Green Roofs

A guide to the design and specification of ABG Green Roof systems

abg creative geosynthetic engineering

Extensive Green Roof, Field Garth, Ambleside, UK

Virtually any type of roof structure can accommodate a Green Roof, including domestic and commercial and new-build and retrofit projects. The benefits are wide ranging; from helping to mitigate the effects of climate change, to whole-life cost advantages of the building or simply adding a natural habitat to an urban setting.

As much as 95% of rainfall on undeveloped land is naturally absorbed into the vegetated surface. By contrast, urbanisation and land development creates hard impervious surfaces that absorb only 5% of rainfall, leaving the remainder to run-off into the local water network that struggles to cope with the volume. This is becoming more apparent in light of climatic change and the increasing intensity of rainfall and flash flooding events.

Green Roofs can play an important role in mitigating these events, especially when designed as an integral element of a sustainable urban drainage system, also known as SuDs. Green Roofs are increasingly being adapted to attenuate stormwater, providing an alternative solution to SuDs tanks and helping to reduce flooding in urban environments.

If you are thinking of incorporating a Green Roof system into a new or existing development, please don't hesitate to contact ABG and let us assist you through each stage of the project; from design through to installation.

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Extensive Green Roof, Alder Hey Children's Hospital, Liverpool, UK

Added protection for the waterproofing layer

The build-up and cover provided by a Green Roof helps to reduce the impact of temperature fluctuations and thermal stresses. A Green Roof protects the waterproofing by mitigating expansion and contraction and shielding the membrane against UV degradation. This protection prolongs the life of the waterproofing and as a result many manufacturers offer extended warranties when an ABG Green Roof is installed.

Scoring BREEAM points

Improving the energy performance of buildings with a Green Roof installation helps towards achieving the desired BREEAM rating. For example, a development incorporating a Green Roof can earn credits in sections LE04 and LE05 by enhancing the ecology of the roof, increasing local biodiversity and through provision of water storage.

It also helps commercial developments in achieving planning consent by enhancing the sustainability and energy efficiency of the application.

Reduces whole life costs

Typical roof installations have a life expectancy in the region of between 15 and 20 years, whereas the lifespan of a Green Roof system has been shown to be in excess of 50 years. This added longevity means that the whole life cost of the development is typically significantly lower than that of a traditional roof construction.

Green roofs as part of a SuDS solution

Urbanisation and land development creates hard impervious surfaces that absorb only 5% of rainfall. The remaining 95% becomes run-off that local streams, rivers and ageing sewer systems struggle to accommodate, resulting in flooding and erosion.

A Green Roof is an effective way to help attenuate rainfall since the vegetated surface allows infiltration into the roof build up. This solution benefits the environment by allowing developments to have a similar rainfall response to the natural land. In addition a Green Roof can replace applications in which a SuDs tank alternative would perform poorly; e.g. prohibitive ground conditions prevalent with clay, contaminated land, aquifers etc.

Aid planning consent

Although there are no specific regulations to make Green Roofs mandatory, the National Planning Policy Framework and local authority planning departments encourages proposals that make provision for sustainable drainage system techniques.

Creates amenity

A Green Roof can be used to create amenity spaces for building occupiers to enjoy. Typical amenities within green roofs can include play areas, ornamental gardens or areas for growing fruit and vegetables.

Mitigating the Urban Heat Island effect

City centres are known to have higher temperatures than surrounding rural areas, a phenomenon known as the Urban Heat Island Effect. During the day, heat from the sun is absorbed by the hard surfaces within a city, which is then radiated back during the night, creating a hotter city microclimate which can lead to a higher energy demand to cool city buildings. Evaporation of water from soil surfaces and the leaves of plants on a Green Roof helps to create a cooling effect on the surrounding air and the many layers within a Green Roof system help to further reduce the solar gain.

Creates habitat

Green Roofs help create a living habitat for small wildlife and a wide variety of plant species. This is particularly useful when a development has taken some existing habitat, and the creation of new space on the roof can be used to offset this environmental impact. Also, whilst the formation of engineered habitat areas is possible, simple practices such as including rocks and logs within the design are often equally as effective.

Insulation

It has been proven that Green Roofs have a cooling effect in summer, reducing air conditioning load whilst providing a level of insulation against heat loss in winter.

Green Roofs still currently rely on an insulating layer to comply with the building regulations. This is a project specific U value calculation to ensure the building's thermal insulation requirements are met in combination with the Green Roof.

Noise reduction

A Green Roof is very good at reducing low frequency sounds, for example an extensive Green Roof can insulate up to 40dB and an intensive Green Roof up to 50dB. This can make a noticeable difference, especially near airports and motorways.

Extracts pollutants

The vegetation, growing media and filtration fabrics within the Green Roof construction all serve to filter dust and pollution from the air and rainfall. This helps to reduce the amount of chemicals and pollutants that reach the water courses surrounding the development.

Water discharged from a green roof is proven to be cleaner than the precipitation from which it fell and in many cases it is clean enough to be collected and used for irrigation and grey water applications such as toilet flushing.

Aesthetics

Green Roofs can be used to allow the creation of a 'green bridge' through the built environment. This not only helps to improve the aesthetics of the development, but also encourages a natural flow of flora and fauna through urban spaces.

Features & Benefits

Green Roof systems protect and prolong the life of a roof by preventing UV degradation of the waterproofing and mitigating against expansion and contraction and the freeze thaw cycle during winter months.

This protection prolongs the life of the waterproofing to such an extent that many membrane manufacturers will extend their warranties when an ABG Green Roof is installed.

On top of this, Green Roofs offer many environmental benefits, and it is proven that including a Green Roof system improves the thermal performance of the roof and helps to mitigate against the Urban Heat Island effect.

