GRAF UK Ltd
Target House
Thorpe Way Industrial Estate
Banbury
Oxfordshire OX16 4SP
Tel: 01608 661500
e-mail: info@grafuk.co.uk
website: www.grafuk.co.uk

BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

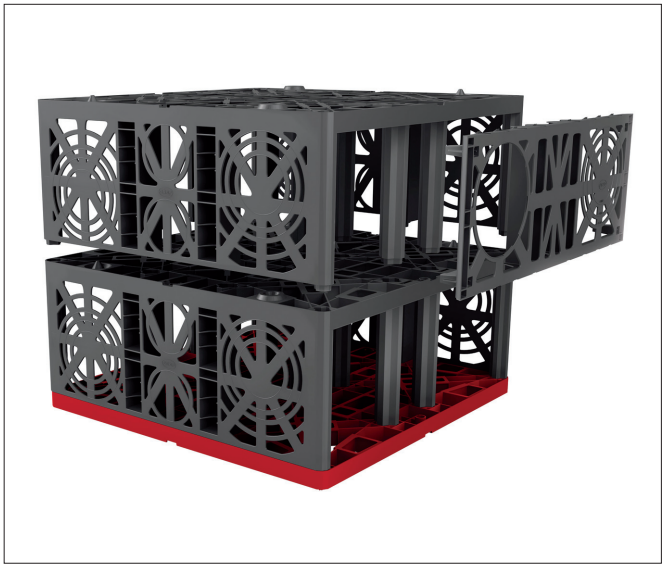
Agrément Certificate
15/5200
Product Sheet 1

GRAF STORMWATER MANAGEMENT SYSTEMS

GRAF ECOBLOC INSPECT FLEX STORMWATER MANAGEMENT SYSTEM

This Agrément Certificate Product Sheet(1) relates to the GRAF EcoBloc Inspect Flex Stormwater Management System, comprising recycled polypropylene modules which can be used to construct below-ground water storage attenuation tanks or soakaways to manage stormwater run-off from impermeable surfaces.

(1) Hereinafter referred to as 'Certificate'.



CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Hydraulic design — data is provided in this Certificate to assist in the design of a below-ground stormwater management system using EcoBloc Inspect Flex (see section 6).

Structural performance — the system has adequate strength and stiffness to resist short-term and long-term loading when used in accordance with this Certificate (see section 7).

Maintenance — data is provided to assist in planning the maintenance of a completed EcoBloc Inspect Flex system installation (see section 11).

Durability — the system will have a service life in excess of 50 years when installed in accordance with this Certificate (see section 12).

The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 3 March 2015

Brian Chamberlain
Head of Approvals — Engineering

Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA
tel: 01923 665300
fax: 01923 665301
clientservices@bba.star.co.uk
www.bbacerts.co.uk
©2015

Regulations

In the opinion of the BBA, the GRAF EcoBloc Inspect Flex Stormwater Management System, if installed, used and maintained in accordance with this Certificate, will satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	H3(3)	Rainwater drainage
Comment:		The system can be used in a construction to satisfy this Requirement. See sections 6.1 to 6.8 of this Certificate.
Regulation:	7	Materials and workmanship
Comment:		The system is acceptable. See section 12 and the *Installation* part of this Certificate.



The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)(2)	Durability, workmanship and fitness of materials
Comment:		The system can contribute to satisfying this Regulation. See sections 11.1 to 11.6, 12 and the *Installation* part of this Certificate.
Regulation:	9	Building standards applicable to construction
Standard:	3.6	Surface water drainage
Comment:		The system can contribute to a construction satisfying this Standard, with reference to clauses 3.6.1[(1)(2)] to 3.6.5[(1)(2)]. See sections 6.1 to 6.8 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system can contribute to satisfying the relevant requirements of Regulation 9, Standards 1 to 6, and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).



The Building Regulations (Northern Ireland) 2012

Regulation:	23(a)(i)(iii)(b)	Fitness of materials and workmanship
Comment:		The system is acceptable. See section 12 and the *Installation* part of this Certificate.
Regulation:	82	Rainwater drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See sections 6.1 to 6.8 of this Certificate.

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections:	3 *Delivery and site handling* (3.1, 3.3, 3.4 and 3.6) and 15 *Procedure* (15.1 and 15.10) of this Certificate.

Additional Information

NHBC Standards 2014

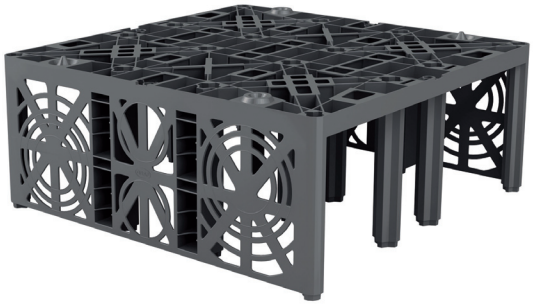
In the opinion of the BBA, the use of the GRAF EcoBloc Inspect Flex Stormwater Management System in relation to this Certificate is not subject to the requirements of these Standards.

Technical Specification

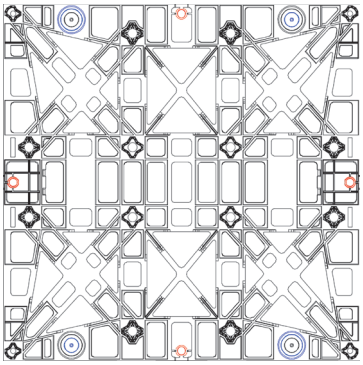
1 Description

1.1 The GRAF EcoBloc Inspect Flex Stormwater Management System (see Figure 1 and Table 1) is a stormwater management system which comprises modules manufactured from recycled polypropylene that clip together on site to form tanks of the required dimension. EcoBloc Inspect Flex baseplates form the base of the system and EcoBloc Inspect Flex end-plates are used around the perimeter of the tank structure. The modules are designed to include clear channels (minimum: 200 mm [8"]) in both directions to allow for inspection of the finished structure. End-plates include cutting guides to facilitate connection of 100 mm, 150 mm and 200 mm pipe (to BS EN 1401-1 : 2009). Alternatively, connections for pipes with diameters from 300 mm up to 500 mm can be made using pre-formed adaptor plates, available from the manufacturer but not covered by this Certificate.

