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Agrément Certificate No 03/4018

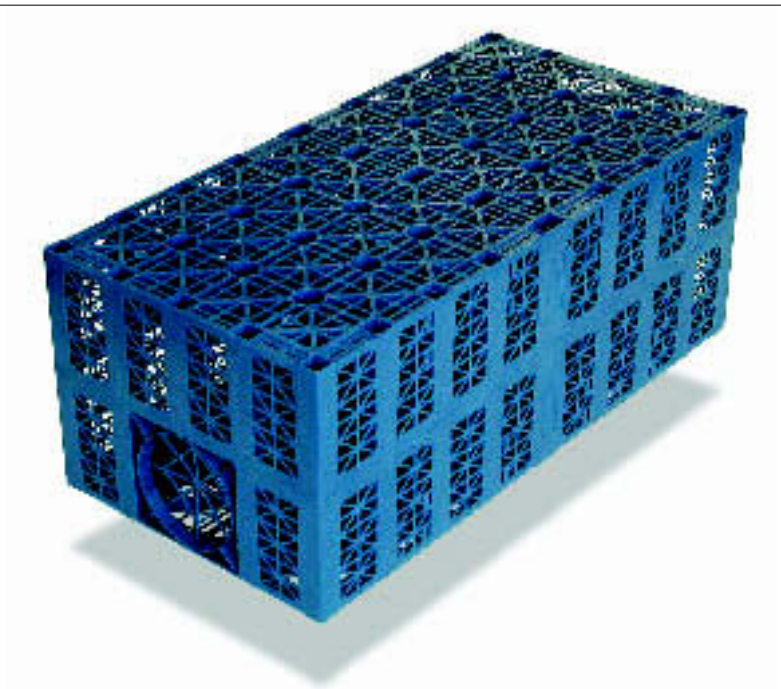
BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

Designated by Government to issue European Technical Approvals

AQUACELL STORMWATER MANAGEMENT SYSTEM

Système de gestion des eaux d'orages
Verwaltungssystem von gewitterwasser

Product



AquaCell unit

- *THIS CERTIFICATE RELATES TO THE AQUACELL STORMWATER MANAGEMENT SYSTEM, CONSISTING OF POLYPROPYLENE UNITS, SHEAR CONNECTORS AND CLIPS.*
- *The system assembles to form an underground structure which can be used either for stormwater storage or as a soakaway to control stormwater run-off from impermeable surfaces.*
- *This system does not cover the collection of the stormwater. For information relating to this, the Certificate holder should be contacted.*

Regulations

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

The Secretary of State has agreed with the British Board of Agrément that aspects of performance to be used by the BBA in assessing the compliance of soakaways and stormwater storage structures constructed from polypropylene units with the Building Regulations. In the opinion of the BBA, soakaways and stormwater storage structures constructed from the AquaCell Stormwater Management System, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements.

Requirement:	H3	Rainwater drainage
Comment:		The units can be used in a construction to meet this Requirement. See section 8.8 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The system components are acceptable. See section 14 of this Certificate.

2 The Building Standards (Scotland) Regulations 1990 (as amended)

In the opinion of the BBA, soakaways and stormwater storage structures constructed from the AquaCell Stormwater Management System, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Regulations and related Technical Standards as listed below.

Regulation:	**10**	Fitness of materials and workmanship
Standard:	B2.1	Selection and use of materials, fittings, and components, and workmanship
Comment:		The system components are acceptable. See section 14 of this Certificate.
Regulation:	**24**	Drainage
Standard:	M2.2	Wastewater and surface water drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See section 8.8 of this Certificate.

3 The Building Regulations (Northern Ireland) 2000

In the opinion of the BBA, soakaways and stormwater storage structures constructed from the AquaCell Stormwater Management System, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Building Regulations as listed below.

Regulation:	**B2**	Fitness of materials and workmanship
Comment:		The system components are acceptable. See section 14 of this Certificate.
Regulation:	**N5**	Rain-water drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See section 8.8 of this Certificate.

4 Construction (Design and Management) Regulations 1994 (as amended)

Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.

See sections: 6 *Delivery and site handling*, 7 *General* and 14 *Procedure* (Installation).

