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**Agrément Certificate**

**15/5200**

Product Sheet 3

## GRAF STORMWATER MANAGEMENT SYSTEMS

### GRAF ECOBLOC MAXX STORMWATER MANAGEMENT UNITS

This Agrément Certificate Product Sheet<sup>(1)</sup> relates to GRAF EcoBloc maxx Stormwater Management Units, 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 the product (see section 6).

**Structural performance** — the system has adequate strength and stiffness to resist short- 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 system installation (see section 11).

**Durability** — the system will have a design 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 product described herein. This product 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

Paul Valentine  
Technical Excellence Director

Claire Curtis-Thomas  
Chief Executive

Date of First issue: 28 August 2019

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](http://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.  
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## Regulations

In the opinion of the BBA, GRAF EcoBloc maxx Stormwater Management Units, if installed, used and maintained in accordance with this Certificate, can 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)

<b>Requirement:</b>	<b>H3(3)</b>	<b>Rainwater drainage</b>
Comment:		The product can be used in a construction to satisfy this Requirement. See section 6 of this Certificate.
<b>Regulation:</b>	<b>7</b>	<b>Materials and workmanship (applicable to Wales only)</b>
<b>Regulation:</b>	<b>7(1)</b>	<b>Materials and workmanship (applicable to England only)</b>
Comment:		The product is acceptable. See section 12 and the <i>Installation</i> part of this Certificate.



### The Building (Scotland) Regulations 2004 (as amended)

<b>Regulation:</b>	<b>8(1)(2)</b>	<b>Durability, workmanship and fitness of materials</b>
Comment:		The product can contribute to satisfying this Regulation. See sections 11 and 12 and the <i>Installation</i> part of this Certificate.
<b>Regulation:</b>	<b>9</b>	<b>Building standards applicable to construction</b>
Standard:	3.6	Surface water drainage
Comment:		The product can contribute to a construction satisfying this Standard, with reference to clauses 3.6.1 <sup>(1)(2)</sup> to 3.6.5 <sup>(1)(2)</sup> . See section 6 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The product 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.
<b>Regulation:</b>	<b>12</b>	<b>Building standards applicable to conversions</b>
Comment:		Comments in relation to the product under Regulation 9, Standards 1 to 6 also apply to this Regulation, with reference to clause 0.12.1 <sup>(1)(2)</sup> and Schedule 6 <sup>(1)(2)</sup> .
		(1) Technical Handbook (Domestic). (2) Technical Handbook (Non-Domestic).



### The Building Regulations (Northern Ireland) 2012 (as amended)

<b>Regulation:</b>	<b>23(a)(i)(iii)(b)(i)</b>	<b>Fitness of materials and workmanship</b>
Comment:		The product is acceptable. See section 12 and the <i>Installation</i> part of this Certificate.
<b>Regulation:</b>	<b>82</b>	<b>Rainwater drainage</b>
Comment:		The product can be used in a construction to satisfy this Regulation. See section 6 of this Certificate.

# Construction (Design and Management) Regulations 2015

## Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: *3 Delivery and site handling (3.4)* of this Certificate.

### Technical Specification

## 1 Description

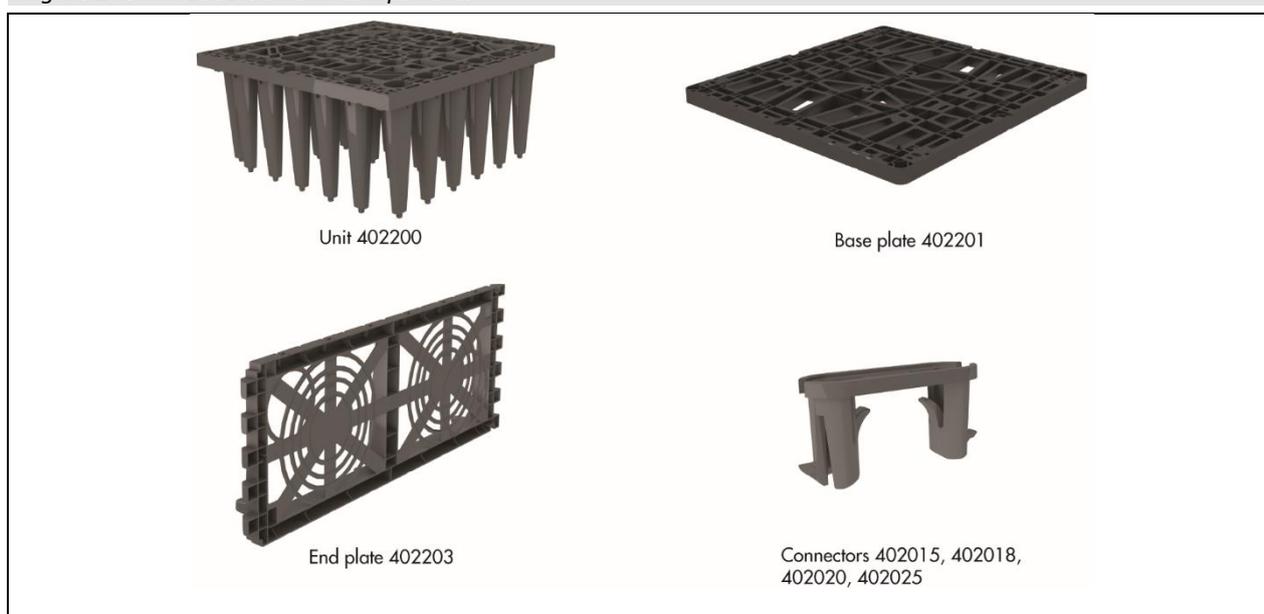
1.1 GRAF EcoBloc maxx Stormwater Management Units (see Table 1 and Figure 1), which form a stormwater management system, are manufactured from recycled polypropylene and clipped together on site to form tanks of the required dimension. EcoBloc maxx base plates form the base of the system and EcoBloc maxx end plates are used around the perimeter of the tank structure.

