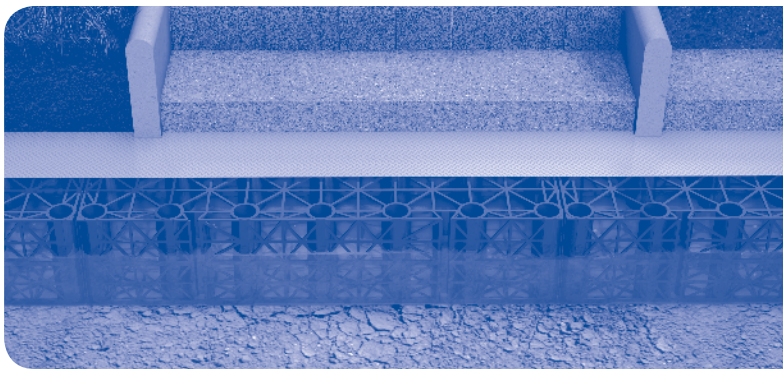
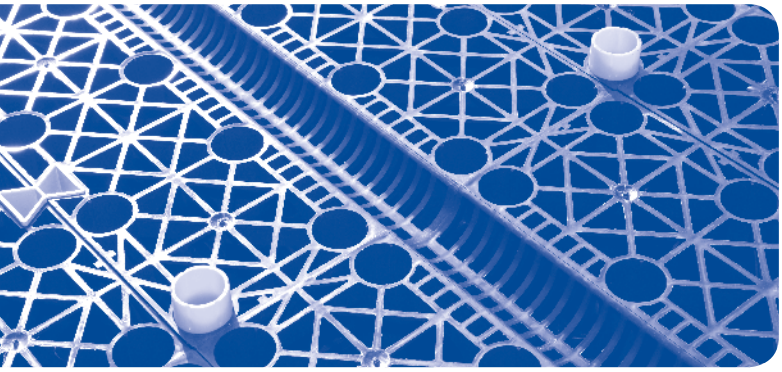
PMVTM1 | JANUARY 2016

Permavoid System Technical Manual

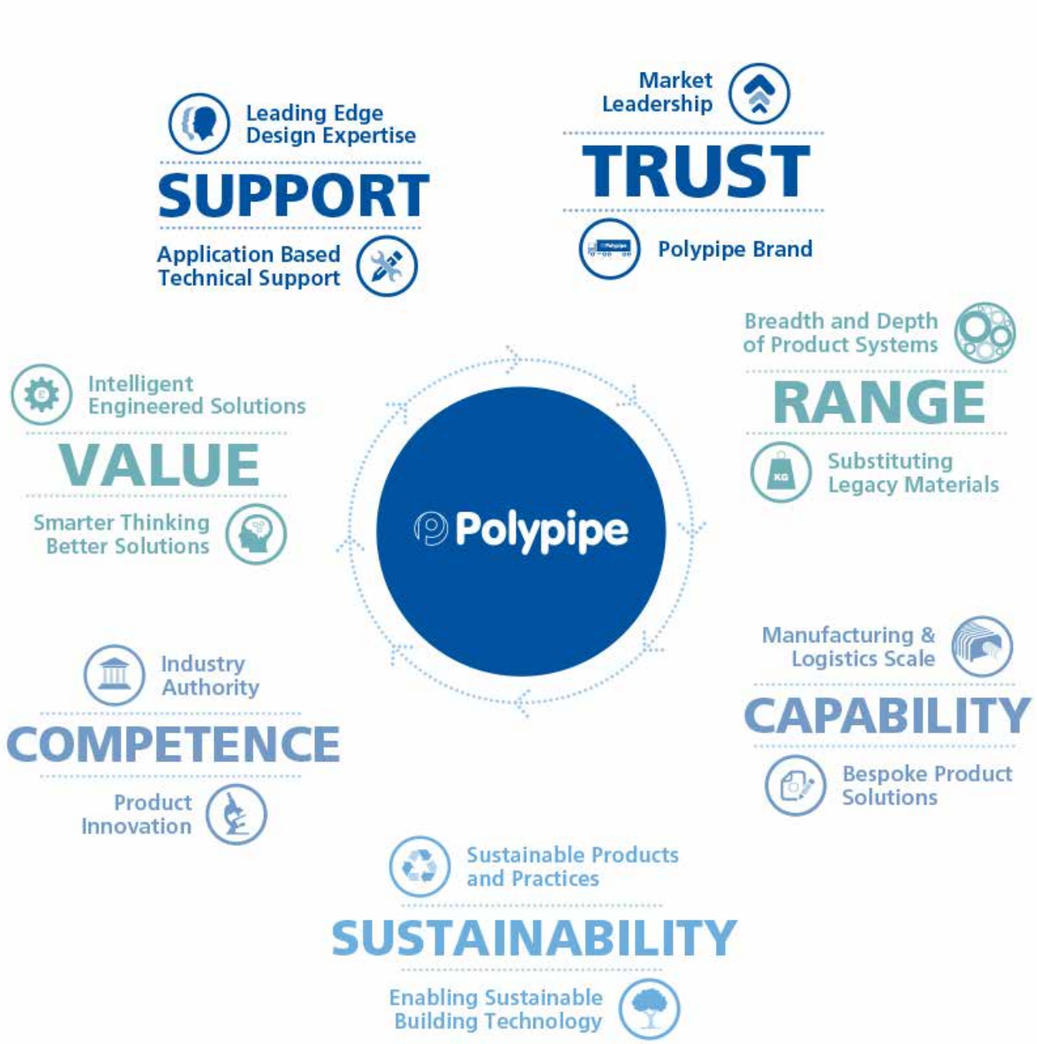




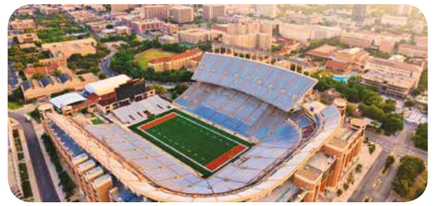

Planning, design, specification and installation guide

Polypipe

Welcome to Polypipe

At Polypipe, conceiving, designing, manufacturing and delivering the most advanced products and systems is more than just an occupation. We see it as our passion. Everything we do has always been based around a few simple beliefs: Quality always beats quantity. Products are nothing without service and support. Sustainability isn't just a 'green' word and working with our customers is much better than simply supplying them.





Polypipe is the UK's largest plastic piping systems manufacturer

With over 20,000 product lines, a substantial fleet of over 400 vehicles and employing over 2,000 people, we have an enviable reputation amongst installers, contractors, stockists and specifiers.

The broadest product range available in the UK

With over 100 product systems, our unrivalled portfolio offers dependable, innovative solutions for pressure and non-pressure applications, enabling the movement of water, air, power, chemicals and telecoms throughout the built environment.

Market-sector focused

We operate through sector-focused businesses, ensuring that our Sales and Technical Teams are equipped to meet the specific needs of residential, civils and infrastructure, commercial and industrial projects.

Innovating for today's construction challenges

Recognising the twin challenges of managing water and carbon resources, we have invested for many years in our water management and carbon efficient solutions, with systems that meet all legislative requirements.

Polypipe intelligent engineering

Through initial involvement our substantial technical knowledge and capabilities can be utilised, ensuring our customers can engage with the project team to deliver the most appropriate and cost-effective solutions and supporting them in a close working relationship from design right through to installation.

Overview - our company, our products, our people

Our product knowledge and service teams provide an unrivalled level of technical support. Working closely with our customers, we can help guide them through current legislation and complex building regulations. This helps us to match the right product range with the correct project requirements, or develop a fully engineered system for specific project needs.

We invest heavily in research and new production technology that allows us to provide high quality products with more precise performance specifications and even greater reliability. Our products are covered by third party accreditations including BBA, BSI Kitemark and WRc, which ensure we meet specification standards. Supporting our product accreditations, our business systems are regularly assessed by BSI to ensure we maintain our BS EN ISO 9001:2008 and BS EN ISO 14001:2004 certifications. These independent assessments confirm that we adhere to strict regulatory requirements and ensure we provide greener credentials for our products.

UKAS accredited laboratories

Our in-house research and development facility is one of the most advanced of its kind and includes the independent UKAS accredited Berry & Hayward Laboratory. This operates 24 hours a day and gives us the body of knowledge and expertise needed to produce the most advanced range of products and solutions.

Full technical design and fabrication service

Polypipe is unique in having its own in-house fabrication unit. In the 2600m² facility, our skilled and highly experienced technicians deliver modular engineered drainage and water management systems. These are provided ready-to-install, maximising the benefits of pre-fabrication, for ease of delivery and reduced installation time on-site.

Design

From the outset, our Design Team will bring their technical expertise and experience to bear, providing assistance with hydraulic, structural and flotation calculations supported by system CAD designs and specifications.

Installation guidance

Providing guidance at the critical installation stage, coordinating deliveries and ensuring the most cost and time efficient pathways to completion.

The calibre of our people

The calibre of the people within our support team is a reflection of the importance we place on customer service in helping to deliver a successful project outcome. They include fully qualified design engineers who, through their experience and in-depth product knowledge, can help to provide detailed specification guidance.

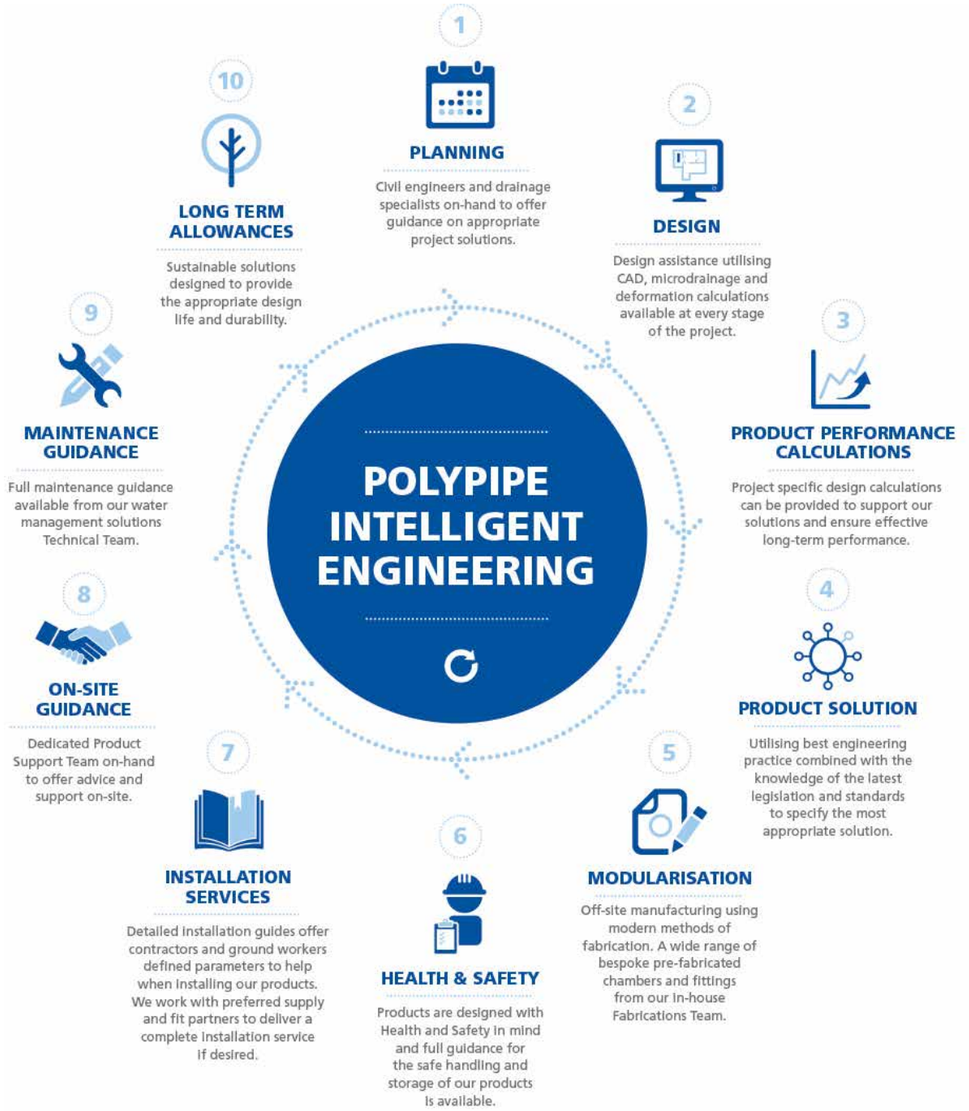
Our accreditations

Polypipe is a member of influential bodies such as the British Plastics Federation (BPF) and Construction Products Association (CPA). We also work with organisations such as DEFRA, CIRIA and Constructing Excellence, which enable us to have an active involvement and understanding of industry drivers. Combining this industry involvement with the high calibre of our staff enables us to provide an unrivalled level of service.

Intelligent engineering

The market leaders in surface water management

Our team of fully qualified drainage specialists, civil engineers and technical support experts offer invaluable experience and knowledge through each and every stage of a project. We provide the most commercially viable solution for a project through our ability to be unbiased. As we offer both pipe and geocellular systems, we have a truly holistic range of products meaning we can tailor our solutions to your needs. You can contact our team on **+44 (0) 1509 615100** or arrange a visit from one of our commercial or technical specialists.



Water management solutions

Our water management solutions embrace a comprehensive range of sustainable drainage systems (SuDS) and services that together address the surface water management requirements of every commercial and domestic project, regardless of the project size.

With a choice of market leading products, plus the highest level of technical support, you can depend on Polypipe to help you deliver the most effective and compliant surface water management plan.

Whether your scheme is adoptable or non-adoptable, we have the right solution for you; retention, attenuation or infiltration systems combined with or without treatment solutions, all supported by our fabrication service that provides off-site engineered solutions.

Stormwater retention, attenuation and infiltration

Large diameter pipes and geocellular systems offer a versatile method of creating shallow or deep buried water storage systems, capable of holding back the impacts of rainfall events and helping to mitigate the risk of surface water flooding.

At Polypipe we understand that every project and site is unique and many have significant challenges when it comes to the design and construction of an efficient and effective drainage system. That is why we have developed the industry's largest range of pipe and geocellular retention, attenuation and infiltration systems.


Polystorm


Permavoid


Ridgistorm-XL


Rainstream RXL


Permafilter


Permachannel


RIDGISTORMSeparate


RIDGISTORM-X4

Surface water treatment

Regulations on the management of surface water through source control and the use of SuDS are now well established. Increasingly, legislation is presenting developers and designers with additional challenges in the control of surface water pollution. New standards aimed at reducing pollution levels in groundwater and rivers are often based on the Polluter Pays Principle (PPP), so our range of water treatment systems are designed to intercept and extract pollution as close to source as possible.

At Polypipe you will find the largest range of treatment solutions for silt removal, collection and separation. From our silt traps and oil interception, to advanced treatment textiles such as Permafilter Geotextile for the removal of heavy metals and RIDGISTORM-X4 for dissolved pollutants. They can all be integrated within an overall 'Roof to River' solution and can be combined to form progressively more efficient treatment depending on anticipated contamination levels.

What is the Permavoid system?

Permavoid is a geocellular sub-base replacement system, designed to provide shallow stormwater retention, attenuation or infiltration. Permavoid can be used as part of an engineered or soft SuDS solution. It enables designers to offer a source control system incorporating water treatment to manage water where it lands.

Our Permavoid system has been extensively tested over the last decade with Salford and Coventry University, the Transport Research Laboratory and Highways England, to ensure that the system meets the legislative requirements set out by CIRIA, the Environment Agency, SEPA and PPG.

Academic site wide trials include:

- Transport Research Laboratory - A pilot-scale trial of reservoir pavements for drainage attenuation incorporating Permavoid sub-base replacement system.
- Coventry University - Assessment and monitoring of the oil retention and performance of the Permaceptor Treatment System.
- SEPA-Perth Prison - A 2 year field monitoring exercise of macro-pervious pavement and car park installation incorporating Permachannel oil and silt retention devices.

Index - pages

How this manual is organised

This manual is presented in clearly marked sections to help you find the information you require quickly and easily.

Section 1 – Legislation and regulations

Section 2 – Permavoid system overview and applications

Section 3 – Permavoid system components

Section 4 – Hydraulic design

Section 5 – Structural design

Section 6 – Surface water treatment

Section 7 – Delivery, installation & maintenance

Section 8 – Standard details

Section 9 – Case studies

Section 10 – Summary

Index - illustrations & tables

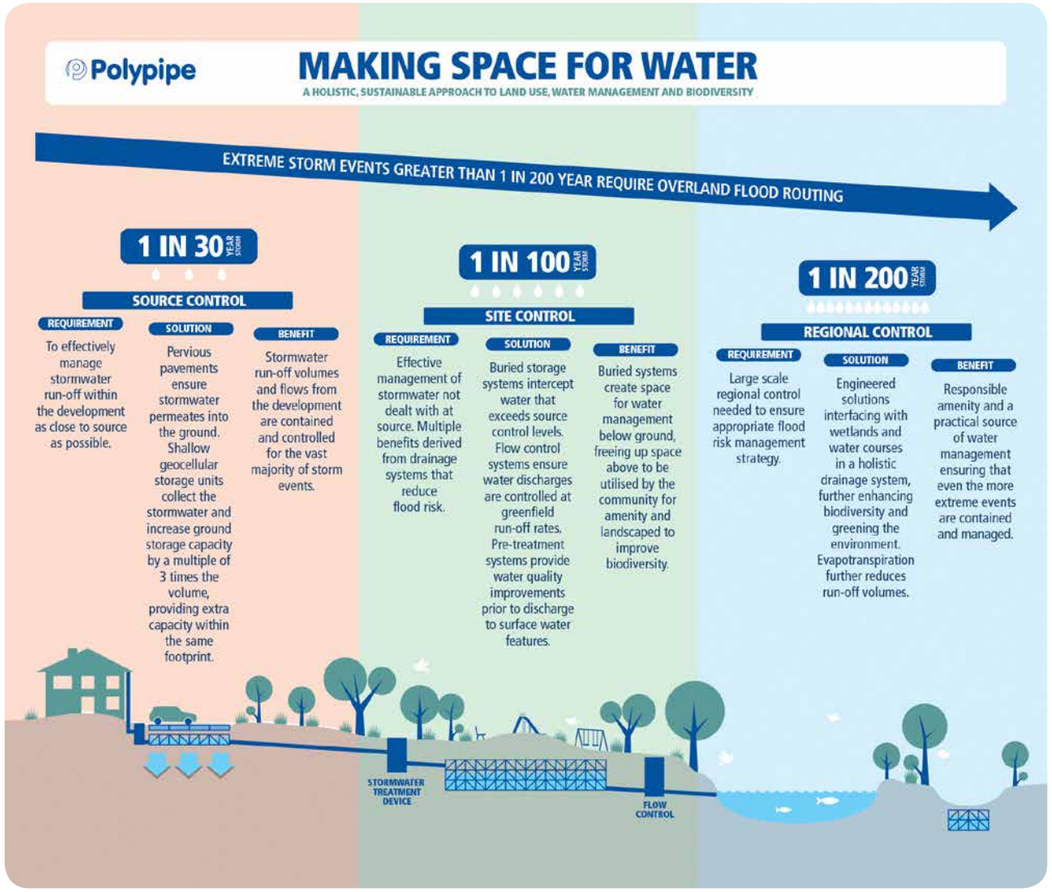
For updates and a PDF of this manual go to:
www.polypipe.com/toolbox

***Please note:** Illustrations shown within this publication are available as downloadable CAD drawings from:
www.polypipe.com/toolbox

The growing importance of SuDS

‘Making Space for Water’ is an integrated, forward-thinking strategy for managing future flood risk in England, first published in 2004.

Among its many recommendations is the adoption of a ‘joined-up’ approach to drainage management in high-risk urban areas and the widespread use of sustainable drainage systems (SuDS) to control the rate at which rainwater runs off paved areas and into sewer networks and rivers.



The challenge each developer faces on both greenfield and brownfield developments is knowing what to do with the excess run-off generated by the development which has to be retained in and around the site. BS8533:2011, 'Assessing and Managing Flood Risk in Development Code of Practice', has been created to help designers analyse flood risk and to guide the selection of appropriate flood risk management solutions.

Soft SuDS alone may not provide sufficient storage on certain sites due to space constraints, particularly driven by the housing density requirements in PPS3:Housing. The Permavoid system can help address these challenges, by providing an effective controlled retention, attenuation or infiltration system to suit site specific requirements.