UK ROOFING AWARDS 2021 WINNER NFRC

BALI National Landscape Awards PRINCIPAL AWARD WINNER 2021

WINNER LRWA AWARDS & GALA DINNER 2022

Multi-award winning extensive wildflower Green Roof - Leeds Skelton Lake Motorway Services, UK

Access & maintenance

The British Standards Institute states that all new builds must provide access to the roof area to enable a minimum of two inspections per year, so working at height regulations must be considered. If a building is of a height which can cause an injury from a fall edge protection is required.

Even though extensive Green Roofs are relatively self-sustaining, they still require some scheduled maintenance. ABG recommends this be dealt with in the form of a maintenance contract. Maintenance for extensive roofs will typically only be required twice per annum, and therefore the overall cost of maintaining a Green Roof can be relatively minimal.

Drainage & water retention

Drainage and water retention are key elements to consider when designing a Green Roof. The type of drainage specified is dependent upon the project's landscaping plans and ensuring adequate water retention/drainage requirements are provided is paramount to the long-term survival of the vegetation and to prevent pooling forming on the waterproofing layer.

Geographical location

Geographical location and orientation are also an important part of designing the roof. Which part of the country, the direction the roof faces, the amount of average rainfall and sunlight in that area and the prevalent wind direction all influence the types of vegetation required for a successful roof. The biodiversity and drainage elements are then derived following consideration of the local conditions. It is worth noting that Green Roofs in coastal locations require careful consideration in order to ensure that the vegetation specified is hardy enough to withstand the elements.

Structural loadings

The introduction of a Green Roof will have loading implications for the building. It is vital to consult a structural engineer at an early stage, especially when designing for a SuDS solution where water may be attenuated within the roof structure. This will enable any constraints to be determined and in turn inform which type of Green Roof system it is most suitable to implement.

Compressive strength

A design consideration that is typically most relevant for podium deck applications is the compressive strength of the drainage layer. The structural requirements of these systems are commonly misinterpreted, with erroneous descriptions such as 1,000kPa sometimes referenced. This is significantly greater than the overall loading requirements of the roof, and in reality, most drainage layers do not need a compressive strength above 150kPa.

Cost

When considering the whole life cost, factors including the extended lifetime of the waterproofing membrane and a potential reduction in the other infrastructure required such as stormwater tanks, a Green Roof typically provides a positive cost benefit.

As opposed to having a 'one system fits all' approach, our supply chain enables us to put forward bespoke systems to help meet the specific needs of the client, on time and within agreed budget.

Thermal performance

Any Green Roof installation needs to meet the relevant building regulations regarding thermal performance. At the moment, the Green Roof build up cannot be considered as part of the roof build up when calculating U values, so insulation specifications must be carried out as per a standard roof design.

However, research shows that the introduction of layers of drainage, growing media and vegetation have a positive impact on the roof's thermal performance, helping to improve the building's energy efficiency and reducing carbon footprint.

Sound insulation

Installing a Green Roof can reduce noise levels inside the development by providing additional acoustic protection against rainfall, wind noise and external sources of low decibel frequencies.

Water attenuation

A Green Roof can be designed to provide rainwater storage and form part of the wider SuDs plan for the site. This can replace the need for below ground storage tanks and is particularly beneficial on sites with tight land boundaries (see Blue Roof system on pages 14-15).

Fire

There is a common misconception about the risks of fire and how this influences the design of a Green Roof. In reality, there is typically less risk of a Green Roof build-up catching fire than a standard roof.

Most importantly, a minimum firebreak of 300mm is required surrounding penetrations and at roof edges. For continuous sections of Green Roof, a maximum run length of 20m is permitted, followed by a 500mm break.

Roof pitch

Contrary to popular belief, Green Roofs can be constructed on sloping roofs. However, it is worth noting that once the slope angle is above twenty degrees, both installation and maintenance may start to become increasingly complex.

Design Considerations

A Green Roof is a complex, multi-component system that requires careful consideration throughout the design process in order for it to function correctly as both a waterproof structure and as a living environment.

Function, location and aesthetics all have a direct effect on the design of the roof, with the final solution varying from project to project to meet the client's exact requirements.

Beneath the surface finish, the roof still has to fulfil its primary role in withstanding the elements throughout its lifetime and careful design of the structural components is required to ensure that the Green Roof can survive all that mother nature will throw at it.