1.2 EcoBloc maxx end plates include cutting guides to facilitate connection of 100, 150, 200 and 250 mm pipes (to BS EN 1401-1 : 2009). Alternatively, connections for pipes with diameters from 300 to 500 mm can be made using pre-formed adaptor plates, available from the manufacturer but are outside the scope of this Certificate.

*Table 1 Characteristics of the units*

Characteristic per storage element (unit)	Unit (with base plate)	Unit (without base plate)	Base plate
Product code	—	402200	402201
Unit dimensions (nominal) (L x W x H) (mm)	800 x 800 x 390	800 x 800 x 350	800 x 800 x 40
Unit volume (nominal) (m <sup>3</sup> )	0.250	0.225	0.025
Storage volume (nominal) (m <sup>3</sup> )	0.237	0.217	0.020
Porosity (%)	94.8%	96.4%	80.0%
Nominal mass (kg)	11.7 kg	8.4 kg	3.3 kg

*Figure 1 GRAF EcoBloc maxx components*



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

1.4 Items used with the units to form the GRAF EcoBloc maxx 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 maxx units, base and end plates are manufactured via injection moulding from 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 and calibrated
- 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 systems of Graf Plastics GmbH and Graf Plasturgie SARL have been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by DEKRA (Certificates 80613353 and 19-02-020 respectively).

## **3 Delivery and site handling**

3.1 EcoBloc maxx components are delivered to site secured together per type of product and on wooden pallets. Each stack carries a label stating the product name, part number, quantity and production code.

3.2 The components are shipped in quantities as follows:

- units — 13, 17 or 96
- base plates — 30, 60 or 180
- end plates — 30 sets (60 in total) or 67 sets (134 in total)
- connectors — 10, 25, 50 or 200.

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

3.4 All stacks should be carefully placed on level ground. Stacks of 13 and 17 units can be double stacked on top of each other.

3.5 The units 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 units should not be stored near fuel bowsers, fuel tanks or other solvents to avoid potential chemical damage.

3.7 The units 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 vertically.

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

## Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on EcoBloc maxx Stormwater Management Units.

## Design Considerations

### 4 Use

4.1 The design of GRAF EcoBloc maxx Stormwater Management Units 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 this 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 C753.

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

- infiltration — stormwater is collected in the system, when wrapped in a geotextile, during rainfall and allowed to drain away by soaking into the surrounding ground over a substantial period of time after rainfall
- attenuation — stormwater is collected in the system, when wrapped in an impermeable membrane, during rainfall and released at a reduced flow rate through a flow control device into an appropriate outfall. This reduces peak flows in the watercourse and thereby minimises the risk of flooding
- a combination of infiltration and attenuation.

4.3 Design of the 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 of individual installations: hydraulic and structural design.

### 5 Practicability of installation

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

### 6 Hydraulic design

#### Infiltration

##### *Calculation principles*



6.1 There are two approaches, either of which may be adopted: CIRIA Report 156 or BRE Digest 365 : 2016. Further information on the design of SUDS may be obtained from *C753 The SUDS Manual*.