Government planning policy has defined the need for sustainable drainage systems (SuDS) to ensure that flood risk is taken into account during all stages of the planning process.

CIRIA (SuDS Manual)

The SuDS Manual provides guidance on all aspects of the design, construction, operation and maintenance of SuDS. In particular, it places a real emphasis on the use of source control techniques and requires designers to consider pollution removal.

The SuDS Manual defines that a sustainable drainage system should consider certain basic requirements, including:

- Run-off from a developed area should be no greater than the run-off prior to development
- Run-off from a developed area should not result in any down-grading of downstream watercourses or habitat
- Consideration should be given at the development feasibility stage to water resource management and control in the developed area
- Run-off should replicate, as far as possible, the natural response of the site to rainfall

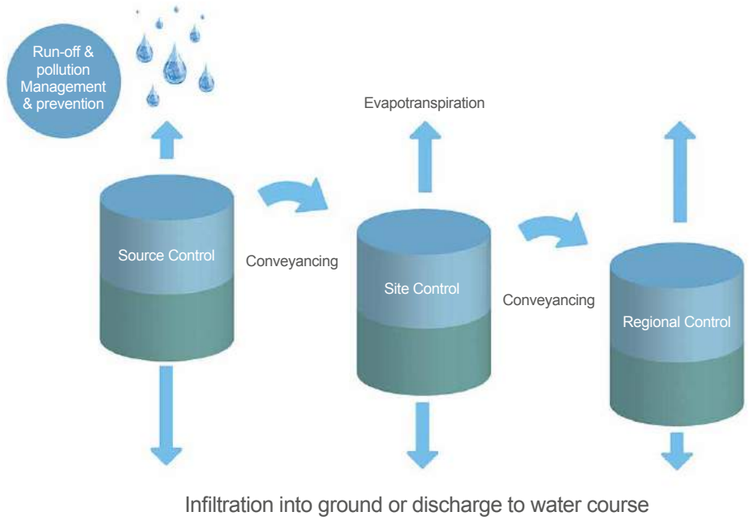
Urbanisation has led to an increasing number of negative impacts on the environment, in particular pollution. Depending on the land use, the following typical surface pollutants can be found in surface water run-off:

- Hydrocarbons and oils
- Sediments
- Heavy metals
- Fertilisers and pesticides
- Salts
- Animal wastes
- Pathogens

Traditionally, pollutants are collected from impermeable surfaces into the drainage systems and treated downstream via large, deep, in-line separators that are typically designed to treat the first 'flush' only. Emulsified oils and hydrocarbons can still be discharged downstream, the discharge of oil and hydrocarbons constitutes a major pollution source and is a serious threat to groundwater sources.

The SuDS Management Train

This is a staged design concept used in sustainable drainage systems (SuDS) which controls volume and quality of surface water run-off. Permavoid gives designers a versatile source control system.



Legislation and regulations

We understand how important it is to keep up to date with legislation. That is why our advice and system selection is informed by the very latest regulations and standards.

Water Framework Directive

The Water Framework Directive (WFD) is a piece of EU legislation to improve water quality in watercourses and coastal areas. It identifies the treatment of pollution at source as one of the most effective ways of reducing pollution and improving water quality. Our geocellular solutions can meet that challenge by integrating a number of surface water treatment and water management control systems into your attenuation and soakaway structures at source.

Flood and Water Management Act 2010 (amended 2012)

The Flood and Water Management Act (FWMA) came into effect in 2010 with the aim to mitigate flood risk and improve water management. As part of the Act, Schedule 3 requires new developments to implement sustainable drainage systems (SuDS) on all new developments using natural and proprietary features in place of conventional drainage, to reduce surface water run-off, mitigate flood risk and improve water quality.

Building Regulations

Building Regulations Approved Document H3 requires rainwater to be either stored in a tank or discharged in the following order:

1. Soakaway or other infiltration
2. Rivers and watercourses
3. Direct to sewers

Many developments are being built on land that is not suitable for infiltration. Brownfield sites, sites with contaminated ground, high water tables, poor percolation and with natural aquifiers are all examples of this. Rivers and watercourses are not always in close proximity/reasonable construction distance from the site, resulting in a very large number of sites still having to utilise mains sewer connections as their only viable means of stormwater discharge.

Lead Local Flood Authorities

The Flood and Water Management Act (FWMA) 2010 requires the Lead Local Flood Authority (LLFA) to be responsible for co-ordinating flood risk management within its area. They have the responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses and for developing, maintaining and applying a strategy for local flood risk management. LLFAs are also responsible for maintaining a register of significant flood risk assets.

It is a requirement under the FWMA that LLFAs develop a local flood risk strategy focused on local issues. The strategy should incorporate effective and robust surface water drainage systems for new developments in accordance with SuDS principles.

National Planning Policy Framework

The National Planning Policy Framework (NPPF) requires that development is undertaken in a sustainable manner and has a presumption in favour of sustainable development. The systems should be designed to control surface water run-off close to where it falls and mimic natural drainage as closely as possible to:

- Reduce the causes and impacts of flooding
- Remove pollutants from urban run-off at source
- Combine water management with green space with benefits for amenity, recreation and wildlife

Information on how this should be applied is provided in the DEFRA non-statutory technical standards for sustainable drainage systems (SuDS).

Local Planning Authorities

When determining planning applications Local Planning Authorities (LPAs) should ensure that any new or redevelopment avoids flood risk to people and property, does not increase flood risk elsewhere and mitigates any flood risk taking into account the impacts of climate change.

The LPA will be required to consult with the LLFA as a statutory consultee on major developments with surface water drainage requirements along with other statutory and non-statutory consultees as required.

Process integration

BS EN 752:2008

BS EN 752:2008 takes a more integrated view of designing sewer systems in the context of the wider urban drainage system and water environment. It helps engineers understand and implement integrated urban drainage systems and management. The National Annex provides information on how to incorporate BS EN 752:2008 practices within the UK.

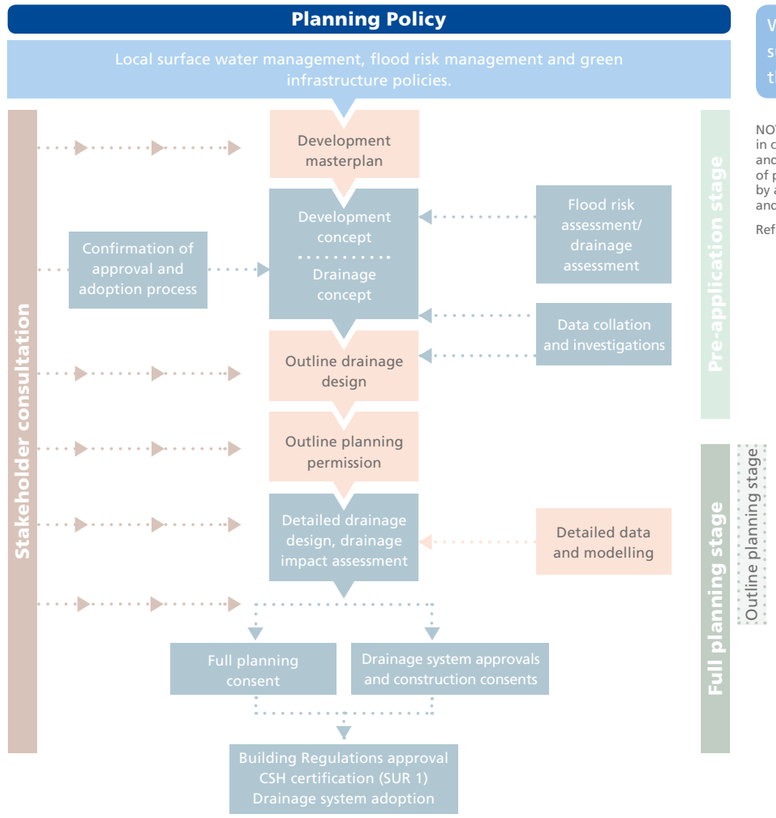
BS 8582:2013

This Code of Practice is for surface water management for development sites. The standard has been developed to support:

- Planners and drainage approval bodies: In setting consistent drainage criteria and principles (for new developments and redevelopments) that deliver effective surface water flood risk management as sustainably as possible while contributing towards the delivery of relevant environmental, sustainability and urban design planning objectives for the site and local area.
- Designers: In planning and implementing safe, robust surface water management systems that meet the criteria and principles referred to above.

In addition, this standard gives recommendations on the planning, design, construction and maintenance of surface water management systems for new developments and redevelopment sites, focusing on the sustainable management of flood risks arising from surface water run-off.

The diagram below demonstrates pertinent key links between the development planning process and the drainage system design process, emphasising the involvement of stakeholders throughout.



NOTE: The need for the steps given in colour would depend on the nature and/or scale of the development and type of planning application and is determined by agreement with the planning authority and drainage approval body.

Ref:- Page 8 of British Standard BS 8582:2013.

Geocellular solutions - for shallower depths

Polypipe provides the widest range of geocellular solutions to meet the needs of SuDS in a wide variety of applications.

Shallower applications

The Permavoid system extends the choice and flexibility of the Polypipe range by providing robust, effective source control through retention, attenuation or infiltration at shallower levels.

Shallower retention, attenuation or infiltration structures are often necessary because the ground at greater depths can present a construction challenge. This could be the presence of chemicals or contamination left behind from previous land use, a high water table or perched water and hard rock areas. A shallower approach reduces or omits the requirement for expensive pumping equipment. Shallower systems have a lower environmental impact, requiring less excavation, temporary works and fewer trips to transport infill and rubble to and from the site reducing construction costs.

Key benefits

Application

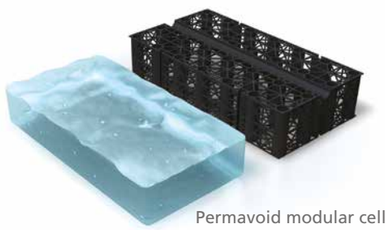
- Provides effective source control
- Can be installed above a high water table
- Allows water to be spread across a wide area
- Ideal for brownfield or contaminated sites
- Provides treatment to remove silt and hydrocarbon deposits

Design

- Designed and tested for retention, attenuation and infiltration at shallower depths
- Removes the requirement for pumping stations
- Oil interception at source – no need for petrol interceptors
- Can be used in combination with the full range of Polystorm geocellular solutions for deeper applications

Installation

- Interlocking raft for rigidity and a high compressive and tensile strength under load
- Suitable for use beneath porous and non-porous surfaces
- Reduction in excavation depth and cost
- No need for trench supports or plant to deliver and remove trench support panels



Permavoid modular cell
95% void ratio

Traditional aggregate
30% void ratio

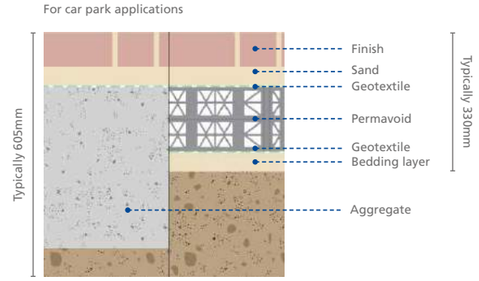
Permavoid - at a glance

The Permavoid system offers a means of providing integrated source control drainage solutions that can meet the volume control and water treatment demands of current guidance and regulations.

The Permavoid system is designed to be used in place of a traditional aggregate sub-base within trafficked pavements. It provides a unique, high strength, consistent structural raft in accordance with BS7533-13:2009, 'Guide for the Design of Permeable Pavements Constructed with Concrete Paving Blocks and Flags, Natural Stone Slabs, Setts and Clay Pavers'.

Permavoid cells have a 95% void ratio, thus considerably enhancing the attenuation capacity of a pavement and also enabling the reduction of aggregate requirements in hydraulic pavements. The system is suitable beneath asphaltic, block-paved or concrete pavements and for the full range of traffic conditions from domestic driveways to highways. The units have a high compressive strength and are joined together with Permaties, a unique patented tapered jointing system, to create a horizontal structural raft.

Figure 2.1.1: Typical Permavoid system vs. traditional aggregate sub-base



Key benefits

- Individual modular units tie together using Permatie interlocking connectors
- The Permaties have integral creep resistance
- The Permatie provides rigidity and minimises deflections
- Permavoid sub-base replacement systems comply fully with the latest CIRIA guidance on structural design of geocellular drainage tanks
- On multi-layer systems, Shear Connectors are inserted to maintain rigidity and minimise lateral displacement
- Permavoid geocellular units are manufactured from recycled polypropylene and can be recycled at the end of their useful life

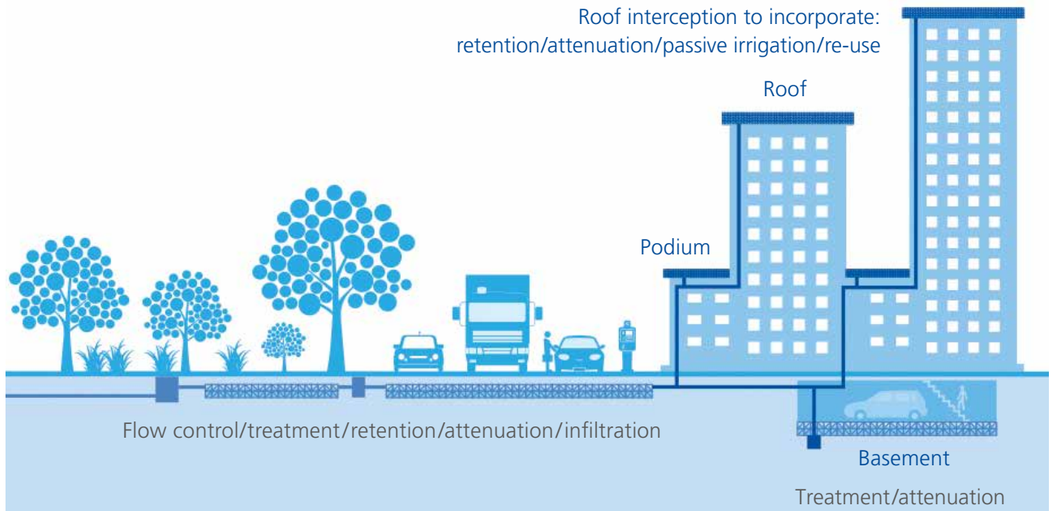
Please note: Illustrations are for guidance only. Not to scale.

Permavoid - at a glance

Source control

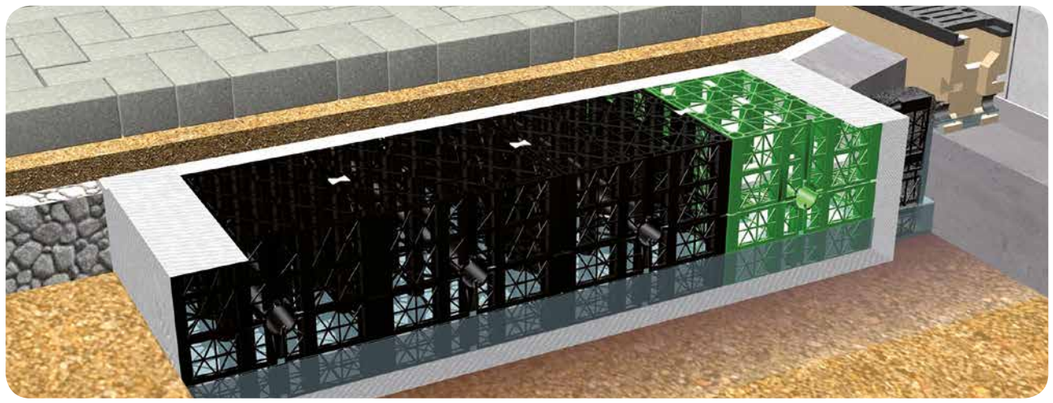
Source control is a vital element of the SuDS Management Train, allowing silt/debris and contaminants to be managed at the head of the system. The versatility of the Permavoid geocellular system allows for numerous variations of stormwater treatment.

SOURCE CONTROL DRAINAGE SYSTEM



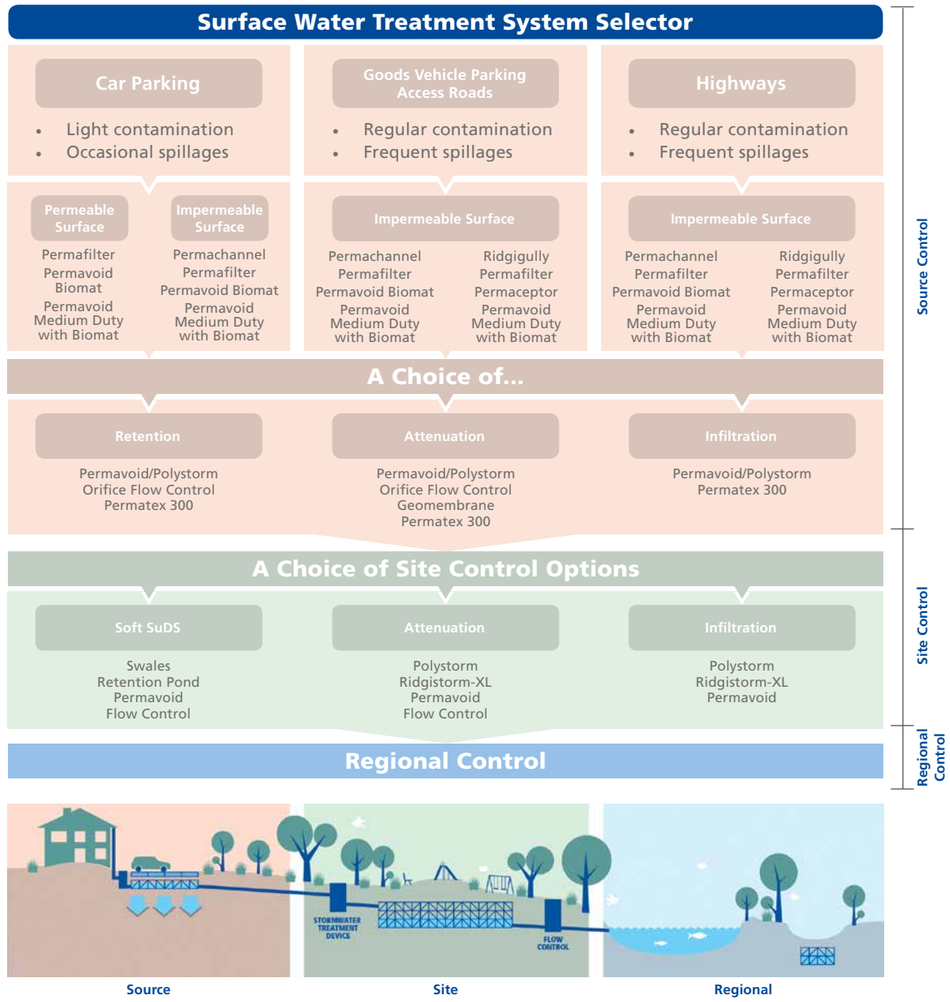
For pollution management

Increasingly, regulations and design guidance highlight developer's obligations to mitigate the risk of pollutants emanating from contaminated run-off from hardstanding surfaces. The most common diffuse pollutants are hydrocarbons and contaminated silts. The Permavoid system offers an integrated technique for the source control treatment of polluted run-off using advanced geotextiles and flotation techniques.



In traditional stormwater drainage systems, silt/debris and contaminants are managed within the system via in-line separators typically installed downstream in the system. This requires larger and deeper chamber installations.

Permavoid is an effective interception system supported by over 10 years of laboratory and field trials to ensure effectual water treatment close to source at shallower depths.



Key benefits

- Effluent loading under normal conditions treated and degraded at source
- Accidental and catastrophic spills recoverable at source
- Outperforms Class I and II separators as defined by PPG3
- Low velocity water flow throughout, minimising emulsification and sediment mobilisation
- No large deep storage tanks or access required
- Routine maintenance easily achieved at source

Permavoid applications

The Permavoid system can be incorporated into the full range of traffic conditions from domestic driveways to HGV applications and is suitable below pervious and impervious asphaltic, block paved or concrete paved areas. The Permavoid system complies with the requirements of BS 7533-13 and incorporates a high vertical compressive strength of 715 kN/m² and lateral compressive strength of 156 kN/m².

High water tables

High water tables and even perched water at shallow depths require specific design and construction measures to avoid issues such as flotation of attenuation structures and often prevents the use of soakaways. Anti-flotation and temporary dewatering measures are invariably very expensive. The Permavoid system can provide the attenuation or infiltration solution for such projects avoiding groundwater issues.

