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BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

Agrément Certificate
06/4297
Product Sheet 2

POLYSTORM STORMWATER MANAGEMENT SYSTEM

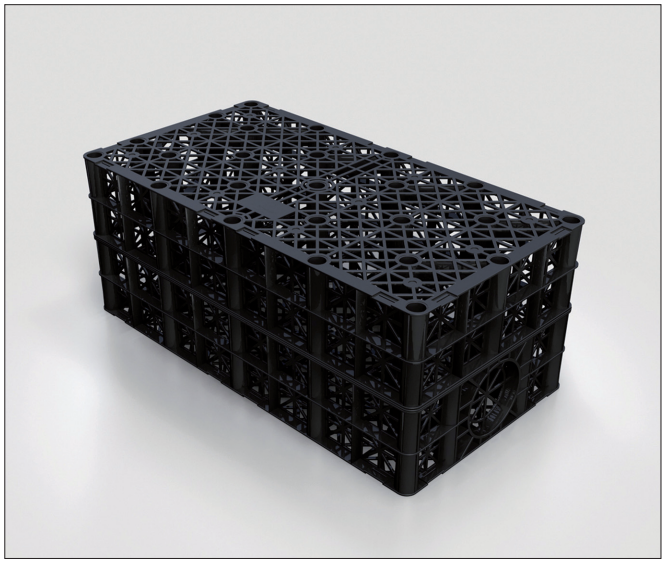
POLYSTORM LITE 20 TONNE UNITS

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to Polystorm Lite 20 Tonne Units, used for sub-surface water storage or as a soakaway to manage stormwater run-off from impermeable surfaces.

THIS CERTIFICATE INCLUDES:

- factors relating to compliance with UK 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

System design — data is provided in this Certificate to assist in the design of a sub-surface water management system incorporating the units (see section 5).

Structural performance — the units have adequate strength and stiffness to resist long- and short-term loads when used in accordance with this Certificate (see section 6).

Maintenance — data is provided to assist in planning the maintenance of a completed installation (see section 10).

Durability — the units will have a service life in excess of 50 years when installed in accordance with this Certificate (see section 11).

The BBA has awarded this Agrément 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: 2 June 2010
Originally certificated on 1 March 2006

Brian Chamberlain
Head of Approvals — Engineering

Greg Cooper
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

Regulations

In the opinion of the BBA, Polystorm Lite 20 Tonne Units, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements of the following Building Regulations:

The Building Regulations 2000 (as amended) (England and Wales)

Requirement:	H3(3)	Rainwater drainage
Comment:		The system can be used in a construction to meet this Requirement. See sections 5.1 to 5.9 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The system components are acceptable. See section 11 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)(2)	Fitness and durability of materials and workmanship
Comment:		The system can contribute to satisfying this Regulation. See sections 10.1 to 10.6, 11 and the *Installation* part of this Certificate.
Regulation:	9	Building standards — 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 5.1 to 5.9 of this Certificate.
		(1) Technical Handbook (Domestic).
		(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2000 (as amended)

Regulation:	B2	Fitness of materials and workmanship
Comment:		The system components are acceptable. See section 11 and the *Installation* part of this Certificate.
Regulation:	B3(2)	Suitability of certain materials
Comment:		The system components are acceptable. See sections 10.1 to 10.6 of this Certificate.
Regulation:	N5	Rain-water drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See sections 5.1 to 5.9 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: 2 *Delivery and site handling* (2.1 and 2.3) and 13 *Procedure* (13.1 and 13.10) of this Certificate.

Non-regulatory Information

NHBC Standards 2008

In the opinion of the BBA, the use of the Polystorm Lite 20 Tonne Units, in relation to this Certificate, is not subject to the requirements of these standards.

General

This Certificate relates to the Polystorm Lite 20 Tonne Units used as part of a sub-surface water management system. The system can be used either for stormwater storage or as a soakaway to manage run-off from impermeable surfaces. This system does not cover the collection of the surface water — information relating to this can be obtained from the Certificate holder.

1 Description

1.1 Polystorm Lite 20 Tonne Units are modular units (see Table 1), used in conjunction with shear connectors and clips. The components are manufactured from black polypropylene (see Figure 1).