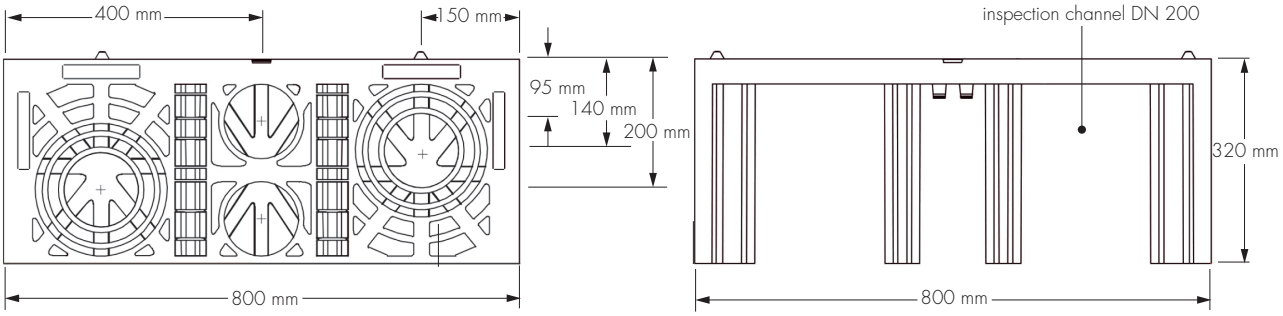
Figure 1 GRAF EcoBloc Inspect Flex components



EcoBloc Inspect flex module

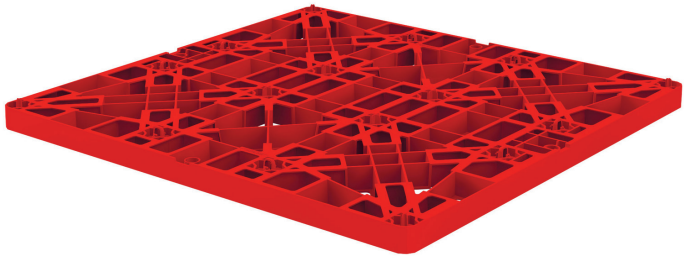


top view

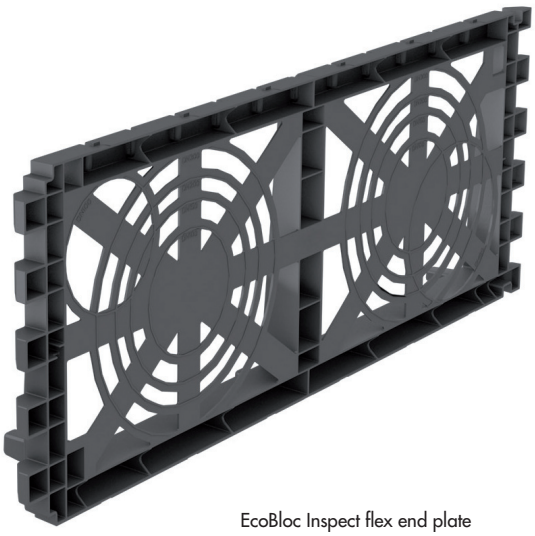


side view

front view



EcoBloc Inspect flex base plate



EcoBloc Inspect flex end plate



EcoBloc Inspect flex connectors
for horizontal connection

Table 1 Characteristics of the module

Module	
Dimensions (nominal) (l x w x h) (mm)	800 x 800 x 320
Volume (nominal) (m^3)	0.205
Storage volume (nominal) (m^3)	0.199
Weight (kg)	8
Porosity (void ratio)[1] (%)	95-97 (*see Table 5*)
Baseplate	
Dimensions (nominal) (l x w x h) (mm)	800 x 800 x 40
Volume (nominal) (m^3)	0.025
Storage volume (nominal) (m^3)	0.020
Weight (kg)	4
Porosity (void ratio)[1] (%)	80

(1) Differing void ratios are taken into account in volume calculations.

1.2 Connector clips are manufactured from recycled polypropylene. The clips are used as horizontal connectors to hold the units together prior to enclosing the unit/tank in geotextile or geomembrane.

1.3 Items used with the units to form the GRAF EcoBloc Inspect Flex Stormwater Management System, but outside the scope of this Certificate, include:

- pipework and pipe adaptors
- geotextile
- geotextile protection fleece
- geomembrane
- vents and connecting pipework
- silt traps and access chambers
- flow control devices and chambers
- granular material/coarse sand (surround material).

2 Manufacture

2.1 GRAF EcoBloc Inspect Flex modules, base and end-plates are manufactured via injection moulding of the recycled polypropylene material to a defined specification.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested, calibrated and operated by trained personnel
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.3 The management system of GRAF GmbH has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by DEKRA (Certificate 80613353).

3 Delivery and site handling

3.1 EcoBloc Inspect Flex modules are supplied to site in stacks of 13 or 15, secured together and with recyclable plastic feet (for transportation purposes only) instead of a wooden pallet (to minimise packaging). Each stack carries a label stating the product name, part number, quantity, production date and time and operator initials.

3.2 Base-plates, end-plates and connectors are shipped in quantities of 30, 80 (pairs) and 25 respectively.

3.3 For ease of off-loading and movement around the site, modules are stacked such that access for fork lift tines is present part way up the stack.

3.4 All stacks should be carefully placed on level ground and must not be stacked on top of each other.

3.5 The modules contain an inhibitor to resist the effects of ultraviolet light for up to 12 months. However, prolonged storage in direct sunlight and high temperatures should be avoided.

3.6 The modules should not be stored near fuel bowsers, fuel tanks or other solvents to avoid potential chemical spillages.