Contaminated land

Redevelopment of brownfield sites is commonplace and issues of ground contamination often come hand in hand. The use of the Permavoid system can often negate the need to excavate into contaminated soils that invariably incur significant costs in either on-site remediation or off-site disposal, as well as numerous associated environmental issues.

Excavation of hard rock

Excavation of hard rock is usually expensive and slow. However, the Permavoid system is ideal for use on sites that are underlain by hard rock at shallow depths, as the systems can be incorporated into the pavement construction, invariably avoiding any net additional excavation for the drainage system.

Shallow outfalls

The Permavoid systems can very often avoid the need for pumping that might otherwise be required with conventional drainage or deep attention tank solutions. Pumped solutions can be costly to install and maintain and are considered to be environmentally unsustainable.

Limited access sites

The Permavoid system can be easily manhandled into place without any heavy lifting or off-loading equipment. The footprint of the tank does not have to be square. Segmented tanks can fit into the available space.

Ground stabilisation

Due to its high compressive strength and bending resistance within the joints, Permavoid cells create a horizontal consistent structural raft providing a stable structure.

Soft landscaped areas

The Permavoid system can be used to provide pre-treatment of stormwater run-off before it enters a swale, dry basin, pond or wetland (Diagram 1). It is even possible to install Permavoid below swales and dry basins to improve treatment and increase storage capacity (Diagram 2).

Diagram 1

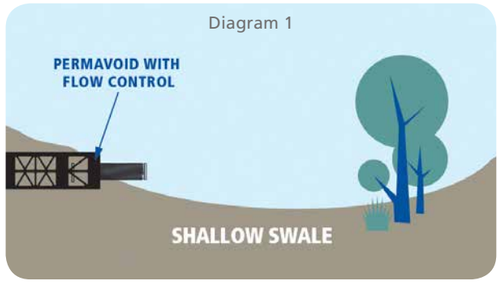
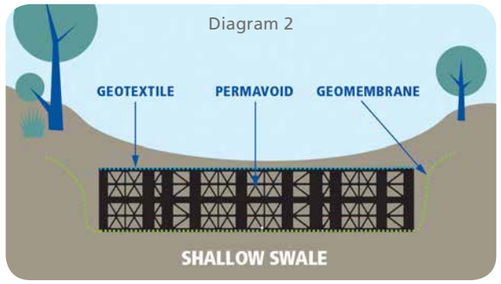


Diagram 2



Public open spaces / Leisure and play areas

Acting as both a sub-base replacement system and drainage component, the Permavoid system can give maximum attenuation and infiltration capabilities for both natural and artificial surfaces and can be integrated into site-wide sustainable drainage systems more effectively. The result is a sustainable development in line with the DEFRA national standards for delivery of sustainable drainage systems.

Driveways

Any domestic driveway or front garden over 5m² that is being paved must incorporate SuDS to minimise the risk of flooding. The Permavoid system, used in conjunction with permeable paving, can help adhere to these requirements whilst allowing a wide range of landscaping options.

Permavoid in the urban environment

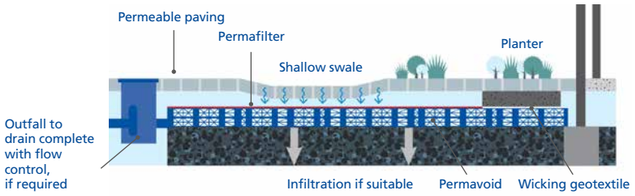
The introduction of SuDS in urban areas allows landscape architects and engineers to design multifunctional urban spaces.

The Permavoid system can help enhance natural features in built-up areas. As it provides excellent source control at shallow depths, the system can not only manage, but also treat water from high stormwater volumes. It also creates a structural platform on which green areas can be cultivated, irrigated and oxygenated.

Key benefits

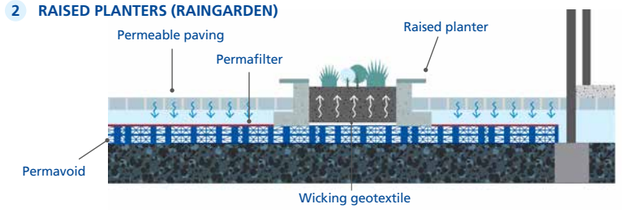
- Controls and manages surface water run-off at source
- Provides effective drainage
- Re-uses water as a resource
- Can be installed above a higher water table
- Removes silt and hydrocarbons to improve biodiverity
- Helps establish calming, tranquil spaces
- Promotes health & wellbeing
- Provides a cooling effect
- Connects people with nature

1 SHALLOW SWALE & PLANTER



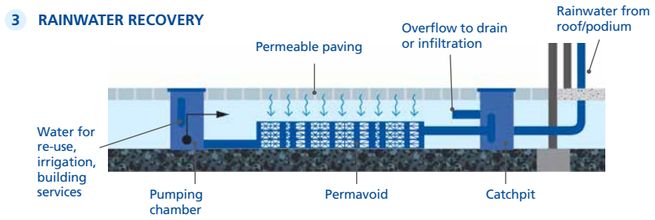
Permeable surfaces can be used to attenuate run-off. Intercepting, storing and re-using surface water at source, this enhances stormwater management and enhances biodiversity.

2 RAISED PLANTERS (RAINGARDEN)



Collected surface water can be used to irrigate planter areas through passive irrigation, providing amenity, infiltration and evapotranspiration, assisting with cooling in urban areas.

3 RAINWATER RECOVERY

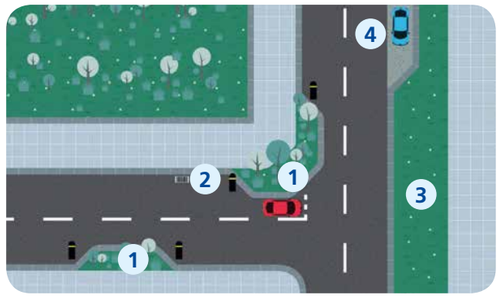


Rainwater from adjacent buildings and porous surfaces can be intercepted and stored for non-potable water use within the building, or re-used for irrigation.

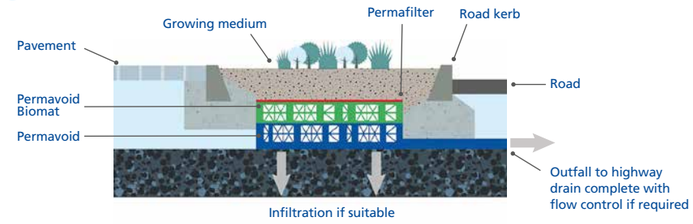
Permavoid in the urban environment

The management of surface water run-off from roads and highways can provide substantial benefits to the built environment.

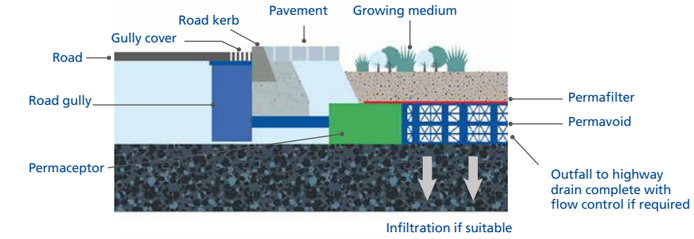
Water management features can be prime design elements in road and highway drainage. Incorporated into a new development or retrofitted into an overall SuDS scheme, Permavoid can enhance the natural environment by providing improved attenuation and treatment at source.



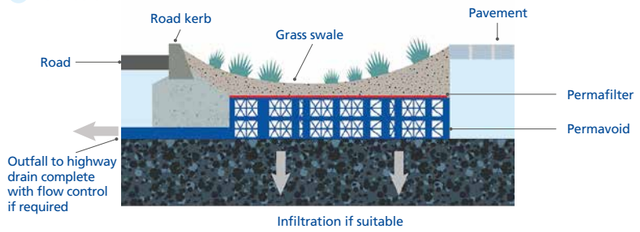
1 BIORETENTION ZONE



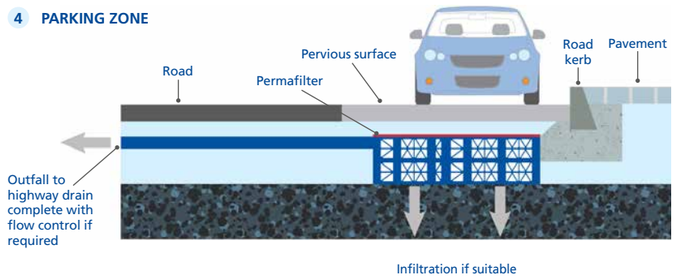
2 BIORETENTION ZONE



3 GRASS SWALE



4 PARKING ZONE



Bioretention zones

The stormwater run-off from highways and pavement areas can be collected and treated using bioretention. Incorporated into traffic calming zones, bioretention systems can enhance biodiversity and amenity, along with providing effective stormwater management at source.

Key benefits

- Traffic calming
- Easy to retrofit
- Reduced pollution loading
- Aesthetically pleasing spaces
- Shallow, easy to maintain systems
- Creates small source control sub-catchments

Grass swales

Highways England have used grass swales alongside roads and highways for many years, due to their cost-effective nature. Swales are designed to be shallow for safety reasons, and can be underdrained to provide effective retention and treatment.

Parking zones

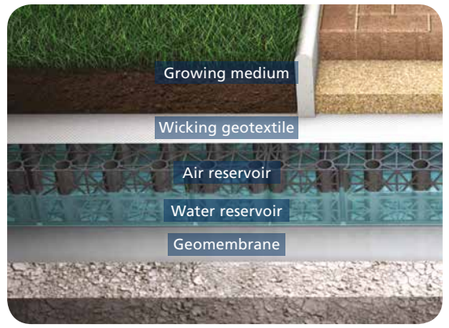
Pervious off-road parking zones can be incorporated into highway designs, particularly in residential areas. Installed beneath pervious surfaces, the Permavoid range of components perform as a sub-base replacement and drainage system to manage the majority of rainfall events, providing treatment and retention at source, at shallow depths.

Passive capillary irrigation

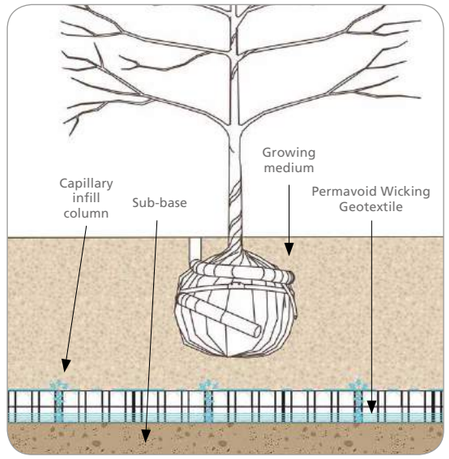
Passive capillary irrigation provides enhanced amenity and biodiversity in urban greenfield developments.

Passive capillary irrigation is a method of growing plants and grasses using an inert porous medium to transport water and oxygen to the root zone by capillary action. The hollow structural columns within the Permavoid geocellular units are filled with an absorbent rockwool, which draws up the water being stored within the unit.

The Permavoid raft is covered with a proprietary wicking geotextile that supplies water on demand across the structural raft to irrigate the growing medium. As the vegetation is planted in a growing medium, access to minerals and nutrients is still available, minimising the requirement for fertilisers and helping to develop a healthy root system.



Typical section through Permavoid capillary irrigation system showing rockwool infilled Permavoid column



Applications

- Green roofs
- Brown roofs
- Landscaped areas
- Sports pitches
- Amenity areas
- Bioretention systems
- Raingardens

Key benefits

- Provides rainwater interception at source
- Enhances storage capacity for green and brown roofs
- Regulates subterranean irrigation
- Air reservoir provides oxygen to root system
- Provides a consistent high strength raft to support growing medium, vegetation and amenity
- Evaporative cooling mitigates the heat island effect by reducing urban air temperatures
- Supports the creation of landscapes in urban settings that mimic nature
- Can remove excess soil moisture through wicking geotextile
- Provides an undersoil drainage system and can be incorporated into a sustainable stormwater management system
- Minimises the requirement for expensive pumping systems, providing 24 hour irrigation
- Reduces energy requirements

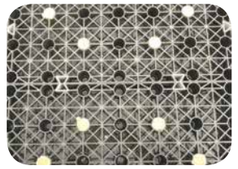
Permafoam irrigation units

For smaller areas or individual landscaped areas it is possible to provide on-demand irrigation using Permafoam units.

Permafoam is an open celled, highly absorbent and water retentive phenolic foam that is incorporated into a Permavoid geocellular unit.

Please see datasheet on page 32 for more information.

Permafoam irrigation units



Rockwool filled columns

Permavoid system

The Permavoid system comprises of high strength modular cells, channel and gully components that incorporate silt/oil gravity separation features, floating oil treatment devices, special oil treatment geotextiles and shallow flow control devices.

Below shows the individual components that may be required within a Permavoid system design.

For full technical datasheets, see pages 24-37.

The Permavoid system comprises of:

Permavoid (85 and 150mm)

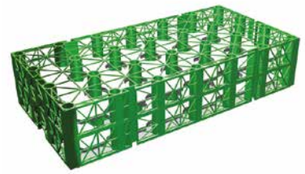
Geocellular sub-base replacement system that locks together to form an interlocking raft of exceptional high compressive and tensile strength.

See page 24

Permachannel

A linear treatment system that combines run-off collection, silt and effluent interception and water treatment functions.

See page 25



Permavoid Biomat

High strength geocellular unit containing a low density, oil treating, geosynthetic floating mat.

See page 26

Permafilter Geotextile

A non-woven dimpled, needle-punched geotextile designed for hydrocarbon pollution treatment.

See page 27

Geomembrane

An impermeable membrane for wrapping around Permavoid structures to form watertight tanks.

See page 28

Permaties

Fully interlocking tapered tie connections to securely link Permavoid cells together horizontally in a single structure and to transfer tensile loads.

See page 29

Shear Connector

Securely links multiple layers of Permavoid together in a single structure.

See page 29

Permavoid Medium Duty with Biomat

Comprising of a low density, oil treating geosynthetic floating mat for use with the Polystorm range of modular geocellular units.

See page 30

Permaceptor

A combined run-off collection, silt/oil interceptor and treatment system used with road/yard gullies.

See page 31

Permafoam

An open celled absorbent phenolic foam incorporated into Permavoid geocellular units for 'on demand' irrigation or check dams.

See page 32

Permatex 300

A heavy duty, non-woven, polypropylene, geotextile designed to protect and separate Permavoid geocellular layers.

See page 33

Orifice Plate Flow Control Chamber

A pre-fabricated orifice plate flow control unit incorporating a removable filter to protect the orifice.

See page 34

Permavoid Saddle Connectors

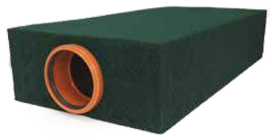
A range of spigot and saddle connectors allowing piped connection to the Permavoid structure.

See page 34

Permavoid Wicking Geotextile

A heavy duty, non-woven geotextile formulated to provide passive irrigation to soft and landscaped areas.

See page 35



Permavoid Rainwater Diffuser Unit

Permavoid units encapsulated with a 2mm mesh fabric diffuse the collected run-off into the surrounding granular sub-base.

See page 36

Permavoid system - components

Permavoid 85 and 150

Product code: PVPP85 and PVPP150

Permavoid is a geocellular interlocking system designed for shallow groundwater storage or infiltration, to be used in place of traditional aggregate sub-base. The system has an exceptionally high compressive and tensile strength and bending resistance with a proprietary jointing system to create a horizontal structural 'raft' within the pavement that is ideal for the shallow attenuation of surface water. The system can also be combined in layers using interlocking shear connectors to increase depth in 85mm and 150mm increments. This is particularly useful in designing infiltration systems, allowing flexibility in balancing the soil permeability/infiltration area of the Permavoid storage units and residual temporary attenuation.

Element	85mm	150mm
Physical Properties		
Weight per unit	2.25kg	3kg
Weight per square metre	9kg	12kg
Length	708mm	708mm
Width	354mm	354mm
Depth	85mm	150mm
Short Term Compressive Strength		
Vertical	715kN/m²	715kN/m²
Lateral	156kN/m²	156kN/m²
Short Term Deflection		
Vertical	1mm per 126kN/m²	1mm per 126kN/m²
Lateral	1mm per 15kN/m²	1mm per 15kN/m²
Tensile Strength		
Of a single joint	42.4kN/m²	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²	18.8kN/m²
Bending resistance of unit	0.71kN/m	0.71kN/m
Bending resistance of single joint	0.16kN/m	0.16kN/m
Volumetric void ratio	92%	95%
Average effective perforated surface area	52%	52%
Other Properties		
Intrinsic permeability (k)	1.0 x 10^{-5}	1.0 x 10^{-5}
Ancillary	Permavoid Permatie Permavoid Shear Connector	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (PP)	Polypropylene (PP)

Hydraulic Performance 85mm			
3 units wide, 1 unit deep (1.06m x 0.15m)			
Free Discharge			
Gradient (%)	0	1	2
Flow Rate (l/m/s)	4	6	7

Hydraulic Performance 150mm						
3 units wide, 1 unit deep (1.06m x 0.15m)						
Free Discharge						
Gradient (%)	0	1	2	3	4	5
Flow Rate (l/m/s)	8	13	15	17	19	21

Applications

The Permavoid units are suitable for use as a stormwater attenuation and/or infiltration system. The system comprises of single, interconnected cells which can be installed in the ground as part of sub-base formation. Permavoid is suitable for use in a range of applications including residential, industrial estates, car parks, sports pitches, roofs, basements, pedestrian areas and rainwater harvesting.

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; for lightly loaded areas such as car parks, a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation standard

All calculations for Permavoid units are based upon site-specific load cases, pavement construction types and thicknesses, soil cover and ground conditions and the suitability must therefore be approved for each project.

Key benefits

- High strength, high capacity, shallow, sub-base replacement system
- Stormwater attenuation and/or infiltration system
- Used as part of a SuDS scheme to offer stormwater storage at shallow construction depths
- Units are manufactured from 90% recycled polypropylene (PP)
- 100% recyclable

Permachannel

Product code: PV03001

Permachannel is a versatile, linear treatment system that can provide source control and pollution treatment in a wide variety of locations and applications.

The Permachannel functions as a combined run-off collection, silt and oil interceptor and treatment system. It is designed to be ideally laid with zero gradient to prevent the development of lateral velocities, 'stilling' sheet run-off from each sub-catchment and encouraging silt deposition within each channel. The outlets discharge from the side of the channel via a weir and baffle component which separates oils and prevents the effluent and silt from progressing into the rest of the drainage system.

Element	Value
Physical Properties	
Weight per unit	29kg
Length	1000mm
Width	150mm
Depth	210mm
Material	Polymer concrete
Grating	Ductile iron standard steel safe
Catchment area	30m²
Loading	Rated to D400
Average effective perforated surface area	Polymer concrete
Chemical resistance	The polymer concrete has a capillary-free, non-porous sealed structure, which makes it naturally resistant to most chemicals (i.e. petrol, oils and acids)
Effluent concentrations are below PPG3 Class I requirements	

Note: Ancillary Universal Channel Connector 40mm diameter.

Applications

Permachannel is used for stormwater collection, interception and the treatment of associated pollutants. The system comprises of single or multiple interconnected channels appropriately located to collect surface water run-off from sub-catchments of predominantly impervious or pervious pavements. Permachannel is suitable for use in a range of applications including residential, industrial estates, car parks, sports pitches, roofs, basements, pedestrian areas and rainwater harvesting.

Performance

Permachannel is related to D400 loading in accordance with BS EN124:1994 when installed with concrete bed and haunch in accordance with site specific construction details.

Installation standard

Permachannel must be installed on a load bearing concrete bed and haunch in accordance with site specific construction details.

Key benefits

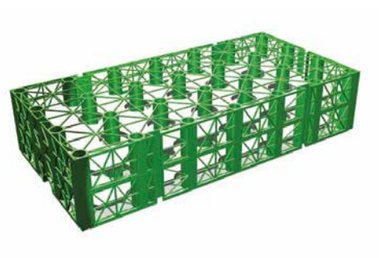
- Gravity separation of oil and silts at source
- Trapped effluent naturally treated by aerobic digestion
- Can enhance the water quality and eliminate the need for end of line petrol/oil interceptors
- The system complies with the regulations of the treatment train criteria in a SuDS scheme as defined in the PPG3
- 100% recyclable

Permavoid system - components

Permavoid Biomat

Product code: PV150BM

Permavoid Biomat is a high strength geocellular unit, containing a low density, oil treating, geosynthetic floating mat (biomat). The biomat floats on water and is designed to intercept and treat any potential residue emulsified oils that may be present within the surface water. The use of Permavoid Biomat provides additional oil retention and water treatment capability to an underground water storage system.