Table 1 Characteristics of modular unit

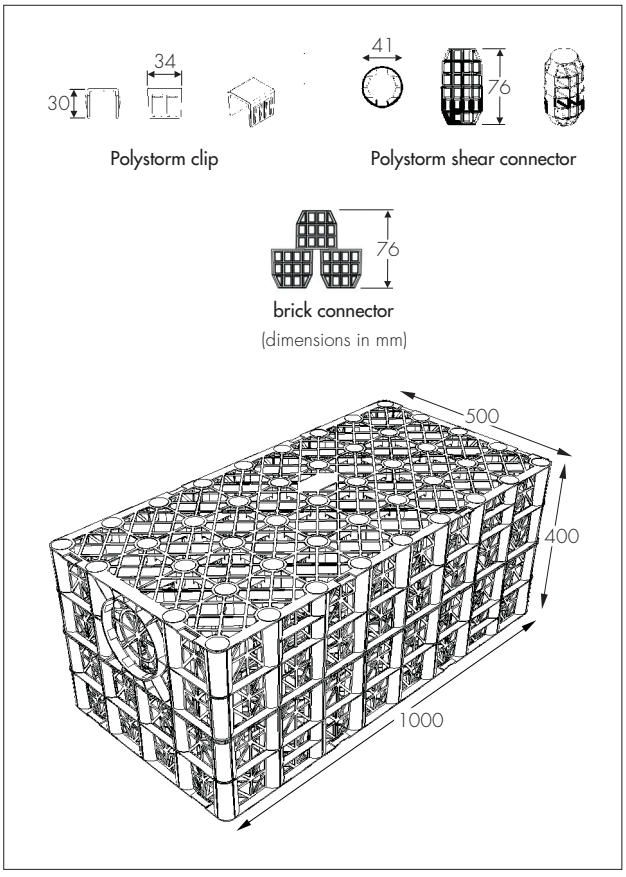
Element (unit)	Value
Unit dimensions (nominal) (mm)	1000 x 500 x 400
Unit volume (nominal) (m^3)	0.20
Storage volume (nominal) (m^3)	0.19
Porosity (void ratio) (%)	95
Ultimate compressive strength at yield ($kN \cdot m^{-2}$)	
vertical loading on top face	200
lateral loading on side face	40
Short-term deflection (mm per $kN \cdot m^{-2}$)(1)	
vertical loading on top side face	1 per 43
lateral loading on side face	1 per 6.4
Estimated long-term deflection(2) (Ln)(3) (mm)	0.773

(1) Applied load.

(2) At up to 20 years at 20°C at 54 $kN \cdot m^{-2}$.

(3) Time in hours.

Figure 1 Components



1.2 The units manage run-off from impermeable surfaces by:

- infiltration — soakaways to infiltrate stormwater back into the ground, or
- attenuation — temporary storage for excess flows and limiting outflow to streams and rivers
- combination — excess flow attenuation with a controlled outlet and soakaway provisions for infiltration of a portion of the total flow.

1.3 The polypropylene modular units have preformed sockets to enable connection with 160 mm diameter pipework (to BS EN 1401-1 : 1998), or alternatively, connection to 150 mm Ridgidrain, 110 mm or 100 mm pipework is possible using suitable adaptors. Adaptors and connecting pipework for use with this system are not covered by the scope of this Certificate. Geotextiles and geomembranes for use with this system are not covered by the scope of this Certificate. Information on the required specification of the geotextile and/or geomembrane can be obtained from the Certificate holder.

1.4 Each assembly is wrapped in either a permeable geotextile when used for infiltration or an impermeable geomembrane when used for storage (attenuation).

1.5 Adequate venting must be provided to the Polystorm structure using an air vent. One 110 mm diameter air vent is required per 7500 m^2 of impermeable catchment area to be drained. Air vent connections and pipework for use with this system are outside the scope of this Certificate.

2 Delivery and site handling

2.1 The units are supplied to site in packs of 12 or 15 units secured to a wooden pallet. Each pack carries a label bearing the product name, quantity, operator initials and pallet number.

2.2 Clips, shear connectors and brick bond connectors are packed in sealed polythene bags of 60, 30 and 30 respectively.

2.3 The unit packs should be carefully placed on level ground and should not be stacked on site. Loose individual units should not be stored more than two units high.

2.4 The units contain an inhibitor to resist the effects of ultraviolet light for up to six months. However, prolonged storage in direct sunlight should be avoided.

2.5 The units should not be stored near fuel bowsers, fuel tanks or other solvents.

2.6 The units are resistant to damage likely to be caused during normal handling. They should be stored in locations where impacts from vehicles and other construction plant will be avoided.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Polystorm Lite 20 Tonne Units.

Design Considerations

3 Use

3.1 Polystorm Lite 20 Tonne Units design must be in accordance with the Certificate holder's installation instructions. Guidance on the application of sustainable drainage systems (SUDS) for new developments, such as the Polystorm Stormwater Management System, can also be found in the Planning Policy Statement PPS25 *Development and Flood Risk*.