3.7 The modules are resistant to damage likely to be caused during normal handling. However, they should be stored in locations where impacts from vehicles and other construction plant will be avoided.

3.8 Stacks should be dismantled in the vertical orientation.

3.9 Prior to installation, all parts should be checked for damage. Damaged or defective modules must not be installed.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the GRAF EcoBloc Inspect Flex Stormwater Management System.

Design Considerations

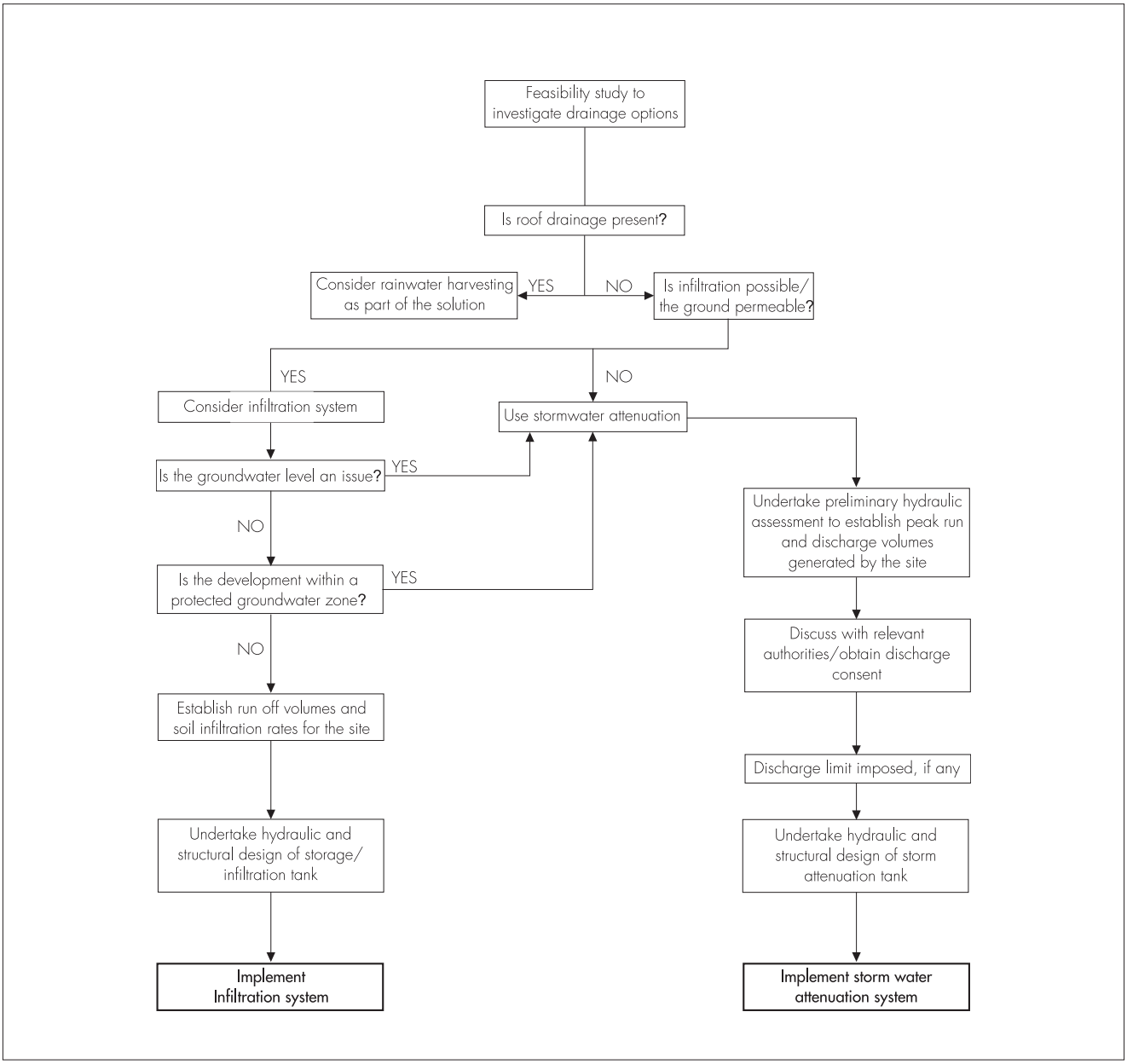
4 General

4.1 The design of a GRAF EcoBloc Inspect Flex Stormwater Management System must be in accordance with the Certificate holder's design guidelines. Guidance on the application of sustainable drainage systems (SUDS) for new developments using systems such as the above can be found in the Communities and Local Government Planning Policy Statement PPS25. Additional guidance is also available in the Construction Industry Research and Information Association (CIRIA) Report C697.

4.2 The system is suitable for the management of stormwater run-off from impermeable surfaces and can be utilised in two ways (see Figure 2), or as a combination of both:

- infiltration — the tank formed from the modules, when wrapped in a geotextile, forms a below-ground tank in which the stormwater is collected via surface water pipes which then infiltrates into the surrounding soil over a period of time following rainfall
- attenuation — the tank formed from the modules, when wrapped in an impermeable membrane, forms a below-ground tank which collects the stormwater. This is then released at a reduced rate via a flow control device into an appropriate outfall. This reduces the peak flow to the watercourse and so reduces the risk of flooding.

Figure 2 Sustainable drainage system selection and design



4.3 Design of an appropriate system for a specific project must always be preceded by a detailed audit of the proposed site to establish:

- existing factors and considerations applicable to the site
- predicted factors relating to the site's use following the planned development, and the parameters within which the installation is required to function
- the type of function of application suggested by this audit.

4.4 Once the project criteria have been established from the site audit, there are two main parts to the design procedure for an individual installation — hydraulic design and structural design.

5 Practicability of installation

The system is designed to be installed by a competent general builder, or a contractor, experienced with this type of system.