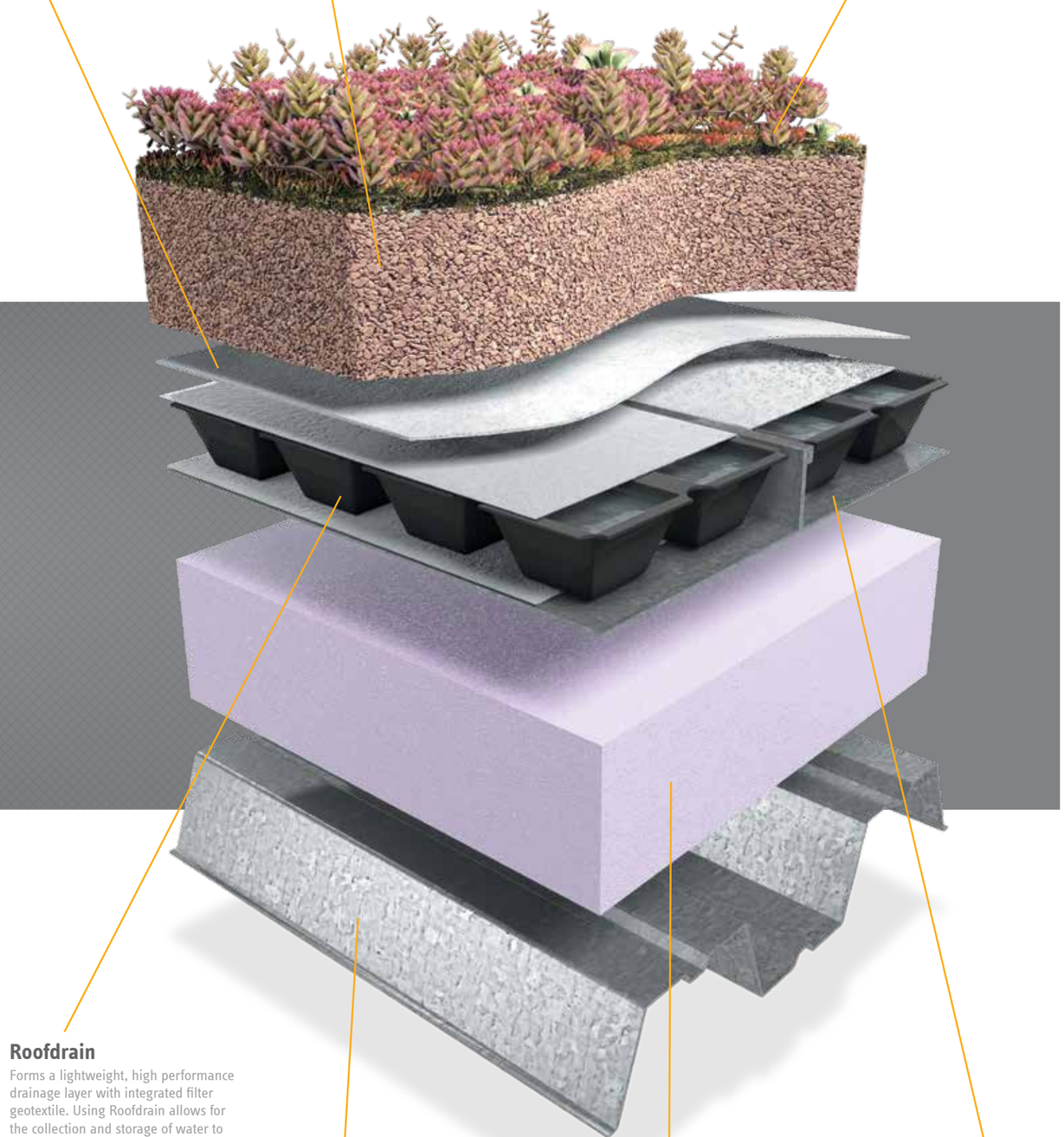
Extensive Green Roof, Leeds Skelton Lake Motorway Services, UK

Extensive Green Roofs

Extensive green roofs are the most commonly specified; characteristically consisting of a shallow layer of growing media - between 60mm and 120mm deep. This is planted with a variety of drought tolerant, hardy plants.

This type of roof is designed to be relatively self-sufficient and they are not constructed with the intention of being trafficked by pedestrians. Whilst not providing a permanent amenity area, they do contribute to improving air quality, reducing the visual impact of the roof and assist in controlling rainwater run-off/ harvesting, as well as contributing to the acoustic and thermal properties of the roof.

Because access to the roof tends to be limited other than for bi-annual maintenance, the choice of vegetation should be selected with this in mind, with low maintenance planting such as sedums and indigenous grasses and wildflower species recommended.



Geotextile Filter Fabric
Laid beneath substrate to prevent fines filtering through to the voids below.

Growing Media
ABG peat free media derived from sustainable, 100% recycled, UK sourced materials. Using a purposefully developed growing media helps to provide the right nutrient levels for the selected vegetation and reduces the load on the roof.

Vegetation
Specifically selected to suit the final finish requirements of the client/end user. On Extensive Green Roofs, low maintenance varieties such as mosses, herbaceous plants, sedums, wildflowers and grasses tend to be used.

Roofdrain
Forms a lightweight, high performance drainage layer with integrated filter geotextile. Using Roofdrain allows for the collection and storage of water to irrigate the plants during low rainfall periods, whilst providing a continuous drainage layer across the roof structure. In this illustration it is shown in strips positioned between the standing seams.

Roof Deck
In this instance, illustrated as a profiled metal deck, but other systems can be used.

Insulation
Specified to meet the thermal performance requirements of the building.

Waterproofing
Illustrated here as a Standing Seam System.

Intensive Green Roofs

Sometimes referred to as roof gardens, an intensive Green Roof can be as simplistic or complex as required to suit the client's overall design concept. Generally speaking an intensive Green Roof requires the same level of care as any traditional garden.

Intensive Green Roofs consist of a deep layer of engineered growing media, typically between 150mm to 1,500mm. As a result of this greater soil depth, there is a wider scope of planting available and the roof can be viewed very much like a traditional garden area including trees, lawns, flower beds and paved areas. With an intensive roof, the only real limit to its scope is the weight of the system and the structure necessary to support it.

Many modern developments incorporate landscaped roofs at ground level, for example above basements and underground car parks. These are commonly referred to as podium decks and these areas create additional opportunities for amenity space in urban developments. For large areas, it is imperative that consideration is given to the provision of adequate sub-surface drainage.

Intensive Green Roof, Mei Foo Train Station Podium Deck, Hong Kong

Deckdrain

Forms a lightweight, high performance drainage layer with integrated filter geotextile to eliminate clogging within the drainage structure. Core / void provides a continuous drainage layer across the structure.

Engineered Growing Media

ABG peat free media derived from sustainable, recycled, UK sourced materials. Using a purposefully developed growing media helps to provide the right nutrient levels for the selected vegetation and reduces the load on the roof.

Vegetation/surfacing

Specifically selected to suit the final finish requirements of the client/end user. On intensive Green Roofs, a wide variety of vegetation can be used; from grasses to shrubs and trees, as well as hard landscaping such as block paving.

Root Barrier

The GRO Best Practice Guide for Green Roof Construction recommends the inclusion of a Root Barrier above the waterproofing on some roof types.

Waterproofing

Waterproofing layer specified according to project requirements and roof type.

Roof Deck

Roof deck specified by others to meet project requirements and roof type.

