level during this event does not exceed the High Water Level in the proposed attenuation tank (48.54m) therefore proposed attenuation in this analysis (18.2m3) has sufficient capacity to accommodate storms up to 1in100 years return.
See drawing ref. D1602-1-KB-XX-DW-DR-C-0001-PL2 for attenuation base and high water level.

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Foul Sewer Network Design

Design Settings

Frequency of use (kDU)	0.50	Minimum Velocity (m/s)	1.00
Flow per dwelling per day (l/day)	2700	Connection Type	Level Soffits
Domestic Flow (l/s/ha)	0.0	Minimum Backdrop Height (m)	3.000
Industrial Flow (l/s/ha)	0.0	Preferred Cover Depth (m)	1.200
Additional Flow (%)	0	Include Intermediate Ground	✓

Nodes

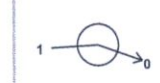
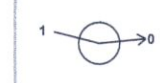
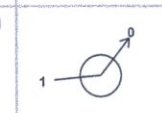
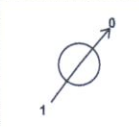
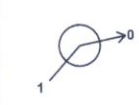
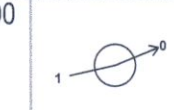
Name	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Easting (m)	Northing (m)
FS1	49.550	Manhole	Foul MH	1200	712958.034	729799.046
FS2	49.500	Manhole	Foul MH	1200	712970.008	729799.825
FS3	49.600	Manhole	Foul MH	1200	712990.773	729792.558
FS4	49.500	Manhole	Foul MH	1200	713029.523	729782.633
FS5	49.750	Manhole	Foul MH	1200	713044.457	729784.031
FS6	49.550	Manhole	Foul MH	1200	713054.763	729797.551
FS7	49.450	Manhole	Foul MH	1200	713068.524	729813.414
FS8	49.400	Manhole	Foul MH	1200	713115.883	729823.872
EX MH - FS Outfall	48.720	Manhole	Foul MH	1200	713136.304	729832.056

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.000	FS1	FS2	11.999	1.500	48.100	47.900	0.200	60.0	150
1.001	FS2	FS3	22.000	1.500	47.900	47.550	0.350	62.9	150
1.002	FS3	FS4	40.001	1.500	47.550	46.900	0.650	61.5	150
1.003	FS4	FS5	14.999	1.500	46.900	46.650	0.250	60.0	150
1.004	FS5	FS6	17.000	1.500	46.650	46.375	0.275	61.8	150
1.005	FS6	FS7	21.000	1.500	46.375	46.025	0.350	60.0	150
1.006	FS7	FS8	48.500	1.500	46.025	45.425	0.600	80.8	150
1.007	FS8	EX MH - FS Outfall	22.000	1.500	45.425	45.150	0.275	80.0	150

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Velocity (m/s)
1.000	1.132	20.0	2.1	1.300	1.450	1.300	1.450	18.0	0.0	0.730
1.001	1.106	19.5	2.1	1.450	1.900	1.450	1.900	18.0	0.0	0.721
1.002	1.118	19.8	2.1	1.900	2.450	1.900	2.450	18.0	0.0	0.721
1.003	1.132	20.0	2.4	2.450	2.950	2.450	2.950	24.0	0.0	0.761
1.004	1.115	19.7	2.4	2.950	3.025	2.950	3.025	24.0	0.0	0.757
1.005	1.132	20.0	2.4	3.025	3.275	3.025	3.275	24.0	0.0	0.761
1.006	0.975	17.2	3.5	3.275	3.825	3.275	3.825	48.0	0.0	0.762
1.007	0.980	17.3	3.5	3.825	3.420	3.420	3.825	48.0	0.0	0.761

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
FS1	49.550	1.450	1200		0 1.000	48.100	150
FS2	49.500	1.600	1200	1 	1 1.000	47.900	150
					0 1.001	47.900	150
FS3	49.600	2.050	1200	1 	1 1.001	47.550	150
					0 1.002	47.550	150
FS4	49.500	2.600	1200	1 	1 1.002	46.900	150
					0 1.003	46.900	150
FS5	49.750	3.100	1200		1 1.003	46.650	150
					0 1.004	46.650	150
FS6	49.550	3.175	1200		1 1.004	46.375	150
					0 1.005	46.375	150
FS7	49.450	3.425	1200		1 1.005	46.025	150
					0 1.006	46.025	150
FS8	49.400	3.975	1200		1 1.006	45.425	150
					0 1.007	45.425	150
EX MH - FS Outfall	48.720	3.570	1200		1 1.007	45.150	150

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Appendix to Surface Water Design

- Rainfall table for subject's site
- HR Wallingford Greenfield runoff rate estimation report
- Specification/Product Information for:
  - Separators
  - Flow Control Device
- StormTech Chamber Information Sheets: SC-740™
- Green Roof: Extensive sedum roof Build Up specification

Met Eireann

Return Period Rainfall Depths for sliding Durations

Irish Grid: Easting: 313000, Northing: 229800,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.7,	4.4,	5.3,	6.0,	6.6,	8.3,	10.4,	11.7,	13.7,	15.5,	16.8,	19.0,	20.7,	22.1,	N/A ,
10 mins	3.5,	5.2,	6.1,	7.4,	8.4,	9.1,	11.6,	14.4,	16.4,	19.1,	21.5,	23.5,	26.5,	28.8,	30.8,	N/A ,
15 mins	4.2,	6.1,	7.1,	8.8,	9.9,	10.7,	13.6,	17.0,	19.2,	22.5,	25.3,	27.6,	31.1,	33.9,	36.2,	N/A ,
30 mins	5.5,	7.9,	9.3,	11.3,	12.7,	13.7,	17.3,	21.4,	24.1,	28.0,	31.4,	34.1,	38.3,	41.6,	44.3,	N/A ,
1 hours	7.3,	10.4,	12.0,	14.5,	16.2,	17.6,	21.9,	26.9,	30.2,	34.8,	39.0,	42.2,	47.2,	51.1,	54.3,	N/A ,
2 hours	9.6,	13.5,	15.6,	18.7,	20.8,	22.4,	27.8,	33.8,	37.8,	43.4,	48.3,	52.2,	58.1,	62.7,	66.5,	N/A ,
3 hours	11.3,	15.8,	18.1,	21.7,	24.1,	25.9,	31.9,	38.7,	43.1,	49.3,	54.8,	59.1,	65.6,	70.7,	74.9,	N/A ,
4 hours	12.7,	17.6,	20.2,	24.1,	26.7,	28.7,	35.2,	42.5,	47.3,	54.0,	59.9,	64.5,	71.5,	77.0,	81.4,	N/A ,
6 hours	15.0,	20.6,	23.5,	27.9,	30.9,	33.1,	40.4,	48.6,	54.0,	61.4,	68.0,	73.0,	80.8,	86.7,	91.7,	N/A ,
9 hours	17.6,	24.0,	27.4,	32.4,	35.7,	38.2,	46.5,	55.6,	61.6,	69.8,	77.1,	82.7,	91.2,	97.8,	103.2,	N/A ,
12 hours	19.8,	26.8,	30.5,	35.9,	39.6,	42.3,	51.3,	61.2,	67.6,	76.5,	84.3,	90.3,	99.4,	106.5,	112.3,	N/A ,
18 hours	23.3,	31.3,	35.5,	41.7,	45.7,	48.9,	58.9,	69.9,	77.1,	87.0,	95.6,	102.2,	112.3,	120.0,	126.4,	N/A ,
24 hours	26.2,	35.0,	39.6,	46.3,	50.7,	54.1,	65.0,	76.9,	84.6,	95.3,	104.5,	111.6,	122.4,	130.7,	137.5,	160.8,
2 days	32.5,	42.5,	47.7,	55.1,	60.0,	63.8,	75.6,	88.4,	96.6,	107.9,	117.6,	125.0,	136.2,	144.7,	151.7,	175.5,
3 days	37.6,	48.6,	54.2,	62.3,	67.6,	71.6,	84.2,	97.8,	106.5,	118.3,	128.5,	136.2,	147.8,	156.6,	163.8,	188.3,
4 days	42.0,	53.9,	59.9,	68.5,	74.1,	78.4,	91.7,	106.0,	115.1,	127.4,	138.0,	146.0,	158.0,	167.1,	174.5,	199.7,
6 days	49.8,	63.2,	69.8,	79.4,	85.5,	90.2,	104.7,	120.2,	130.0,	143.2,	154.5,	163.0,	175.8,	185.4,	193.2,	219.7,
8 days	56.7,	71.3,	78.5,	88.8,	95.5,	100.5,	116.1,	132.6,	142.9,	156.9,	168.9,	177.8,	191.2,	201.3,	209.5,	237.1,
10 days	63.0,	78.7,	86.5,	97.5,	104.5,	109.9,	126.4,	143.8,	154.7,	169.3,	181.8,	191.2,	205.2,	215.7,	224.2,	252.8,
12 days	68.9,	85.6,	93.8,	105.5,	112.9,	118.5,	135.9,	154.1,	165.5,	180.8,	193.8,	203.5,	218.1,	229.0,	237.8,	267.3,
16 days	79.8,	98.3,	107.4,	120.1,	128.3,	134.4,	153.3,	173.0,	185.2,	201.6,	215.6,	226.0,	241.4,	253.0,	262.4,	293.6,
20 days	89.9,	110.0,	119.8,	133.6,	142.4,	148.9,	169.1,	190.1,	203.2,	220.6,	235.3,	246.3,	262.6,	274.8,	284.6,	317.4,
25 days	101.7,	123.7,	134.3,	149.2,	158.7,	165.7,	187.4,	209.9,	223.8,	242.3,	258.0,	269.6,	286.8,	299.7,	310.1,	344.6,