6 Hydraulic design

Infiltration

Calculation principles



6.1 There are two approaches, either of which may be adopted: the Construction Industry Research and Information Association (CIRIA) Report 156 or BRE Digest 365 : 2003. Further information on the design of sustainable drainage systems (SUDS) may be obtained from CIRIA Report : C697.

6.2 A simplified approximate approach can be used on a small site (eg a single-house development), where detailed site infiltration rate information may not be required or available (see Table 2). From Approved Document H of the England and Wales Building Regulations, a storage volume equal to the area to be drained multiplied by 10 mm, for areas up to 25 m^2 is allowed. Beyond this size, the design should be carried out in accordance with BS EN 752 : 2008 or BRE Digest 365 : 2003. It is suggested in BS EN 752 : 2008 that a storage volume equal to 20 mm multiplied by the area to be drained may be used. In Scotland, guidance for the design of single-house soakaways is given in Mandatory Standard 3.6, clause 3.6.5[1].

(1) Technical Handbook (Domestic).

Table 2 Simplified soakaway design for single-house development[1]

Number of modules	Storage volume (m^3)	Maximum area to be drained (m^2)
1	0.22	22[2]
2	0.44	25[2]
3	0.66	33[3]
4	0.88	44[3]
5	1.10	51[3]
6	1.32	66[3]

(1) Where doubt exists as to the suitability of the ground for infiltration permeability, figures should be derived by test (see BRE Digest 365 : 2003).

(2) In accordance with Approved Document H.

(3) In accordance with BS EN 752 : 2008, clause NA 4.4.8.

6.3 When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found in Tables 3 and 4 of this Certificate.

Table 3 Data for use in hydraulic design — one module wide trench configuration

Number of modules high	Available water storage volume (m^3/metre length of trench)	Area of both sides (m^2/metre length of tank)	Area beneath base of tank (m^2/metre length of tank)
1	0.274	0.72	0.80
2	0.522	1.36	0.80

Table 4 Data for use in hydraulic design — three-dimensional tanks, two modules high

	2 modules wide			4 modules wide			8 modules wide		
System length (modules long)	Available water storage volume (m^3)	Area, sides and ends (m^2)	Base area (m^2)	Available water storage volume (m^3)	Area, sides and ends (m^2)	Base area (m^2)	Available water storage volume (m^3)	Area, sides and ends (m^2)	Base area (m^2)
1	0.84	3.26	1.28	1.67	5.44	2.56	3.34	9.79	5.12
2	1.67	4.35	2.56	3.34	6.53	5.12	6.68	10.88	10.24
4	3.34	6.53	5.12	6.68	8.70	10.24	13.36	13.06	20.48
8	6.68	10.88	10.24	13.36	13.06	20.48	26.72	17.41	40.96
10	8.36	13.06	12.80	16.72	15.23	25.60	33.44	19.58	51.20
100	83.56	110.98	128.00	167.12	113.15	256.00	334.24	117.50	512.00

6.4 For the purpose of calculation, the size and volume of the modules are given in Table 1. The total areas of the base and sides are required to enable the rate of infiltration of the stored water into the surrounding soil to be established. This will also depend on the permeability of the soil surrounding the tank and that of the geotextile. The void ratio depends on the number of modules high (see Table 5). As an example, using Table 5, for a typical one-module-wide linear trench 40 m long and two modules deep, the storage volume is 0.68 by 0.8 by 40 by 96% = 21 m^3. The effective area for infiltration is the base area (40 by 0.8 in example) and side faces (2 by 40 by 0.68) total of 86.4 m^2.

Table 5 Void ratios for the GRAF EcoBloc Inspect Flex Stormwater Management System

Number of layers	Void ratio
1	0.95
2	0.96
4	0.97
8	0.97

Attenuation

Calculation principles



6.5 The anticipated total run-off volume from the site is estimated. The most commonly used method for evaluating storm rainfall events in the UK is the Wallingford Procedure by which the total rainfall level of storms over defined time periods (ranging from five minutes up to 48 hours) is assessed. The allowable discharge rate from the site to an appropriate outfall is established, which will normally be set by the Environment Agency, the Scottish Environmental Protection Agency or Planning Authorities. The volume to be stored underground in the system is then determined and the number of modules needed to contain this volume is calculated taking account of the void ratios in Table 5.

Connections

6.6 Connection is made to the tank system using the end/side plate cut-outs. Other methods of connection are available from the manufacturer but are not covered by this Certificate.

Flow control

6.7 The outflow from the system must be controlled to comply with the discharge rate consent of the site. The main methods to achieve outflow control are: orifice plate, vortex control or small pipe. Comparative features and benefits of these various control flow devices should be considered prior to selection.

Outflow positioning and head calculations

6.8 The invert level of the outflow pipe should be flush with the bottom of the lowest module to allow the system to drain. As the tank fills, a depth of water develops on the upstream side of the outflow control, creating a driving head to push the flow through the control device. For design purposes, the head used in calculations is taken as that at the invert line of the outflow device.

7 Structural performance

7.1 The structural design of each installation incorporating the system should be carried out by a suitably qualified and experienced engineer.

7.2 Guidance on the design and installation of systems incorporating the modules can be found in CIRIA Report C680 *Structural design of modular geocellular drainage tanks*. Consideration should be given to the effects of cumulative deflection in tanks comprising several layers of modules.

7.3 The system can be placed under landscaped or lightly-trafficked areas/car parks. Application to areas subject to greater loads are outside the scope of this Certificate. Advice should be sought from the Certificate holder.

7.4 Care should be taken when the system is used for infiltration below trafficked areas and close to structures. It is important to ensure that the infiltrating water will not soften the soils or cause loss of fines and settlement.

7.5 The engineer responsible for the design of the installation must confirm that the ground-bearing capacity at the formation level is sufficient for the proposed operational loads. In areas of weak or compressible soils, advice should be sought from a geotechnical engineer.

7.6 When the system is wrapped in an impermeable geomembrane and placed below the groundwater table, flotation may occur. To prevent this, the weight of the soil over the top of the system must be greater than the uplift force caused by the unit's buoyancy in the water. This can be achieved with most types of fill if the depth of cover fill is equal to, or greater than, the depth of penetration of the units below groundwater level.