3.2 The units are suitable for the management of stormwater run-off from impermeable surfaces. They can be utilised in three main ways (see Figure 2):

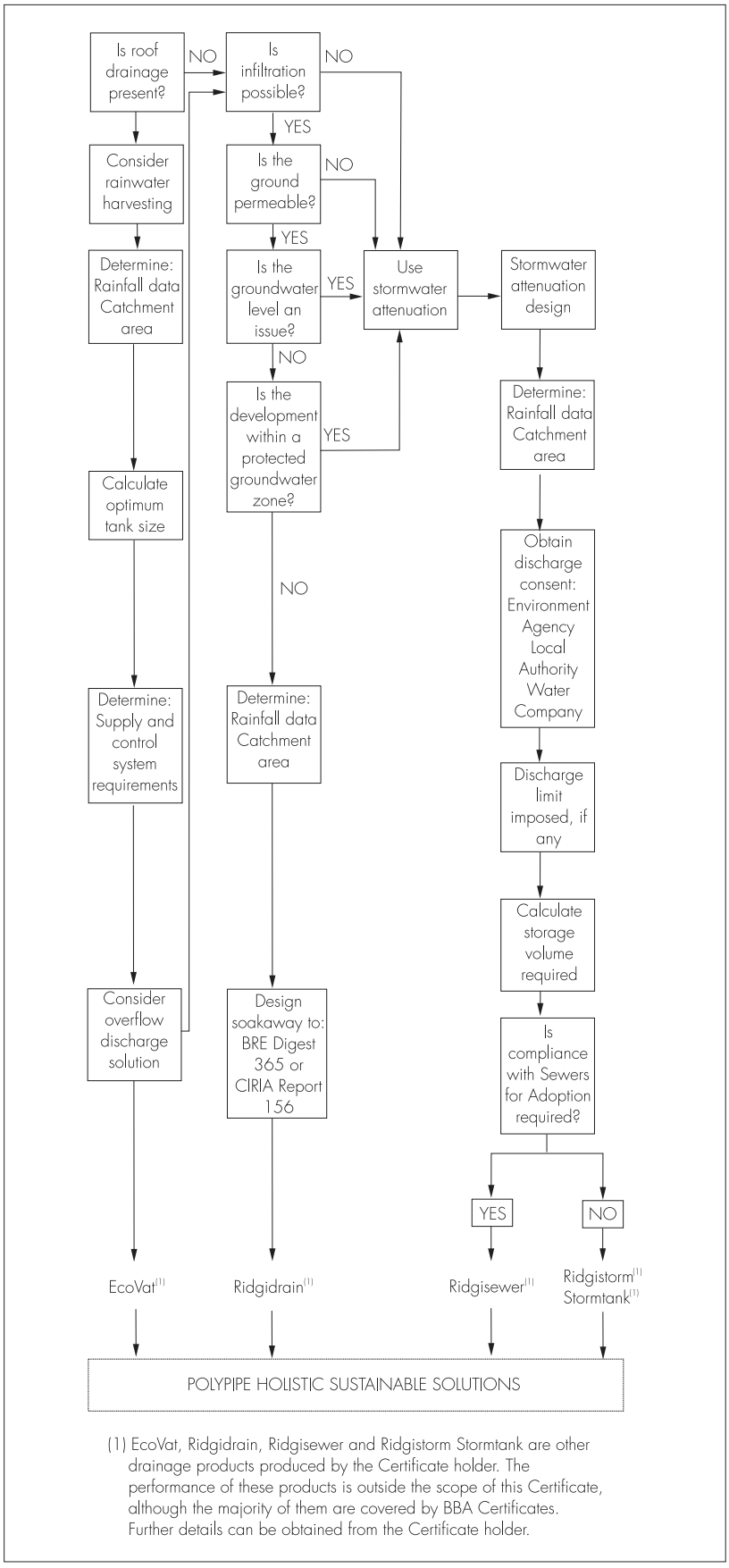
- infiltration (retentions/recharge/soakaway) — water is collected in the units during rainfall and allowed to drain away by soaking into the surrounding ground over a substantial period of time after the rain has stopped
- attenuation (detention) – water is collected in the units during rainfall and released at a reduced flow rate through a flow control device, into an appropriate outfall. This reduces peak flows in the watercourse and, therefore, minimises the risk of flooding
- combination of retention and detention.

3.3 Design of the appropriate units 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.

3.4 Once the project criteria have been established from the site audit, there are two main parts to the design procedure: system design and structural design.

Figure 2 Sustainable drainage system selection and design



(1) EcoVat, Ridgidrain, Ridgisewer and Ridgistorm Stormtank are other drainage products produced by the Certificate holder. The performance of these products is outside the scope of this Certificate, although the majority of them are covered by BBA Certificates. Further details can be obtained from the Certificate holder.

4 Practicability of installation

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

5 System design

Infiltration

Calculation principles

5.1 There are two approaches, either of which may be adopted: the Construction Industry Research and Information Association (CIRIA) Report 156 *Infiltration drainage — Manual of good practice* or BRE Digest 365 *Soakaway Design*. Further information on the design of sustainable drainage systems (SUDS) may be obtained from *The SUDS manual* (C697) published by CIRIA.

5.2 A simplified approximate approach can be used on a very small site (ie a single-house development) where detailed site infiltration rate information may not be required nor available (see Table 2). Approved Document H allows a storage volume equal to the area to be drained multiplied by 10 mm, for areas up to 25 m^2. Beyond this size, design should be carried out in accordance with BS EN 752 : 2008 or BRE Digest 365. BS EN 752 : 2008 suggests a storage volume equal to 20 mm multiplied by the area to be drained. In Scotland, guidance for the design of single-house soakaways is given in Standard 3.6, clause 3.6.5(1).