NOTES:

N/A Data not available

These values are derived from a Depth Duration Frequency (DDF) Model

For details refer to:

'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

HR Wallingford
Working with water

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Elena Dragoje
Site name:	Wainsfort Grove
Site location:	Manor Ave, Terenure

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.

Site Details

Latitude:	53.30632° N
Longitude:	6.30535° W
Reference:	1454379996
Date:	Apr 15 2023 15:45

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.1328

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	883	729
Hydrological region:	12	12
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.13	2.13
Growth curve factor 100 years:	2.61	2.61
Growth curve factor 200 years:	2.86	2.86

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	0.32	0.25
1 in 1 year (l/s):	0.27	0.22
1 in 30 years (l/s):	0.68	0.54
1 in 100 year (l/s):	0.83	0.66
1 in 200 years (l/s):	0.91	0.73

Kingspan Klargester

SEPARATORS

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to make the right decision
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Kingspan Environmental

Separators

A RANGE OF FUEL/OIL SEPARATORS FOR PEACE OF MIND

Surface water drains normally discharge to a watercourse or indirectly into underground waters (groundwater) via a soakaway. Contamination of surface water by oil, chemicals or suspended solids can cause these discharges to have a serious impact on the receiving water.

The Environment Regulators, Environment Agency, England and Wales, SEPA, Scottish Environmental Protection Agency in Scotland and Department of Environment & Heritage in Northern Ireland, have published guidance on surface water disposal, which offers a range of means of dealing with pollution both at source and at the point of discharge from site (so called 'end of pipe' treatment). These techniques are known as 'Sustainable Drainage Systems' (SuDS).

Where run-off is draining from relatively low risk areas such as car-parks and non-operational areas, a source control approach, such as permeable surfaces or infiltration trenches, may offer a suitable means of treatment, removing the need for a separator.

Oil separators are installed on surface water drainage systems to protect receiving waters from pollution by oil, which may be present due to minor leaks from vehicles and plant, from accidental spillage.

Effluent from industrial processes and vehicle washing should normally be discharged to the foul sewer (subject to the approval of the sewerage undertaker) for further treatment at a municipal treatment works.

SEPARATOR STANDARDS AND TYPES

A British (and European) standard (EN 858-1 and 858-2) for the design and use of prefabricated oil separators has been adopted. New prefabricated separators should comply with the standard.

SEPARATOR CLASSES

The standard refers to two 'classes' of separator, based on performance under standard test conditions.

CLASS I

Designed to achieve a concentration of less than 5mg/l of oil under standard test conditions, should be used when the separator is required to remove very small oil droplets.

CLASS II

Designed to achieve a concentration of less than 100mg/l oil under standard test conditions and are suitable for dealing with discharges where a lower quality requirement applies (for example where the effluent passes to foul sewer).

Both classes can be produced as full retention or bypass separators. The oil concentration limits of 5 mg/l and 100 mg/l are only applicable under standard test conditions. It should not be expected that separators will comply with these limits when operating under field conditions.

FULL RETENTION SEPARATORS

Full retention separators treat the full flow that can be delivered by the drainage system, which is normally equivalent to the flow generated by a rainfall intensity of 65mm/hr.

On large sites, some short term flooding may be an acceptable means of limiting the flow rate and hence the size of full retention systems.

BYPASS SEPARATORS

Bypass separators fully treat all flows generated by rainfall rates of up to 6.5mm/hr. This covers over 99% of all rainfall events. Flows above this rate are allowed to bypass the separator. These separators are used when it is considered an acceptable risk not to provide full treatment for high flows, for example where the risk of a large spillage and heavy rainfall occurring at the same time is small.

FORECOURT SEPARATORS

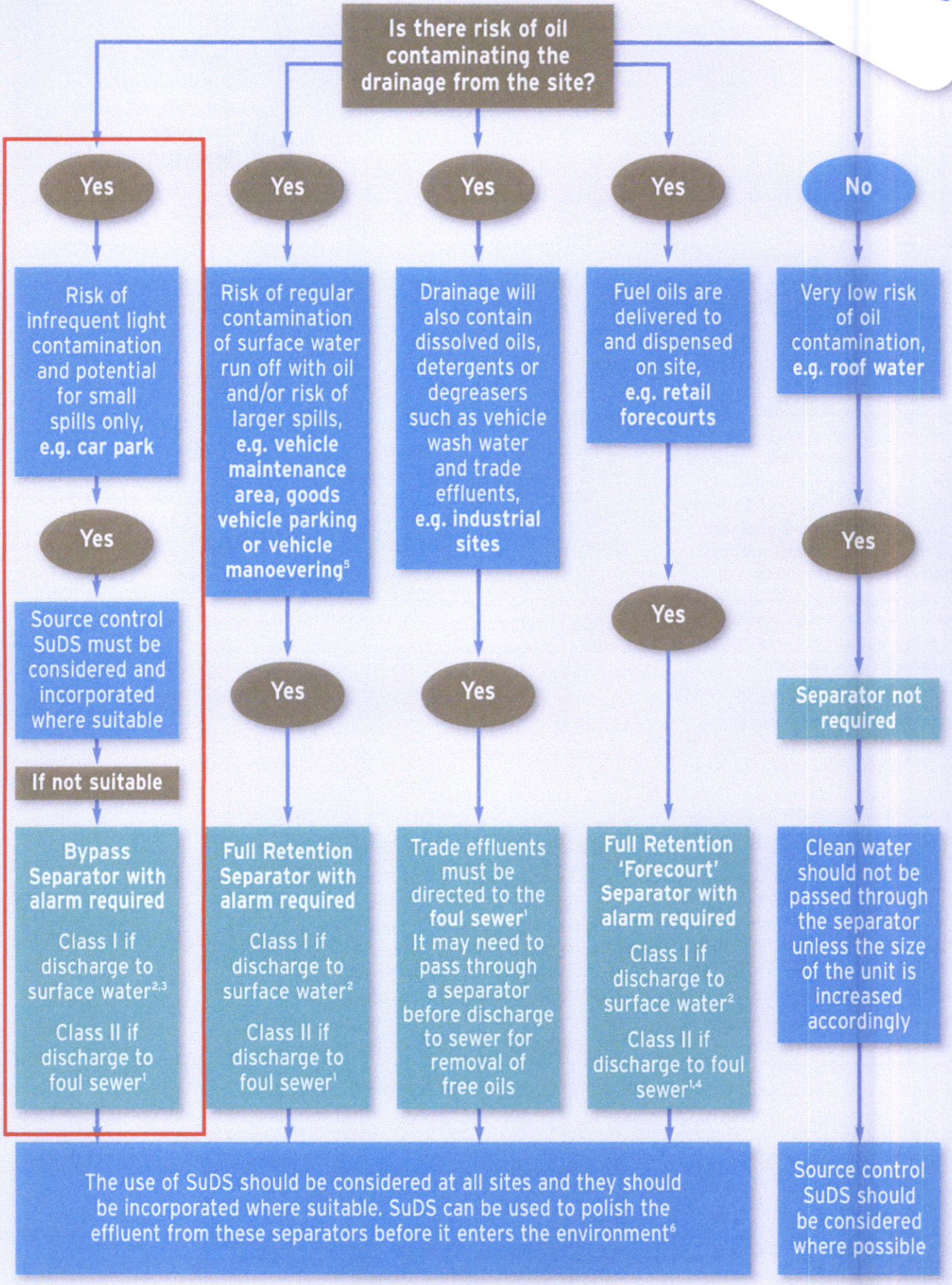
Forecourt separators are full retention separators specified to retain on site the maximum spillage likely to occur on a petrol filling station. They are required for both safety and environmental reasons and will treat spillages occurring during vehicle refuelling and road tanker delivery. The size of the separator is increased in order to retain the possible loss of the contents of one compartment of a road tanker, which may be up to 7,600 litres.