Module performance characteristics

7.7 Characteristic compressive strength at the yield point and elastic deflection values for the system have been determined from independent, short-term tests on samples incorporating a stack of two modules plus a base-plate (see Table 6).

Table 6 Short-term performance values

Module	Value
Characteristic compressive strength at yield ($kN \cdot m^{-2}$)	
vertical loading on top face	340
lateral loading on side face	82
Short-term deflection (mm per $kN \cdot m^{-2}$) (applied load)	
vertical loading on top face	1 per 23
lateral loading on side face	1 per 7

7.8 The equations in Table 7 of this Certificate have been established from creep tests carried out in excess of 3000 hours on a stack of two modules plus a baseplate and can be used for up to 50 years, where the design temperature is less than 20°C.

Table 7 Equations for estimation of long-term deflection

For loads up to ($kN \cdot m^{-2}$):	Equation for estimation of total vertical deflection long-term
78.1	Deflection = 0.8288 ln [time (hours)] + 4.6
62.5	Deflection = 0.6416 ln [time (hours)] + 2.7

7.9 The partial load and material factors in Table 8 of this Certificate, as defined in CIRIA Report C680, should be used for design purposes.

Table 8 Partial factors for loads and materials

Description		Ultimate limit state	Serviceability limit state
Partial factors for loads	Vertical dead-load (F_{dl})	1.40	1.00
	Earth pressure (horizontal) + hydrostatic (horizontal) load (F_{ep})	1.35	1.00
	Imposed live-load (F_{ll})	1.60	1.00
Partial safety factors for materials (F_m)		2.75	1.50

7.10 Example maximum installation depths and minimum depths of cover calculated as described in this section, and in accordance with CIRIA Report C680, are shown in Tables 9, 10 and 11 of this Certificate.

7.11 For small-scale applications, such as soakaways for individual house roof drainage, the system is installed below a garden (inaccessible to motor vehicles), a minimum of 5 m from the building, Table 9 of this Certificate indicates the maximum depth and minimum cover applicable to most locations in the UK.

Table 9 Design criteria for use of GRAF EcoBloc Inspect Flex as a soakaway for individual houses(1)

Criterion	Value
Maximum depth to base of system (m)	3.50
Minimum depth of cover required over units to prevent accidental damage (m)	0.30

(1) The following assumptions apply:
- soakaway constructed in sandy gravels with a soil weight not exceeding 20 $kN \cdot ^{-3}$ and angle of shearing resistance for surrounding soil not less than 30°
- groundwater at least 1 m below the base of the system
- soakaway located beneath small gardens or landscaped areas (inaccessible to motor vehicles), in accordance with Table 4.2 of CIRIA C680
- for installation below landscaped and lightly-trafficked areas.

7.12 Tables 10 and 11 of this Certificate are only applicable in temperate climate conditions such as those in the UK. Site specific calculations should be carried out for configurations and prevailing ground conditions other than those shown.

Table 10 Maximum installation depths (to base of units)

Soil description	Soil weight ($kN \cdot m^{-3}$)	Angle of internal friction (degrees)	No groundwater present		Groundwater present (1 m below ground level)	
			Car parks[1][2]	Landscaped areas[3]	Car park[1]	Landscaped areas[3]
Over consolidated stiff clay	20	24°	2.53	2.48	1.88	2.01
Silty sandy clay	19	26°	2.88	2.88	2.14	2.13
Loose sand and gravel	18	30°	3.53	3.48	2.33	2.33
Medium-dense sand and gravel	19	34°	3.38	3.38	2.40	2.40
Dense sand and gravel	20	38°	3.28	3.28	2.50	2.50

(1) Car parks, cars or light vehicles up to 9000 kg (GVW) in accordance with Table 4.2 of CIRIA C680.

(2) Installations greater than 4 m deep beneath car parks are outside the scope of this Certificate.

(3) Landscaped areas where drive-on mowers are used (drive-on mowers in accordance with Table 4.2 of CIRIA C680).

Notes:

- calculations are based on tanks comprising a stack of two modules plus a baseplate (0.68 m high)
- weight of ground water taken as $kN \cdot m^{-3}$
- angle of spread of wheel loadings taken as 27° in car parks with asphaltic surfaces
- spread of wheel loading taken as the angle of internal friction (degrees) of the soil in landscaped areas
- no account is taken of accidental loading
- ground surface in vicinity of system is assumed to be level
- formation below system assumed to have adequate load-bearing capacity
- partial load and material factors are defined in Table 8 of this Certificate
- values for distributed load and concentrated wheel loads/contact areas as defined in Table 4.2 of CIRIA 680.

Table 11 Minimum cover depths over top of units

	Landscaped areas[1]	Driveways and car parks with height barriers[2]	Car parks[3]
Minimum cover depth required (m)	0.30	0.60	1.15

(1) Landscaped areas where drive-on mowers are used (drive-on mowers in accordance with Table 4.2 of CIRIA C680).

(2) Driveways to individual houses and car parks with height barriers to limit vehicle size, cars up to 3000 kg GVW (eg people carriers) in accordance with Table 4.2 of CIRIA C680.

(3) Car parks, cars or light vehicles up to 9000 kg (GVW) in accordance with Table 4.2 of CIRIA C680.

Notes:

- calculations are based on tanks comprising a stack of two modules plus a baseplate (0.68 m high)
- soil weight and angle of friction of the soil above the system taken as 20 $kN \cdot m^3$ and 38° respectively
- calculation based on there being no groundwater present
- angle of spread of wheel loadings taken as 27° in car parks with asphaltic surfaces
- spread of wheel loading taken as the angle of internal friction (degrees) of the soil in landscaped areas
- no account is taken of accidental loading
- ground surface in vicinity of system is assumed to be level
- formation below system assumed to have adequate load-bearing capacity
- partial load and material factors are defined in Table 8 of this Certificate
- values for distributed load and concentrated wheel loads/contact areas as defined in Table 4.2 of CIRIA 680.