Technical Specification

5 Description

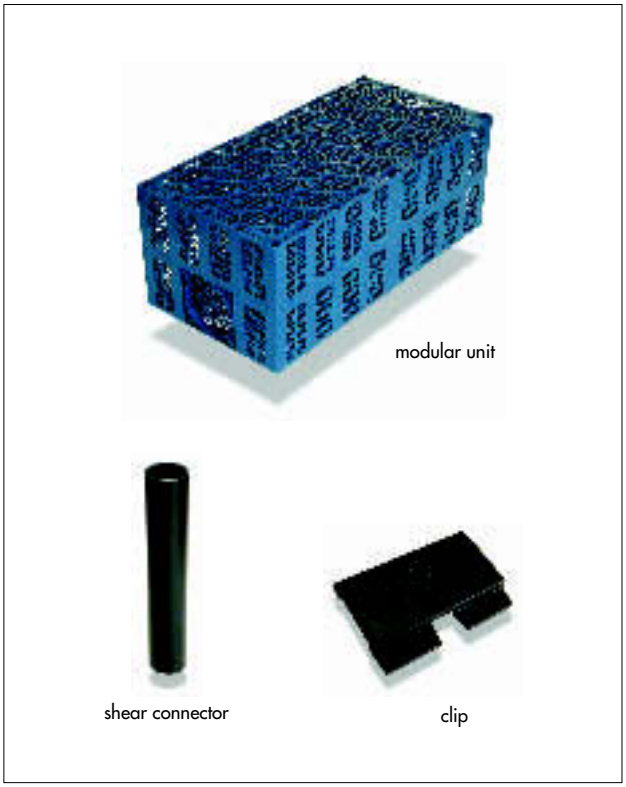
5.1 The AquaCell Stormwater Management System consists of individual, blue polypropylene modular units (see Table 1), black polypropylene shear connectors and black polypropylene clips (see Figure 1).

Table 1 Characteristics of modular unit

Element (unit)	Value
Unit dimensions (nom) (mm)	1000 x 500 x 400
Unit volume (nom) (m^3)	0.20
Storage volume (nom) (m^3)	0.19
Porosity (void ratio) (%)	95
Ultimate compressive strength at yield (kNm^{-2})	
vertical loading on top face	560
lateral loading on side face	77.5
Short-term deflection (mm per kNm^{-2})(1)	
vertical loading on side face	1 per 97
lateral loading on side face	1 per 7
Estimated long-term deflection(2) (Ln)(3)	0.4705

(1) Applied load.
(2) At up to 10 years at 20°C at 10 kN load.
(3) Time in hours.

Figure 1 Components



5.2 The system controls stormwater run-off from impermeable surfaces by either:

infiltration — soakaways to infiltrate stormwater back into the ground, or

attenuation — temporary storage for excess flows and limiting outflow to streams and rivers.

5.3 The polypropylene modular units have pre-formed sockets to enable connection with 160 mm diameter pipework (covered by BBA Certificate No 87/1835), or alternatively, connection to 150 mm pipework is possible using an adaptor. Connection can also be made at points other than the pre-formed socket to suitable 150 mm pipework using a flange adaptor. 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.

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

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

6 Delivery and site handling

6.1 The AquaCell Stormwater Management System units are supplied to site in packs of 12 (four layers of three) units, secured with two straps with plastic feet attached to the underside to enable placing and movement by a fork-lift. Each pack of 12 units carries a label bearing the product name, order number, MOS number, quantity, operator signature and pallet number.

6.2 Clips and shear connectors are packed in sealed polyethylene bags of 36 and 4 respectively. A further 16 shear connectors form part of the packaging.

6.3 The packs of AquaCell units 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.

6.4 AquaCell 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.

6.5 AquaCell units should not be stored near fuel bowsers, fuel tanks or other solvents.

6.6 AquaCell 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.

Design Data

7 General

7.1 The AquaCell Stormwater Management System design must be in accordance with the Certificate holder's instructions, *Stormwater Management Design and Installation Manual 2002*. Guidance on the application of sustainable drainage systems (SUDS) for new developments, such as the AquaCell Stormwater Management System, can also be found in the Planning Policy Guidance PPG25 *Development and Flood Risk*.

7.2 The system is suitable for the control of stormwater run-off from impermeable surfaces. It can be utilised in two main ways:

Infiltration — 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 — 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. Figure 2 shows a general flowchart for the design process.