6.2 When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found in Tables 2 and 3 of this Certificate.

**Table 2 Data for use in hydraulic design — one unit wide trench configuration**

Number of units high	Tank volume (m <sup>3</sup> ) per metre length of trench	Vertical surface area (m <sup>2</sup> ) (both sides) per metre length of the tank	Area beneath system (m <sup>2</sup> ) per metre length of trench
1	0.30	0.78	0.80
2	0.57	1.48	0.80

**Table 3 Data for use in hydraulic design — three-dimensional tank, two units high**

Tank length (number of units long) (0.8 m side)	2 units wide			4 units wide			8 units wide		
	Volume (m <sup>3</sup> )	Area around sides and ends (m <sup>2</sup> )	Area under base (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Area around sides and ends (m <sup>2</sup> )	Area under base (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Area around sides and ends (m <sup>2</sup> )	Area under base (m <sup>2</sup> )
1	0.95	3.55	1.28	1.89	5.92	2.56	3.79	10.66	5.12
2	1.89	4.74	2.56	3.79	7.10	5.12	7.58	11.84	10.24
4	3.79	7.10	5.12	7.58	9.47	10.24	15.16	14.21	20.48
8	7.58	11.84	10.24	15.16	14.21	20.48	30.31	18.94	40.96
10	9.47	14.21	12.80	18.94	16.58	25.60	37.89	21.31	51.20
100	94.72	120.77	128.00	189.44	123.14	256.00	378.88	127.87	512.00

6.3 For the purpose of calculation, the size and volume of the units 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 through the geotextile soil interface to be established. The storage volume depends on the number of modules high (see Table 4). As an example, using Table 4, for a typical one-unit-wide linear trench 40 m long and two units deep, the storage volume is (0.39+0.35) by 0.8 by 40 by 95.6% = 22.6 m<sup>3</sup>. The effective area for infiltration is the base area (40 by 0.8) and side faces (2 by 40 by 0.74) total of 59.2 m<sup>2</sup>.

**Table 4 Porosity for the GRAF EcoBloc maxx Stormwater Management tank**

Number of units deep	Porosity (%)
1	94.8
2	95.6
4	96.0
8	96.2

## Attenuation

### Calculation principles



6.4 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, Scottish Environmental Protection Agency or Planning Authorities. The volume to be stored underground in the tank is then determined and the number of modules needed to contain this volume is calculated taking account of the porosity in Table 4.

### Connections



6.5 Connection is made to the tank system using the end plate cut-outs. Other methods of connection are available from the manufacturer but are outside the scope of this Certificate.



6.6 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 reduced pipe diameter. Comparative features and benefits of these various flow control devices should be considered prior to selection.

*Outflow positioning and head calculations*



6.7 The invert level of the outflow pipe should be flush with the bottom of the lowest unit to allow the system to drain. As the system 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 the difference between the level of the top of the tank and the invert of the outflow device.

## 7 Structural performance

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

7.2 Guidance on the design and installation of a system incorporating the units can be found in CIRIA Report C680. Consideration should be given to the effects of cumulative deflection in a system comprising several layers of units.

7.3 The system can be placed under landscaped areas and car parks/lightly trafficked areas. For areas where greater loads are anticipated, these applications 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 allowable 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 tank 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 system’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 system below groundwater level.

### 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 5).

*Table 5 Short-term performance values*

Element (unit)	Value
Characteristic compressive strength at yield ( $\text{kN}\cdot\text{m}^{-2}$ )	
vertical loading on top face	365.7
lateral loading on side face	99.6
Short-term deflection (mm per $\text{kN}\cdot\text{m}^{-2}$ ) (applied load)	
vertical loading on top side face	1 per 38.6
lateral loading on side face	1 per 10.4

7.8 The equations in Table 6 have been established from creep tests carried out in excess of 6655 hours on a stack of two modules plus a base plate and can be used for up to 50 years, where the design temperature is less than 20°C.

**Table 6 Equations for estimating long-term deflection**

For loads up to (kN·m <sup>-2</sup> )	Equation for estimation of long-term deflection
140 (vertical)	Deflection = 1.7008 Ln [time (hours)] – 1.9356
46 (horizontal)	Deflection = 3.3634 Ln [time (hours)] – 13.588

7.9 The partial load and material factors given in Table 7, as defined in CIRIA Report C680, may be used to attain the ultimate limit state.

**Table 7 Partial factors for loads and materials**

Description	Ultimate limit state	Serviceability limit state
Partial load factors		
Vertical dead-load (F <sub>dl</sub> )	1.40	1.00
Earth pressure (horizontal) + Hydrostatic (horizontal) load (F <sub>ep</sub> )	1.35	1.00
Imposed live-load (F <sub>ll</sub> )	1.60	1.00
Partial material factors (F <sub>m</sub> )	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 8 and 9 of this Certificate.

7.11 For small-scale applications, such as soakaways for individual house roof drainage, the system is installed below a garden a minimum of 5 m from the building, inaccessible to motor vehicles. Table 8 indicates the maximum depth and minimum cover applicable to most locations in the UK.