SELECTING THE RIGHT SEPARATOR

The chart on the following page gives guidance to aid selection of the appropriate type of fuel/oil separator for use in surface water drainage systems which discharge into rivers and soakaways.

For further detailed information, please consult the Environment Agency Pollution Prevention Guideline 03 (PPG 3) 'Use and design of oil separators in surface water drainage systems' available from their website.

Klargester has a specialist team who provide technical assistance in selecting the appropriate separator for your application.



1 *You must seek prior permission from your local sewer provider before you decide which separator to install and before you make any discharge.*
2 *You must seek prior permission from the relevant environmental body before you decide which separator to install.*
3 *In this case, if it is considered that there is a low risk of pollution a source control SuDS scheme may be appropriate.*
4 *In certain circumstances, the sewer provider may require a Class 1 separator for discharges to sewer to prevent explosive atmospheres from being generated.*
5 *Drainage from higher risk areas such as vehicle maintenance yards and goods vehicle parking areas should be connected to foul sewer in preference to surface water.*
6 *In certain circumstances, a separator may be one of the devices used in the SuDS scheme. Ask us for advice.*

Bypass NSB RANGE

APPLICATION

Bypass separators are used when it is considered an acceptable risk not to provide full treatment, for very high flows, and are used, for example, where the risk of a large spillage and heavy rainfall occurring at the same time is small, e.g.

- Surface car parks.
- Roadways.
- Lightly contaminated commercial areas.

PERFORMANCE

Klargester were one of the first UK manufacturers to have separators tested to EN 858-1. Klargester have now added the NSB bypass range to their portfolio of certified and tested models. The NSB number denotes the maximum flow at which the separator treats liquids. The British Standards Institute (BSI) tested the required range of Klargester full retention separators and certified their performance in relation to their flow and process performance assessing the effluent qualities to the requirements of EN 858-1. Klargester bypass separator designs follow the parameters determined during the testing of the required range of bypass separators.

Each bypass separator design includes the necessary volume requirements for:

- Oil separation capacity.
- Oil storage volume.
- Silt storage capacity.
- Coalescer.

The unit is designed to treat 10% of peak flow. The calculated drainage areas served by each separator are indicated according to the formula given by PPG3 NSB = 0.0018A(m2). Flows generated by higher rainfall rates will pass through part of the separator and bypass the main separation chamber.

Class I separators are designed to achieve a concentration of 5mg/litre of oil under standard test conditions.

Class II separators are designed to achieve a concentration of 100mg/litre of oil under standard test conditions.

FEATURES

- Light and easy to install.
- Class I and Class II designs.
- Inclusive of silt storage volume.
- Fitted inlet/outlet connectors.
- Vent points within necks.
- Oil alarm system available (required by EN 858-1 and PPG3).
- Extension access shafts for deep inverts.
- Maintenance from ground level.
- GRP or rotomoulded construction (subject to model).

To specify a nominal size bypass separator, the following information is needed:-

- The calculated flow rate for the drainage area served. Our designs are based on the assumption that any interconnecting pipework fitted elsewhere on site does not impede flow into or out of the separator and that the flow is not pumped .
- The required discharge standard. This will decide whether a Class I or Class II unit is required.
- The drain invert inlet depth.
- Pipework type, size and orientation.

SIZES AND SPECIFICATIONS

UNIT NOMINAL SIZE	FLOW (l/s)	PEAK FLOW RATE (l/s)	DRAINAGE AREA (m^2)	STORAGE CAPACITY (litres) SILT	STORAGE CAPACITY (litres) OIL	UNIT LENGTH (mm)	UNIT DIA. (mm)	ACCESS SHAFT DIA. (mm)	BASE TO INLET INVERT (mm)	BASE TO OUTLET INVERT	STANDARD FALL ACROSS (mm)	MIN. INLET INVERT (mm)	STANDARD PIPEWORK DIA. (mm)
NSBP003	3	30	1670	300	45	1700	1350	600	1420	1320	100	500	160
NSBP004	4.5	45	2500	450	60	1700	1350	600	1420	1320	100	500	160
NSBP006	6	60	3335	600	90	1700	1350	600	1420	1320	100	500	160
NSBE010	10	100	5560	1000	150	2069	1220	750	1450	1350	100	700	315
NSBE015	15	150	8335	1500	225	2947	1220	750	1450	1350	100	700	315
NSBE020	20	200	11111	2000	300	3893	1220	750	1450	1350	100	700	375
NSBE025	25	250	13890	2500	375	3575	1420	750	1680	1580	100	700	375
NSBE030	30	300	16670	3000	450	4265	1420	750	1680	1580	100	700	450
NSBE040	40	400	22222	4000	600	3230	1920	600	2185	2035	150	1000	500
NSBE050	50	500	27778	5000	750	3960	1920	600	2185	2035	150	1000	600
NSBE075	75	750	41667	7500	1125	5841	1920	600	2235	2035	200	950	675
NSBE100	100	1000	55556	10000	1500	7661	1920	600	2235	2035	200	950	750
NSBE125	125	1250	69444	12500	1875	9548	1920	600	2235	2035	200	950	750

Rotomoulded chamber construction *GRP chamber construction* ** Some units have more than one access shaft – diameter of largest shown.*

PROFESSIONAL INSTALLERS

Klargester Accredited Installers

Experience shows that correct installation is a prerequisite for the long-lasting and successful operation of any wastewater treatment product. This is why using an installer with the experience and expertise to install your product is highly recommended.

Services include :

- Site survey to establish ground conditions and soil types
- Advice on system design and product selection
- Assistance on gaining environmental consents and building approvals
- Tank and drainage system installation
- Connection to discharge point and electrical networks
- Waste emptying and disposal

Discover more about the Accredited Installers and locate your local expert online.

www.klargester.com/installers

Kingspan Klargester Accredited Installer

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Who better to look after your treatment plant than the people who designed and built it?

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BRITISH WATER

UK GREEN BUILDING COUNCIL Founding Member

Issue No. 20: August 2014

Hydro-Brake® Flow Control

Modelling Guide

Unit Selection Design Guide

Overview

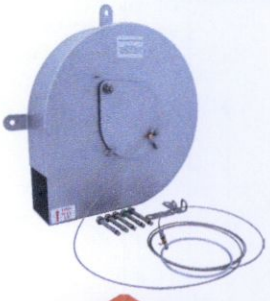
Hydro-Brake® Flow Controls restrict the flow in surface/storm water or foul/combined sewer systems by inducing a vortex flow pattern in the water passing through the device, having the effect of increasing back-pressure.