Element	Value
Physical Properties	
Weight per unit	3kg
Length	708mm
Width	354mm
Depth	150mm
Short Term Compressive Strength	
Vertical	715kN/m²
Lateral	156kN/m²
Short Term Deflection	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
Tensile Strength	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
Volumetric void ratio	92%
Average effective perforated surface area	52%
Other Properties	
Intrinsic permeability (k)	1.0×10^{-5}
Oil retention	56g/m²
Effluent discharge at max. oil loading	10ppm
Ancillary	Permavoid Permatie
	Permavoid Shear Connector

Applications

Permavoid Biomat units are suitable for use as a stormwater attenuation and/or infiltration system. The system comprises of single, interconnected cells which can be installed in the ground as part of a sub-base formation. Permavoid Biomat is suitable for use in a range of applications including residential, industrial estates, car parks, sports pitches, roofs, basements, pedestrian areas and rainwater harvesting.

Performance

The structural load bearing capacity of the Permavoid Biomat units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; for lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation standard

All calculations for Permavoid Biomat units are based upon site-specific load cases, pavement construction types and thickness, soil cover and ground conditions and the suitability must therefore be approved for each project.

Key benefits

- Secondary treatment phase for potential residual hydrocarbons
- Pollutant-intercepting floating mat
- Same size as Permavoid so can be incorporated into Permavoid attenuation designs
- Floating medium maintained at air-water interface allowing optimum conditions for aerobic degradation
- Self maintaining, degrades residual oils by absorption and aerobic digestion
- Units are manufactured from 90% recycled polypropylene (pp)
- 100% recyclable

Permafilter Geotextile

Product code: PV23002

Permafilter Geotextile is a non-woven, dimpled, needle-punched Geotextile that has been specifically designed for hydrocarbon pollution treatment in sustainable drainage systems (SuDS) and other civil engineering applications.

Element	Value
Physical Properties	
Weight per unit	300g/m²
Roll length	100m
Roll width	2.4m
Roll weight	72kg
Mechanical Properties	
Tensile strength EN10319 (md/cmd)	9/12kN/m
Static puncture (CBR test) EN12236	1575N
Hydraulic Properties	
Water permeability EN ISO 11058	57 l/m²/s
Other Properties	
Air permeability	1000 l/m²/s
Max. oil retention	6L/10m²
Effluent discharge at max. oil loading	10ppm
Material	Modified polyester

Key benefits

- Captures residual hydrocarbons
- Removes pollutants by biodegradation
- 100% recyclable
- Enhances water quality when used as part of a source control SuDS and eliminates the need for end of line petrol/oil interceptors
- Designed to be self-maintaining for the life of the installation

Applications

Permafilter Geotextile is suitable for use in a range of applications including residential, industrial estates, swales, sports pitches, car parks, roofs, basements, pedestrian areas and rainwater harvesting.

Performance

The dimpled Geotextile comprises a proprietary blend of polyester fibres that incorporates hydrophilic (water attracting and oil repellent) and hydrophobic (oil attracting and water repellent) properties to achieve superior oil retention. Permafilter Geotextile is capable of retaining oil contamination ranging from daily car drip losses up to catastrophic spillages, i.e. originating from car oil-sump failures. The entrapped hydrocarbons are biodegraded by naturally occurring microorganisms providing a self-cleansing mechanism.

Laying generally

Permafilter will be laid to suit site specific requirements. Overlaps shall be a minimum of 300mm or heat sealed. Ensure Geotextile is clean and debris free before installing Permavoid.

Permavoid system - components

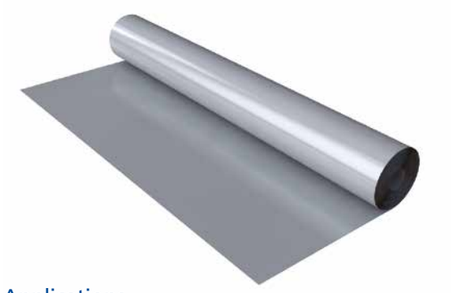
Permavoid Geomembrane

Geomembranes are impermeable liners used in sustainable drainage systems (SuDS) to form water tight tanks.
The membrane used depends on a risk assessment of the site and the ground and groundwater conditions.

Element	Value	Test Method
Physical Properties		
Thickness mm ±10%	1.0	ASTN D-751
Density g/cm³ minimum	0.9	ASTM D-792
Tensile stress at break minimum N/mm²	18	ASTM D-638
Elongation at break %	>700	ASTM D-638
Puncture resistance minimum N	150	FTMS 101C method 2065
Tear resistance minimum N	60	ASTM D-104
Dimensional stability % change max	±2.0	ASTM D-1204 1hr at 100ºC
Stress crack resistance	100%	ASTM 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 1603
Moisture vapour g/m²/day	<0.1	ASTM E96
Friction angle (non-woven Geotextile)	21°	Shear box
Methane permeability	0.11 g/m²/ day/atm	European standard
Methane transmission rate	1.8 x 10^{-9} m³/m²/s/atm	BRE
Permeability coefficient	1.8 x 10^{-12}	
Core material	Polypropylene	

Laying generally

For retention and attenuation applications the units need a sealed geomembrane to prevent the release of water and prevent the ingress of groundwater. All joints should be sealed, using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures as given in CIRIA SP 124:1996. Barriers, lines and cover systems for containment and control of land contamination.



Applications

The Geomembrane is suitable for use in a range of applications including residential, industrial estates, swales, sports pitches, car parks, roofs, basements, pedestrian areas and rainwater harvesting.

Performance

A robust, heavy duty Geomembrane resistant to puncture. Geomembrane combines excellent chemical resistance with low flexural modulus to provide a malleable, flexible membrane suitable for nonsmooth surfaces and factory pre-fabrication to optimise on-site installation. Jointing shall be formed using fusion or extrusion bead welding in accordance with manufacturing recommendations.

Key benefits

- Heavy duty polypropylene membrane
- Used to create a water-tight construction and minimise risk of subgrade softening
- 100% recyclable

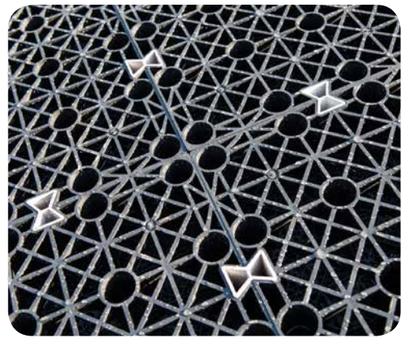
Available to download on the website toolbox.

Permaties

Product code: PVCLIP

Permatie is a patented tapered tie that interlocks the Permavoid geocellular units into a secure and consistent raft. Once connected the ties provide tensile resistance within the Permavoid structure.

Element	Value
Physical Properties	
Weight per unit	30g
Length	74mm
Width	45mm
Depth	34mm
Other Properties	
Material	Polypropylene



Shear Connector

Product code: PVSC

When two or more layers of Permavoid are used to form a structure, Shear Connectors are inserted between the layers to create stability and prevent lateral movement and shear resistance.

Element	Value
Physical Properties	
Weight per unit	10g
Length	40mm
Diameter	35mm
Other Properties	
Material	Polypropylene

Available to download on the website toolbox.

Permavoid system - components

Permavoid - Medium Duty with Biomat

Product code: PSM1BM

Permavoid Medium Duty with Biomat is designed for use with Polystorm attenuation and infiltration systems and comprises of a tri-laminate of low density plastic composite (biomat). The biomat floats on water and is designed to intercept and treat any potential residual emulsified oils that may be present within the surface water. The use of Permavoid Medium Duty with Biomat provides additional oil retention and water treatment capability to an underground water storage system.

Technical Specification Overview	
Length	1m
Width	0.5m
Depth	0.4m
Total volume	0.2m³
Unit weight	9kg (approx)
Unit storage volume	0.19m³ (190 litres)
Void ratio	95%
Vertical compressive strength	Maximum 610 kN/m² **
Lateral compressive strength	Maximum 63 kN/m² **
Short-term vertical deflection	70.1 kN/m² per mm
Short-term lateral deflection	4.4 kN/m² per mm
Estimated long term vertical deflection (creep)	0.2798 Ln (design life in hrs) [Based on an applied test load = 162 kN/m²] Creep data limit 60 years
Estimated long term lateral deflection (creep)	1.0192 Ln (design life in hrs) [Based on an applied test load = 30.8 kN/m²] Creep data limit 60 years
Other Properties	
Intrinsic permeability (k)	Minimum 1.0 x 10^{-5}
Oil retention	56g/m²
Effluent discharge at max. oil loading	10ppm

Note: Permavoid Medium Duty With Biomat is ideal for use in trafficked and pedestrian applications subject to a structural design check and suitable installation conditions.

* Each unit includes 4 clips and 2 shear connectors.

** Compressive strength at yield, maximum recommended value for design purposes.

Exact colour may vary due to recycled materials.

Applications

The Permavoid Medium Duty with Biomat units are suitable for use as a stormwater retention, attenuation or infiltration system. Used to provide hydrocarbon treatment, they are suitable for a range of applications including, retail, residential, commercial and off-road car parking.

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with CIRIA C680. The structural design life is a minimum 60 years.

The units provide 3D flow and have a void ratio of 95%.

Key benefits

- Pollutant-intercepting floating mat degrades residual oils by absorption and aerobic digestion
- Can be incorporated into Polystorm retention, attenuation and infiltration systems
- 95% void ratio
- Light weight yet robust – excellent health and safety and installation benefits
- 60 years creep limited life expectancy
- 100% recyclable
- Units are manufactured from recycled materials

Permaceptor

Product code: PV04002

The Permaceptor functions as a combined run-off collection, silt/oil interceptor and treatment system. The system is designed to be used with conventional road/yard gullies and ideally laid with zero gradient to prevent the development of lateral velocities. Thus, its initial function is to 'still' sheet run-off from each sub-catchment and to encourage silt deposition. The outlet discharges via a weir and baffle component that separates oils and prevents the effluent and silt from progressing into the rest of the drainage system.

Element	Value
Physical Properties	
Weight per unit	29kg
Length	1062mm
Width	708mm
Height	300mm
Short Term Compressive Strength	
Vertical	715kN/m²
Lateral	156kN/m²
Short Term Deflection	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
Tensile Strength	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
Volumetric void ratio	92%
Average effective perforated surface area	52%
Other Properties	
Intrinsic permeability (k)	Minimum 1.0 x 10^{-5}
Oil retention	56g/m²
Effluent discharge at max. oil loading	10ppm
Ancillary	Permavoid Permatie
Material	Polymer concrete

Applications

Permaceptor is used for stormwater collection, interception and the treatment of associated pollutants. The system comprises of Permavoid and Permavoid Biomat units located to collect surface water run-off from sub-catchments of predominantly impervious or pervious pavements via Polypipe Ridgigully and Midigully. Permaceptor is suitable for use in a range of applications including residential, industrial estates, car parks and basements.

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; for lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation standard

All calculations for Permaceptor units are based upon site-specific load cases, construction types and thickness, soil cover and ground conditions and the suitability must therefore be approved for each project.

Key benefits

- Gravity separation of oils and silts at source
- Accidental/catastrophic spills recoverable at source
- Trapped effluent naturally treated by aerobic digestion
- Can enhance the water quality and eliminate the need for end of line petrol/oil interceptors
- The system complies with the regulations of the treatment train criteria in a SuDS scheme as defined in the PPG3
- 100% recyclable
- Units are manufactured from 90% recycled polypropylene (PP)

Permavoid system - components

Permafoam

Product code: PVPP85PF or PVPP150PF

Permafoam is an open-celled, phenolic foam that is highly absorbent and water retentive. Incorporated into Permavoid high-strength units, Permafoam has the capacity to store 31 litres of water for 'on-demand' irrigation or check dams. The Permavoid structure prevents the foam from damage due to imposed backfill or traffic loads.

Element	Value
Physical Properties	
Weight per unit	2.5kg or 3.65kg
Length	708mm
Width	354mm
Depth	85mm or 150mm
Short Term Compressive Strength	
Vertical	715kN/m²
Lateral	156kN/m²
Short Term Deflection	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
Tensile Strength	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
Volumetric void ratio	83%
Water storage capacity (foam)	31 Litres
Water permeability (in plane flow)	0.0452 Litres/second/lin.m
Other Properties	
Ancillary	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (CoPo), polyurethane

Applications

Permafoam units are used for stormwater collection and provide velocity control to drainage flows within sub-bases laid over sloping surfaces. Due to the very large surface area compared to traditional check-gate flow control, Permafoam assures against the risk of the control clogging associated with traditional check-gate flow controls. It is used in conjunction with the Permavoid Wicking Geotextile. They can be incorporated into irrigation systems to provide water 'on-demand' around landscaped areas.

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; For lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation standard

All calculations for Permafoam within designs are based upon site-specific load cases, construction types and thicknesses, soil cover and ground conditions and the suitability must therefore be approved for each project.

Key benefits

- Can be used to provide 'on-demand' irrigation for landscaped areas when used with Permavoid Wicking Geotextile
- Permafoam units can be used to form check dams and gates within pervious pavements

Permavoid Permatex 300

Product code: PV23006

A heavy duty, non-woven, needle punched, polypropylene geotextile designed to protect and separate Permavoid geocellular layers. It comprises of a three-layer composite scrim reinforced with low elongation. 300mm lap-jointing is required.

Element	Value	Test Method
Physical Properties		
Roll length	65m	
Roll width	5.25m	
Mass per unit area	300g/sq.m	EN ISO 9864
Thickness under load 2kPa	2mm	EN ISO 9863-1
CBR puncture resistance	4000N	EN ISO 12236
Dynamic cone drop	11mm	EN ISO 13433
Tensile strength (min) at max. load	25kN/m	EN ISO 10319
Tensile extension (max) at max. load	50%	EN ISO 10319
Protection efficiency	300N	EN ISO 14575
Breakthrough head	nil	BS EN ISO 10319
Coefficient of permeability	55 x 10-3m/s	EN ISO 11058
Characteristic opening size	70 microns	EN ISO 12956

Applications

- Separation
- Protection

Laying generally

Permatex protection geotextile shall be laid continuously around the drainage to suit site specific requirements. Overlaps shall be a minimum of 300mm or heat sealed. Ensure geotextile is clean and debris free before installing Permavoid.

Permavoid system - components

Preformed Spigot Connector with weldable membrane

Element	Value
Physical Properties	
Weight per unit	50g
Other Properties	
Material	Polypropylene

When forming a Permavoid attenuation or storage structure, it is necessary to use the Preformed Spigot Connector with weldable membrane in association with the Permavoid Geomembrane. A welded joint can be made to ensure the tank is leak free.

Orifice Plate Flow Control Chamber

Element	Value
Physical Properties	
Weight per unit	Variable
Minimum diameter	500mm
Height	Variable
Sump depth	300mm as standard, others available on request
Other Properties	
Material	Polypropylene

Discharge limitations are normally achieved by the incorporation of pre-fabricated orifice plate flow control devices, fitted with removable filters to protect the orifices. These are sized to suit the permitted discharge rate and the size of the subcatchment using standard hydraulic theory.

Universal Permachannel Connector

Product code: PV06305

Element	Value
Physical Properties	
Weight per unit	210 g
Length	260mm
Width	180mm
Depth	39mm
Spigot diameter	40mm
Spigot Length	135mm
Other Properties	
Material	Polypropylene

The Permachannel Connector is installed where adjacent Permachannel units butt against each other to form a 40mm diameter outlet. The connector fits into the outlet from the Permachannel and allows water to be conveyed from the Permachannel into the Permavoid system. One connection unit is required per linear metre of Permachannel.

If required, outlet connections can be extended using 40mm HDPE pipework.

Saddle Connector for infiltration applications

Element	Value
Physical Properties	
Weight per unit	80g
Other Properties	
Material	Polypropylene

Proprietary saddle connections for use within Permavoid storage structures installed to soakaway captured water.

Permavoid Wicking Geotextile

Product code: PV23008

A heavy-duty, non-woven, needle-punched geotextile made from a blend of modified polyester fibres. It is specially formulated to absorb water to irrigate mineral substrates when used in conjunction with Permafoam units.

Element	Value
Physical Properties	
Nominal thickness	3.6mm
Surface weight	500gm²
Saturated weight	4.5K/gm²
Roll width	2m
Roll length	25m
Roll weight	26kg
Mechanical Properties	
Maximum tensile strength - Longitudinal	10kN/m
Maximum tensile strength - Lateral	28kN/m
Puncture resistance	2600N
Hydraulic Properties	
Water retention capacity	4 l/m²
Water permeability	37 l/m²/s

Laying generally

Permavoid Wicking Geotextile shall be laid continuously to suit the site specific requirements. Overlaps shall be a minimum of 300mm or heat sealed.

Applications

The Wicking Geotextile is suitable for use in most landscaped applications including roof gardens, soft SuDS applications and sports pitches.

Performance

A robust heavy duty geotextile, when constantly charged with water, it allows moisture to be fed naturally by capillary action to landscaped areas for irrigation. 300mm lap jointing is required. Used in conjunction with Permafoam units. Water is drawn by capillary attraction to ensure the Wicking Geotextile is kept charged.

Key benefits

- Passive capillary irrigation
- Can remove excess soil moisture

Permavoid system - components

Permavoid Rainwater Diffuser Unit

Element	Value
Physical Properties	
Weight per unit	3kg
Length	708mm
Width	354mm
Depth	150mm
Short Term Compressive Strength	
Vertical	715kN/m²
Lateral	156kN/m²
Short Term Deflection	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
Tensile Strength	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
Volumetric void ratio	95%
Average effective perforated surface area	52%
Other Properties	
Intrinsic permeability (k)	Minimum 1.0 x 10-5
Ancillary	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (PP)

Hydraulic Performance						
3 units wide, 1 unit deep (1.06m x 0.15m)						
Free Discharge						
Gradient (%)	0	1	2	3	4	5
Flow rate (l/m/s)	8	13	15	17	19	21

Run-off from building roofs is collected into downpipes and flows into a back inlet gully incorporating an internal filter or catchpit inspection chambers. The back inlet gully or chamber discharges the filtered stormwater into the permeable sub-base via Permavoid Rainwater Diffuser Unit encapsulated in a 2mm mesh fabric. The run-off will then diffuse out of the Permavoid Rainwater Diffuser Unit and into the modified granular sub-base layer. The Permavoid unit is a 150mm deep modular interlocking plastic unit storage system designed for use as a combined drainage component and sub-base replacement system, ideal for shallow infiltration/attenuation.

Permavoid Rainwater Diffuser unit - Configuration options

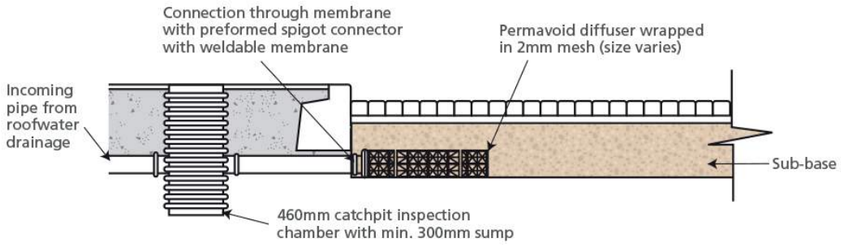
Width

Length	354mm	708mm	1062mm	1416mm	2124mm
708mm	✓	✓	✓	✓	✓
1062mm	✓	✓	✗	✓	✓
1416mm	✓	✓	✓	✓	✓
2124mm	✓	✓	✓	✓	✓

Depths available are either 150mm or 300mm. Connections available are either Ø110mm or Ø160mm.