7.3 Design of the appropriate system (see Table 2) 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.

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

Figure 2 Flowchart of the design process

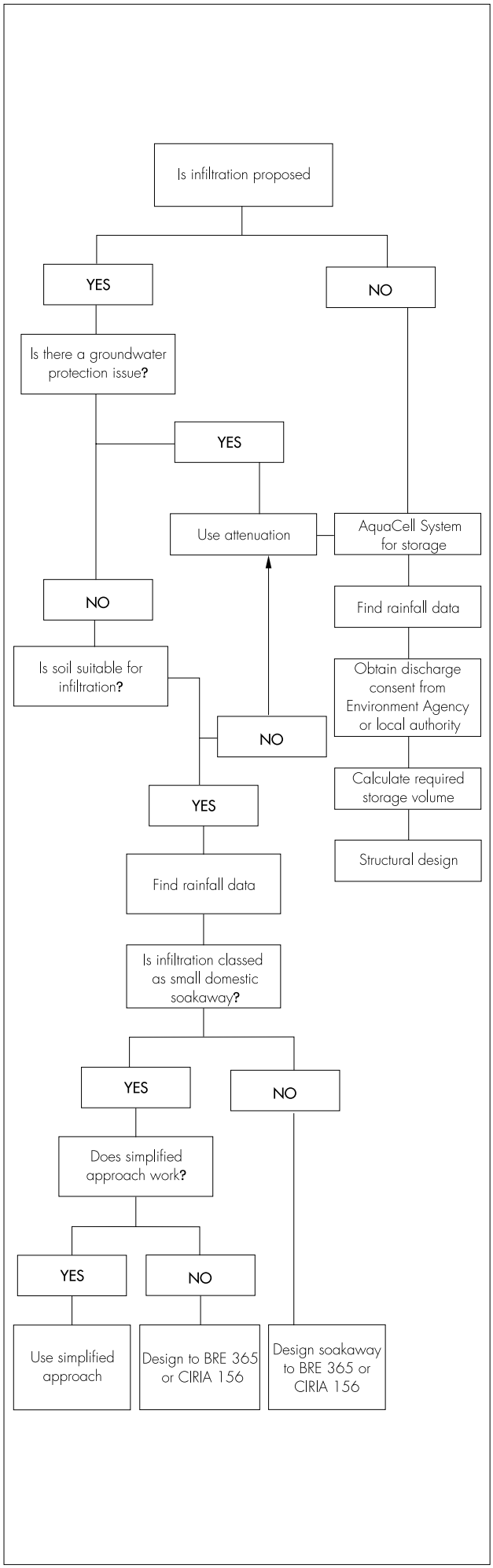


Table 2 Design information checklist

Description	Information sources
A Existing factors	
Topography	Site survey or inspection
Area of catchment[1]	Site survey
Hydrology of catchment	Site inspection and observations
Soil type[1]	Site investigation
Structural properties of soil — CBR, stiffness	Site investigation and laboratory testing
Infiltration potential of soil[1]	Site investigation
Contamination[1]	Site investigation and desk research
Details of receiving water watercourse/aquifer	Environment Agency, Scottish Environment Protection Agency or water and sewerage company
Environmental sensitivity of site	Environment Agency, Scottish Environment Protection Agency or water and sewerage company
Groundwater vulnerability and source protection status	Environment Agency, Scottish Environment Protection Agency or water and sewerage company
B Predicted factors	
Development type and land use	Proposed development plans
Traffic loads	Proposed development plans
Rainfall data[1]	Meteorological Office or Wallingford procedure
Discharge design criteria — quantity	Environment Agency, Scottish Environment Protection Agency or water and sewerage company
Discharge design criteria — quality	Environment Agency, Scottish Environment Protection Agency or water and sewerage company
Health and safety	All affected parties
C Planned function	
Infiltration	Conclusions from **A** and **B** audit/review
Attenuation	Conclusions from **A** and **B** audit/review

(1) For individual house soakaways, only the items referenced for this footnote are required.

8 Hydraulic design

Infiltration

Calculation principles

8.1 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*.

8.2 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. The design parameters (see Table 3) allow an estimate of the required tank size to be made based on the area to be drained and the soil type. It assumes: 100% run-off; a 1-in-100-year storm event of critical duration; UK location; both vertical sides of structure available for infiltration (trench layout). For a more accurate approach on one of the more complex methods (BRE or CIRIA) should be used.

Table 3 Design parameters for single-house roof soakaway

Soil type	Impermeable catchment area per AquaCell unit (max) (m^2)	No of AquaCell units per 100 m^2 catchment area
Gravel	95.0	2
Sand	14.4	7
Chalk[1]	7.9	13
Silt	0.475	211
Clay[2]	—	—

(1) Blocky, fissured chalk, where fissure flow is dominant. (Excludes putty chalk and chalk marl).

(2) The Certificate holder should be consulted for specific information.

8.3 When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found from Tables 4 and 5.

Table 4 Volumetric data per linear metre for a 1 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 5 Volumetric data for 3D usage two units high

Units long	2 wide (0.5 m side)			4 wide (0.5 m side)			8 wide (0.5 m side)		
(1 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

8.4 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 2 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

8.5 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 are assessed. The depth of water (mm) found can be multiplied by the catchment area to assess the size of attenuation systems and is normally based upon a two-hour storm of 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 AquaCell units constructed as an underground tank. The number of AquaCell 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.

Flow control

8.6 Connection is made to AquaCell units using a pre-formed socket and adaptor or a flange adaptor. These items are not covered by the scope of this Certificate. Information can be found in the Certificate holder's *Stormwater Management Design and Installation Manual, 2002.*

8.7 It is recommended that all connections into storage applications (using a geomembrane) are made using a flange adaptor. Adhesive or double-sided tape should be used between the geomembrane and flange adaptor to ensure a watertight seal.