8 Geotextiles and geomembranes

Infiltration

8.1 The system requires a geotextile wrapping when used as an infiltration device to:

- allow the water infiltration into adjacent ground
- prevent silt that may be contained in the surface water run-off from contaminating the surrounding soil, in addition to reducing its permeability
- prevent surrounding soil from entering the units.

8.2 Selection of an appropriate geotextile requires careful consideration (see section 8.6).

Attenuation

8.3 The system requires a sealed geomembrane wrapping to create an attenuation storage tank and prevent:

- the release of surface water into the surrounding ground
- inflow of groundwater that may overload downstream systems and contain pollutants on contaminated sites.

8.4 Site conditions may also require the use of an additional thick, protective geotextile fleece to prevent puncture or excessive strain in the geomembrane, on which further advice should be sought from the geomembrane manufacturer.

8.5 Selection of an appropriate geomembrane requires careful consideration (see section 8.7).

Specification of geotextile

8.6 The selection of an appropriate geotextile (see Table 12 of this Certificate) for a specific EcoBloc Inspect Flex Stormwater Management System should be considered carefully, particularly with reference to the surrounding soil properties and required performance. Points to consider are:

- pore size — this should be designed and specified to assist infiltration and prevent migration of fine soil particles
- permeability and breakthrough head — the geotextile should not limit flow of water in the system, and should have a similar or greater permeability than the surrounding ground
- puncture resistance — the geotextile must be able to resist piercing by potentially sharp objects, eg stones in the soil
- tensile strength — the geotextile should have sufficient strength to resist any imposed forces (eg from wheel loads)
- durability
- specialist advice should be sought if surrounding soil characteristics exhibit a high degree of fines/low infiltration capacity and/or there is risk of damage from ground contaminants.

Table 12 Infiltration geotextile minimum specification

Tested property	Minimum value
Thickness (mm)	1
Mass per unit area ($g \cdot m^{-2}$)	125
CBR puncture resistance (N)	1500
Cone drop test (mm)	24
Peak tensile strength ($kN \cdot m^{-2}$)	8
Opening size (µm)	105
Permeability vertical ($l \cdot m^{-2} \cdot s^{-1}$)	115
Material	100% uv-stabilised polypropylene
Description	non-woven mechanically bonded

Specification of geomembrane

8.7 The specification and selection of the impermeable geomembrane (see Table 13 of this Certificate) must be correct for the proposed installation, to ensure it performs to the level required. It is essential that the specified material:

- withstands the rigours of installation
- resists puncture
- resists multi-axial elongation stress and strains associated with settlement
- resists environmental stress cracking
- resists damage from ground contaminants
- remains intact for the full design life.

Table 13 Geomembrane minimum specification

Tested property	Test method	Minimum value
Thickness (mm)	EN 1849-2 : 2001	1.0
Mass per unit area ($g \cdot m^{-2}$)	EN 1849-2 : 2001	880
Tensile strength (MPa)	BS EN ISO 527-3 : 1996	>18
Elongation at break (%)	BS EN ISO 527-3 : 1996	>750
Tear propagation resistance ($N \cdot m^{-2}$)	DIN 53515 : 1977 (with cut)	>45
Piercing resistance (N)	FTMS 101C	>150
Water absorption after 7 days (%)	BS EN ISO 62 : 2008	>0.2
Stress cracking resistance (h)	ASTM D5397	>1150
Dimensional changes after heat ageing (%)	DIN 53377 : 2007 (1h/1400)	±3

8.8 A geomembrane less than 1 mm thick is unlikely to meet these criteria (except in shallow, domestic installations), and is not recommended for use with the EcoBloc Inspect Flex Stormwater Management System. For further details the Certificate holder's advice should be sought.

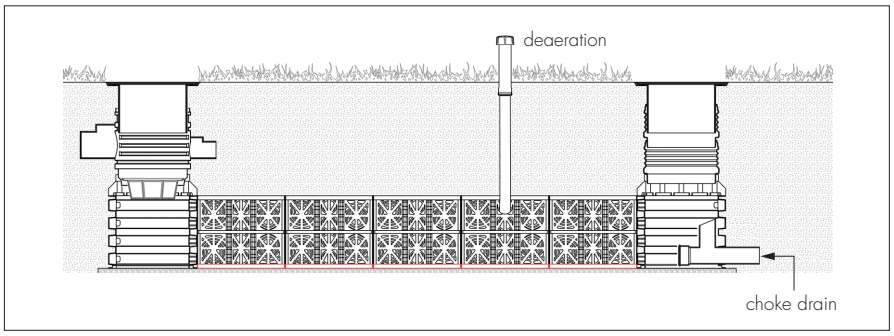
8.9 All joints must be sealed, using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures is given in CIRIA SP 124 : 1996.

9 Venting

9.1 Adequate venting must be provided to the system. As a minimum, one 110 mm diameter air vent is required per 7500 m^2 of impermeable catchment area to be drained (see Figure 3). Air vent connections and pipework for use with this system are outside the scope of the Certificate.

9.2 Typical air vent connections and pipework (generally to BS EN 1401: 2009) are shown in Figure 3. It is recommended that all air vent installations in storage applications (using a geomembrane) are made using a suitable adhesive or welding to ensure a watertight seal. Venting should be positioned in a non-trafficked area, wherever possible.

Figure 3 Typical venting of the GRAF EcoBloc Inspect Flex System



Notes:

- the manholes shown are outside the scope of this Certificate
- the left shaft illustrates the presence of a filter strainer
- the right shaft illustrates an outflow restriction device.

10 Resistance to chemicals

10.1 An assessment by the BBA indicates that the components of the system are suitable for use in contact with the chemicals likely to be found in rainwater.

10.2 An assessment of the suitability for use of the system on brownfield sites should be made only after a suitable site investigation (outside the scope of this Certificate) to determine the possibility for chemical attack. Particular care must be taken where acids and organic solvents are present at high concentrations. Further information can be obtained from the Certificate holder.