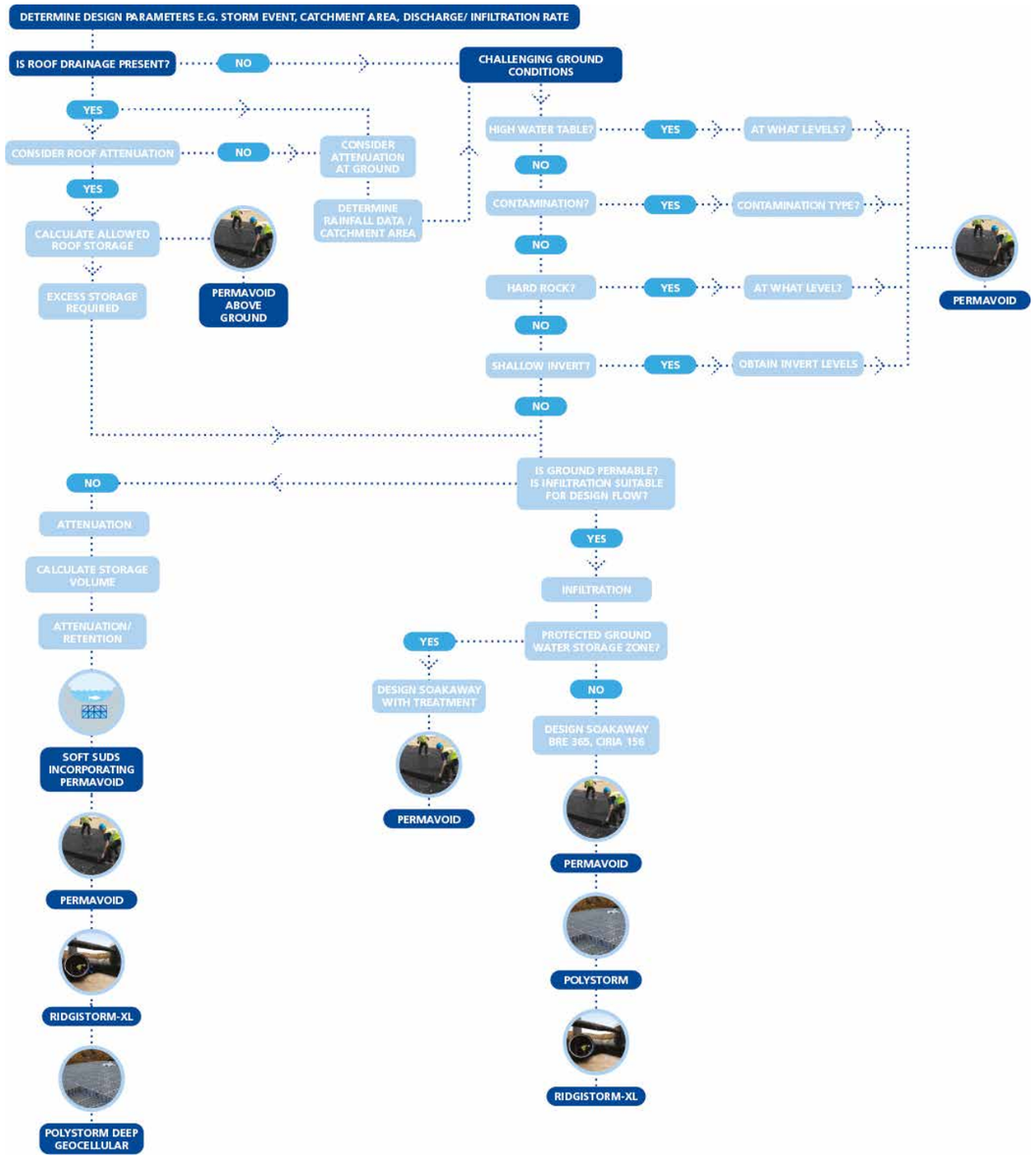
Catchpit: 460mm diameter catchpit with 160mm inlet - PSMT 160
460mm diameter catchpit with 110mm inlet - PSMT 110

Figure 3.1.1: Typical layout - Rainwater downpipe drainage into sub-base reservoir



Sustainable drainage systems - selection & design

It is important to consider as many factors as possible when selecting the most appropriate sustainable drainage system. The process below is a guide to the most efficient design.



Hydraulic design - attenuation

Hydraulic design calculations provide the storage volume required on any particular site that is needed to reduce the speed, frequency and volume of rainfall run-off into rivers or sewers. The required volume depends on the site location, the size of the area being drained, the soil infiltration rate (for soakaways) or allowable discharge rate (for attenuations systems).

The design of SuDS should follow the requirements in the CIRIA Report C 753 The SuDS Manual. This identifies three types of storage that are required:

Interception storage

The aim is to reduce the frequency of run-off and **prevent run-off from sites for rainfall events up to 5mm** in order to simulate the behaviour of greenfield catchments more closely. This is achieved using infiltration or source control methods where evapotranspiration can reduce the volume of run-off. Typically this is achieved using soft SuDS solutions. Increased capacity of soft SuDS solutions can be achieved utilising Permavoid beneath them.

Attenuation storage

Reduces the peak discharge rate from a site (i.e. how fast water flows off the site) and is used to store excess water where the rate of discharge is limited to greenfield run-off rates or stormwater sewer rates. It is designed to operate for a range of annual probabilities in accordance with the Environment Agency and/or local water company requirements.

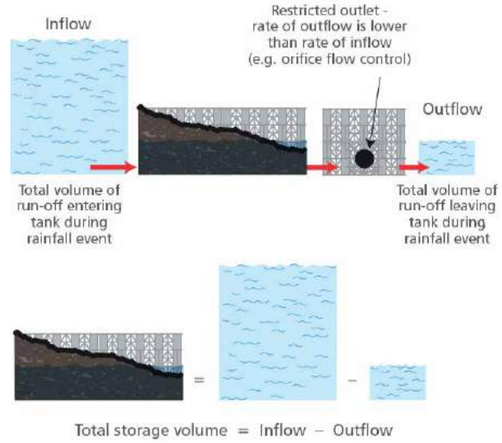
Long term storage

Used to reduce the additional volume of run-off caused by developments. Stores excess water that is the difference in total volume of run-off between the developed and greenfield site for a 1 in 100 year, 6 hour rainfall event. Outflow from the long term storage should be to either infiltration or to a water course or sewer.

Design of attenuation storage

The volume of Permavoid required for attenuation storage is typically calculated using drainage software based on the Wallingford Procedure. The volume of temporary run-off storage required is shown below and is simply the difference between the volume of run-off that enters the tank during a design storm and the volume of water that is allowed to flow out in the same period (which is governed by the discharge rate allowed by the regulators). In this way, Permavoid can be used to limit the peak rate of run-off from a site (usually to the greenfield run-off rate). The calculations are completed for a range of return periods and durations.

Attenuation storage volume



Attenuation

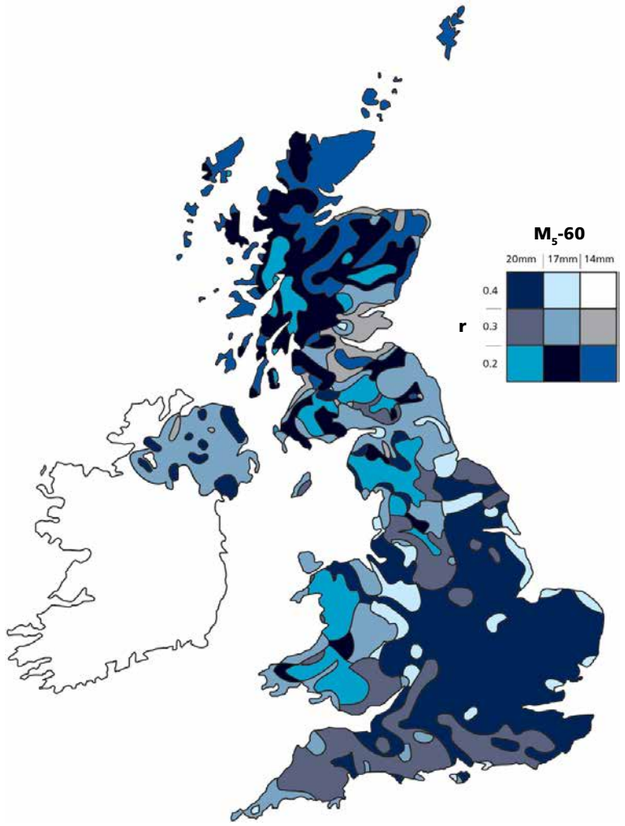
Hydrological rainfall zones for the UK

The table below can be used to size a Permavoid tank. The tables are based on the hydrological rainfall regions shown on the map.

The tables are based on the following assumptions:

- Storage is provided for development design events of 1 in 30 years, 1 in 100 years and 1 in 100 years plus 20% increase for climate change but the greenfield run-off rate is always considered to be 5 l/s/ha
- Time of entry and time of concentration within the drainage system is not considered
- 100% run-off is assumed

Note: HR Wallingford, use of SuDS in high density developments, defining hydraulic performance criteria, Report SR 640, December 2003.



Note:

Volumes include allowance for 95% void ratio of Permavoid.

Permavoid has a void ratio of 95% (i.e. for every 1m³ there is 0.95m³ of space available for water storage).

The volume of Permavoid required is therefore calculated by dividing the required storage volume by 0.95.

This factor is allowed for in the design table.

M_5-60 Rainfall depth (mm)
The rainfall depth for the 60 minutes, 5 years return period event

'r' Ratio M_5-60 / M_5-2 day:
Variable 'r' represents the ratio of the rainfall depth of the 60 minute to the 2 day, 5 year rainfall event.

Required attenuation storage (m³ of storage per Ha of impermeable area)

	r	1 in 30 year design event	1 in 100 year event	1 in 100 year event plus 20% climate change
M_5-60 = 20mm	0.4	357	510	643
	0.3	413	582	749
	0.2	556	770	968
M_5-60 = 17mm	0.4	293	419	545
	0.3	335	483	631
	0.2	444	637	822
M_5-60 = 14mm	0.3	258	383	511
	0.2	335	500	665

Example of Permavoid sizing for attenuation storage

A site in London has impermeable area as follows:

1200m² roof area

1475m² car park and other areas

Therefore the total impermeable area = **2675m²**

Assume the required return period for the drainage design is 1 in 100 years as agreed with the Environment Agency

From the table on page 40, London is in the region where M_5-60=20mm and r=0.4

Therefore from the table the volume of the Permavoid tank required is 510m³/ha

Required attenuation storage on this site =
510 x 2675/10000 = 136.4m³

Hydraulic design - infiltration

Design of infiltration storage

Where ground infiltration is suitable for design flows, there are three approaches for hydraulic sizing:

1. BS EN 752:2008 'Drain and Sewer Systems Outside Buildings'
2. Soakaway Design BRE Digest 365
3. CIRIA Report 156 'Infiltration Drainage - Manual of Good Practice'

A simplified approximate approach can be used on a very small site (i.e. a single house development) where detailed site infiltration rate information may not be required nor available. Approved document H3 allows a storage volume equal to the area to be drained multiplied by 10mm for areas up to 25m^2. Beyond this size, designs should be carried out in accordance with BS EN 752-4:2008 or BRE Digest 365.

Percolation test for designing a shallow infiltration system

The depth of the trial pit should reflect the (expected) proposed depth of installation and water depth likely to occur in the completed structure.

Step 1 - Trial hole excavation

- Where the infiltration test is to be conducted in a 'kept turfed' area; first carefully cut and remove the turf in location of the excavation and put to one side
- Excavate a shallow rectangular pit either by hand or by machine (suggested minimum 2000mm x 1000mm x 500mm depth, subject to ground conditions), attempting to get the base as flat and the sides as vertical as possible (subject to ground conditions). Aiming to get close to the proposed depth of installation of the infiltrated device(s)
- Measure and record the dimensions of the pit
- Record the soil type(s) excavated and general ground conditions, the apparent moisture content of the soil(s) and any visual or olfactory (odour) evidence of possible contamination
- Place length of level timber or similar across pit with a mark near the centre (but within easy reach) as a measure datum
- If there are any inflows of groundwater into the pit; record the apparent inflow rate (slow flow etc.) and delay the start of the test to see if the groundwater flows away or rises to a constant level. If standing groundwater is present measure from the datum the level of any standing water in the base of the pit

Infiltration

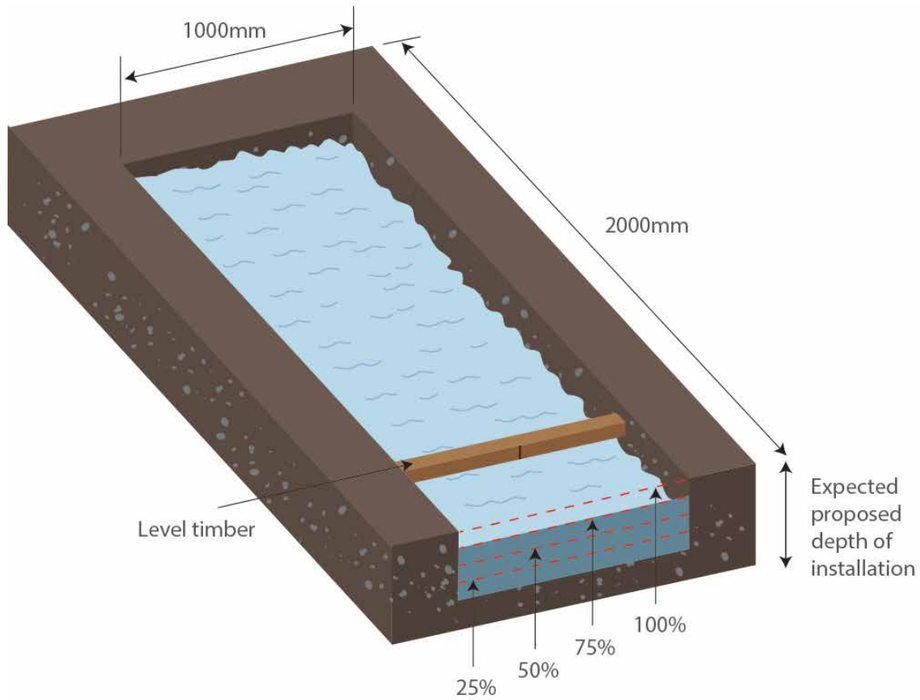
Step 2 - Fill trial hole with water

- Fill the pit as quickly as possible with water to at least 75% of the pit depth or the top level of the proposed soakaway to mimic a real storm event
- Measuring from the marked point on the datum rod, record depth to water at start of test
- Then record depth to water at typically:
  - 20 second intervals up to 2 minutes, then at
  - 30 second intervals up to 5 minutes, then at
  - 1 min. intervals up to 10 minutes, then at
  - 5 min. intervals up to 30 minutes, then at
  - 15 min. intervals up to 2 hours then,
  - Hourly thereafter to the end of day if water has not soaked away

Until the water level drops below 25% of the initial recorded water depth within the trial pit.

- Refill and retest the test pit twice more (where time permits) allowing the trial hole to drain between tests
- Record the weather conditions before and during the tests, particularly any rainfall (duration and relative intensity)
- Unless instructed otherwise, place the excavated material back in the exaction and compact as best as possible
- If turf was kept, place back over the filled exaction as best as possible

Step 1 and 2 - Illustrated example



Infiltration

Step 3 - The results - soil infiltration rate

Calculation principles

Adopting the approach given in Construction Industry Research and Information Association (CIRIA) Report 156 Infiltration Drainage - Manual of Good Practice.

$$\text{Soil infiltration co-efficient, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

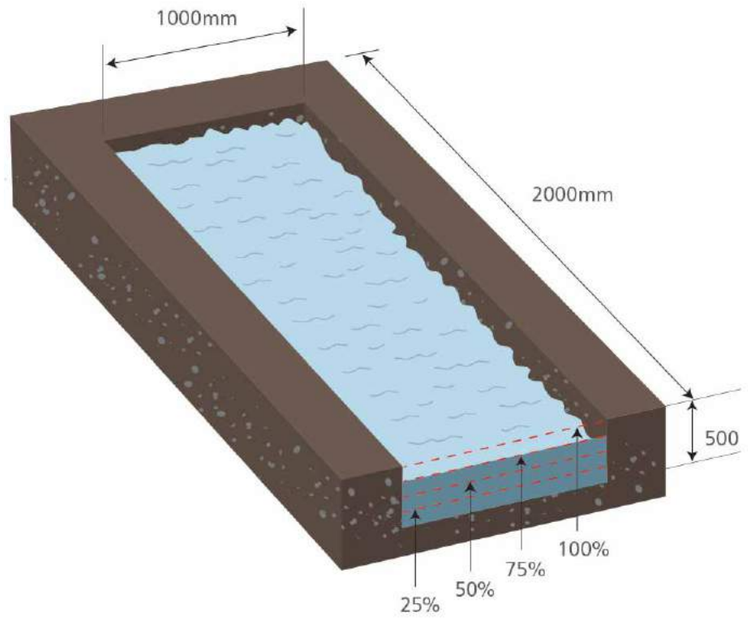
Where:

V_{p75-25} = Volume of the hole from 75% and 25% depth (m^3)

a_{p50} = Internal surface area of test hole at 50% depth (including base) (m^2)

t_{p75-25} = Time taken for the hole to drain from 75% to 25% depth (sec)

Continuing with the example given:



Test hole depth at 75% and 25%

$V_{(p75-25)}$ = 1.000 x 2.000 x (0.375 - 0.125) = 0.5m³

$a_{(p50)}$ = 0.250 x [2 x (1.000 + 2.000)] + (1.000 x 2.000) = 0.250 x (6.000) + 2.000 = 3.500m²

From the completed tests, the longest duration test took 11 and 80 minutes to drain to 75 & 25% trail hole depths respectively.

$t_{(p75-25)}$ = 80 - 11
= 69 minutes

Therefore:

$$\text{Soil Infiltration rate, } f = \frac{0.500}{3.500 \times (69 \times 60)} = \mathbf{3.45 \times 10^{-5}\ m/sec}$$

The soil infiltration rate can be used in volume calculations. If you require assistance, please call our Technical Team on +44 (0) 1509 615100.

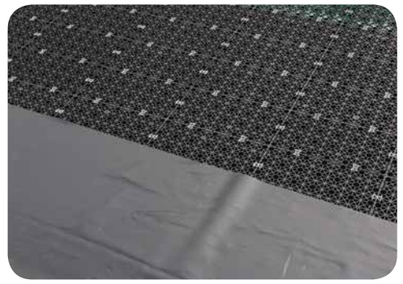
Geotextiles and Geomembranes

The use of geosynthetics is an integral component of a geocellular structure. They are wrapped around the geocellular units to create attenuation or infiltration tanks. The function of the geotextiles and geomembranes are to prevent:

- Silt that may be contained in the surface water run-off from contaminating the surrounding soil (infiltration)
- Surrounding soil from entering the units (infiltration)
- The release of surface water into the surrounding ground (attenuation)
- Inflow of groundwater that may overload downstream systems and contain pollutants on contaminated sites (attenuation)

Therefore any damage of the geosynthetic wrap, may lead to a decreased performance of the tank.

The design of the surrounding medium and choice of geosynthetic is an important consideration. The designer/installer should confirm with the geosynthetic manufacturer that the specification of the proposed material is suitable for the application and site conditions. The designer should determine and define the following:



- The application requirements - retention, attenuation and infiltration
- Boundary conditions – site investigation to establish in-situ soil parameters, enabling lateral earth pressures and water flow conditions to be calculated
- Soil retention requirements – using the in-situ soil parameters, determine if additional bed and surround measures should be specified
- Geosynthetic permeability requirements – the breakthrough head should be considered in addition to water flow rates
- 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
- Resistance to mechanical damage requirements – the geosynthetic should be sufficiently robust to survive installation activities
- 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

Structural design

When designing Permavoid geocellular structures for attenuation or infiltration, care has to be taken to ensure the finished system is safe to carry the loads they will be subjected to. A brief summary of the points which should be considered for a typical installation are given below:

Applied loads

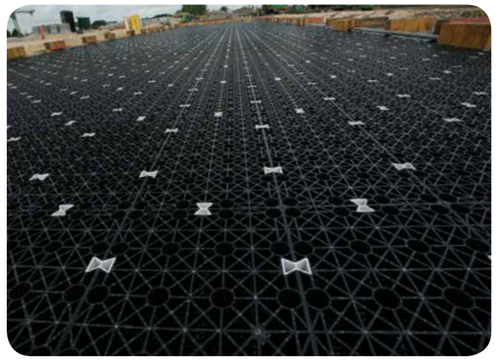
- Uniformly distributed
- Concentrated
- Backfill
- Stockpiles
- Traffic
  - Construction
  - In service
- Earth pressure
- Hydrostatic pressure (groundwater)
- Uplift

Partial factors of safety

- On material properties
- On loads

Unit characteristics

- Compressive strength at yield
- Deflection
- Creep



The main design considerations to ensure system integrity are:

- Structure failure or collapse – where the structure cannot support the applied loads
- Excessive deflection or movement of the structure when vehicles pass over the tank; that compromises the structural integrity of a surface pavement (i.e. crack)

Limit state design

Current structural design philosophy is based on limit state criteria, where a number of limit states are considered. The methodology applies partial factors of safety to the various design parameters, the magnitude of which is dependent on the potential variability of that parameter and the consequences of the limit state being exceeded.