(1) Technical Handbook (Domestic).

Table 2 Simplified soakaway design for single-house development(1)

Number of units	Storage volume (m^3)	Max area to be drained (m^2)
1	0.19	19.0(2)
2	0.38	25.0(2)
3	0.57	28.5(3)
4	0.76	38.0(3)
5	0.95	47.5(3)
6	1.14	57.0(3)

(1) When doubt exists over suitability of ground for infiltration permeability, figures should be derived by test (see BRE Digest 365).

(2) In accordance with Approved Document H.

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

5.3 When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found from Tables 3 and 4.

Table 3 Volumetric data per linear metre for a one unit (0.5 m) wide trench configuration

Number of units high	Volume (m^3)	Side area (m^2)	Base area (m^2)
1	0.19	0.8	0.5
2	0.38	1.6	0.5
3	0.57	2.4	0.5

Table 4 Volumetric data for 3D usage two units high

Units long (1 m side)	2 wide (0.5 m side)			4 wide (0.5 m side)			8 wide (0.5 m side)		
	vol (m^3)	side (m^2)	base (m^2)	vol (m^3)	side (m^2)	base (m^2)	vol (m^3)	side (m^2)	base (m^2)
1	0.76	3.2	1.0	1.52	4.8	2.0	3.04	8.0	4.0
2	1.52	4.8	2.0	3.04	6.4	4.0	6.08	9.6	8.0
4	3.04	8.0	4.0	6.08	9.6	8.0	12.16	12.8	16.0
8	6.08	14.4	8.0	12.16	16.0	16.0	24.32	19.2	32.0
10	7.60	17.6	10.0	15.20	19.2	20.0	30.40	22.4	40.0
100	76.00	161.6	100.0	152.00	163.2	200.0	304.00	166.4	400.0

5.4 For calculations, the size and volume of the units are given in Table 1. The total areas of the base and sides are required as water is absorbed through the geotextile soil interface. Storage volume is 95% of the total volume. As an example, using Table 4, for a typical linear trench 40 m long and two units deep, the volume is 0.38 by 40 = 15.2 m^3 and the side area 1.6 by 40 = 64 m^2.

Attenuation

Calculation principles

5.5 The anticipated run-off volume (A) from the site must be 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 depth of water (mm) found can be multiplied by the catchment area to assess the size of attenuation systems and is traditionally based upon a storm duration and a return period appropriate for the catchment. The allowable discharge rate from the site to an appropriate outfall is established but will normally be set by the Environment Agency or Planning Authorities. The outflow volume (B) to be discharged at this rate over the two-hour period is calculated and subtracted from the run-off volume (A – B). This defines the excess volume (C) to be stored in Polystorm units constructed as an underground tank. The number of units needed to contain this excess is calculated on the basis that the storage volume is equal to 95% of the total volume of the tank.