Manifold design

8.8 The capacity of this input pipe is limited and may be insufficient for the anticipated flow load. Therefore, the flow load may be split between a number of 150 mm diameter flow pipes from the adjacent manhole (see Figure 3). The maximum areas that can be drained according to the number of input pipes provided is given in Table 6. This has been calculated on the following assumptions:

paved surfaces — two-year, three- to five-minute event;
eaves drained roofs — one-year, two-minute event;
internal gutters — 500-year, two-minute event.

Table 6 Multipipe manifolds

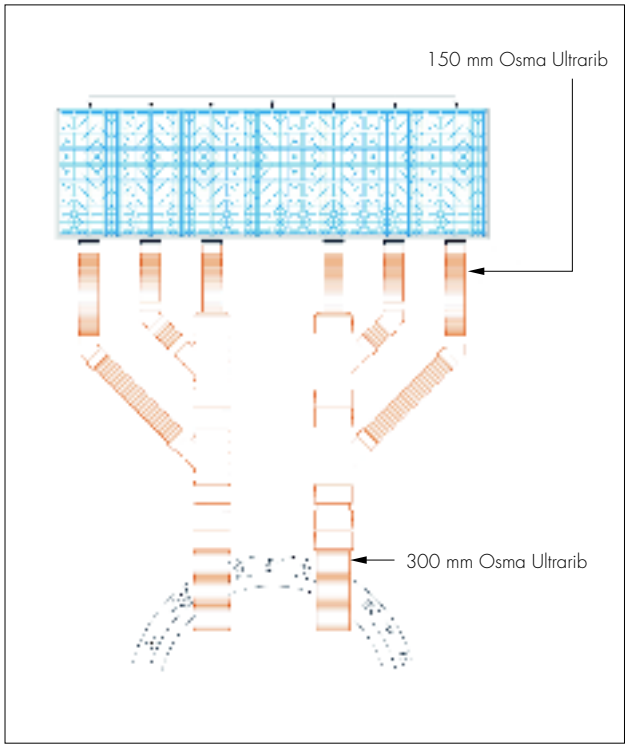
Surface type	Drainage area (m^2)					
	Number of inlet pipes					
	1	2	3	4	5	6
Paved area	1110	2220	3330	4440	5550	6660
Roof area[1]	841	1682	2523	3364	4205	5046
Roof area[2]	210	420	630	840	1050	1260

(1) Roofs drained by eaves gutters, close (within 25 m) to the attenuation site.

(2) Roofs drained by internal gutters, close (within 25 m) to the attenuation site (especially siphonic roof drainage).

8.9 The outflow from the tank must be controlled to comply with the discharge rate consent of the site. There are four main methods to achieve outflow control: orifice plate, garastor, 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.

Figure 3 Typical manifold design



Outflow positioning and head calculations

8.10 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 AquaCell 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 centre line of the outflow device.

9 Structural design

9.1 AquaCell units can be placed under a wide variety of landscaped or lightly-trafficked areas. Design procedures for heavily-trafficked applications are not within the scope of this Certificate. If the proposed application of the AquaCell is in areas subject to high-intensity traffic, commercial vehicles or other heavy loads, advice should be sought from the Certificate holder.

9.2 Short-term loading design parameters for the AquaCell units have been derived from independent test data (see Table 7). The short- and long-term deflection is given in Table 1.

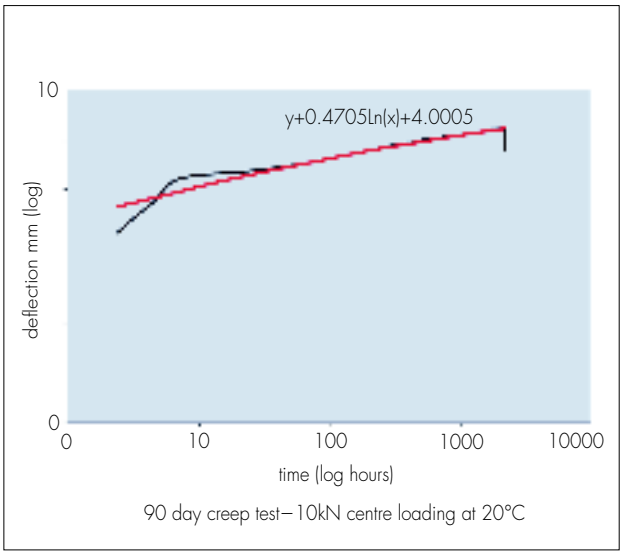
Table 7 Loading design parameters for AquaCell units(1)

	Vertical loading on top face	Lateral loading on side face
Short-term ultimate compressive strength at yield (kNm^{-2})	560	77.5

(1) A partial factor of safety for materials, Fm, 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.