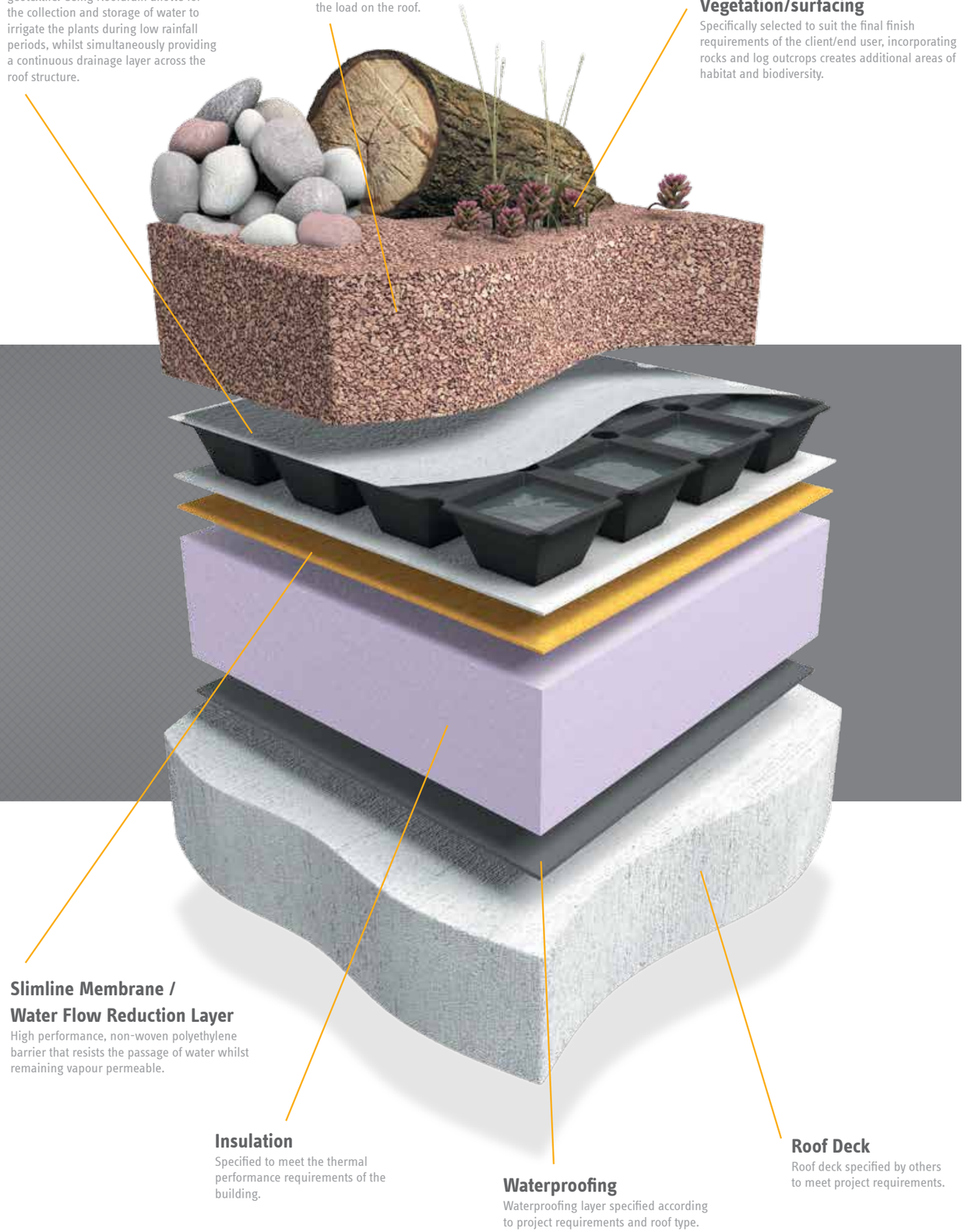
Biodiverse Roofs

A biodiverse roof, often formerly referred to as a ‘brown roof’, is a roof which is commonly specified when the vegetation is intended to replace or replicate an area of existing site habitat. With an increasing number of developments being undertaken on brownfield land, the use of biodiverse roofs can partly mitigate the loss of habitat and contribute to Biodiversity Net Gain assessments.

This type of roof may be seeded (as per intensive and extensive Green Roofs) or can be allowed to self-colonise. Active seeding will increase the biodiversity potential of the roof in the short term and biodiverse roofs also typically include areas of logs and rocks to create a habitat for colonisation by a wide range of insect species.

Maintenance requirements are low and similar to that of an extensive green roof with only minimal maintenance required. The choice of aggregate and vegetation is determined by the biodiversity objective the client is seeking to achieve.