Their 'hydrodynamic' rather than 'physical restriction' based operation provides flow regulation whilst maintaining larger clearances than most other types of flow control, making them less susceptible to blockage. Their unique "S"-shaped head-flow characteristic also enables them to pass greater flows at lower heads, which can enable more efficient use of upstream storage facilities.

This document provides guidance relating to the selection and use of Hydro-Brake® Flow Controls for use in surface/storm water and foul/combined sewer systems.

The information provided here is intended for the purposes of general guidance only - individual application requirements may differ. If in doubt, or to enquire about new product additions, please contact HRD Technologies Ltd.

STH Range of Hydro-Brake® Flow Controls



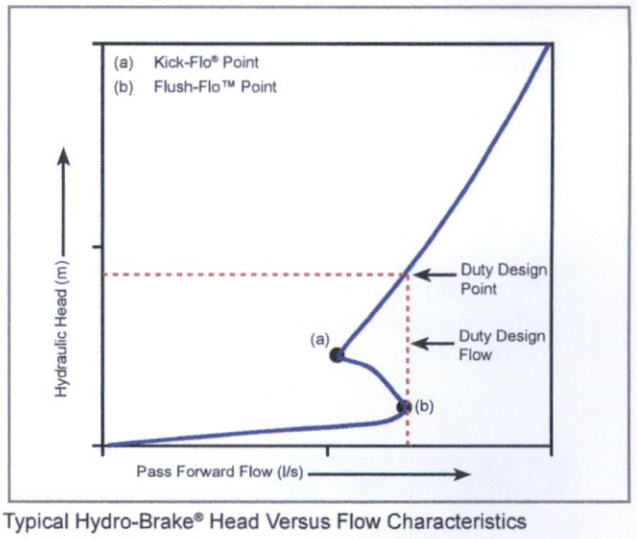
BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4599

See back cover for details.

Hydraulic Characteristics and Specification

Hydro-Brake® Flow Controls should be selected such that the duty/design flow is not exceeded at any point on the head-flow curve, see illustration right. If this is not achievable using the initially selected unit, it may be appropriate to select an alternative option (see selection guidance overleaf).

While the primary aim of a flow control is to provide a particular flow rate at a given upstream head (giving a design/duty point), it is important to note that secondary opportunities, such as potential for optimised storage use, derive from consideration of the full hydraulic characteristic. It is therefore important to ensure that the same flow control, or one confirmed to provide equivalent hydraulic performance, is implemented in any final installation.



Typical Hydro-Brake® Head Versus Flow Characteristics

To ensure correct implementation a multiple design-point specification, defining the main hydraulic features of the selected flow control, can be provided by HRD Technologies Ltd. This should include at least the following information:

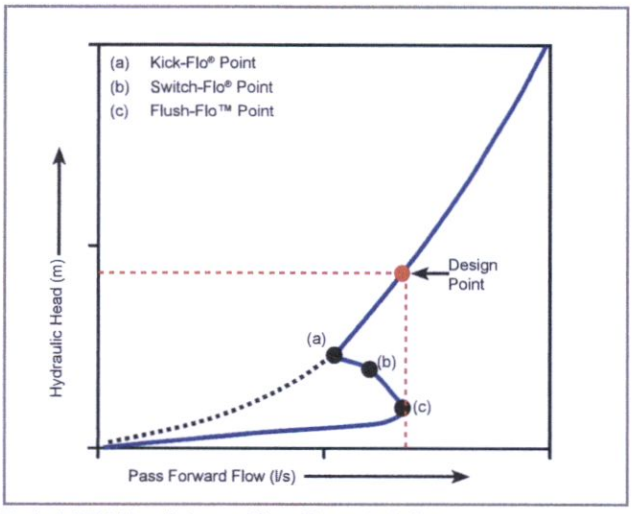
- outlet size and model of Hydro-Brake® Flow Control
- definition of the duty/design point (head and flow)
- definition of the Flush-Flo™ point (head and flow)
- definition of the Kick-Flo® point (head and flow)

To ensure that a drainage system performs as designed, it is strongly recommended that this information is reproduced on any technical specifications.

STH Type Hydro-Brake® Flow Control with BBA Approval

Now included in WinDes® W.12.6!

The new STH type Hydro-Brake® Flow Control range has a unique head / discharge performance curve which introduces a very important feature - the Switch-Flo® Point. This point illustrates the unique performance feature of the STH range which can lead to further savings in upstream storage, whilst also enabling increased inlet / outlet size to further reduce the risk of blockage.



Typical STH Head Versus Flow Characteristics

Kick-Flo® (a) - the point at which the vortex has initiated and at which the curve begins to return back to follow the orifice curve and reach the same design point or desired head / flow condition.

NEW Switch-Flo® (b) - marks the transition between the Kick-Flo® and Flush-Flo™, from vortex initiation to stabilisation. This point adds a new layer of resolution to the Hydro-Brake® curve that has implications to upstream storage savings.

Flush-Flo™ (c) - the point at which the vortex begins to initiate and have a throttling effect. This point on the Hydro-Brake® curve is usually much nearer to the maximum design flow (Design Point), than other vortex flow controls leading to more water passing through the unit during the earlier stages of a storm, thus reducing the amount of water that needs to be stored upstream.

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4599

STH Range of
Hydro-Brake® Flow Controls

The STH Hydro-Brake® Flow Control is the only vortex flow control available today that has been given the prestigious BBA Approval Certificate. The BBA assessment procedure entails rigorous assessment of production and manufacturing standards, and confirms that the hydraulic performance of the Hydro-Brake® Flow Control matches the data given to designers by HRD Technologies with their head / discharge curves.

A worked example showing the steps to model a Hydro-Brake® Flow Control and associated Stormcell® Storage System within Micro Drainage WinDes® is available on our website:

www.hrdtec.com

Take a Look at Our New Stormwater Web Resource

Engineering Nature's Way™

www.engineeringnaturesway.co.uk

Engineering Nature's Way is a brand new resource for people working with Sustainable Drainage and flood management in the UK.

The site provides an opportunity to share news, opinion, information and best practice for people working in local and central Government; developers, consulting engineers and contractors. Do you have something to share? We would be delighted to receive your contributions.

turning water around ...®

HRD Technologies Ltd

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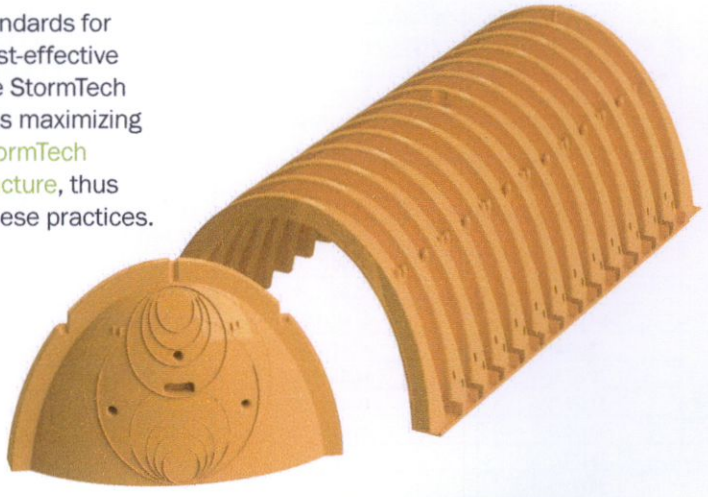
HRD Technologies Ltd is a subsidiary of Hydro International plc

STORMTECH SC-740 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.