9.3 Typical creep results (see Figure 4) enable a long-term rate of deflection to be determined and long-term deformations for periods up to 20 years estimated. In locations where settlement is not of concern, then designs up to 50 years can be undertaken.

Figure 4 Typical creep test results



9.4 For small-scale application such as soakaways for individual house roof drainage, the AquaCell system is typically located below a garden a minimum of 5 m from the building (see Table 8). In this case there are no traffic loads.

Table 8 Design criteria for use of AquaCell system as soakaway for individual house

Maximum depth to base of units(1) (m)	2.95
Minimum cover depth cover units (to prevent accidental damage) (m)	0.5

(1) Assumes a minimum value for the angle of shearing resistance of the surrounding soil of 29°. This should be confirmed from the results of the site investigation. Groundwater must be at least one metre below base of units. No traffic loads.

9.5 AquaCell 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.

9.6 The criteria provided in Tables 9 and 10 can be used to design the AquaCell units for installation below lightly- and 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, Fdl, 1.40, earth pressure (horizontal) dead load, Fep 1.40, imposed live load, Fll, 1.60, serviceability limit state — vertical dead load, Fdl, 1.00, earth pressure (horizontal) dead load, Fep, 1.00, imposed live load, Fll, 1.00. Partial factors of safety for materials, Fm, of 2.75 for ultimate limit state and 1.5 for serviceability limit state have

been applied. The AquaCell 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.

9.7 For lightly-loaded applications, the bearing capacity of the underlying soils, typically, should not be exceeded by the AquaCell System. Therefore settlement of the underlying soils should be negligible. On weak or compressible soils, the bearing capacity and settlement characteristics should be confirmed by a geotechnical engineer.

Table 9 Maximum installation depths (to base of units)[1]

Typical soil type	Typical angle of shearing resistance[2][3] (ϕ)	Maximum depth of installation (to base of units) (m)			
		With groundwater at 1 m below ground level and units wrapped in geomembrane		Without groundwater (below base of units) — normal case	
		Trafficked area (cars only)	Non-trafficked	Trafficked area (cars only)	Non-trafficked
Stiff over consolidated clay, eg London Clay	24°	1.65	1.75	2.35	2.50
Normally consolidated silty sandy clay, eg alluvium, made ground	26°	1.70	1.80	2.50	2.65
Loose sand and gravel	29°	1.80	1.90	2.85	2.95
Medium dense sand and gravel	33°	1.90	2.00	3.30	3.45
Dense sand and gravel	38°	2.05	2.15	4.10	4.25

(1) Design table is only applicable for car parks or other areas trafficked only by cars or occasional refuse collection trucks or similar vehicles (typically one per week). Assumptions made are:

- ground surface is horizontal
- shear planes or other weaknesses are not present within the structure of the soil

(2) Loosening of dense sand or softening of clay by water can occur during installation. The designer should allow for any such likely effects when choosing an appropriate value of ϕ.

(3) The design is very sensitive to small changes in the assumed value of ϕ, therefore, it should be confirmed by a chartered geotechnical engineer. In clay soils, it may be possible to utilise cohesion in some cases.

Table 10 Minimum cover depths over top of AquaCell units[1]

Location	Minimum cover depth (m)
Non-trafficked areas, eg landscaping	0.50
Car parks, vehicle up to 2500 kg gross mass, AquaCell system up to three units wide in trench	0.60
Car parks, vehicle up to 2500 kg gross mass AquaCell system greater than three units wide	0.75

(1) Assumes 27° load distribution through fill material and overlying surface of asphalt or block paving, and trafficking by occasional refuse collection trucks or similar vehicles (typically one per week).

9.8 Care should be taken when the AquaCell 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.

9.9 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 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.

10 Geotextiles and geomembranes

10.1 A geotextile is wrapped around the AquaCell system in infiltration applications to:

- prevent clogging of the soil which surrounds the unit with silt present in run-off
- prevent soil entering the units

and in storage applications to:

- protect the geomembrane.

10.2 The selection of an appropriate geotextile for a specific AquaCell infiltration installation should be considered carefully, with particular reference to the surrounding soil properties and required performance. Points to consider are:

- pore size — 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 materials
- puncture resistance — the geotextile must be able to resist the punching stresses caused by loading on sharp points of contact
- tensile strength — the geotextile should have sufficient strength to resist the imposed forces (eg from traffic).

10.3 The geotextile should be selected according to specific site conditions. However, typically a 300 g non-woven material will be suitable for most situations. 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.