Biodiverse Green Roof, 7 Air Street / Regent Street, London, UK



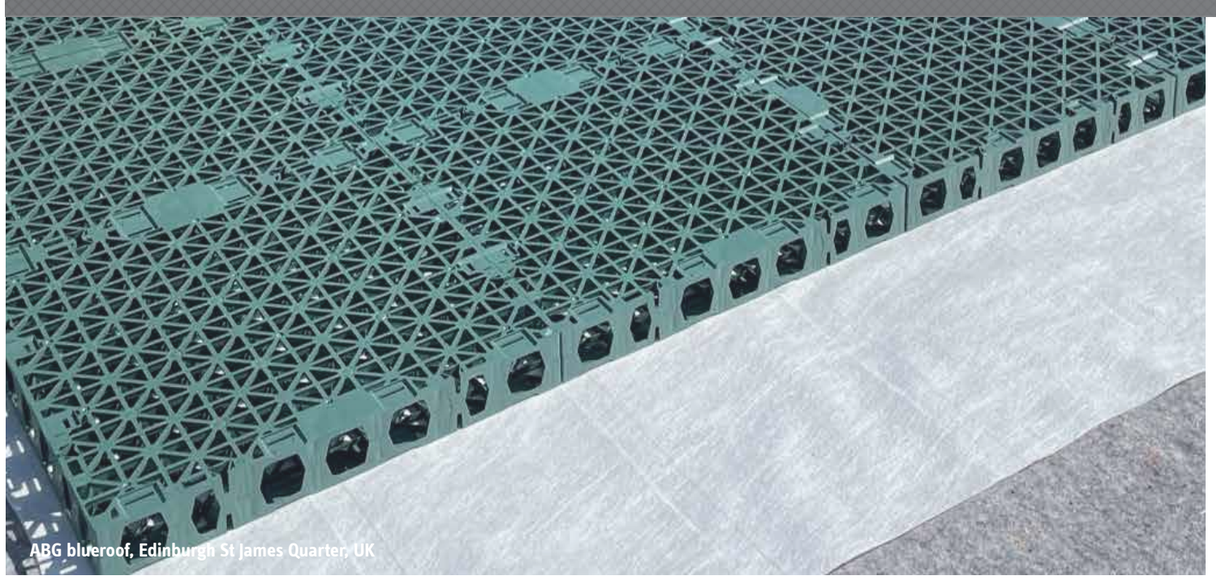
Blue Roof System

The ABG blueroof system provides a SuDS attenuation solution to control rainwater at source as it falls onto the roof. The geocomposite, water attenuation and substrate layers are specifically designed with enhanced water storage capacity built-in, and the discharge is controlled using a patented outlet designed specifically for this purpose. Designing a Green Roof in this way allows storage capacities to meet a 1-100 year storm event with an added allowance for future climate change. The attenuated water, as with a 'traditional' underground storage tank alternatives, can be released at a controlled rate or even re-used as grey water and for the irrigation of vegetation across the development.

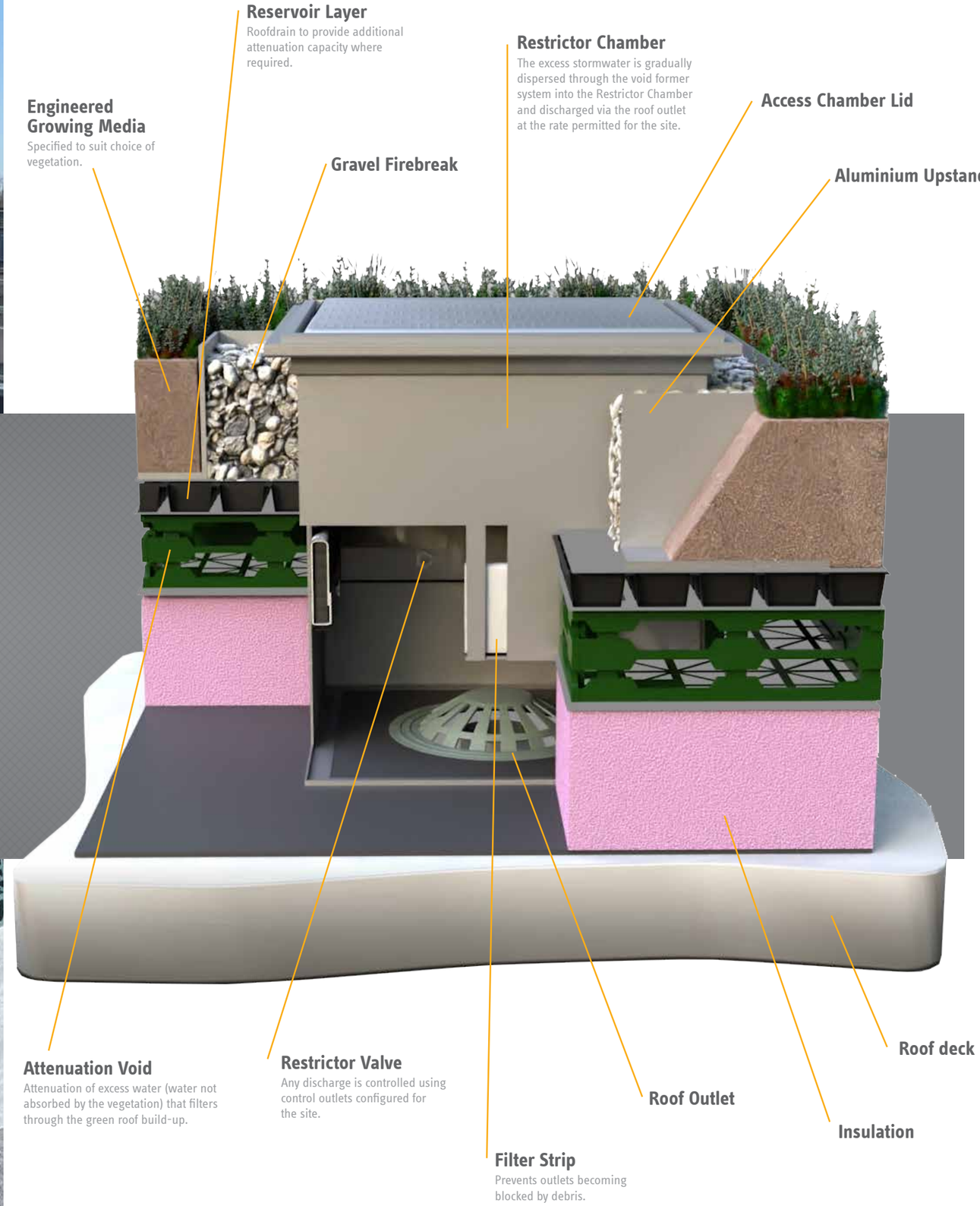
The ABG blueroof system consists of three main components; namely the void former attenuation modules and/or Roofdrain geocomposite, integral filter geotextiles and Restrictor Chamber outlets.

Excess water that is not absorbed by the vegetation filters through the Green Roof surface and builds up within the geocomposite drainage and attenuation layers below. This water is gradually dispersed through the system to the Restrictor Chamber and discharged via the roof's rainwater outlets at the rate permitted for the site.