STORMTECH SC-740 CHAMBER
(not to scale)

Nominal Chamber Specifications

Size (L x W x H)
85.4" x 51" x 30"
2,170 mm x 1,295 mm x 762 mm

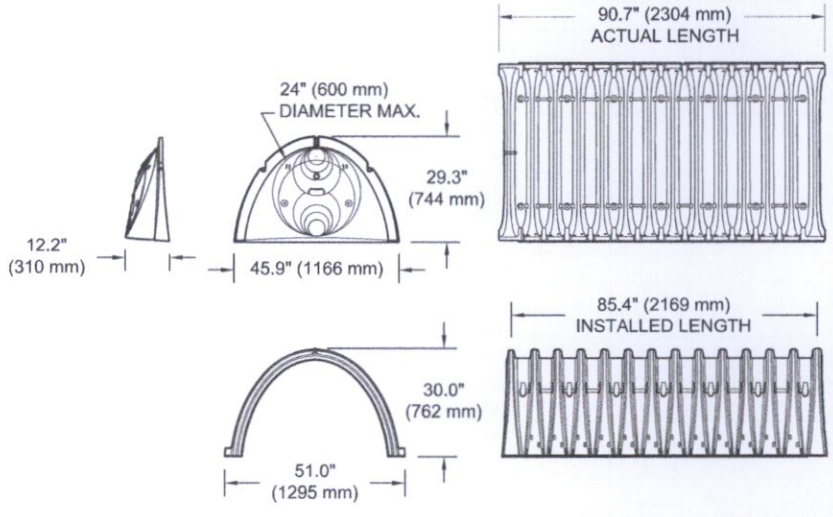
Chamber Storage
45.9 ft³ (1.30 m³)

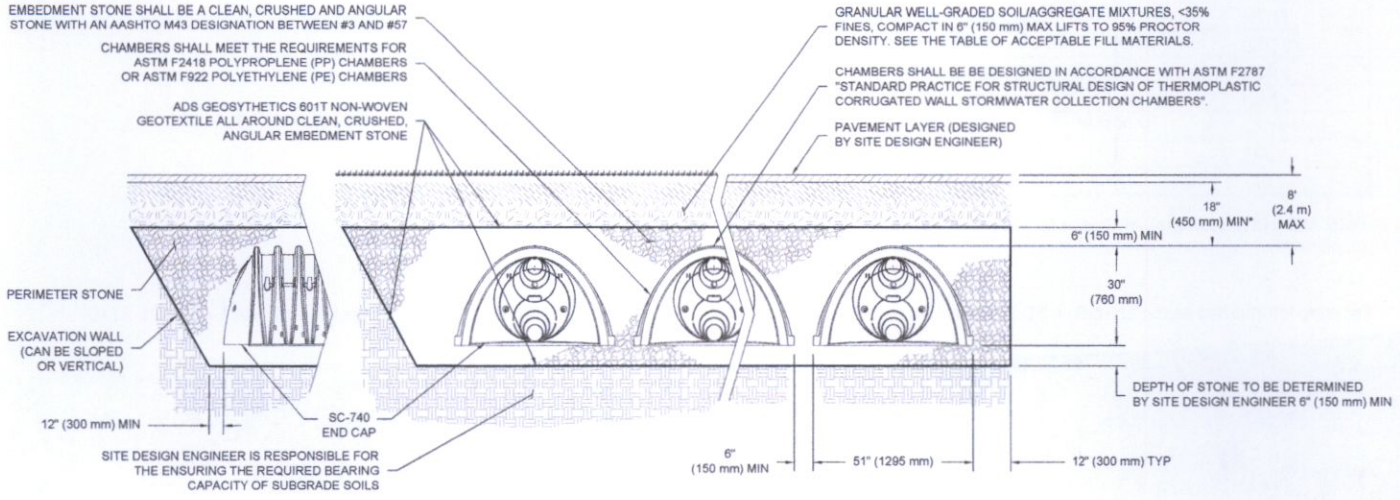
Min. Installed Storage*
74.9 ft³ (2.12 m³)

Weight
74.0 lbs (33.6 kg)

Shipping
30 chambers/pallet
60 end caps/pallet
12 pallets/truck

*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.





*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

StormTech®

ADS®

SC-740 CUMULATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	45.90 (1.300)	72.64 (2.057)
39 (991)	45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	1.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	0 (0)	6.76 (0.191)
5 (127)	0 (0)	5.63 (0.160)
4 (102)	0 (0)	4.51 (0.128)
3 (76)	0 (0)	3.38 (0.096)
2 (51)	0 (0)	2.25 (0.064)
1 (25)	0 (0)	1.13 (0.032)

Stone Cover

Stone Foundation

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

STORAGE VOLUME PER CHAMBER FT³ (M³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-740 Chamber	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

AMOUNT OF STONE PER CHAMBER

ENGLISH TONS (yds³)	Stone Foundation Depth		
	6"	12"	16"
SC-740	3.8 (2.8)	4.6 (3.3)	5.5 (3.9)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
SC-740	3,450 (2.1)	4,170 (2.5)	4,490 (3.0)

Note: Assumes 6" (150 mm) of stone above and between chambers.

VOLUME EXCAVATION PER CHAMBER YD³ (M³)

	Stone Foundation Depth		
	6 (150)	12 (300)	18 (450)
SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as depth of cover increases.

Working on a project?
Visit us at www.stormtech.com
and utilize the StormTech Design Tool

For more information on the StormTech SC-740 Chamber and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710

*THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™*

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Larne, Co. Antrim BT40 3HY

GREEN ROOFS DIRECT

Extensive Sedum Roof Build Up Specification

Extensive Sedum Roof Build Up Specification

Consisting of: Protective Fleece, Drainage Layer, Growing Medium and Pre Grown Sedum Blanket

Drainage Layer

Product Description

Drainage Layer is made of cross-linked, closed cell polyethylene (PE) foam flakes, which are connected together by thermal processing. The already applied/laminated filter fleece is made of polyester (PET) fibres.

Uses:

Drainage Layer is used as a drainage, protection, filter and root expansion layer for extensive green roof systems on flat roofs.

Characteristics / Advantages

- 4 in 1 product (drainage, protection, filter and root expansion layer)
- Light and easy to cut
- Suitable for low pitch roofs
- High porosity and very high water transmissibility
- Drainage Layer does not rot
- Compressive strength
- Recyclable

Tests Approvals / Standards

Quality management system EN ISO 9001/14001
Reaction to fire according to EN 13501-1, class E

Product Data:

Appearance Surface: structured
Colour Drainage layer: coloured Filter fleece: light grey Packaging,
Packing unit: 40 pieces per pallet (90 m2)
Storage Conditions Drainage Layer shall be stored at dry conditions.
Shelf-Life Drainage Layer does not expire during correct storage.

Drainage Layer:

Technical Data

Material Bases

Drainage layer:	Polyethylene foam (PE)
Filter fleece:	Polyester fibres (PET)

Length	2.25 m (± 3 %)
Width:	1.00 m (± 3 %)
Thickness:	25 mm (- 0 mm / + 3 mm)

Mass per unit area EN 9864

Drainage layer:	2100 g/m2 (- 120 g / + 100 g)
Filter fleece:	145 g/m2 (- 3 g / + 5 g)

Static puncture EN 12236

Drainage layer:	1800 N
Filter fleece:	1600 N

Water permeability normal to the plane (V H50) EN 11058

0.11 m/s (± 0.01)

Application Conditions / Limits:

Temperature

The use of Drainage Layer 30 is limited to geographical locations with average monthly minimum temperatures of -50 °C. Permanent ambient temperature during use is limited to +50 °C.

Growing Medium:

Install	50mm multi-layer extensive roof substrate composed of mineral bulk mixture with a proportion of mineral and organic matter.
Total pore volume	> 60-70 Vol %
Max water capacity	≥ 35% Vol
Key data	
Dry weight approx.	≤ .75 g/cm3
Water saturated	≤ 1.4g/cm3
Organic content	≥65 g/L
pH value	5.8-7.9
Water permeability	≥ 0.6 mm/min
Compression factor	1,2

Vegetation Layer:

Please see data sheet for information

Ecology, Health and Safety Information	The product does not fall within the EC-regulation of hazardous goods. As a result, a material safety data sheet following EC-Guideline 91/155 EWG is not needed to bring the product to the market, transport or use it. The product does not damage the environment when used as specified.