10.4 A geomembrane is wrapped around the AquaCell system in attenuation/storage applications where infiltration is not possible or permitted and functions to:

- prevent release of attenuated/stored water to surrounding ground
- prevent inflow of pollutants from contaminated subsoil into the storage reservoir.

10.5 The specification and selection of the impermeable geomembrane must be correct for the installation envisaged, 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.

10.6 Geomembranes less than 1 mm thick are unlikely to meet these criteria[1], and are not recommended for use with the AquaCell system[2]. A specification for a typical polypropylene geomembrane is shown in Table 11.

(1) Except in shallow, domestic installations.
(2) For further details contact the Certificate holder.

Table 11 Typical specification for a polypropylene geomembrane

Property	Value	Test method
Thickness ±10% (mm)	1.0	ASTM D 751
Density (min) (g cm^{-3})	0.9	ASTM D 792
Tensile stress at break (min) (Nmm^{-2})	18	ASTM D 638
Elongation at break (%)	>700	ASTM D 638
Puncture resistance (min) (N)	150	FTMS 101C Method 2065
Tear resistance (min) (N)	60	ASTM D 1004
Dimensional stability (max) (% change)	±2.0	ASTM D 1204 1 hour at 100°C
Stress crack resistance (%)	100	ASTM D 5397
Volatile loss 5% Loss max	0.2	ASTM D 1203 Method A
Ozone resistance	No cracks	ASTM D 1149
Carbon black content	2–3%	ASTM D 1603
Moisture vapour ($gm^{-2}day^{-1}$)	<0.1	ASTM E 96
Friction angle (non-woven geotextile)	21°	Shear box
Methane permeability ($gm^{-2}day^{-1}/atm$)	0.11	European Standard
Methane transmission rate ($m^3m^{-2}s^{-1}atm^{-1}$)	0.8×10^{-9}	BRE
Permeability coefficient	1.8×10^{-12}	
Application temperature (°C)	>4	

10.7 To ensure total impermeability, joints between adjacent sheets of impermeable geomembranes should be sealed correctly using proprietary welding techniques. The integrity of joints should be demonstrated by non-destructive testing[1].

(1) Advice on seam testing is given in CIRIA SP124 *Barriers, liners and cover systems for containment and control of land contamination.*

11 Venting

11.1 Adequate venting must be provided to the AquaCell structure. One 110 mm diameter air vent is required per 7500 square metres of impermeable catchment area to be drained (see Figure 5).

11.2 Typical air vent connectors and pipework can be seen in the Certificate holder's *Stormwater Management Design and Installation Manual, 2002*. It is recommended that all air vent installations in storage applications (using a geomembrane) are made using a flange adaptor. Adhesive or double-sided tape should be used between the geomembrane and flange adaptor to ensure a watertight seal.

12 Resistance to chemicals

12.1 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.

12.2 An assessment of the suitability for use of AquaCell 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. For further information contact the Certificate holder.

13 Maintenance

13.1 The customer is responsible for maintenance.

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

13.3 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.

13.4 It is recommended that a silt trap is incorporated into the pipework at the inlet to the tank (see Figure 6). 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.

13.5 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.

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

14 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 AquaCell Stormwater Management System, when used in accordance with this Certificate, will have a life in excess of 50 years.