The stormwater attenuation requirements are met within the roof construction, therefore the need for underground storage can be eliminated. The benefits to the overall project include the removal of the disruption, time and cost of installing an underground tank. Placing the storage within the footprint of the building also has advantages on urban developments where external space is at a premium and where onsite working space and materials storage is limited. This reduction in material movements also significantly helps reduce the overall carbon footprint of the project.



ABG blueroof, Edinburgh St James Quarter, UK

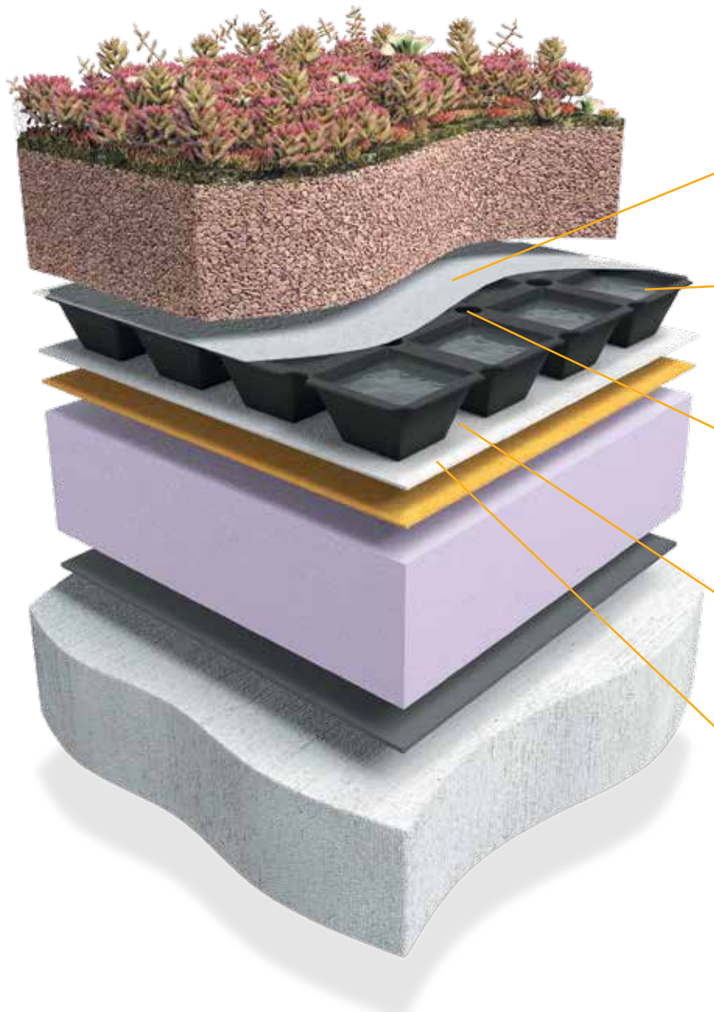


Roofdrain

Modern installation methods for an extensive Green Roof require a Roofdrain geocomposite layer, a combination of efficient drainage and water attenuation that allows ecology to flourish. For the design of intensive Green Roofs, a higher strength structural drainage layer may be required (e.g. see Deckdrain, p.18).

Roofdrain retains water within the nodes of the HDPE core, whilst facilitating the efficient drainage of any excess water away from the roof. This helps prevent the root growing media from drying out during spells of warm weather and from becoming oversaturated during periods of heavy rainfall.

When installed as part of the roof build-up, Roofdrain provides a versatile system for the collection of surplus seepage water at the base of the growing medium and for the prevention of water pressure build-up on the structural waterproofing.



Filter Geotextile
Filter geotextile allows free drainage of water into the core.

Attenuation Void
Wells formed by cuspated core allow for water storage to feed plants during periods of low rainfall.

Perforations
Perforations in core allow free passage of surcharge water into drainage channels.

Drainage Channels
Channels in core allow free lateral drainage of water to discharge outlets.

Protection Geotextile
Protects underlying elements against damage.

	Thickness	Reservoir Capacity (l/m^2)	Typical Applications
Roofdrain 20	20mm	5.5	Beneath 75mm substrate depths on extensive and brown roofs.
Roofdrain 25	25mm	4.3	Standard grade product for substrate layers 150mm and below, including extensive and brown roofs. Particularly useful on pitched roofs due to the cone shaped profile of the cuspates.
Roofdrain 40	40mm	12	Used to store additional rainwater to support a greater diversity of vegetation.
Roofdrain 60	60mm	23	Used to attenuate large volumes of rainfall and significantly reduce run-off.

For further information about Roofdrain, visit:
abg-geosynthetics.com/products/geocomposite-drainage/roofdrain/

Deckdrain

Deckdrain consists of a combination of a cuspated core with a geotextile fleece bonded to the upper face.