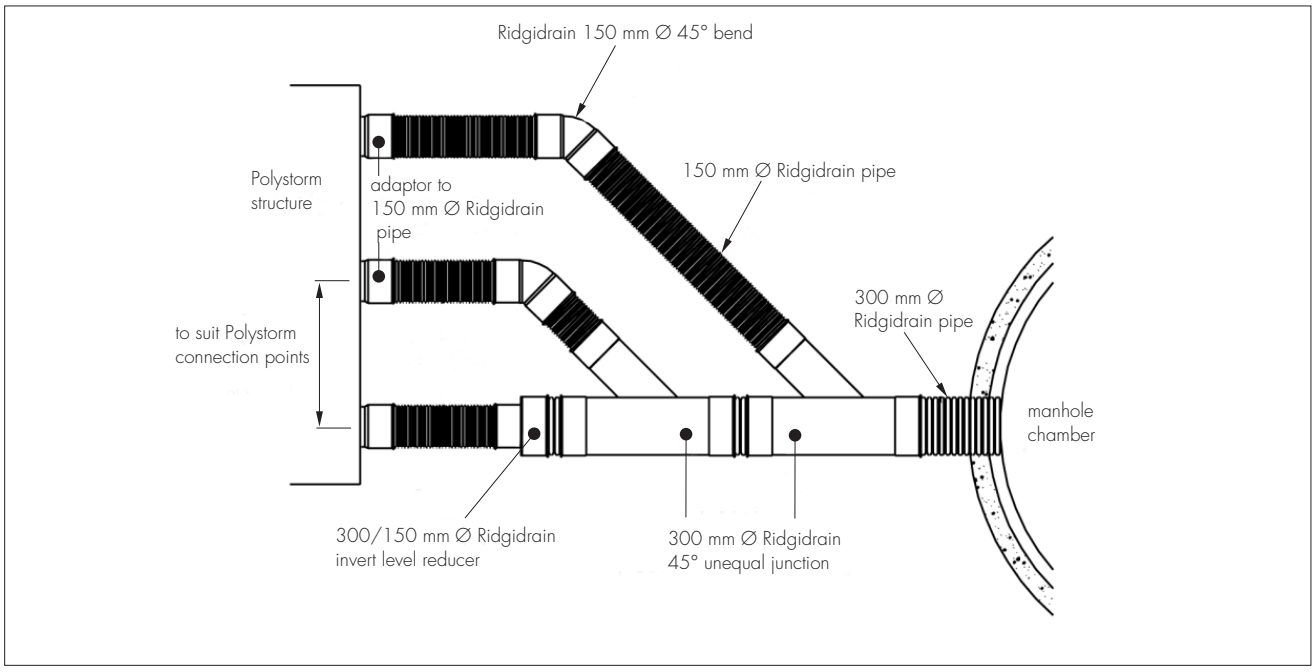
Connections

5.6 Connection is made to the units using a preformed socket and adaptor. These items are not covered by the scope of this Certificate.

Manifold design

5.7 The units are manufactured to allow a connection to be easily formed by insertion of 160 mm diameter BS EN 1401-1 : 2009 pipes into the convenient knock-out incorporated in each cell. The capacity of a 160 mm pipe is limited and may be insufficient for the anticipated design flow. The flow may be split amongst a number of 160 mm pipes connected to a manifold to provide increased hydraulic capacity (see Figure 3). The system designer should ensure the pipework connecting the Polystorm units to the drainage system has sufficient capacity to cope with the design flow.

Figure 3 Typical manifold design



Flow control

5.8 The outflow from the tank 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. These devices are not within the scope of this Certificate.

Outflow positioning and head calculations

5.9 The invert level of the outflow pipe should be flush with the bottom of the lowest unit to allow the tank to drain. As the tank fills, a depth of water develops on the upstream side of the outflow control. For a tank with two layers of units, this depth is 0.8 m when the units are full, 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.

6 Structural performance

6.1 The units can be placed under a variety of landscaped areas. Design procedures for trafficked applications are not within the scope of this Certificate. Further guidance may be found in *Structural design of modular geocellular drainage tanks* (C680) published by CIRIA.

6.2 Short-term loading design parameters for the Polystorm Lite 20 Tonne Units have been derived from independent test data (see Table 5). The short- and long-term deflection is given in Table 1.

Table 5 Loading design parameters for Polystorm Lite 20 Tonne Units(1)

	Vertical loading on top face	Lateral loading on side face
Short-term compressive strength at yield ($kN \cdot m^{-2}$)	200	40

(1) A partial safety factor for materials (F_m) of 2.75 for ultimate limit state and 1.5 for serviceability limit state, should be applied to these values for a design life of 20 years.

6.3 From creep test results, an estimate of the long-term deflection can be derived from deflection (mm) = 0.773 Ln [time (hours)] + 2.965. This is valid for loads up to 54 $kN \cdot m^{-2}$ and periods of up to 20 years at 20°C. In locations where settlement is not of concern, designs up to 50 years can be undertaken.

6.4 For small-scale applications such as soakaways for individual house roof drainage, the system is typically located below a garden a minimum of 5 m from the building (see Table 6). In this case there are no traffic loads.

Table 6 Design criteria for use of Polystorm Lite 20 Tonne Units as soakaway for individual house(1)

Maximum depth to base of units	1.77 m
Minimum cover depth	0.5 m

(1) The following assumptions apply:
- minimum angle of shearing resistance for surrounding soil 29° — to be confirmed by site survey.
- groundwater should be at least one metre below the base of the Polystorm units.

6.5 The units used for large-scale storage or infiltration must be designed to carry all loads that will be applied, including dead and imposed loads. Design parameters and estimated loads should be used to determine the maximum depth of installation and the maximum and minimum cover depths.

6.6 The criteria provided in Table 7 can be used to design the units for installation below non-trafficked areas. These design tables are only applicable in temperate climate conditions such as the UK. The following partial safety factors for loads have been applied:

- ultimate limit state — vertical dead load (F_{dl}) 1.40, earth pressure (horizontal) dead load (F_{ep}) 1.40, imposed live load (F_{ll}) 1.60
- serviceability limit state — vertical dead load (F_{dl}) 1.00, earth pressure (horizontal) dead load (F_{ep}) 1.00, imposed live load (F_{ll}) 1.00.

Table 7 Maximum installation depths(1) *(to base of units)*

Soil description	Typical angle of friction (ϕ)	Maximum installation depth (from invert of structure) (m)	Minimum cover depth (m)
Over consolidated stiff clay	24°	1.49	0.5
Silty sandy clay	26°	1.60	0.5
Loose sand and gravel	30°	1.77	0.5
Medium-dense sand and gravel	33°	2.05	0.5
Dense sand and gravel	38°	2.49	0.5

(1) The above values are for non-trafficked sites where groundwater is not present. For other conditions, further advice should be sought from the Certificate holder.

6.7 Partial factors of safety for materials (F_m) of 2.75 for ultimate limit state and 1.5 for serviceability limit state have been applied.