Figure 5 Typical air vent design

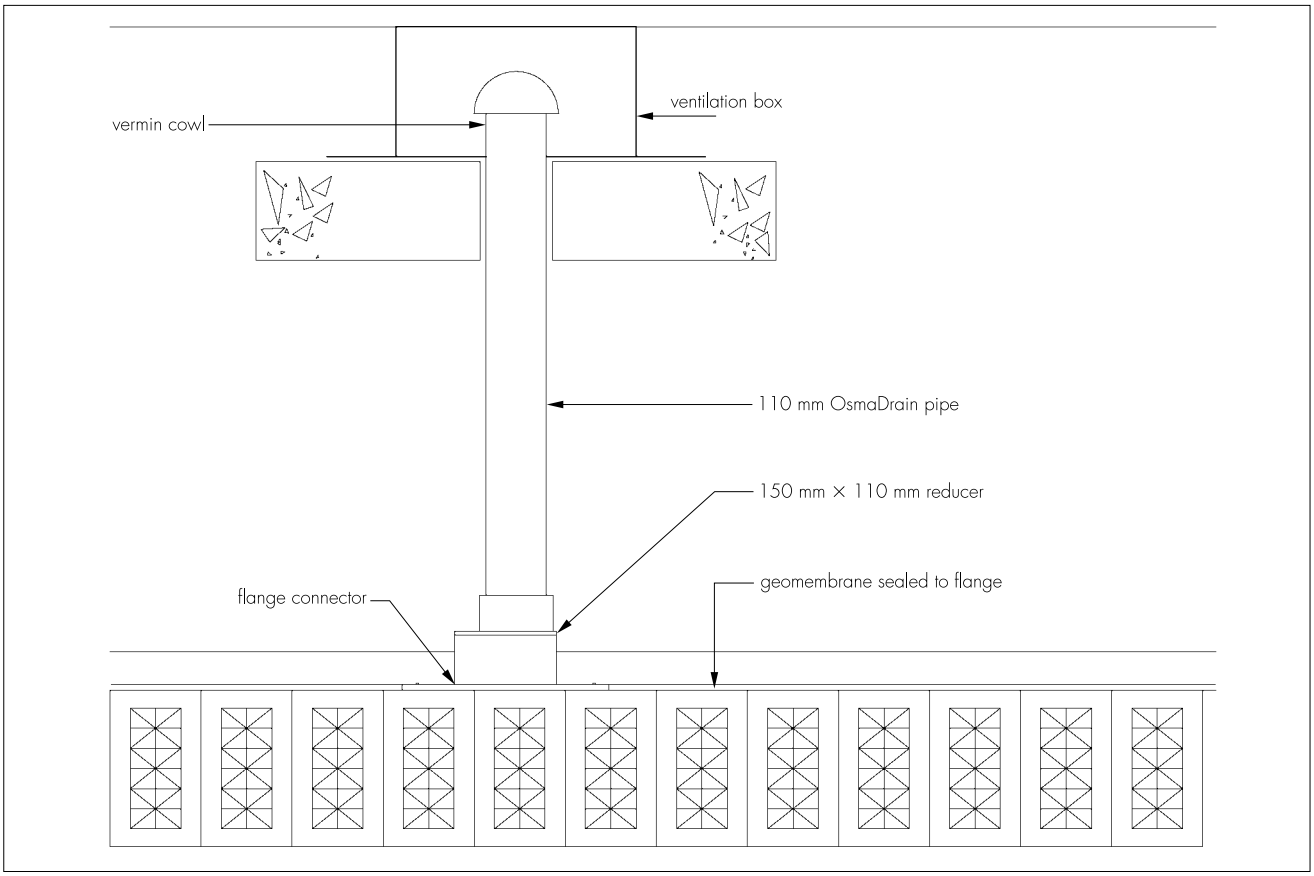
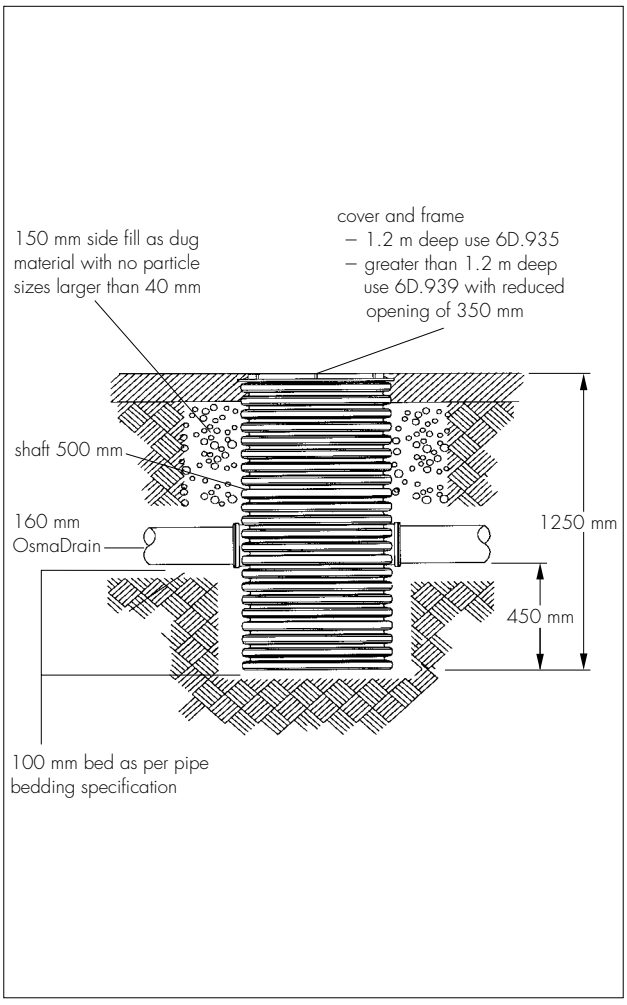


Figure 6 Typical silt trap



Installation

15 General

The system should be installed in accordance with the Certificate holder's *Stormwater Management Design and Installation Manual, 2002*.

16 Procedure

16.1 The hole or trench is excavated to the required depth, dimensions and levels. It must be ensured that the plan area is sufficient to allow compaction plant access around sides to compact backfill material (300 mm minimum). 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.