In the case of the Permavoid system, the two limit states typically considered are:

Ultimate Limit State (ULS)

Considers if the strength of the geocellular unit is exceeded by the applied loads and cause the structure or structural element to fail.

This is obviously serious, therefore the partial factors of safety used in this assessment are chosen to ensure the installation remains serviceable. In the case of Permavoid this would typically mean that deflections are not excessive and do not cause damage to overlying surfaces (such as asphalt pavements) or cause a significant reduction in the storage volume of the structure.

Serviceability Limit State (SLS)

Considers the operational behaviour of a geocellular structure to ensure that the installation remains serviceable. In the case of Permavoid this would typically mean that deflections are not excessive and do not cause damage to overlying surfaces (such as asphalt pavements) or cause a significant reduction in the storage volume of the structure.

Applied loads and load factors

Loads that may be imposed on a cellular storage structure such as Permavoid can be broken down into the following types.

Partial material factors of safety: Permavoid

Limit state	fm
Ultimate limit state	2.75
Serviceability limit state	1.50

Industry guidance

A generic design method has been developed that can be applied to most types of cells, using basic structural design theory and relevant British Standards. Imposed loading on geocellular plastic tanks may be considered to be similar to other buried structures. Loads and partial factors of safety applied to loads and materials detailed in this section have been based on latest CIRIA Guidance.

CIRIA Guidance

Currently the only guidance to the structural design of geocellular structures is published by CIRIA.

Factors of safety

To minimise the risk of exceeding the limit states, factors of safety are applied to the geocellular units characteristic compressive strengths and to any applied loads.

Material factors

The strength characteristics of the Permavoid cells have been obtained from laboratory testing. A design strength is derived by dividing the cell's characteristics strength by a material partial factor of safety (fm), appropriate to the material and limit state. This takes into consideration variations due to manufacturing processes, variability and uncertainties in material strength, damage during installation and environmental effects.

Structural design life

The design life is based on the scale and frequency of loadings and extrapolation of creep test data. The lighter and less frequent the load, the longer the design life. Large permanent loads (e.g. from a significant depth of fill on top of a tank) will give shorter design life compared to light permanent loads. Areas where heavy vehicles are standing for prolonged periods will give a shorter design life than where vehicles are mainly transient.

For lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank. Maintenance of the pavement will be required after the design life has exceeded. It is recommended structural calculations are always carried out in accordance with the latest CIRIA Guidance.

Chemical resistance

Permavoid is resistant to automotive products such as motor oil, petrol, diesel, brake fluid, antifreeze, grease and washer fluid at the concentrations and temperatures likely to be encountered within a typical surface water drainage application.

Permanent (dead) loads

Permanent loads applied to the Permavoid cells, including the weight of backfill material placed over the top and lateral (horizontal) earth and water pressure loads acting on the side of the system.

Transient (live) loads

Loads due to pedestrian, vehicle and construction traffic that are temporary. Traffic wheel loads are normally given as static loads, with a factor applied to allow for dynamic effects (a moving wheel will impose more force on the ground than a static one).

Design loads

A design load is obtained by applying a partial factor of safety to the estimated characteristic load. This allows for unforeseen variations of loading and also the severity of the consequences of the limit state occurring. The loads detailed within CIRIA Guidance have been based on loads applied in the design of structures using rigid materials such as concrete and therefore the partial safety factors for loads that are appropriate to the design of plastic storage systems are taken from British Standard BS 8110.

Partial material factors of safety

Limit state	Imposed vertical dead load fm	Imposed earth pressure dead load fm	Imposed live load fm
Ultimate limit state	1.4	1.4	1.6
Serviceability limit state	1.0	1.0	1.0

Additional dynamic amplification factors may be applied where structures are expected to be heavily trafficked by HGV's.

If you require assistance, please call our Technical Team on +44 (0) 1509 615100.

Structural design

Pavement applications

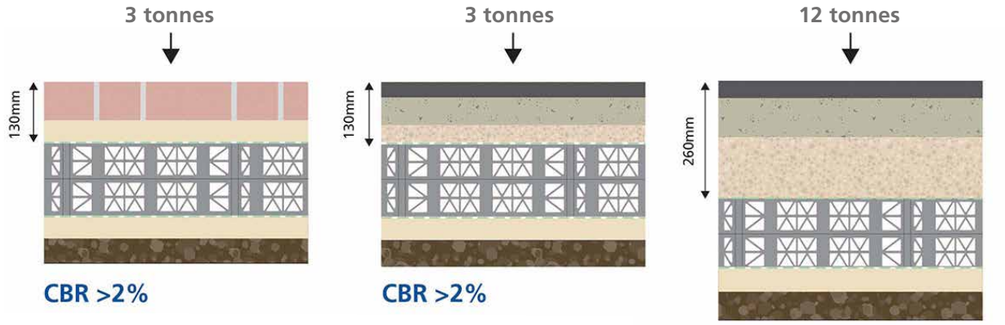
The Permavoid system has undergone numerous laboratory tests and instrumented site trials to validate use in pavement constructions. Permavoid exceeds the minimum unit performance recommended in industry guidance for geocellular units installed within a pavement structure.

Many factors should be considered when designing Permavoid below pavements, including:

- Vehicle types
- Frequency of loading
- Load duration
- Speed
- Pavement construction

Pavement construction examples

Typical minimum recommended pavement construction details, for a number of loading situations, are reproduced below; amended to illustrate how Permavoid would typically be installed within these pavement structures.



80mm block
+ 50mm sand bed
= 130mm

Applications:

- Private drives
- Car parks with height restrictions

30mm asphalt surface
+ 60mm asphalt base
+ 40mm Type 1 sub-base
= 130mm

Applications:

- Private drives
- Car parks with height restrictions
- Includes for occasional/ accidental HGV overrun

30mm asphalt surface
+ 90mm asphalt base
+ 140mm Type 1 sub-base
= 260mm

Applications:

- Car parks without height restrictions
- Includes for occasional/ accidental HGV overrun
- Suitable for access roads

Industry guidance

The following guidance documents provide minimum pavement construction details for a range of typical installations; the construction detail varying according to the expected level of vehicle traffic and ground conditions.

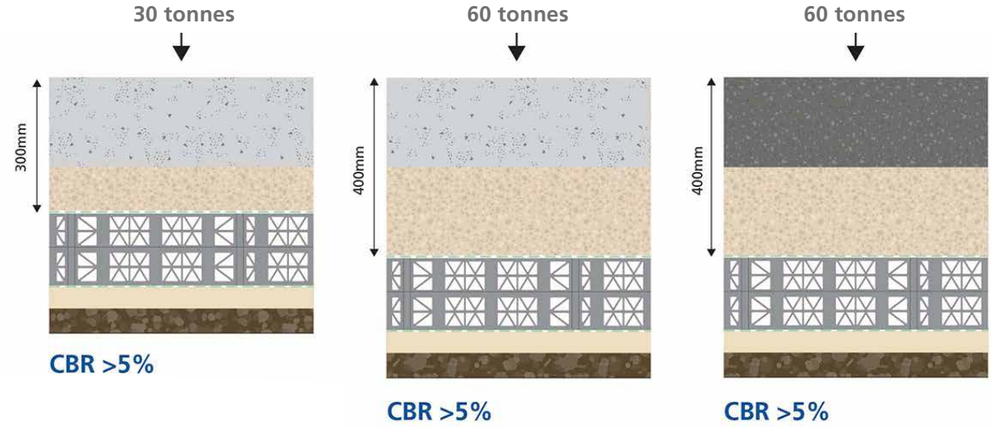
The Permavoid system complies with the requirements of BS 7533-13:2009 and incorporates a high vertical compressive strength of 715kN/m² and lateral compressive strength of 156kN/m².

British Standard

BS 7533-13:2009, Pavements Constructed with Clay, Natural Stone or Concrete Pavers – Part 13: Guide for the Design of Permeable Pavements Constructed with Concrete Paving Blocks and Flags, Natural Stone Slabs and Setts and Clay Pavers.

Interpave

Interpave (2010); Permeable Pavements. Guide to the Design, Construction and Maintenance of Concrete Block Permeable Pavements; 6th Edition; British Precast Concrete Federation Ltd.



200mm concrete slab
+ 100mm Type 1 sub-base
= 300mm

Applications:

- Car parks and access roads
- Includes for occasional/ accidental HGV overrun

200mm concrete slab
+ 200mm Type 1 sub-base
= 400mm

Applications:

- HGV park access and small estate roads (<15mph)

200mm reinforced concrete slab
+ 200mm Type 1 sub-base
= 400mm

Applications:

- Main roads
- Frequent HGV's

Note: Site ground investigations are recommended in accordance with BS 7533-19:2009.
If CBR is below 5% an additional capping layer or geo-grid ground reinforcement is required.

Pollution control - Permachannel

The SuDS Management Train refers to source control and emphasises 'run-off should be managed as close to the source as possible'. Using Permavoid it is possible to collect and treat rainwater adjacent to where it falls. Silt, debris and hydrocarbons can be managed at the head of the system using system components preventing pollution migration into the rest of the stormwater drainage system and reducing lifetime maintenance.

Permachannel

Permachannel is a versatile linear treatment system that can provide source control and pollution treatment in a wide variety of locations and applications.

Can reduce hydrocarbon pollution loading below 5mg/l

Performance

Permachannel is not used to convey water like conventional channel drainage, instead it is used to trap silts and oils. The outlet incorporated in the channel is a weir and baffle system that captures any silt or free floating hydrocarbons and retains them in the channel. The performance of the Permachannel system has been assessed by laboratory testing of full-scale prototypes. The results show that the Permachannel alone will outperform conventional Class 2 oil separators and so will meet the design requirements of the Environment Agency's Pollution Prevention Guideline PPG3. The performance can be improved by providing a geotextile filter as a further stage of treatment after the Permachannel, which will ensure the whole treatment train meets the requirements of a Class 1 oil separator. Permachannel performs several key functions in relation to controlling pollution in run-off, including stilling the sheet flow to encourage controlled deposition of silt and effluent, interception and separation at source.

Water treatment design

The design of the Permachannel system should ensure sufficient pollution removal and storage capacity. A maximum catchment area of 30m² should drain to each 1m length of Permachannel. The volume of the silt trap within the channel or kerb is required to provide sufficient silt and floating oil storage capacity. The spacing of the Permachannel outlets also ensures that flow velocities are not excessive.

Catchment area 30m²

Example silt and oil loading calculation

Calculate required silt and oil storage volumes in accordance with the Environment Agency's Pollution Prevention Guideline 3.

Silt trap capacity

Volume of silt trap in Permachannel = 0.0045m³/m

Sediment load in catchment = 865kg/ha/y

Catchment area = 6800m²

Total sediment load from catchment = 588kg/ha/yr

Assume density of unconsolidated sediment in base of silt trap is 1200kg/m³ (typical value for dock silt) then volume of sediment per year from whole car park = 0.5m³

Channel length is 700m

Volume of silt trap in channel in total for the site = 3.15m³

So, time to fill this with silt is approximately 6.3 years (assuming no maintenance is undertaken) (3.15÷0.5)

Oil trap capacity

The amount of oil that can be retained is the difference in height between the weir and baffle in the separator

Height difference = 40mm

So, volume that can be accommodated = 0.003m³/m

Total volume for site = 2.1m³

Required capacity from PPG 3

Nominal size of separator = NSB = site area x 0.0018

NSB = 0.0018 x 6800 = 12.2 litres

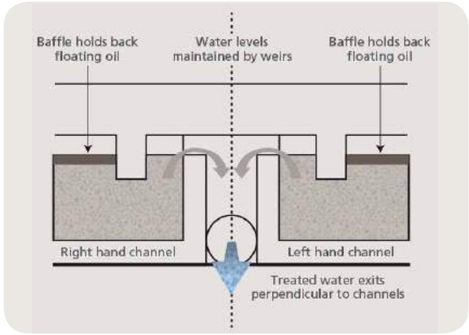
Required silt storage = NSB x 100 = 1220 litres = 1.2m³

Actual storage = 3.15m³ which is acceptable

Oil storage required

= NSB x 15 = 183 litres = 0.18mm³

Actual is 2.2m³ which is acceptable

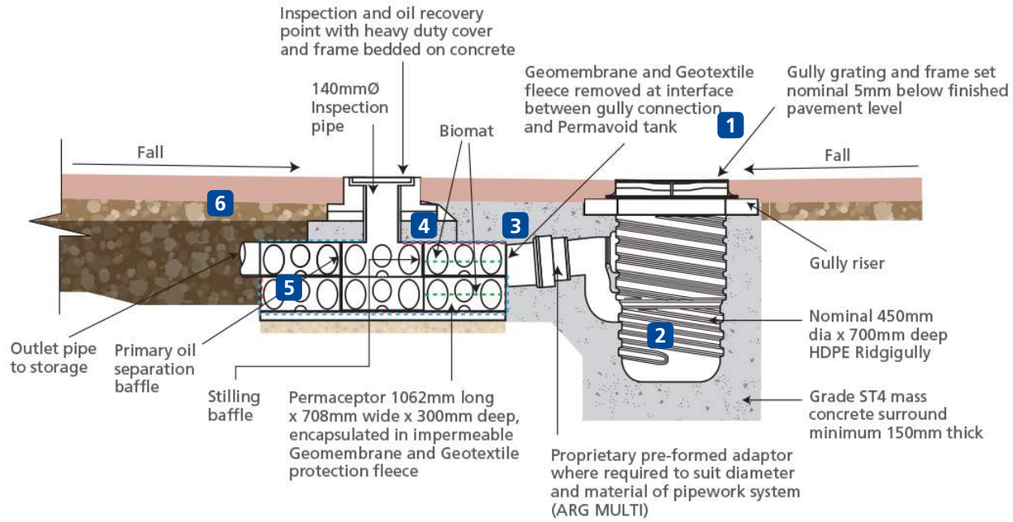


Pollution control - Permaceptor

Permaceptor

Permaceptor is a versatile, efficient and effective source control volume and treatment system for use with conventional road and yard gullies.

Figure 6.1.1: Performance



One Permaceptor can treat a catchment area of 150m²

Stormwater from impervious surfaces (1) enters the road/yard gully (2). The gully will slow down the inflow and silts/debris are separated out. The gullies incorporate a basic baffle arrangement and some hydrocarbons are retained or slowed down within the flow process. Stormwater passes from the gully into the Permaceptor unit via a raised inlet (3) and flows through to be 'stilled' by a baffle (4) allowing the water to pass through the biomat(s) where hydrocarbons are separated. As the water passes through the chamber a primary baffle (5) also retains hydrocarbons allowing clean water to discharge into the drainage system via a raised outlet (6). The raised outlets create a permanent pool of water. The chamber incorporates an inspection and oil recovery heavy duty cover. The biomats encourage natural biodegrading of free oil products, acting as an additional stilling element and prevention of entrainment of oil into drainage system due to poor maintenance.

All dimensions in millimeters, unless otherwise stated. All dimensions are nominal and may vary within manufacturing tolerances. All site temporary and enabling works by others. Ridgistorm-XL units to be installed in accordance with Polypipe Civils recommendations (refer to Polypipe technical guidance for further information); giving due consideration to the requirements of the organisation who will be taking ultimate ownership of the installation. These drawings are intended for guidance only. Confirmation of the information contained within this document should be sought from the consulting Engineers before final design or construction activities commence.

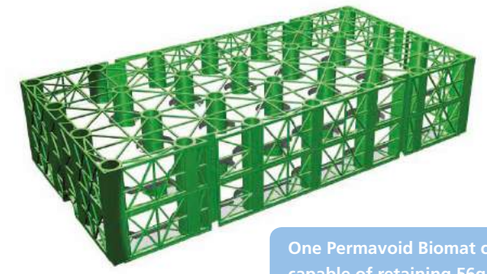
Pollution control - Permavoid Biomat

Permavoid Biomat

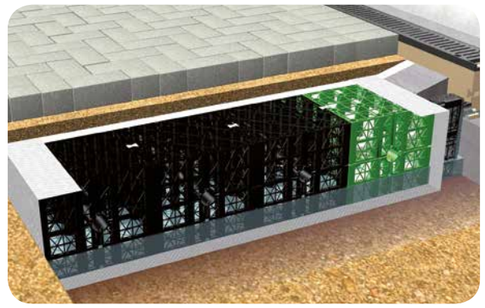
Permavoid Biomat has been specifically designed to remove hydrocarbon pollutants from surface water run-off. It comprises of a buoyant geocomposite located inside the Permavoid unit.

The composite interacts with oil deposits, allowing formation of a 'biofilm' on its solid surface and providing the opportunity for nutrient recycling which would allow active biofilm development. The system provides an environment which encourages the growth of oil-degrading microorganisms as moisture, oil and oxygen from the atmosphere are all present supplied with a large surface area for oil absorption and biofilm attachment.

Permavoid Biomat has been extensively researched in partnership with Coventry University. The experiments included studies of the oil retention, the biofilm formation and the mineralisation of the entrapped hydrocarbons. Model systems were used for the study, comprising of a full pavement cross-section.



One Permavoid Biomat cell is capable of retaining 56g of oil



Performance

Research has demonstrated that the system is capable of retaining and biodegrading the hydrocarbon pollutants from the surface water. The system is capable of retaining **56g of oil per m².** The entrapped hydrocarbons become part of a complex biofilm, which utilises the oil pollutants as a nutrient source (mineralisation). The system also demonstrates other beneficial results, such as that both unused and used lubricating oil can be degraded.

Permavoid Medium Duty with Biomat

Permavoid Medium Duty with Biomat is designed for use with Polystorm attenuation and infiltration systems. The use of Permavoid Medium Duty with Biomat provides additional oil retention and water treatment capability to deeper underground water storage systems. The size of this unit is 1m x 0.5m x 0.4m.

Pollution control - Permafilter Geotextile

Permafilter Geotextile

Permafilter Geotextile has been specially designed to retain hydrocarbon pollutants. Permafilter Geotextile comprises of a non-woven, needle punched geotextile made from a proprietary blend of modified polyester fibres. The entrapped pollutants are either removed or reduced to levels suitable for discharge into controlled waters.

Working principle

The proprietary blend of fibres in Permafilter Geotextile exhibit specific hydrophilic and hydrophobic properties and these, combined with the dimpled structure, work together to form multiple layers with inherent oil retention properties. The hydrophobic (repelling) material receives and retains the hydrocarbon pollutants, whilst the hydrophilic (water-attracting) elements simultaneously facilitate water retention resulting in a long-term stable biofilm, which subsequently degrades the entrapped pollutants.

Applications

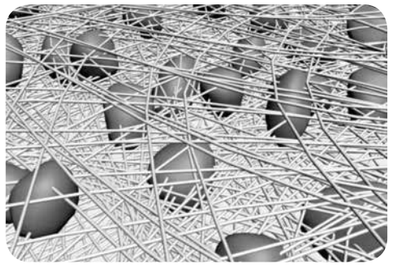
The range of applications for the Permafilter Geotextile is virtually unlimited in traditional geotextile applications, where enhanced hydrocarbon treatment can be achieved. Furthermore, it is applicable in many retrofit applications where the superior hydrocarbon retention is an indispensable requirement.

Performance

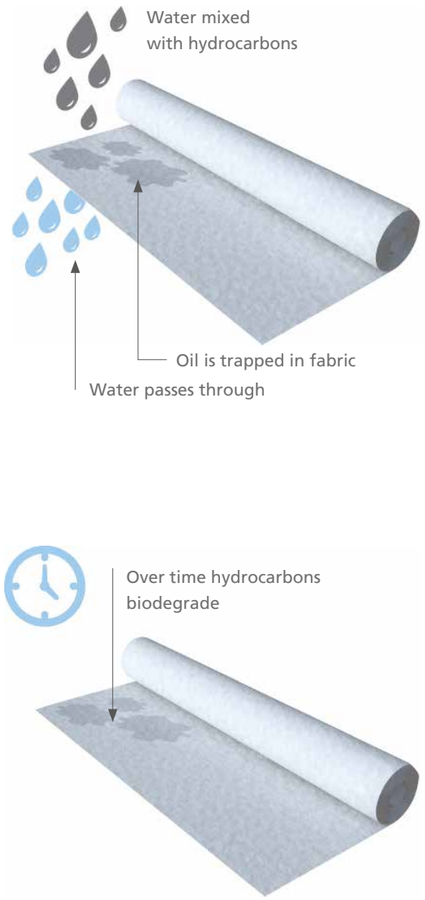
Permafilter Geotextile demonstrates retention of up to 6 litres of oil per 10m². The maximum discharge of effluent is typically 4.5ppm* during the first flush and during consecutive rain events only an average concentration of 1.5ppm.