11 Maintenance



11.1 The owner of the structure is responsible for maintenance.

11.2 For soakaways to individual houses, the only necessary maintenance of the system is to keep all gullies clear of debris such as leaves.

11.3 For large installations or where the receiving waters are environmentally sensitive, a system of regular inspections should be established to prevent siltation of the system which, if allowed to develop, would reduce effectiveness. They should also be inspected after every major storm event.

11.4 It is recommended that silt traps, filters or other means of reducing the amount of silt and solids entering the system to a minimum, should be incorporated into the pipework at the inlet to the tank (see Figures 3 and 4). There must be a maintenance plan that ensures regular cleaning of the trap to ensure correct performance.

Figure 4 Typical silt trap (not covered by this Certificate)



11.5 For all flow control devices, it is sensible to incorporate access (via a manhole or similar) to the location of the pipe entry, orifice or vortex control. This will enable easy removal of any blockage. The orifice itself may be protected by a debris screen.

11.6 Paved surface areas above an installation should be inspected at the same time to ensure the units continue to provide the required structural support.

12 Durability

The structural properties of the recycled polypropylene used in the components of the system will deteriorate with time and should be taken into account at the design stage by the application of suitable safety factors. In the opinion of the BBA, the system, when used in accordance with this Certificate, will have a life in excess of 50 years.

13 Reuse and recyclability

The units consist of polypropylene material which is readily recyclable.

Installation

14 General

The GRAF EcoBloc Inspect Flex Stormwater Management System should be installed in accordance with the Certificate holder's installation instructions and this Certificate. Special attention should be paid to temporary work requirements in excavations.

15 Procedure

15.1 The hole or trench is excavated to the required plan, dimensions and level ensuring that the excavation will allow installation of connecting pipework. Sufficient construction plant access must be maintained for reinstating around the installed units. The formation must be smooth and level without sharp drops or humps. Slopes must be cut to a safe angle or adequately supported, and safe access must be provided to allow personnel to enter the excavation. Excavation should be carried out in accordance with BS 6031 : 2009, with particular attention paid to safety procedures.

15.2 It must be ensured that the ground-bearing capacity at formation level is adequate for the design loads.

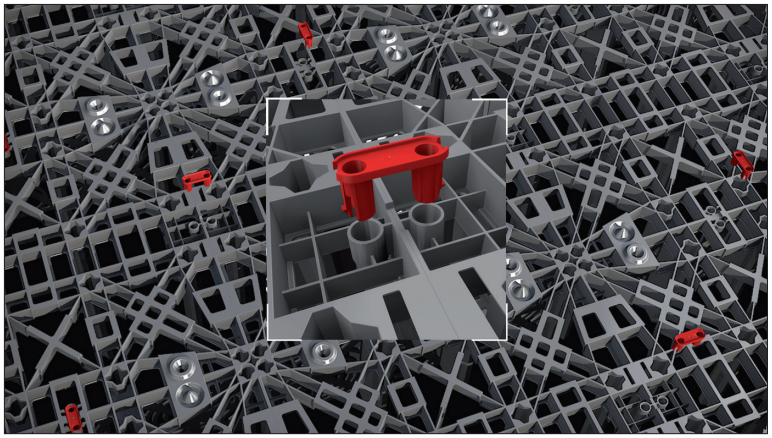
15.3 The subgrade must be inspected for soft spots in the formation and, if present, they must be excavated and replaced with compacted granular fill material. For all applications, a minimum of 80 mm thick bedding layer of compacted 8 mm/16 mm granular material is laid on the formation of the excavation. It is important that the surface of this layer is nominally level, with no large undulations.

15.4 For attenuation installations, the geotextile protection fleece is laid on the bedding layer and up the sides, if required. The geomembrane is laid on top of the fleece and up the sides of the excavation. A second layer of geotextile fleece is laid over the geomembrane covering the plan area of the tank only. Joints should be made in accordance with the membrane manufacturer's recommendations with provision made for connecting pipework or adaptor plates.

15.5 For infiltration applications, the geotextile protection fleece is laid on the bedding layer and up the sides of the excavation. Joints are formed in accordance with the manufacturer's recommendations and provision made for connecting pipework or adaptors.

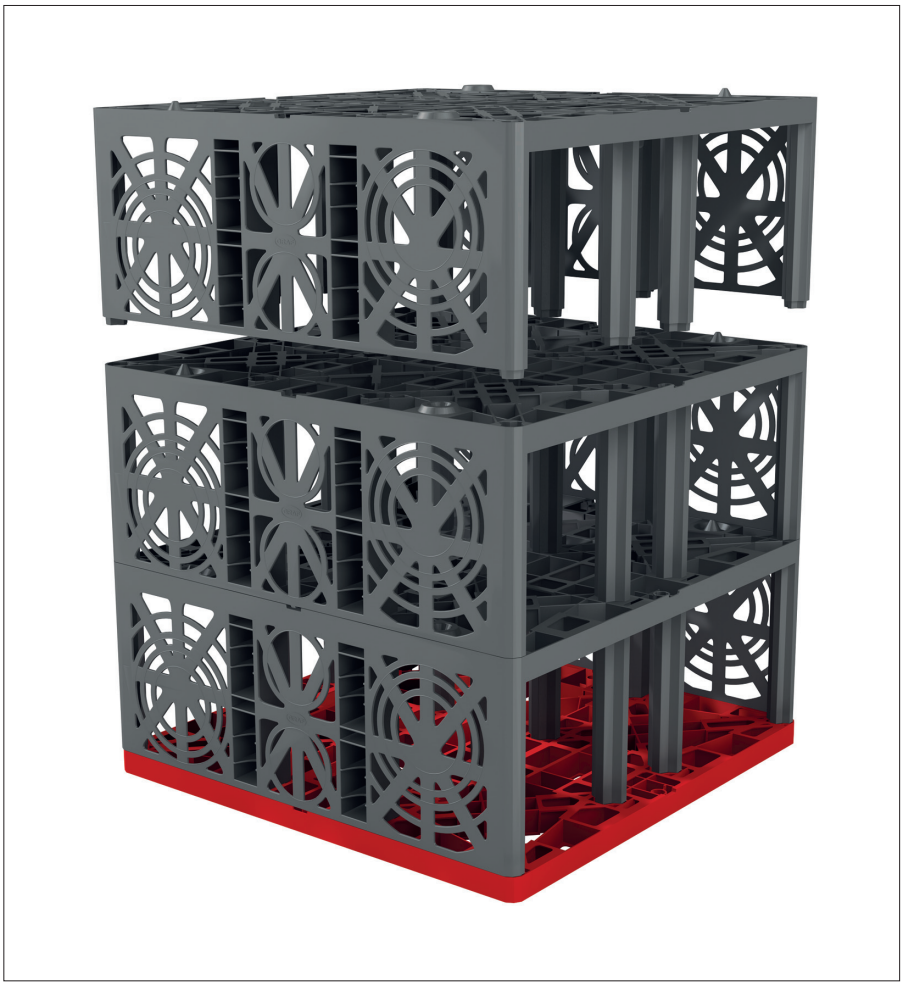
15.6 The system is installed in accordance with the installation instructions with the base-plates laid directly onto the geotextile in the correct orientation, and then each base-plate is joined to the adjacent ones with connectors. Once the entire base has been constructed, the EcoBloc Inspect Flex Modules are laid on top of the base-plates. Connectors are used to join each module together (see Figure 5).