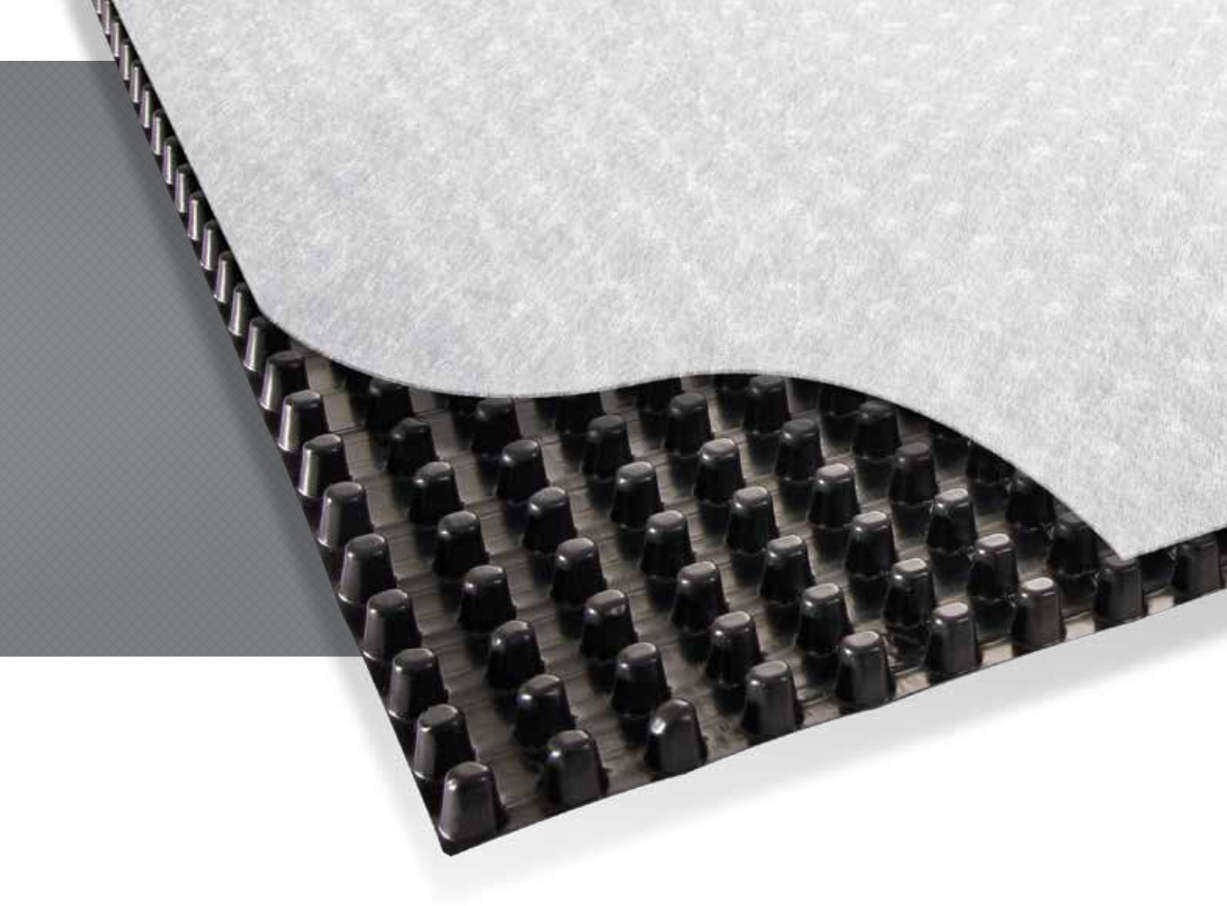
Deckdrain is manufactured in the UK using up to 95% recycled material, making it an environmentally sound choice, especially when compared with gravel drainage layer alternatives.

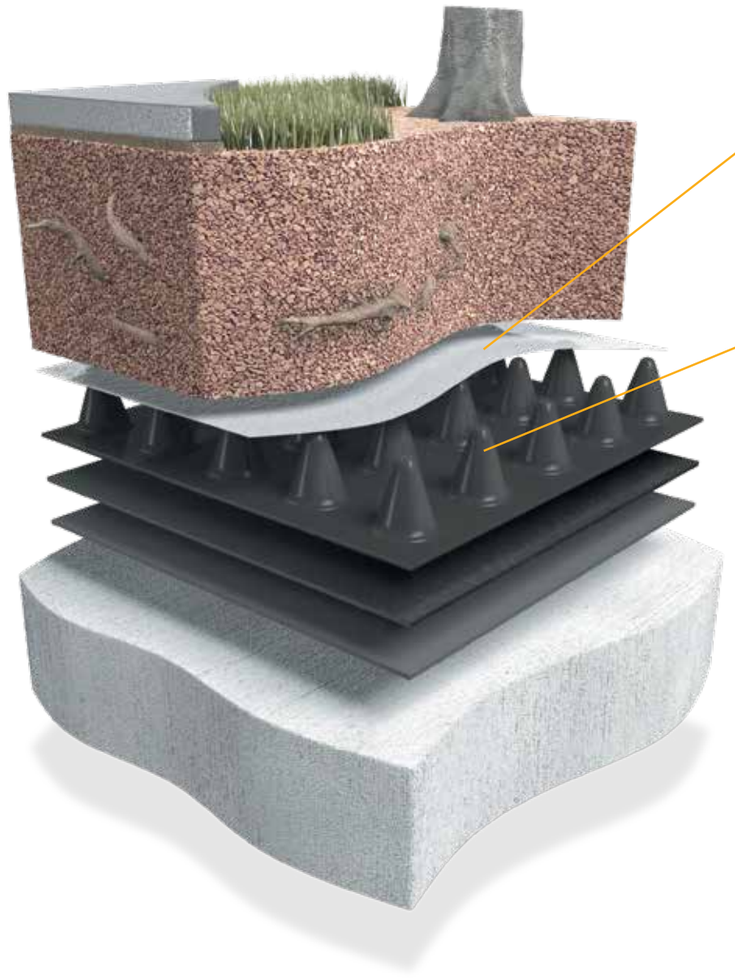
Deckdrain provides excellent drainage to the whole base area of the soil layer, as well as providing additional waterproofing protection.

Intensive Green Roofs have a deeper layer of growing medium than extensive roofs. This increased depth has a greater capacity to retain water, making it less likely to dry out. Utilising a drainage composite such as Deckdrain reduces the risk of oversaturation of soils during periods of heavy rainfall.

The high strength core used in Deckdrain allows the product to be used in high load areas, such as on podium decks with vehicular traffic.

With more emphasis on reducing the amount of carbon used in construction, utilising recycled materials provides substantial environmental benefits.





Filter Geotextile
Filter fabric allows free drainage into core whilst preventing intrusion of over fill materials.

Drainage Core
High strength drainage core allows a defined, constant drainage capacity and protection of the waterproofing layer.

	Thickness	Flow Rate*	Puncture Resistance	Typical Applications
Deckdrain 700	7mm	0.67	2,400N	Smaller podium decks and car parks where outlets are closely spaced.
Deckdrain 1200	12mm	1.25	2,300N	Larger podium decks and car parks where outlets are less frequent.
Deckdrain 2500	25mm	4.30	4,800N	Podium deck and Green Roof applications where large volumes of water will be travelling over large distances.
Deckdrain 5000	50mm	29.00	N/A	Used as part of the SuDS attenuation system detailed on page 15.