**Table 8 Design criteria for use of the GRAF EcoBloc maxx as soakaway for an individual house<sup>(1)</sup>**

Criterion	Value (m)
Maximum depth to base of system (m)	4.14
Minimum depth of cover required	0.3 <sup>(2)</sup>

(1) The following assumptions apply:

- soakaway constructed in sandy gravels with a soil unit weight not exceeding 20 kN·m<sup>-3</sup> and angle of internal friction for surrounding soil not less than 30°
- groundwater at least one metre below the base of the units
- soakaway located beneath small gardens or landscaped areas, no vehicles in accordance with CIRIA Report C680, Table 4.2.

(2) CIRIA Report C680 recommends a minimum cover of 500 mm where drive-on movers may be used.

7.12 For installations as detailed in Table 9, the information given is 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 9 Minimum cover depths**

Location	Minimum permissible cover (m)
Landscaped areas <sup>(1)</sup>	0.3
Car parks <sup>(2)</sup>	0.5
Low speed roads <sup>(3)</sup>	0.8

(1) Landscaped area where drive on mowers are used, drive on mowers in accordance with with CIRIA Report C680, Table 4.2.

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

(3) Low speed roads (<15mph) where vehicles up to 60000 kg (GVW; eg articulated lorries) are used, in accordance with CIRIA Report C680, Table 4.2.

Notes:

- calculations based on tanks comprising two layers of attenuation units
- soil unit weight and angle of internal friction of the soil above the system taken as 20 kN·m<sup>-3</sup> and 30°, respectively
- calculations based on there being no groundwater present
- angle of spread for wheel loads taken as 27° from the vertical in car parks with asphaltic surfacing and angle of internal friction of soil in landscaped areas
- no account is taken of accidental loading
- ground surface in vicinity of the system assumed to be level
- formation below the system assumed to have adequate bearing capacity
- partial load and material factors are defined in Table 7 of this Certificate.

## 8 Geotextiles and geomembranes

### Infiltration

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

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

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

### Attenuation

8.3 The whole 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 for a specific EcoBloc maxx Stormwater Management tank 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)
- 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.

#### *Specification of geomembrane*

8.7 The specification and selection of the impermeable geomembrane 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 of the system.

8.8 A geomembrane less than 1 mm thick is unlikely to satisfy these criteria (except in shallow, domestic installations), and is not recommended for use with the EcoBloc maxx Stormwater Management tank. 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 whole system. As a minimum, one 110 mm diameter air vent is required per 7500 m<sup>2</sup> of impermeable catchment area to be drained. Air vent connections and pipework for use with the system are outside the scope of this Certificate.

9.2 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.

## 10 Resistance to chemicals

10.1 An assessment by the BBA indicates that the product is 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 product 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 schedule of regular inspections via CCTV should be established to prevent siltation of the system which, if allowed to develop, would reduce effectiveness. It 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. There must be a maintenance plan that ensures regular cleaning of the trap to ensure correct performance.

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 system components 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 product, when used in accordance with this Certificate, will have a design life in excess of 50 years.

## 13 Reuse and recyclability

The units consist of polypropylene material, which is readily recyclable.

### 14 General

GRAF EcoBloc maxx Stormwater Management Units should be installed in accordance with the Certificate holder's installation instructions, this Certificate and PD CEN/TR 17179 : 2018. 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 allowable 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 8/16 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. 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. Firstly, base plate and module are mounted together. Afterwards they are laid directly onto the geotextile in the correct orientation, and then each unit is joined to the adjacent ones with connectors. Subsequent layers are placed directly on top of the previous layer.

15.7 Once all of the GRAF EcoBloc maxx Stormwater Management Units have been placed in position, the end plates are fitted to the open ends of the tank.

15.8 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.

15.9 A 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.

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

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

15.12 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 of roll
- 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.

15.13 It is recommended that a CCTV inspection of the system is carried out following installation to ensure that the membrane/geotextile liner has been installed.

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

## Technical Investigations

### 16 Tests

Tests were carried out and the results assessed to determine:

- dimensional and weight accuracy
- impact resistance at 0 and 23°C
- short-term resistance to vertical and horizontal loading
- long-term resistance to vertical and horizontal loading
- oxidation induction time to BS EN ISO 11357-6 : 2013.

### 17 Investigations

17.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials 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

BRE Digest 365 : 2016 *Soakaway Design*

BS 6031 : 2009 *Code of practice for earthworks*

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BS EN ISO 9001 : 2015 *Quality management systems — Requirements*

BS EN ISO 11357-6 : 2013 *Plastics. Differential scanning calorimetry (DSC) — Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

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

CIRIA Report C680 : 2008 *Structural design of modular geocellular drainage tanks*

CIRIA Report C753 : 2015 *The SUDS manual*

CIRIA Report SP124 : 1996 *Barriers, liners and cover systems for containment and control of land contamination*

Communities and Local Government Planning Policy Statement PPS25, *Development and Flood Risk*.

PD CEN/TR 17179 : 2018 *Thermoplastics piping and ducting systems — Rainwater infiltration and storage attenuation systems — Practices for underground installation*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*

### 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.