GREEN ROOFS DIRECT

Sedum Blanket Datasheet:

Carrier	Predominately rottable Cocomat with geo textile weave
Substate	Locally produced mix containing at least 25% recycled green waste
Vegetation compostion	Sedum Acre Aureum, Sedum Album Coral Carpet, Sedum Album mini, Sedum Album Athoum, Sedum Hispanicum, Sedum Summer Glory, Sedum Reflexum, Sedum Weihenstephaner Gold, Sedum Voodoo
Vegetation coverage	Vegetation coverage
Thickness	2.5cm -4.5cm
Water saturation weight	18-22 kg /m²
Standard Size	1 m x 1.5 m

OVERVIEW OF GREEN ROOFS

WADHAM COLLEGE

Location: **Oxford**

"The Bauder Hot Melt System with intensive green roof landscaping offers incredible durability, versatility and cost effectiveness. The roof garden has transformed the graduate centre at Wadham and undeniably assisted in maximising the building's potential. Bauder provided the highest standards of technical support throughout the works and delivered a single-point of contact roofing solution that met our exact specifications under one all-encompassing guarantee."

Tim Lee, Lee Fitzgerald Architects

We were the first company to introduce lightweight landscaping technology into the UK and Ireland, partnering on many prestigious projects since 1982. Our unrivalled expertise ensures we deliver any green or blue roof scenario, from recreational gardens and parks to simple low maintenance environmental greening and biodiverse ecological solutions.

Sedum System
Non-Accessed Extensive Green Roof

All in one system comprising mature sedum species pre-grown on an integrated blanket with 20mm of extensive substrate. The system has been developed for use directly over our waterproofing.

Substrate Roofs
Extensive Non-Accessed Green Roofs

Substrate green roofs are designed to be comparatively lightweight, work towards providing some storm water attenuation and support a wide variety of low maintenance plant species which are generally self-sustaining, and wind, frost and drought tolerant.

Biodiverse Habitats

Created to encourage a wider spread of birds, insects and plant species into the area and generally replicate the ecological environment of the site. This is particularly important if there are planning conditions or a local Biodiversity Action Plan (BAP) must be followed.

Pre-grown Vegetation Blankets

Designed to give instant greening to a roof. Two options are available; Bauder WB native wildflower blanket or a sedum mix in the Bauder SB substrate blanket.

Plug Planted Systems

The selection and location of each plant species can be controlled according to requirements which is ideal when the roof has a number of different aspects. We can supply over 100 different plugs: British Native Wildflowers, herbs, grasses to sedums and other succulents.

Seeded Roofs

Our unique range of British native seed mixes provides the specifier with a selection of seed blends to suit particular locations and are designed to meet BREEAM and BAP requirements.

BioSOLAR Roofs

Combining a green roof with a solar PV array where the substrate and vegetation provide ballast for the PV mounting. The system raises the modules above the substrate to allow liberal growing room for the plants.

Recreational Gardens, Terraces and Spaces
Accessed Intensive Green Roofs

Rooftops and podiums where the design may include flowerbeds, lawns, shrubs and trees intermixed with paths, driveways and patios. The combinations of finishes will impact on the design, construction, drainage and components used to deliver to each element's requirements.

ENVIRONMENTAL CREDENTIALS

Aiding Biodiversity and Meeting a Biodiversity Action Plan (BAP)

A green roof can provide a range of natural habitats specifically designed to support particular species of plant, insect or wildlife. Designed for the local ecology, in which vegetation will establish and provide an environment for wildlife as well as insects and invertebrates. The provision of a healthy habitat in a place that could otherwise be empty encourages wildlife to remain in the area, providing wildlife corridors to support the natural colonisation of locally arising plants, birds and insects, boosting the resilience of species in the area.

Our wildflower blanket and Flora Seed Mixes are all specifically devised to meet BAP criteria through their inclusion of species within the RHS 'Perfect for Pollinators' and Flora Locale 'native origins criteria'.

Bauder works with Buglife, the invertebrate charity, to produce a range of habitat features that favour some of the UK's most vulnerable species.

Storm Water Management and SuDS

The specifically engineered outlet within a blue roof restricts the discharge of storm water to a calculated and predesigned flow rate to significantly slow down the volume of water leaving the site. As the storm passes, water continues to discharge from the roof at a controlled rate which helps to avoid downstream or localised flooding. (see chapter 10)

Green roofs can retain rainwater in the substrate, drainage/reservoir board and plants. This water is then used by the vegetation or evaporates back into the atmosphere. The FLL reports that, over the course of a calendar year, a green roof can frequently retain 40% of average rainfall on an extensive green roof with 20-40mm of substrate and sedum vegetation and 90% of average rainfall on an intensive green roof with over 500mm of substrate.

Improving Air Quality of Local Surroundings

Localised air quality is improved as the vegetation assists in filtering out both gaseous pollutants and dust particles, effectively purifying the air. Additionally, the natural evaporation of water from the plants and soil helps to cool and humidify the air, so lowering the ambient temperature and reducing the heat island effect.

Prof. Dr. H. J. Liesecke, the former chairman of the German FLL regulatory body, carried out tests at the University of Hanover to provide evidence of the natural air purifying effects of Xero Flor XF301 sedum system with its patented substrate.

The test container housing the sedums and mosses was filled with the waste gas from petrol and diesel engines and after 48 hours the pollution levels were measured showing a reduction by 95% within the period. A second chamber was also set up without vegetation as a comparative control.

In conclusion, extensive green roof systems effectively mitigate car emmissions.

Urban Heat Island Effect

The urban heat island effect is the difference in temperature between urban areas and the surrounding countryside and is a result of large building surfaces reflecting and radiating solar, which will not dissipate fully overnight. The substrate of a green roof will absorb some of this heat and the natural evaporation of water from both the plants and soil helps to cool and humidify the air, thus lowering the ambient air temperature.

Recycled Content of Green Roof Components

Many recycled or waste materials are used within our green roof build ups to enable us to provide environmental solutions to the industry.

Water Retention and Drainage Layers

Our DSE 20, 40 and 60 boards all utilise recycled high density polyethylene which is easily moulded to create the cupped profile boards that provides water retention and multi-directional drainage.

Protection Layers

Our protection layers FSM600 and FSM1100 are made from a mixture of two recycled materials, reground polyester and polypropylene fibre, that are combined before being mechanically and thermally solidified to deliver a layer which prevents mechanical damage to the waterproofing beneath the green roof build up.

Our ProMat is made of granulate from recycled shredded tyres reformed and bound by Polyurethane to give a high protection layer against mechanical damage.

Our Ecomat product is a protective layer created from mechanically bonded recycled Polyester clothing and fabric.

Substrates and Growing Mediums

Our FLL compliant substrates are based around recycled crushed brick and composted recycled organic material to give growing mediums which correctly balance water storage, structural stability, water permeability and grain size distribution according to the requirements of the planting scheme.

Separation and Slip Layer

Our PE Foil allows the green roof to operate independently of the waterproofing system and is manufactured from recycled polyethylene granulate.