*Flow rate determined at HG=0.1 under 20kPa load which represents the hydraulic gradient typical for a horizontal roof construction. For further flow figures, including at HG=1 (vertical), please contact technical sales for the latest Deckdrain datasheet.

For further information about Deckdrain visit:
abg-geosynthetics.com/products/geocomposite-drainage/deckdrain/

Erosion Control

ABG's erosion control product range assists with delivering both surface protection and improving the structural stability of soil slopes. These products cover a broad section of erosion control requirements, including biodegradable or non-biodegradable varieties.

Silt laden run-off from exposed soil slopes is considered to be a pollutant and is a major concern for the Environment Agency. ABG erosion control products help ensure that the slope is protected from construction through to the final vegetation being established.

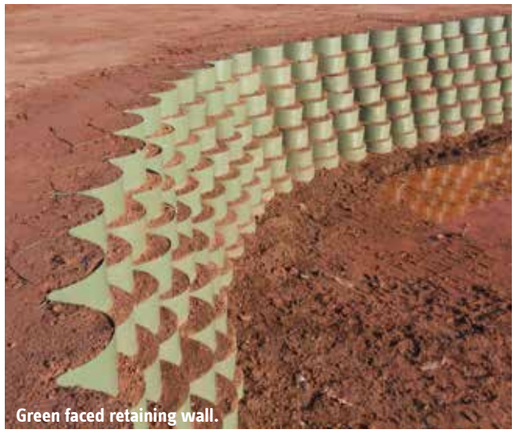
As with all ABG products, design advice on which materials are best for each individual application is available from our experienced technical department.

Installing Erosaweb for top-soil retention on a steep embankment.

Retaining Walls

We first became involved in designing reinforced earth retaining walls over twenty years ago following the launch of our own range of geotechnical solutions, including Webwall, a geocellular retaining wall system that provides a vegetated green surface.

Today ABG are in position to offer full PI covered design, material specification and supply; including advice and specification on the drainage works through to the installation and planting of the Webwall to suit the project environment.



Green faced retaining wall.

Structural Drainage

ABG have vast experience in drainage solutions, with systems installed on major projects around the World in a wide range of sectors including infrastructure, energy, water, waste and many other sub-surface structures.

Using preformed drainage systems, we offer sub-surface drainage with higher performance, lower environmental impact and lower cost than traditional granular filters. ABG systems have been designed to be compatible with waterproofing systems, whilst withstanding the high loads associated with backfilling to give optimum performance over the whole life of the structure.

Applying Deckdrain for a structural drainage application.

Other Systems

Our fin drains (Fildrain) offer a high performance, economic alternative to traditional stone groundwater drainage solutions and are used extensively in a wide range of civils applications; from highway edge drainage through to landscape drainage. Sports pitch drainage can be tackled using Pozidrain which is suitable for both retrofit and new build applications and basement drainage problems can be addressed using the Cavidrain below ground cavity drainage system. ABG's range of cellular confinement systems are proven solutions for use in slope stabilisation, for creating access roads and tree root protection, and finally our range of root barriers prevents the spread of invasive roots to unwanted areas and pond liners.

Cavidrain installation as part of a basement drainage system.

About ABG

ABG are a market leader in the development, manufacture and technical support of high performance geosynthetic solutions for use in a wide range of building and environmental projects.

Formed in 1988, based in Meltham, in the heart of the Pennines, ABG has developed an excellent reputation for developing quality products and outstanding service. The ability for rapid product development ensures that the most innovative, up to date and cost effective solution can be found for many engineering problems - including Green Roofs, SuDs, irrigation, reinforced earth and drainage.

Our involvement with Green Roofs goes back over thirty years and we have a complete product range developed specifically for this application. During this period we have supplied products to award winning projects throughout the UK, Ireland and beyond, including over 1,000,000m^2 of geocomposite drainage into both extensive and intensive green roof projects.

Technical support is provided by our trained and experienced staff, many of whom are Chartered Civil Engineers. This extensive support includes design, design confirmation, feasibility study, cost advice and meeting regulatory requirements including BREEAM and LEED.

As part of this technical support, much work is undertaken in developing knowledge within our active markets including working with leading industry associations such as CIRIA (Construction Industry Research and Information Association) on a number of guidance documents. We have also worked in partnership with universities on a number of research projects, including the installation and monitoring of our very own Green Roof with The University of Sheffield and work with The University of East London on developing biodiversity in Green Roofs and the management of stormwater.

To complement this product range and knowledge base, ABG works closely with our installation partners Geogreen Solutions to allow a complete package solution to be offered, from design to installation and on-going maintenance, all working in partnership with the client to deliver bespoke project solutions.

Intensive Green Roof, Raithwaite Hall, Whitby, UK

This literature, together with technical data, specifications, design guidance, technical advice, installation instructions or material can be obtained by contacting ABG Ltd. All information in this brochure is supplied in good faith, and without charge, to enable a reasonable assessment of the practical performance of our products. Final determination of the suitability of any information or material for the use contemplated and the manner of its use is the sole responsibility of the user. As design and installation is beyond our control, no warranty is given or implied and the information does not form part of any contract. The right is reserved to update the information at any time without prior notice.

Further reading

The GRO Code of Best Practice
Green Roof Organisation, 2021

Work at Height Regulations, 2005

Useful Websites

www.greenrooforganisation.org
www.ciria.org/buildinggreener

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BALI National Landscape Awards PRINCIPAL AWARD WINNER 2021

WINNER LRWA AWARDS & GALA DINNER 2022

abg creative geosynthetic engineering

Cert no: 570 ISO 9001 ISO 14001

INTERNATIONAL GEOSYNTHETICS SOCIETY

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