*ppm = parts per million

6 litres of oil retained per 10m²



Microscopic view of self-maintaining eco-system



Delivery and storage

Permavoid

- Permavoid is delivered to site on pallets. Palletised load measurements are approx. 1.2m x 1.1m x 2.3m high and each pallet will contain 72 Permavoid units
- Pallet weight is circa 220kg
- Deliveries shall be unloaded using mechanical handling equipment

Permachannel

- Permachannel is delivered to site on pallets. Palletised load measurements are approx. 1.0m x 0.8m x 1.0m high and each pallet will contain 20 Permachannel units
- Pallet weight is circa 850kg
- Permachannel is delivered with gratings in position
- Deflection plates are supplied within the channel and need to be positioned during installation
- Deliveries shall be unloaded using mechanical handling equipment

Storage

- Position pallets on stable, level ground
- Stacking of pallets is not recommended
- Store away from direct sources of heat or ignition
- Transit banding should not be removed until installation

Geotextile and Geomembrane

- Deliveries shall be unloaded using mechanical handling equipment

Geosynthetic	Permafilter	Permatex 300	Wicking Geotextile	Geomembrane
Material	Polyester blend	Modified polyester	Polyester blend	Polypropylene
Roll size	2.4m x 100m	5.25m x 65m	2m x 25m	Variable
Weight	300g/m²	300g/m²	500g/m²	900g/m²
Delivery	Single rolls	Single rolls	Single rolls	Single rolls

Installation

Excavation and preparation

Excavation

- Ensure that the ground-bearing capacity at formation level is adequate for the design loads.
- The excavation is dug to the required plan, dimensions and level, ensuring that the excavation will allow installation of connecting pipework. Slopes must be cut to a safe angle or adequately supported and safe access must be provided to allow personnel to enter the excavation. Excavation should be carried out in accordance with BS 6031:2009, with particular attention paid to safety procedures.
- It is recommended that the excavation provides a minimum of 500mm clear zone on all sides of the plan dimensions of the tank to allow working space for the installation. If required, suitable protection and earthwork support must be provided beyond the clear zone to all excavated faces.

Base

To be trimmed smooth and free from sharp objects and projections to provide an even formation that shall be free from undulations. Any present must be excavated and replaced with compacted granular fill material.

Tolerance

The formation shall be graded to achieve a maximum deviation of 5mm in 3m in any direction to prevent formation of voids below installation which will cause Permavoid units to ‘rock’. A blinding layer may be used to achieve required tolerances.

Blinding

A 50mm thick blinding layer of 20/6 clean crushed stone or sand to BS EN13242:2002 shall be used to achieve a suitable bedding surface.

Laying

Ensure membrane is clean and free from debris before laying Permavoid. Check installation plan/details to confirm Permavoid orientation. Commence laying in corner of installation area and work forwards in a diagonal line to the opposite corner until layer is complete. Repeat for further layers.

Permatie

Adjacent Permavoid units are connected using Permatie interlocking pins, which have integral creep resistance. Permaties must be inserted into all available slots where units butt together up to a maximum of 5 Permaties per Permavoid unit. The Permatie provides rigidity and minimises deflections.

Shear Connectors

Multi-layered Permavoid tank configurations shall be fixed with proprietary Shear Connectors between each layer interface to maintain rigidity and minimise lateral displacement. A minimum of four Shear Connectors per square meter at layer interface is recommended.

Drainage connections

Proprietary drainage connections are available where a drainage connection is required to the Permavoid installation. There are several different options available subject to type of tank encapsulation and whether the connection is at invert or centrally located.

Installation

Attenuation applications

Where required, all penetrations through an impermeable encapsulation shall be sealed. Create an impermeable seal using a preformed spigot connector with a weldable membrane.

The adaptors comprise a rigid body and spigot with a flexible outer membrane manufactured from compatible material to the geomembrane encapsulating the tank. Adaptors are available as invert or standard type and come in a range of diameters. The adaptors are fully welded to the main tank encapsulation.

All joints should be sealed, using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures is given in CIRIA Report SP124.

Protection

Permatex protection geotextile should be installed to the outside face of the base, top and sides of the installation as protection layer to geomembrane.

Installation

Adjacent sheets to be lap jointed with a minimum lap of 300mm or heat sealed. Corners to be formed in folded welts and heat sealed if required. Ensure geotextile is clean and free from debris. Trafficking over placed material to be avoided.

Geotextile for infiltration

Permafilter Geotextile should be used for infiltrations applications. The geotextile should be laid with minimum of 300mm overlap or to lap marker and to be applied to all external surfaces of Permavoid units.

Installation

Corners to be formed into folded welts and heat sealed if required. Ensure geotextile is clean and free from debris before installing Permavoid. Trafficking over laid material to be kept to a minimum.

It is recommended that site vehicle traffic is prevented from trafficking the Permavoid tanks until the installation is complete.

Backfilling

The Permavoid tanks shall be backfilled with an initial layer minimum 50mm thick of 20/6 clean crushed stone or sand to BS EN 13242:2002. The preferred method of aggregate placement is for the plant to be situated on top of a minimum of 300mm thick aggregate layer. Recommended plant to be used for placement of the aggregate to be a tracked machine with a maximum operating bearing pressure of 200kN/m². Wheeled machines to have low bearing pressure tyres (maximum permitted pressure 30psi), maximum tread/cleat projection 15mm. **Under no circumstances should plant operate in direct contact with Permavoid units.**

Permachannel excavation and bedding preparation

Base

To be trimmed smooth and free from sharp objects and projections. For optimum capacity the Permachannel should be installed with zero gradient but it can be installed to shallow gradients should the drainage design require. The Permachannel should be laid on a 200mm deep concrete bed with a minimum 150mm thick haunch to both sides. A 30N/mm² concrete mix is recommended.

Tolerance

Local subgrade below concrete bed tolerance of ±5mm within any 3m direction. The commensurate level for the Permachannel installation should allow for the height of the Permachannel and the depth of the concrete bedding, plus a further 3-5mm below the finished level to protect the Permachannel and prevent ponding. Ensure the membrane encapsulation from the Permavoid tanks (if required) spans below the Permachannel installation with sufficient length to return up the rear of the Permachannel run.

Manual handling

It is recommended to remove the gratings and stainless steel diverter plate prior to installation to reduce the handling weight from 42kg to 29kg. Consult your employer for specific manual handling advice.

Installation of Permachannel

Check installation plan/details to confirm Permachannel orientation in relation to Permavoid tank(s). Align using a builder's line or suitable laser alignment equipment. When positioning the Permachannel, insertion of the stainless diverter plate will assist alignment. The diverter plate should be positioned so that it spans from the ends of adjacent Permachannel units to divert rainwater run-off into the central Permachannel unit. Install the Permachannel connection units along the length of the Permachannel run, 1 connection unit required per linear metre of Permachannel, installed where adjacent Permachannel units butt against each other to form a 40mm diameter outlet. Install the connection unit by firstly removing the fresh concrete bed (before hardening) in immediate area and inserting 'o' ring (supplied with connection unit) into the rebate of the 40mm diameter outlet from the Permachannel and then insert 40mm diameter spigot into the Permachannel aperture.

Ensure connection unit is seated in a vertical position if installing Permachannel ahead of the Permavoid tank, or is butted against the Permavoid tank if installing the Permachannel after the Permavoid tanks. Redundant Permachannel outlet, if not used must be blanked prior to placing concrete haunch. 40mm blanking plugs are available. Place the concrete haunch to the front and rear of the Permachannel. The channel elements must be kept clean during installation. Trafficking over laid material is to be kept to a minimum.

Surface finish options

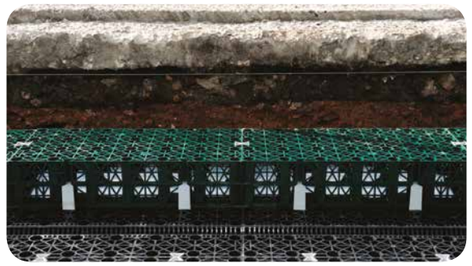
It is recommended the grating is installed within the Permachannel prior to construction of the pavement.

Concrete

Between the minimum 150mm concrete surround and the concrete slab, an expansion joint must be inserted, as structural engineer's specification.

Bituminous bound

To avoid damaging the channels during compaction of the surfacing, the concrete surround must be haunched as high as possible (45° back to the Permachannel). The bituminous bound surfacing can be installed against the side of the channel. The finished level following compacting has to be 3-5mm above the height of the grating.



Maintenance

Like any conventional drainage system, sustainable drainage systems (SuDS) should be inspected regularly and correctly maintained to ensure optimum performance.

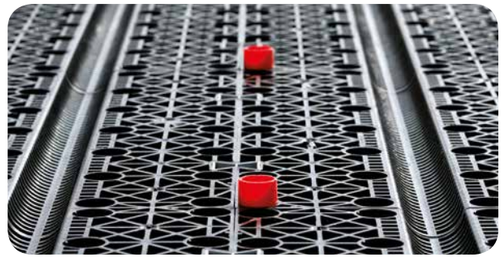
Maintenance plan

This should be initiated by the drafting of routine maintenance plans to suit the site installation. A pre-handover inspection should be carried out and the Permavoid system cleaned prior to final handover.

Routine inspection and maintenance should include:

- Inspection of systems
- Removal of silts
- Decanting of oils and hydrocarbons
- Channel jetting
- Water sampling and testing at point of discharge (if required)

Excess silt/debris held within Permachannel and gullies should be cleared manually or with a vacuum tank. We do not recommend pressure led cleaning.



Routine maintenance

Permachannel

For Permachannel the following routine maintenance procedures are required:

- 3 monthly inspections of channels for signs of blockage and oil spillage
- Remove litter and blockages as required
- Every 12 months inspect all chambers for silt and oil build up
- Every 12 months sweep external surfaces
- Remove silt as required but at least every year
- Records of inspections and maintenance undertaken should be kept by the client

Permaceptor

For Permaceptors the following routine maintenance procedures are required:

- 3 monthly inspections of road/yard gullies for signs of blockage and oil spillage
- Remove litter and blockages as required
- Every 6 months inspect all Permaceptors for silt and oil build up
- Every 12 months sweep external surfaces
- Records of inspections and maintenance undertaken should be kept by the client

Accidental spillages

If accidental spillages occur of oil or other substances that can cause water pollution, they must be dealt with immediately. An example of this is if a car sump fails and there is large spillage of oil on the car park or road surfaces. A spillage kit appropriate to the size of the car park should be kept by the site caretaker. This should include absorbent pads, socks and rain seals.

As soon as a spillage is identified, the drain inlets in that area should be covered to prevent pollution entering the system. The pollution should then be cleared from the road or car park surface. The local channel system and/or Permaceptor receiving the spillage should be emptied of all pollution that has entered.

The Permachannels and Permaceptors should prevent any significant pollution entering the rest of the drainage system. The Environment Agency should be informed of the spillage and the appropriate actions should be taken.

General design details

The Permavoid range of products can be used individually or linked together to provide unique and flexible water management solutions.

The following typical design details highlight a range of solutions available. These drawings are available on the Polypipe website at www.polypipe.com/toolbox. Individual projects may require tailored solutions that are not detailed. For more information please contact our Technical Team on +44 (0) 1509 615100.

Typical permeable pavements

Figure 8.1.1: Sub-base infiltration detail (drawing no. PV_SD_IN_PP_001)

(For illustration purposes, we have shown a permeable block paving system. For Permeable asphalt a 40mm surface course and 80mm binder course are recommended)

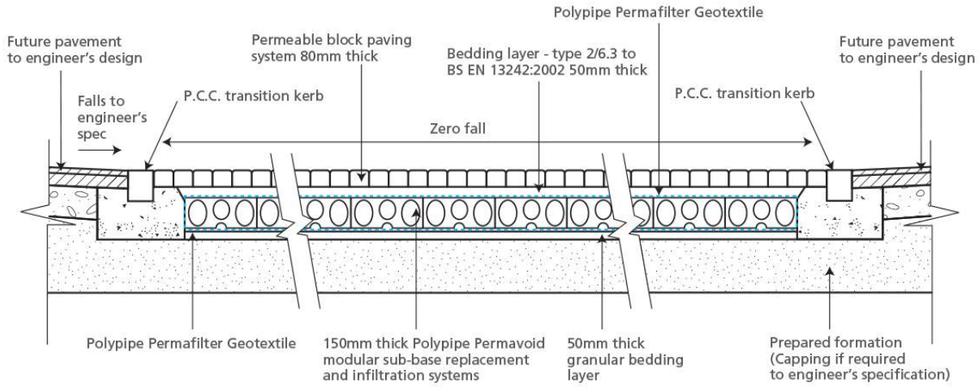
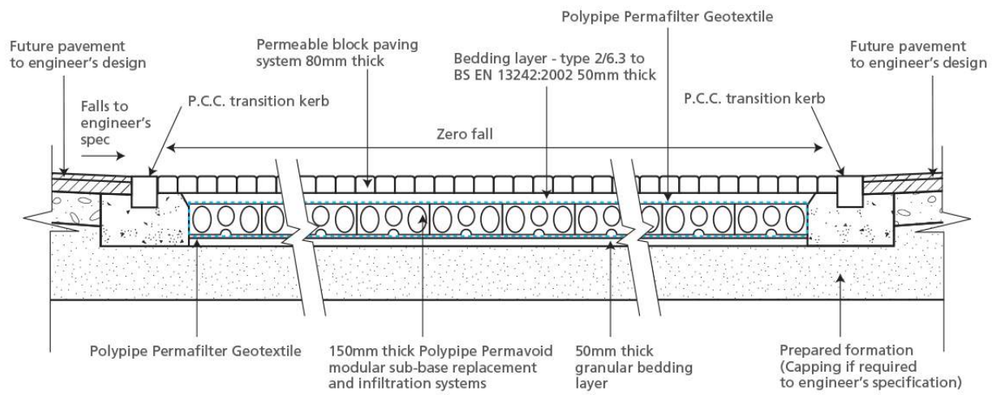


Figure 8.1.2: Permavoid permeable pavement sub-base attenuation detail (drawing no. PV_SD_AT_PP_001)

(For illustration purposes, we have shown a permeable block paving system. For Permeable asphalt a 40mm surface course and 80mm binder course are recommended)



40mm Permeable asphalt

CAD drawings are also available on the website toolbox

General design details

Typical permeable pavements - attenuation

Figure 8.2.1: Permavoid with Permachannel shallow cellular attenuation detail (drawing no. PV_SD_AT_PC_001)

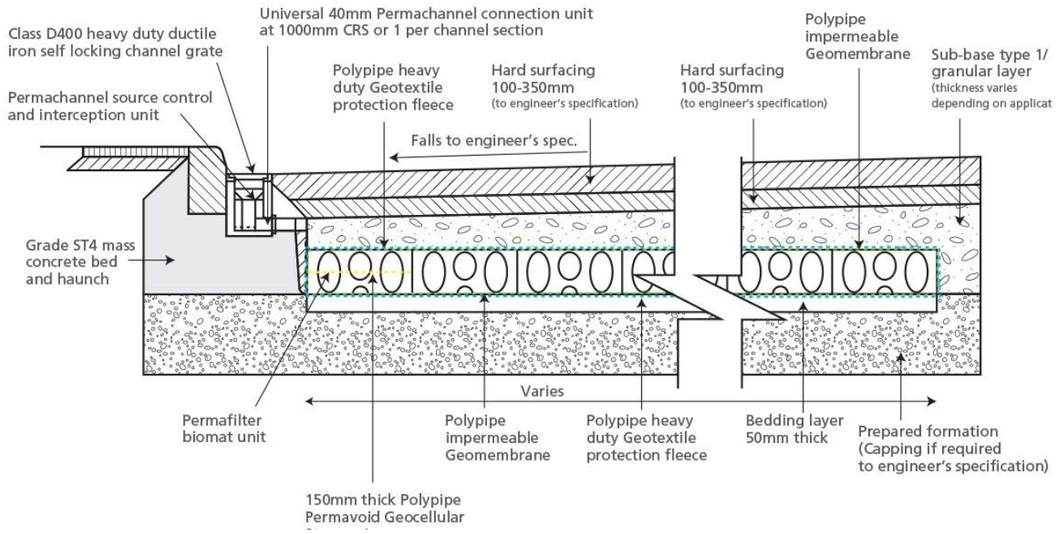
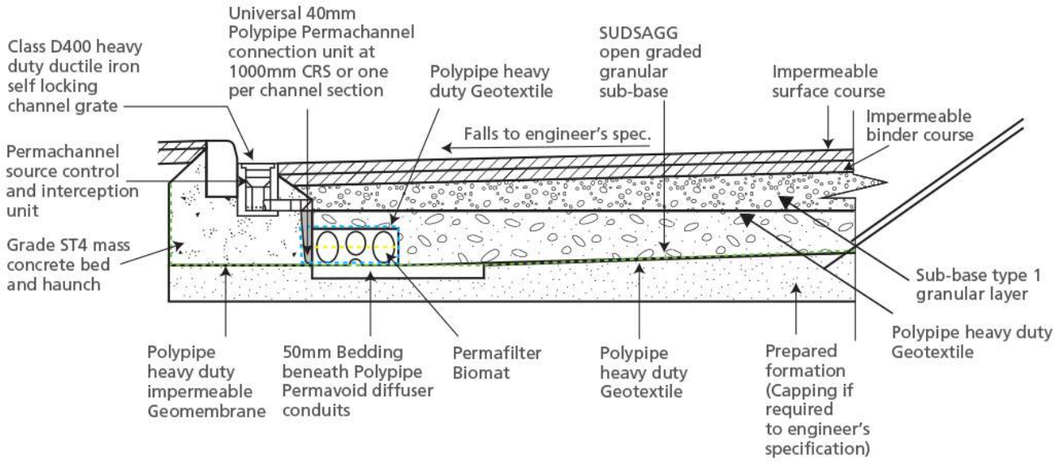


Figure 8.2.2: Permavoid with Permachannel SuDSAGG attenuation detail (drawing no. PV_SD_AT_PC_002)



CAD drawings are also available on the website toolbox.

Figure 8.3.1: Permavoid with Permachannel deep cellular attenuation detail with Medium Duty Biomat (drawing no. PV_SD_AT_PC_003)

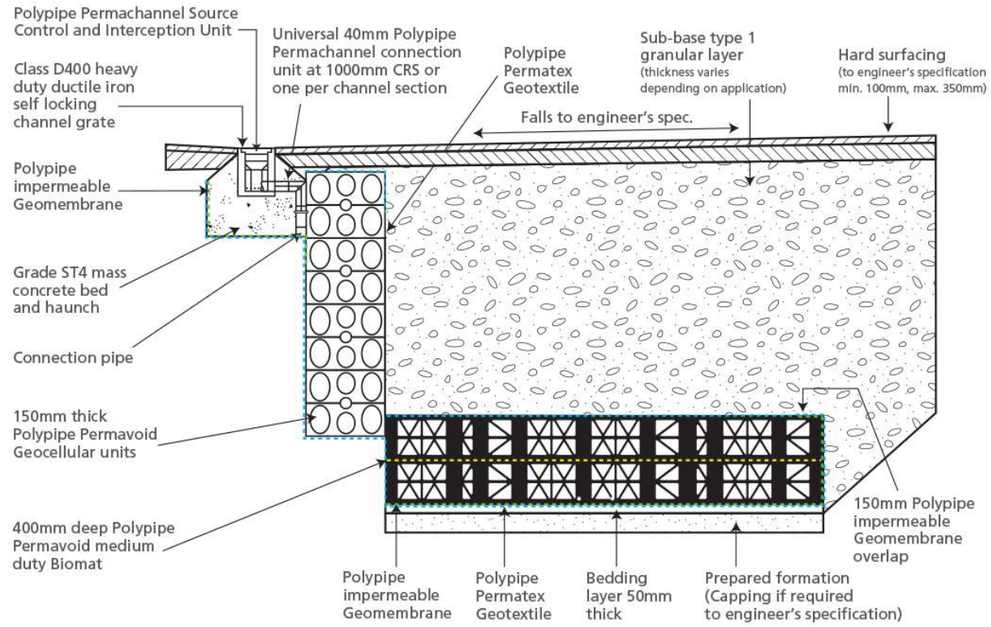
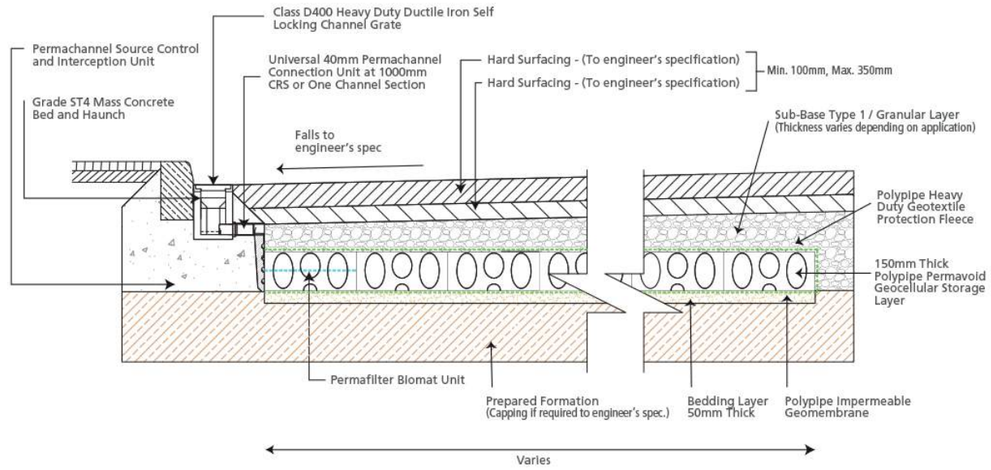


Figure 8.3.2: Permavoid with Permachannel shallow cellular infiltration detail (drawing no. PV_SD_IN_PC_001)



CAD drawings are also available on the website toolbox.