Recycling End of Life

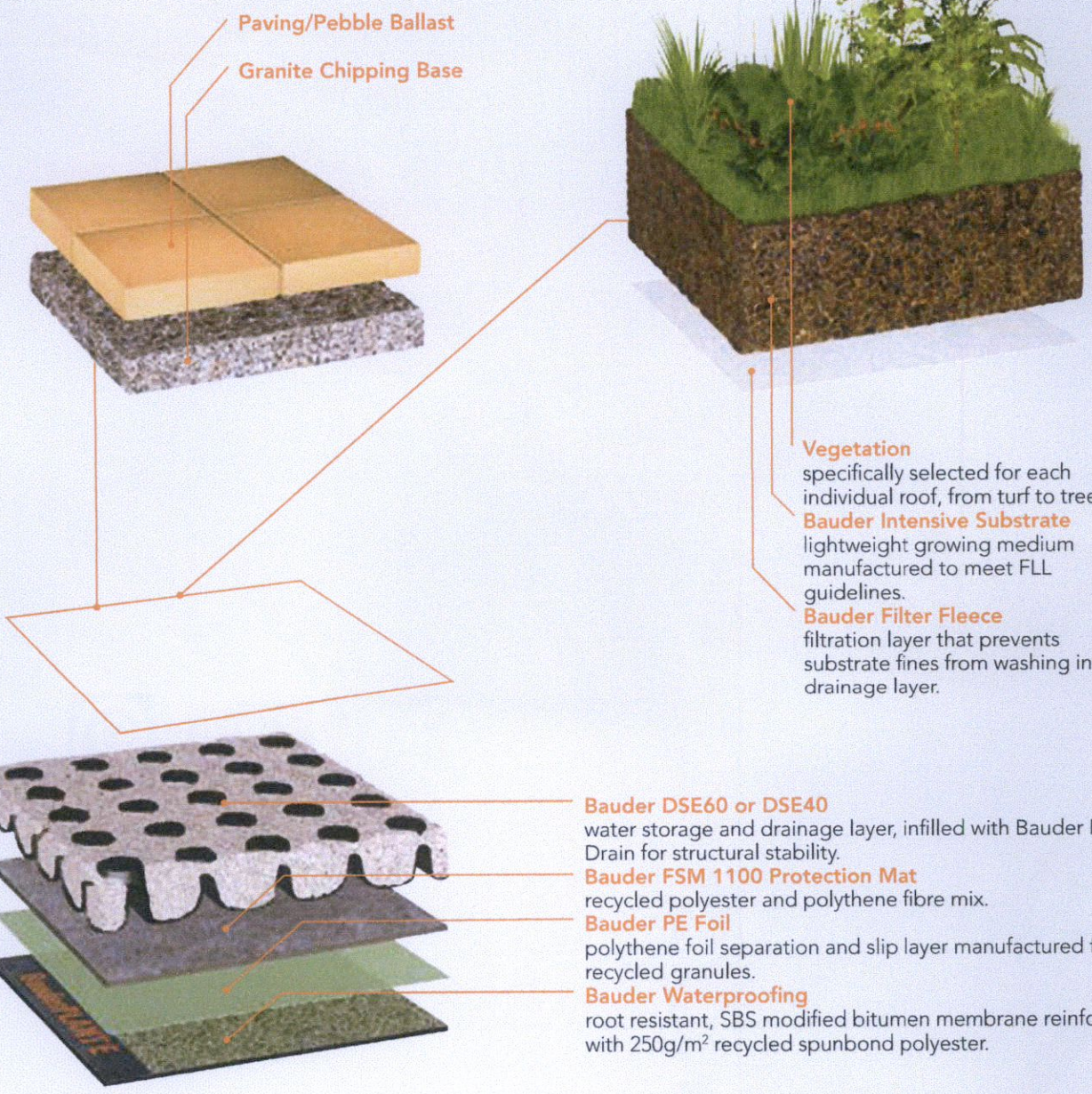
The level of recycled content within our components clearly demonstrates that these products are then easily returned to the convention.

RECREATIONAL SPACES, GARDENS AND TERRACES

Example System Configurations

Our lightweight substrates combined with specially developed water storage and drainage components all ensure that the modern green roof can replicate a traditional landscape at roof level at only a fraction of the weight and with a substantially shallower build up.

It is crucial that an integrated approach is taken to the design and specification of both the waterproofing and landscaping components, so that the desired outcomes are achieved. We can work with you from the earliest design stage to ensure that your green roof project is successful.



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SUBSTRATE GREEN ROOF SYSTEMS

Example System Configurations

Substrate-based extensive green roofs can incorporate a variety of vegetation and hard landscaping finishes.

Vegetation Mats

The installation of a pre-grown vegetation mat allows instant coverage of the roof. Native wildflower blanket, Bauder WB, meets the growing demand to satisfy the requirements of BREEAM and should meet the biodiversity action plan for the site.

Bauder SB vegetation is a mature sedum blanket with a broad mix of sedums, 12-14 species, and is typically grown for a year prior to installation for excellent coverage.

Plug Planting

This method gives the client both a much greater choice of plant species and the opportunity to plan the layout. The individual immature plants or 'plugs' are planted into the substrate, which can then grow on to give good cover over the next few years.

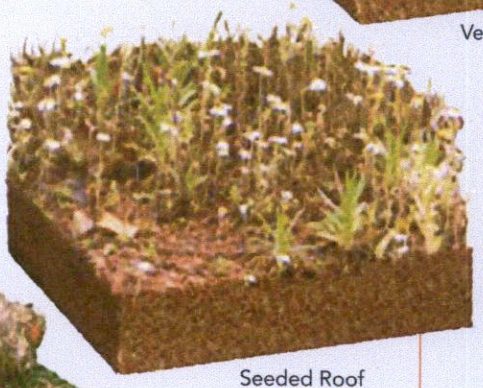
Seeding

An economical and practical method for vegetating larger roof areas. Our seed mixes are designed for the harsh conditions on a roof. Plant establishment and coverage will take 18-24 months, depending upon the time of year sowing takes place and the weather conditions during the period of establishment.

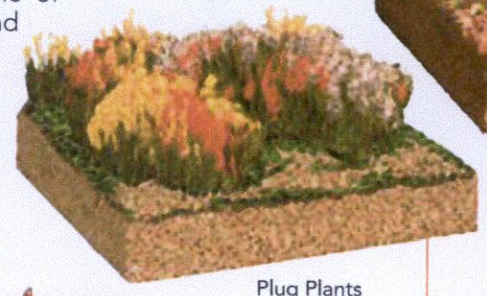
Biodiverse Options

Bauder's range of seed, plug and blanket can be used in combination to create the matrix of habitat and surface finishes required. Bauder has allied with Buglife (the invertebrate charity, buglife.org.uk) to produce roofs designed with dead wood, sand/stone piles as well as dew ponds etc to give a truly sustainable insect friend environment.

Vegetation Mat

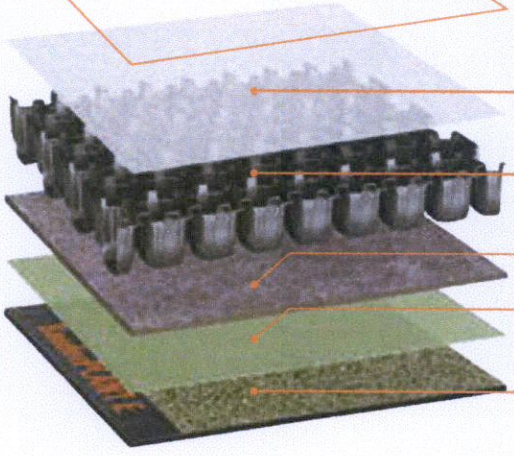


Seeded Roof



Plug Plants

Biodiverse Habitat



Bauder Filter Fleece
filtration layer that prevents substrate fines from washing into the drainage layer.

Bauder DSE40
40mm water storage layer that provides multi directional drainage.

Bauder FSM600 Protection Mat
recycled polyester and polypropylene fibre mix.

Bauder PE Foil (specified in some projects)
polyethylene foil separation and slip layer manufactured from recycled granules.

Bauder Waterproofing (all four types are suitable)
show here with root resistant, SBS modified bitumen membrane reinforced with 250g/m² recycled spunbond polyester.

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LIGHTWEIGHT SEDUM SYSTEM

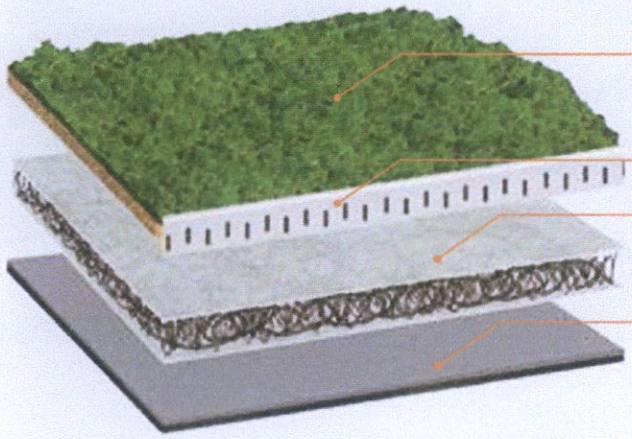
System Configuration

The multi-functional XF301 combines the vegetation support layer with a moisture retention fleece to provide the perfect base for all roofing scenarios with a labour efficient installation.

Our patented geo-textile carrier fleece with its ultraviolet resistant nylon loops provides a support base for the specially developed substrate growing medium and gives stability to the established vegetation whether on a flat roof or up to 25° degrees.