6.8 The system can be used for areas where greater loads are anticipated but these applications are outside the scope of this Certificate and specific advice should be sought from the Certificate holder.

6.9 It must be ensured 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.

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

6.11 When the units are wrapped in geomembrane and placed below the groundwater table, flotation may occur. To prevent this, the weight of the soil over the top of the units must be greater than the uplift force caused by the units' 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.

7 Geotextiles and geomembranes

Infiltration

7.1 The units require a geotextile wrapping when used as an infiltration device to prevent:

- 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.

7.2 Selection of an appropriate geotextile requires careful consideration (see section 7.6).

Attenuation

7.3 The units require 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.

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

7.5 Selection of an appropriate geomembrane requires careful consideration (see section 7.6).

Specification of geosynthetic

7.6 Careful consideration should be given to the selection of an appropriate geosynthetic. A recognised design methodology is to follow these steps:

(1) define the application filter requirements — retention (attenuation storage) or permeability (soakaway)

(2) define boundary conditions — site investigation to establish in-situ soil parameters, enabling lateral earth pressures and water flow conditions to be calculated

(3) determine soil retention requirements — using the in-situ soil parameters, determine if additional bed and surround measures should be specified

(4) determine geosynthetic permeability requirements — the breakthrough head should be considered in addition to water flow rates

(5) determine anti-clogging requirements (infiltration only) — ensure that the porosity of the geotextile, in conjunction with the specified bed and surround is sufficient to prevent the geotextile from prematurely clogging

(6) determine survivability requirements — the geosynthetic should be sufficiently robust to survive installation activities

(7) determine durability requirements — consideration should be given as to whether the geosynthetic will be subjected to a significant chemical exposure, either present in the ground or rainwater run off

(8) miscellaneous design considerations:

- — intrusion of geosynthetic into drainage layer
- — biological and bio-chemical clogging factors
- — safety factors.

7.7 All joints should be sealed, using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures is given in CIRIA SP 124 : 1996 *Barriers, liners and cover systems for containment and control of land contamination*.

7.8 The designer/installer should confirm with the geosynthetic manufacturer that the specification of the proposed material is suitable for the application and site conditions by following the design methodology (see section 7.6). Typical geosynthetic specifications are given in Tables 8 and 9.

Table 8 Typical specification for a polypropylene geomembrane

Property (unit)	Impermeable geomembrane	
Physical		
Thickness (mm)	Min 1.0	ASTM D 5199
Density (kg·m^{-3})	900	ASTM D 1505
Mechanical		
Tensile strength, at yield (kN·m^{-2})	Min 1600	ASTM D 4885
Elongation at break	>500%	ASTM D 4885
Puncture resistance (N)	Min 170	ASTM D 4833
Tear resistance (N)	Min 67	ASTM D 1004 Die C
Impact resistance (J)	Min 15	ASTM D 3998 mod
Stress crack resistance (h)	Min 200	ASTM D 5397 (SP-NCTL)
Permeability coefficient	Max 2.0 x 10^{-12}	ASTM D 4491
pH	Resistant to all naturally occurring soil acids and alkalis	
Chemical/biological resistance	Resistant to all substances found to naturally occur in soils and rainwater. Detailed information would need to be provided to geosynthetic manufacturer in instances of contaminated land	