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

16.3 A 100 mm thick, bedding layer of coarse sand is laid on the base and sides of the excavation. The geotextile protection fleece is laid if required for geomembrane (attenuation).

16.4 The geomembrane (or geotextile, if in an infiltration system) is laid over the sand bedding layer and up the sides of the excavation. The geomembrane is inspected for damage and all welds are tested as required. Joints between adjacent sheets of impermeable membrane should

be sealed correctly using proprietary techniques with a minimum lap of 50 mm. Jointing with tape is not recommended as this places reliance on the mechanical properties of the tape to maintain the integrity of the system.

16.5 The AquaCell 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 pre-formed sockets are in the correct alignment for inlet and outlet pipes. For single-layer applications, Wavin clips are used and for multi-layers Wavin clips and shear connectors are used.

16.6 The geotextile or geomembrane encapsulation to base, sides and top of installation, including protective geotextile (where required) is completed. Geomembranes should be welded with double seams. The geomembrane is inspected for damage and all welds are tested as required.

16.7 Drainage connections are made to the installation using proprietary adaptors. Pre-formed socket positions for pipe connections must be located at the correct position for receiving pipework. Alternatively, flange adaptors are used attached to AquaCell units with adhesive tape and self-tapping screws (flange adaptors cannot be used at invert of AquaCell units into the pre-formed socket). It is recommended that all connections and air vent installations, in attenuation applications, are made with a flange adaptor, using adhesive or double-sided tape to form a seal. Alternatively, drainage connections are sealed into a pre-formed socket using proprietary seals approved by the geomembrane manufacturer.

16.8 The installation is backfilled with Type 1 or 2 sub-base or Class 6P (side fill only) selected granular material in accordance with the Manual of Contract Documents for Highway Works, Volume 1. The backfill is compacted in 150 mm thick layers.

16.9 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:

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 plant over top of system 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. Compaction plant over top of system must not to exceed 2300 kg per metre width.

16.10 The pavement construction or landscaping is completed over the AquaCell system.

Technical Investigations

The following is a summary of the technical investigations carried out on the AquaCell Stormwater Management System.

17 Tests

Tests were carried out on the system to determine:

long-term and short-term resistance to loading
performance and durability of geosynthetic
volumetric capacity and discharge rate.

18 Investigations

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

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

material properties
design procedures.

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

Bibliography

ASTM D 638 : 2002 *Test Method for Tensile Properties of Plastics*

ASTM D 751 : 2000 *Standard Test Methods for Coated Fabrics*

ASTM D 792 : 2000 *Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*

ASTM D 1004 : 1994 *Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting*

ASTM D 1149 : 1999 *Standard Test Method for Rubber Deterioration–Surface Ozone Cracking in a Chamber*

ASTM D 1203 : 1994 *Standard Test Methods for Volatile Loss From Plastics Using Activated Carbon Methods*

ASTM D 1204 : 1994 *Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperatures*

ASTM D 1603 : 2001 *Test Method for Carbon Black in Olefin Plastics*

ASTM D 5397 : 1999 *Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test*

ASTM E 96 : 2000 *Test Methods for Water Vapor Transmission of Materials*

FTMS 101C : Method 2065 *Puncture Test*

Manual of Contract Documents for Highway Works, Volume 1 : *Specification for Highway Works* : May 2001 edition

Conditions of Certification

19 Conditions

19.1 This Certificate:

(a) relates only to the product that is described, installed, used and maintained as set out in this Certificate;

(b) is granted only to the company, firm or person identified on the front cover — no other company, firm or person may hold or claim any entitlement to this Certificate;

(c) has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective;

(d) is copyright of the BBA.

19.2 References in this Certificate to any Act of Parliament, Regulation made thereunder, Directive or Regulation of the European Union, Statutory Instrument, Code of Practice, British Standard, manufacturers' instructions or similar publication, shall be construed as references to such publication in the form in which it was current at the date of this Certificate.

19.3 This Certificate will remain valid for an unlimited period provided that the product and the manufacture and/or fabricating process(es) thereof:

(a) are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA;

(b) continue to be checked by the BBA or its agents; and

(c) are reviewed by the BBA as and when it considers appropriate.

19.4 In granting this Certificate, the BBA makes no representation as to:

(a) the presence or absence of any patent or similar rights subsisting in the product or any other product;

(b) the right of the Certificate holder to market, supply, install or maintain the product; and

(c) the nature of individual installations of the product, including methods and workmanship.

19.5 Any recommendations relating to the use or installation of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do 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 or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future 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 installation and use of this product.

BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

In the opinion of the British Board of Agrément, the AquaCell Stormwater Management System is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 03/4018 is accordingly awarded to Wavin Plastics Limited.

On behalf of the British Board of Agrément

Date of issue: 28th March 2003

Chief Executive

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