The integral fleece is a unique feature of our XF301 sedum system, retaining moisture after rainfall and thus allowing the plants to take up the water for future use. The sedums are grown to maturity before being harvested, thus ensuring that they acclimatise quickly to their new rooftop location.

We currently cultivate 60,000m² of XF301 and are able to harvest the sedum and deliver to site within 24 hours.



Bauder XF301 Sedum System
pre-cultivated vegetation blanket on a patented nylon loop and geo-textile base carrier with special substrate and a pre-attached integral 8mm moisture retention fleece.

AL40 Sedum Blanket Edge Trim
perforated edge/drainage trim.

Bauder SDF Mat
multifunctional drainage, filtration and protection layer manufactured from ultraviolet resistant nylon woven loops which are thermally bonded to geo-textile filter fleece facings.

Bauder Waterproofing (all four types are suitable)

System Installation

Long length rolls are used to speed up installation process.

Short 2m rolls of XF301 Sedum System installed by hand.

GREEN ROOF DESIGN CONSIDERATIONS

Green roofs have now become big business and it is important that any supplier is able to prove their credibility and to offer valuable guarantees.

This section briefly explains items that need to be considered when designing a green roof.

We have a comprehensive Green Roof Design Considerations guide available to download from www.bauder.co.uk/technical-centre/design-guides

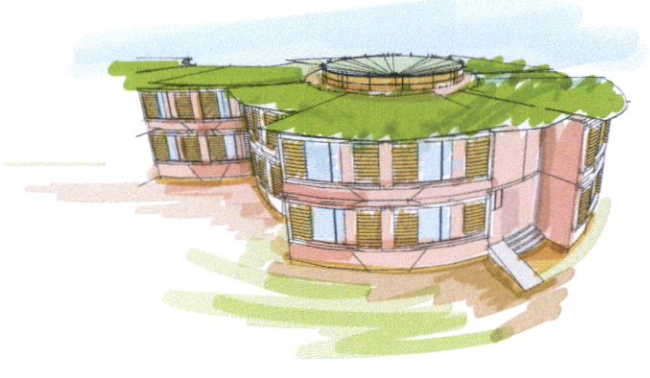
Why is a green roof required and what performance is expected?

There could be many reasons why a green roof is required. It may be to satisfy a planning constraint, in which case economic options will be considered; mitigate against storm water where the design will maximise rainwater attenuation; support specific wildlife for a biodiversity solution; provide recreational space with public access; offer additional energy savings or generation as photovoltaic units are up to 5% more efficient when used on a green roof; or for aesthetic reasons where the building needs to be masked into its surrounding environment.

Essential Factors to be Considered

The most important factor when considering a green roof is the strength and durability of the underlying waterproofing which must:

- Meet all waterproofing standards.
- Have an FLL Compliant Root Barrier.
- Be leak tested prior to installation of the green roof elements.
- Have drainage calculated to cope with severe storm events.
- Incorporate safe access to the roof for maintenance.
- The green roof should be designed to:
- Balance with the environment and growing conditions on the roof.
- Meet any planning requirements.
- Work within the constraints of the building design (height, weight etc).
- Be maintained safely.
- Provide a mixture of different habitats for plants and insects.



The Landscape Finish

The primary decision is the type of landscape required that best suits the rationale behind the development, whether it is an intensive, extensive or biodiversity roof. Whatever the landscape chosen, the plants will have some basic requirements to sustain them; nutrients, a balance between moisture and drainage to suit the vegetation, and aeration to the root system.

Structural Loading

Most roof deck constructions are suitable provided that they can support the imposed load. The saturated weight of the system should be determined at an early stage. Our technical team can provide information so relevant data can be passed to the client's structural engineer.

Indicative weight loadings:

- Intensive systems - 300-400Kg/m^2.
- Extensive substrate systems - 120-200Kg/m^2.
- Lightweight sedum system 44Kg/m^2.

Root Resistant Waterproofing System

All our waterproofing systems are suitable for green roofs, depending on the type speified.

Bituminous and single ply membranes have passed the stringent four year FLL root resistance test widely regarded as the toughest green roof performance trial currently available.

Falls

Intensive green roofs can be safely installed on horizontal decks whereas with extensive green roofs minimum falls of 1:60 and above are preferred. The criteria is to have a depth of drainage layer deep enough to hold the landscape above any residual standing water that occurs on the surface of the deck.

Drainage
The soft landscaping on a green roof will retain a large percentage of the average annual rainfall, as for example an intensive green roof can retain up to 90%, which will result in a significant reduction in the number of outlets required and will thus reduce costs.

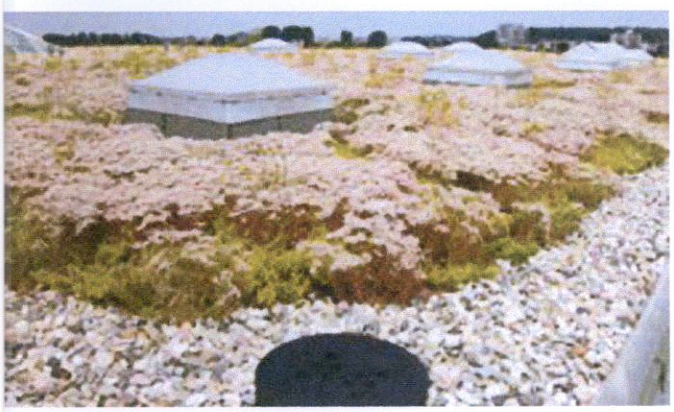
All outlets should be protected by an inspection chamber with removable covers to allow access for maintenance, and be surrounded by a pebble vegetation barrier to prevent encroachment.

Growing Mediums
Usually referred to as substrates, they provide the necessary nutrients, aeration and anchorage for the plants. We blend a number of different substrates tailored to the vegetation being grown, they are FLL compliant, peat free, and weigh significantly less than top soil.

Vegetation Barriers
These provide important functions on a green roof:

- As required by FLL and GRO as a fire break.
- Provide rapid surface drainage during heavy rainfall.
- Reduce and ease routine maintenance.
- Protection of the waterproofing from mechanical damage during maintenance.
- Wind uplift resistance by increasing the imposed load at roof perimeters.

Pebble barriers should be provided at perimeters, abutments, rooflights, inspection chambers and all other protrusions. They are not suitable on roofs with a pitch greater than 9° where alternative materials are used.



Wind Uplift
The stability of the system is increased because the negative pressure forces that can develop during high wind conditions are counteracted by the weight of the green roof system.

Wind can also lead to erosion problems on exposed sites, especially if plant establishment is in the early stages.

Irrigation
Requirement for irrigation will depend upon the location of the building, the local climate and the type of plants used to vegetate the roof.

On our XF301 Sedum System, we recommend installing a leaky pipe irrigation system where the following conditions apply:

- South facing roof slopes exceeding 5° pitch.
- All roof slopes exceeding 10° pitch.
- Windy or exposed site locations.
- Inland sites where rainfall is less frequent.

On intensive green roofs an automated system is generally the best option and the frequency at which it is applied will depend on the plant species.

Safe Roof Access
Provision should always be made for safe access to the roof for routine maintenance, which may include man-safe systems with harness and attachment points, internal access hatches or an externally mounted bracket to secure a ladder.

Maintenance
All roofs require a minimum of two inspections a year to ensure that the outlets etc. are maintained. An extensive green roof will need only minimal maintenance to feed the vegetation and ensure that any unwanted species do not become established.

Intensive schemes will require more regular maintenance. download more information from the Technical Centre on our website, bauder.co.uk/technical-centre

Bauder Green Roof Maintenance Service
Our green roof maintenance service focuses primarily on extensive systems and is set up to be tailor made to suit the client's budget and type of extensive roof installed.

The Bauder Green Roof Promise
Our Green Roof Promise links with our Maintenance Agreement to ensure the continuous health of the Bauder supplied vegetation and that all aspects of the green roof remains healthy and established with the appropriate vegetation.

These documents are bound together and work in unison to give clients peace of mind, knowing that the entire green roof is insafe hands.