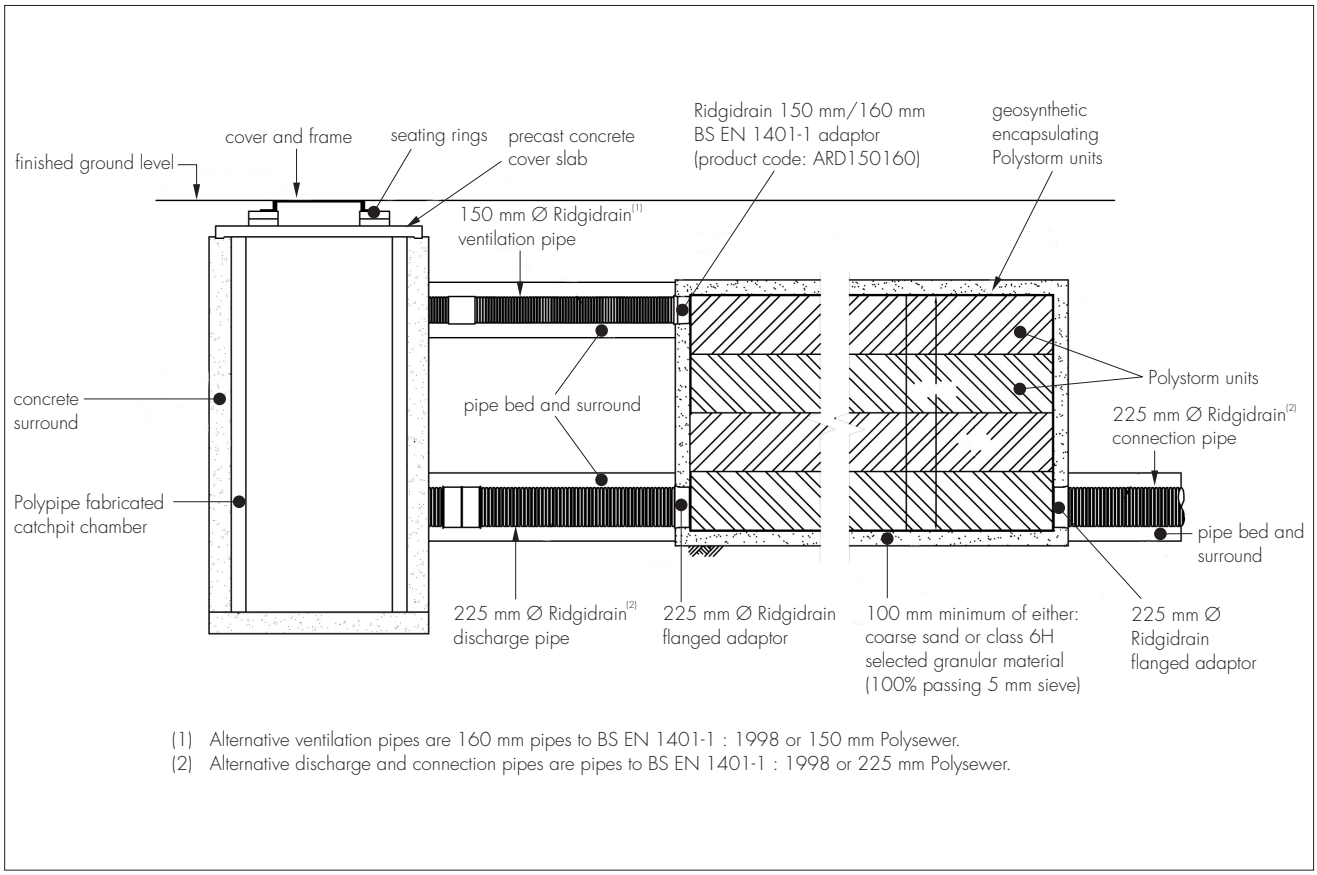
Table 9 Typical specification for a geotextile

Property (unit)	Permeable geotextile	
Physical		
Material	Typically polypropylene/polyethylene	
Mass (g·m^{-2})	Min 1.25	BS EN ISO 9864
Mechanical		
CBR puncture resistance (N)	Min 1500	EN ISO 12236
Peak tensile strength (kN·m^{2})	Min 8	EN ISO 10319
Hydraulic		
Water flow rate normal (l·s^{-1}·m$^{-1)}$ to plane	Min 100 (at 50 mm head)	EN ISO 11058
Pore size O_{90} (µm)	Typical 100	EN ISO 12956
pH	Resistant to all naturally occurring soil acids and alkalis	
Chemical/biological resistance	Resistant to all substances found to naturally occur in soils and rainwater. Detailed information would need to be provided to geosynthetic manufacturer in instances of contaminated land	

8 Venting

Adequate venting must be provided to the structure. As a minimum, one 110 mm diameter air vent is required per 7500 m^2 of impermeable catchment area to be drained (see Figure 4).

Figure 4 Typical Polystorm arrangement including ventilation pipe



(1) Alternative ventilation pipes are 160 mm pipes to BS EN 1401-1 : 1998 or 150 mm Polysewer.
(2) Alternative discharge and connection pipes are pipes to BS EN 1401-1 : 1998 or 225 mm Polysewer.

9 Resistance to chemicals

9.1 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.

9.2 An assessment of the suitability for use of the units on brownfield sites should be made only after a suitable site investigation 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.

10 Maintenance

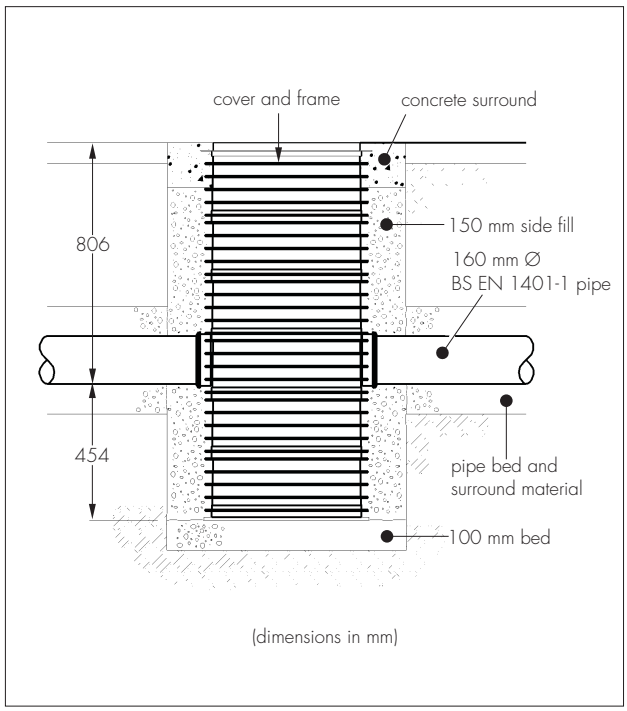
10.1 The owner of the structure is responsible for maintenance.