Figure 5 EcoBloc Inspect Flex connectors



15.7 Subsequent layers are placed directly on top of the previous layer. The modules are aligned in the same direction, creating the inspection tunnel (see Figure 6). Installation lugs on the top and base of each module ensure that modules are installed in the correct orientation.

Figure 6 Stacking of EcoBloc Inspect Flex modules



15.8 Once all of the EcoBloc modules have been placed in position, the end-plates are fitted to the open ends of the tank.

15.9 Inlet/outlet drainage and vent connections are made to the installation using proprietary adaptors and located in the correct position for receiving pipework. For attenuation applications, all pipe connections penetrating the geomembrane must be adequately sealed.

15.10 An additional layer of geotextile protective fleece is laid on the top of the tank and then encapsulated with the membrane and geotextile already laid. The geomembrane must be welded in accordance with the manufacturer's recommendations. Welding of the membrane should only be undertaken by persons certified to UKCAS CSWIP (Certificate Scheme for Welding and Inspection Personnel). The geomembrane and/or the geotextile should be inspected for damage and all welds tested as required.

15.11 The encapsulated structure is backfilled around the sides using 8 mm/16 mm granular material up to at least the top edge of the tank.

15.12 A minimum of a 100 mm layer of 8 mm to 16 mm gravel must be placed on top of the geotextile layer immediately above the tank.

15.13 Backfilling is continued with:

- trafficked areas (eg car parks) — type 1 or 2 sub-base material compacted in 150 mm layers in accordance with the *Manual of Contract Documents for Highway Works*, Volume 1. Compaction of the first 300 mm of cover should be carried out using laminar working devices. Thereafter, compaction plant over the top of the system should not exceed 2300 kg per metre width
- landscaped and non-trafficked areas — selected 'as-dug' material with size of pieces less than 75 mm, compacted to 90% maximum dry density vehicle movement over the top of the system should be performed in straight passes only.

15.14 It is recommended that a closed-circuit television (CCTV) inspection of the system is carried out following the installation to ensure that the membrane/geotextile liner has been installed.

15.15 The pavement construction or landscaping is completed over the units.

16 Tests

Tests were carried out on the system to determine:

- short-term resistance to vertical horizontal loading
- long-term resistance to vertical and loading
- short and long-term tensile strength of the polypropylene.

17 Investigations

17.1 The manufacturing process was examined including the method adopted for quality control, and details obtained on the quality and composition of the material used.

17.2 An assessment of the system was made in relation to:

- material properties
- design procedures
- volumetric capacity.

17.3 A site visit was made to assess the practicability and ease of installation and connection.

Bibliography

ASTM D5397 : 2007 *Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test*

BRE Digest 365 : 2003 *Soakaway Design*

BS 6031 : 2009 *Code of practice for earthworks*

BS EN 752 : 2008 *Drain and sewer systems outside buildings*

BS EN 1401-1 : 2009 *Plastics piping systems for non-pressure underground drainage and sewerage — Unplasticized poly(vinylchloride) (PVC-U) — Specifications for pipes, fittings and the system*

BS EN ISO 62 : 2008 *Plastics — Determination of Water Absorption*

BS EN ISO 527-3 : 1996 *Plastics — Determination of Tensile Properties — Test Conditions for Films and Sheets*

BS EN ISO 9001 : 2008 *Quality management systems — Requirements*

CIRIA Report SP 124 : 1996 *Barriers, liners and cover systems for containment and control of land contamination*

CIRIA Report 156 *Infiltration drainage — Manual of good practice*

CIRIA : C680 : *Structural design of modular geocellular drainage tanks*

CIRIA C697 : *The SUDS manual*

DIN 53377 : 2007 *Testing of plastic films — Determination of dimensional stability*

DIN 53515 : 1977 *Determination of tear strength of rubber elastomers and plastic film using Graves angle test piece with nick*

EN 1849-2 : 2001 *Flexible sheets for waterproofing — Determination of thickness and mass per unit area — Plastic and rubber sheets*

FTMS 101C — *Puncture Test Federal Test Method Standard (FTMS) 101C — Method 2065*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works* Planning Policy Statement PPS25, *Development and Flood Risk*

18 Conditions

18.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

18.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

18.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

18.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

18.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

18.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA
©2015
tel: 01923 665300
fax: 01923 665301
clientservices@bba.star.co.uk
www.bbacerts.co.uk