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

10.3 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.

10.4 It is recommended that a silt trap is incorporated into the pipework at the inlet to the tank (see Figure 5). There must be a maintenance plan that ensures regular cleaning of the trap to ensure correct performance. Silt traps for use with this system are outside the scope of this Certificate.

Figure 5 Typical silt trap



10.5 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.

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

11 Durability

The structural properties of 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.

Installation

12 General

Polystorm Lite 20 Tonne Units should be installed in accordance with the Certificate holder's installation instructions and relevant legislation. Special attention should be paid to temporary work requirements in excavations.

13 Procedure

13.1 The hole or trench is excavated to the required plan, dimension and level ensuring that the excavation will allow easy installation of connecting pipework. It must be ensured sufficient construction plant access is maintained for reinstating around the installed units. The base 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 : 1981, with particular attention paid to safety procedures.

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

13.3 The base must be inspected for soft spots in the formation — any present must be excavated and replaced with compacted granular fill material.

13.4 For an attenuation application a 100 mm thick, bedding layer of coarse sand is laid on the base of the excavation. The geotextile protection fleece is laid on base and sides if required. The geomembrane is laid over the sand bedding and up the sides of the excavation. Joints should be made in accordance with the manufacturer's recommendations with allowance made for connecting pipework or adaptors. The geomembrane and joints are inspected for damage.

13.5 For an infiltration application a 100 mm thick bedding of either coarse sand or Class 6H selected granular material [with 100% passing the 5 mm sieve, in accordance with the Manual of Contract Documents for Highway Works (MCHW), Volumes 1 and 2] is laid on the base of the excavation. The geotextile is laid over the bedding and up the sides of the excavation and joints formed in accordance with the manufacturer's recommendations, and allowance made for connecting pipework or adaptors.

13.6 The units are installed in accordance with the installation schedule for correct orientation. Wherever possible continuous vertical joints should be avoided. The units are arranged so that preformed sockets are in the correct alignment for inlet and outlet pipes. For single-layer applications, Polystorm clips only are used and for multi-layers Polystorm clips, shear connectors and brick bond connectors (when using brick-bond arrangement) are used.

13.7 The geotextile or geomembrane encapsulation to base, sides and top of installation, including protective geotextile (where required) is completed. Geomembranes should be welded in accordance with manufacturer's recommendations. The geomembrane and/or geotextile is inspected for damage and all welds are tested as required.

13.8 Drainage connections are made to the installation using proprietary adaptors. Preformed socket positions for pipe connections must be located at the correct position for receiving pipework. In attenuation applications, all pipe connections penetrating the geomembrane must be adequately sealed.

13.9 The installation is backfilled around the side of the encapsulated units to form a 100 mm layer of coarse sand or Class 6H selected granular material immediately adjacent to the units. Any remaining excavated areas around the units are backfilled with Class 6N or 6P selected granular material in accordance with the MCHW, Volumes 1 and 2. The backfill is compacted in 150 mm layers.

13.10 A coarse sand protection layer 100 mm thick should be placed over the top of the units that are wrapped in either a geotextile (infiltration system) or a geomembrane with protective geotextile (attenuation system). Backfilling is continued with selected as-dug material with size of particles less than 40 mm within 300 mm of top of units. Above this level selected as-dug material may be used. Backfill is placed and compacted in layers no greater than 300 mm thick. Compaction plant over top of system must not exceed 2300 kg per metre width.

13.11 The landscaping is completed over the units.

Technical Investigations

14 Tests

Tests were carried out on the system to determine:

- long-term and short-term resistance to loading
- volumetric capacity.

15 Investigations

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

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

- material properties
- design procedures.

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

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16 Conditions

16.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is granted only to the company, firm or person named on the front page — no other company, firm or person may hold or claim any entitlement to this Certificate
- 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.

16.2 Publications and documents referred to in this Certificate are those that the BBA deems to be relevant at the date of issue or re-issue of this Certificate and include any: Act of Parliament; Statutory Instrument; Directive; Regulation; British, European or International Standard; Code of Practice; manufacturers' instructions; or any other publication or document similar or related to the aforementioned.

16.3 This Certificate will remain valid for an unlimited period provided that the product/system and the manufacture and/or fabrication including all related and relevant 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.

16.4 In granting this Certificate, the BBA is not responsible for:

- 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
- individual installations of the product/system, including the nature, design, methods and workmanship of or related to the installation
- the actual works in which the product/system is installed, used and maintained, including the nature, design, methods and workmanship of such works.

16.5 Any information relating to the manufacture, supply, installation, use and maintenance 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 and maintained. It does not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date 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. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the manufacture, supply, installation, use and maintenance of this product/system.

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