General design details

Figure 8.4.1: Permavoid with Permachannel SuDSAGG infiltration detail (drawing no. PV_SD_IN_PC_002)

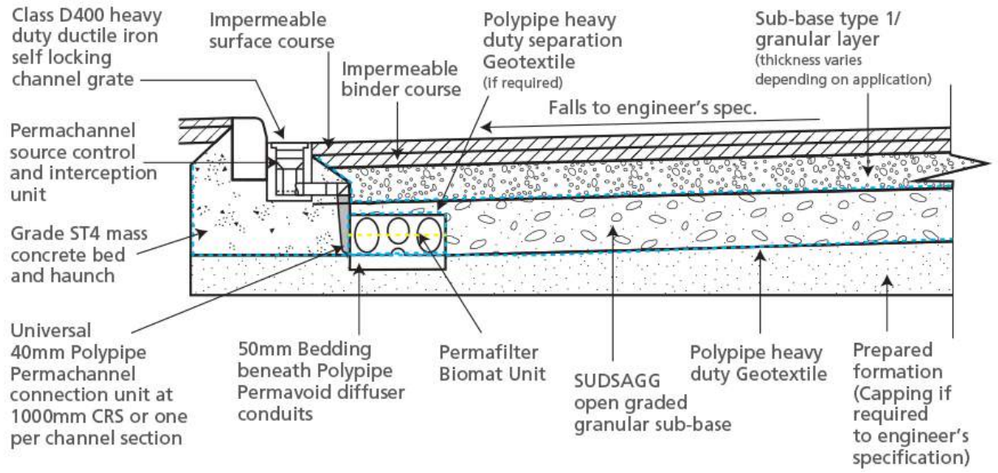


Figure 8.4.2: Permavoid with Permachannel deep cellular infiltration detail (drawing no. PV_SD_IN_PC_003)

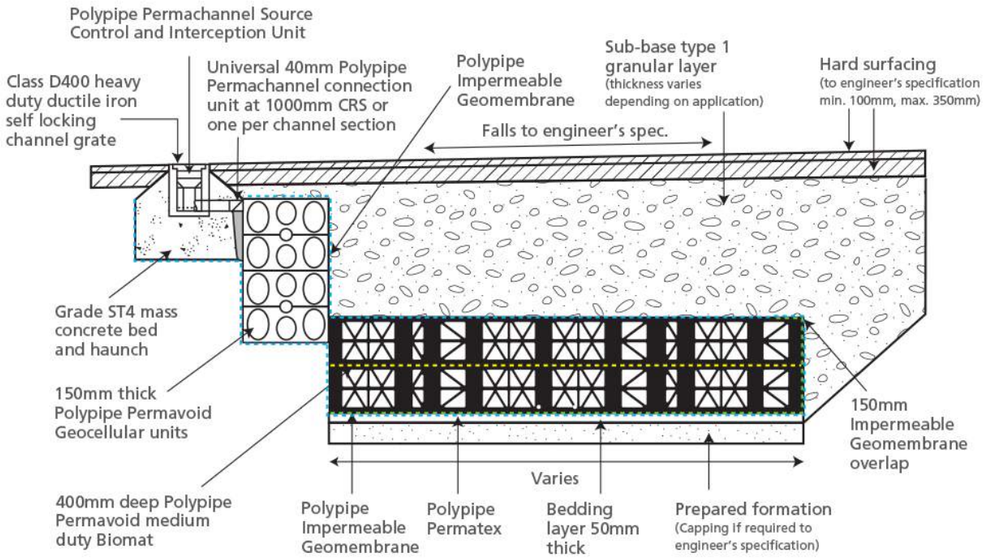


Figure 8.5.1: Permavoid with Gullyceptor detail (drawing no. PV_SD_ID_GC_001)

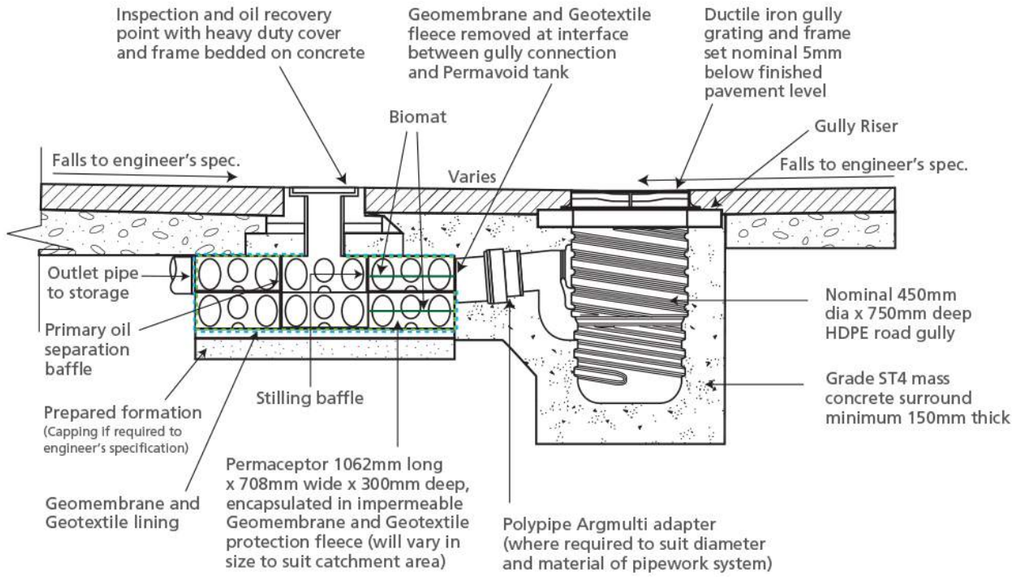
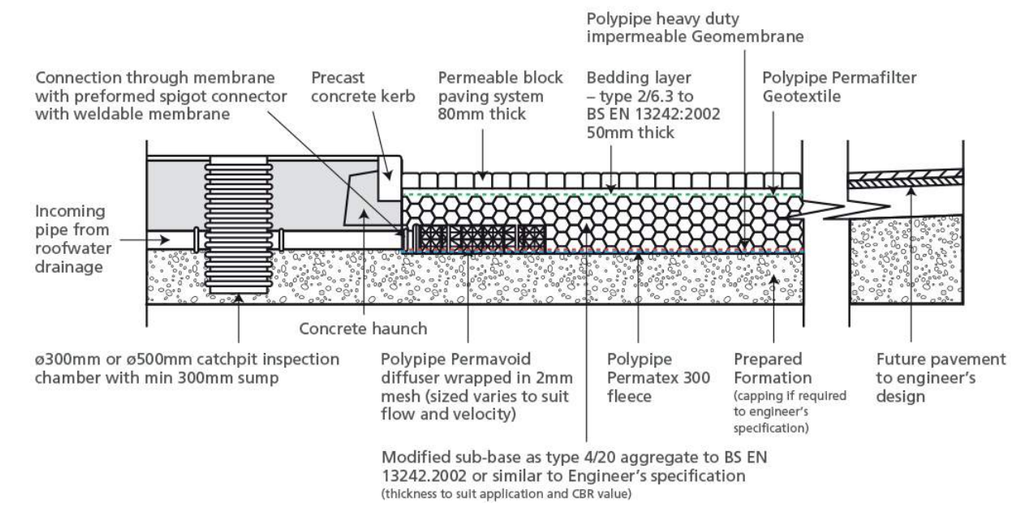


Figure 8.5.2: Permavoid rainwater pipe connection detail (drawing no. PV_SD_AT_MC_001)



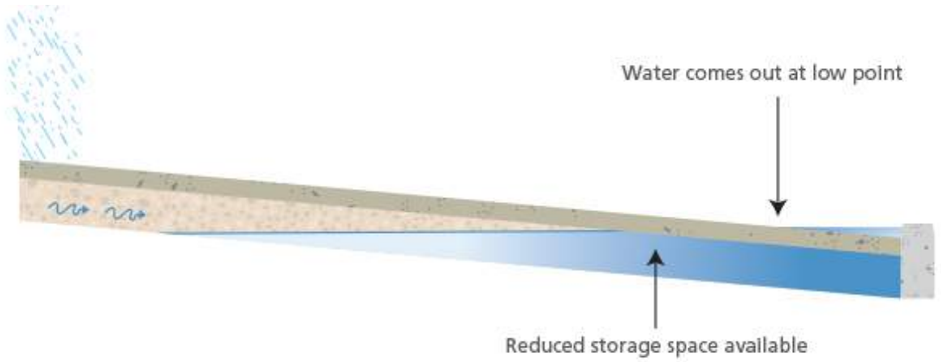
CAD drawings are also available on the website toolbox.

CAD drawings are also available on the website toolbox.

General design details

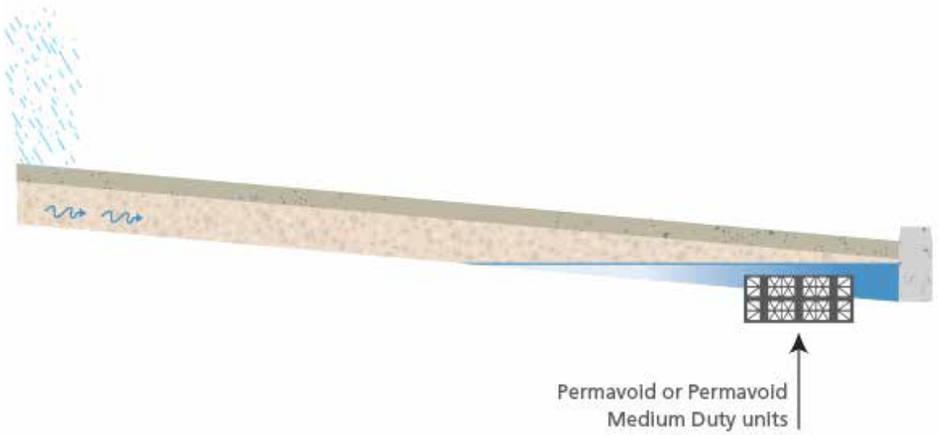
Managing permeable pavements on sloping sites:

THE PROBLEM



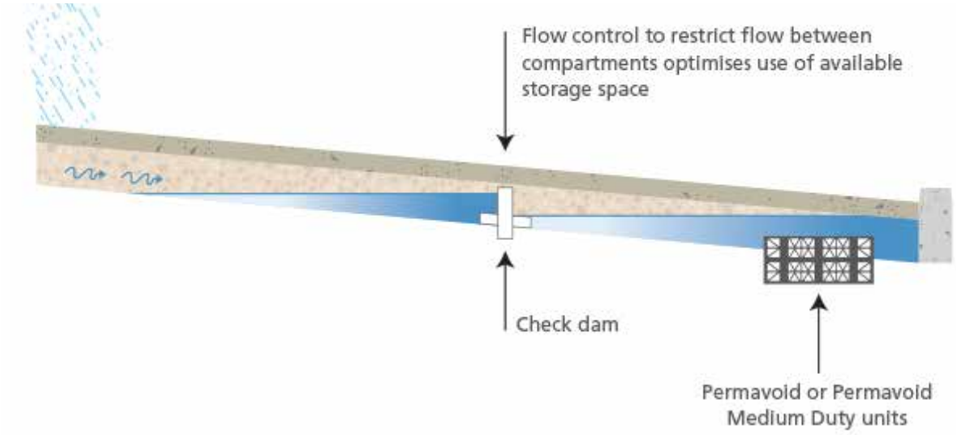
If a pervious pavement is built on a sloping site, it must be designed to prevent all the water in the sub-base running to the bottom of the slope and exiting the surface. The slope also reduces the available storage in the sub-base. The Permavoid system can be incorporated to create effective sub-catchments to control the quantity and quality of the water using various components and techniques.

SOLUTION 1



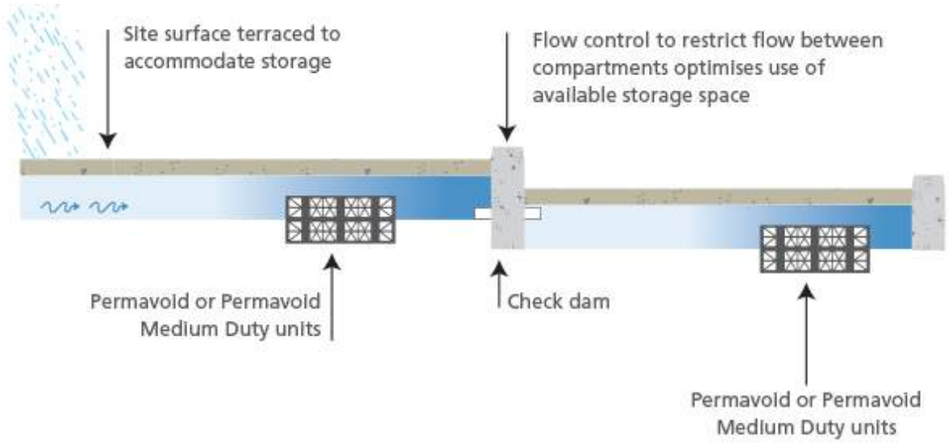
The use of Permavoid and/or Permavoid Medium Duty units at the lower end of the site to increase total storage capacity.

SOLUTION 2



Install dams as required within the sub-base with flow controls to reduce the flow down the slope. Flow control can be achieved in a number of ways including incorporating Permafoam units within the check dam.

SOLUTION 3



If practicable, terrace the site to give level areas of permeable paving separated by check dams to create manageable sub-base storage areas.

Case study - Walthamstow

Polypipe was called upon to provide a stormwater management system for the redevelopment of Walthamstow Stadium.

Working closely with main contractor Quadrant Construction and consultant engineers MLM, our Permavoid geocellular stormwater attenuation system was specified due to its ability to work perfectly as a sub-base replacement system, avoiding deep excavation at the site which contained contaminated ground and a high water table.

Located on the site of the former greyhound stadium and adjacent to the River Ching, the Walthamstow Stadium development boasts 294 new homes that incorporate sustainable drainage features, including brown roofs and permeable paving.

Utilising the high strength Permavoid system, we designed and supplied the system beneath 4,500m² of permeable paving to provide 1,500m³ of stormwater attenuation to meet the requirements of the Environment Agency.

The design featured 150mm deep Permavoid cells, with Permafilter geotextile laid on top between the cells and the permeable paving. The Permafilter acts as a barrier to capture and treat surface water run-off at source from the permeable paving above, before entering the tank. The sides and the bottom of the tank were wrapped in a geomembrane to allow for stormwater to be attenuated, before discharging at a rate set by the Environment Agency into the river with the use of flow control devices. In areas of hard standing, without permeable paving, Permachannel and Permavoid Biomat were installed to capture, treat and attenuate surface water run-off.

The Permavoid system is capable of handling rainfall in the event of a '1 in 100' year storm, and reduces urban stormwater run-off from the site by 80%.

Despite being so lightweight, the strength of the Permavoid cells allows them to support structural loads across heavily trafficked areas, making them suitable to withstand the compressive and dynamic loads produced by vehicles at the site.

Case study - Coronation Street

A shallow stormwater management system using Permavoid was specified for use as part of the construction of the new Coronation Street set.

Working closely with the construction company, The Carey Group Plc and international consultancy and construction company Mace, our supply and install partner, SEL, undertook an evaluation of the site and its ground conditions. They recommended a Permavoid system to provide a shallow solution, due to the site being on brownfield land, having a high water table and a shallow outfall.

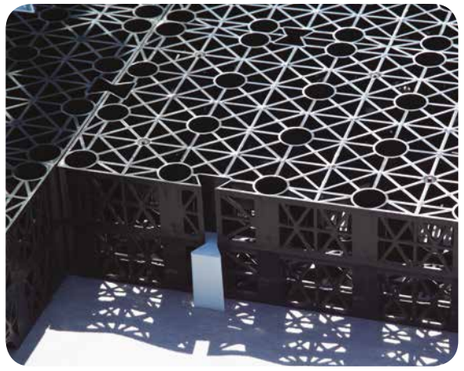
The shallow depth of the solution not only negated the need for pumping stations, it also reduced the need for temporary works, which in turn reduced installation and labour costs as well as Health and Safety risks.

The project saw 28 separate Permavoid attenuation tanks installed throughout the site, providing a combined storage capability of 420,000 litres.

High strength Permavoid cells were combined with strategically located Permachannel and Permavoid Biomat cells for the capture, treatment, storage and controlled discharge of rainwater at source.

Permachannel acts as both a surface water collection point and a treatment system that intercepts silt and oil with a zero gradient at pavement level. Water is then discharged from the side of each Permachannel into the Permavoid cells, complete with Permavoid Biomat and Permafilter for further treatment and storage, allowing only treated water to be discharged into the local watercourse.

The system incorporates a unique jointing mechanism that forms an interlocking 'raft' that will support structural loads across the most heavily trafficked areas, such as those found at the Coronation Street set.



Product summary

Product Summary	WATER CAPTURE	TREATMENT	INFILTRATION	ATTENUATION	RETENTION (RE-USE)	
PERMAVOID 85mm & 150mm	✓		✔	✔	✔	Geocellular storage unit used to capture water for retention, attenuation or infiltration.
PERMACHANNEL	✔	✔	✓	✓	✓	A combined run-off collection, silt/oil interceptor and treatment system.
PERMACEPTOR	✔	✔	✓	✓	✓	A combined run-off collection, silt/oil interceptor and treatment system.
PERMAVOID BIOMAT		✔	✓	✓	✓	Used with Permavoid, Permachannel and Permaceptor to provide additional water treatment and storage.
PERMAVOID MEDIUM DUTY WITH BIOMAT		✔	✓	✓	✓	Geocellular storage unit for use with Permavoid, Permachannel, Permaceptor and Polystorm to provide additional water treatment and storage.
PERMAFILTER		✔	✔	✓	✓	Specifically designed for hydrocarbon treatment.
GEOMEMBRANE				✔	✔	Impermeable membrane used for retention and attenuation.
PERMATEX 300			✔	✓	✓	A geotextile designed to protect and separate Permavoid geocellular layers.
PERMAVOID WICKING	✓				✔	Formulated to provide passive irrigation to soft and landscaped areas.
PERMAFOAM	✓			✓	✔	Phenolic foam filled Permavoid geocellular unit used for irrigation and flow regulation.

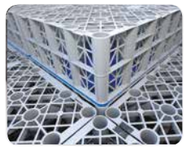
✔ Key Primary Application

✓ Additional Application

Associated products

Permavoid

A sub-base replacement geocellular water management system for use at shallower depths.



Polystorm

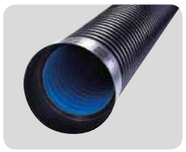
A geocellular system used for retention, attenuation and infiltration at deeper depths.

Ridgistorm-XL

An engineered, large diameter pipe solution for surface water, foul water and combined sewer applications.

Rainstream

Rainwater re-use systems for both commercial and residential applications.

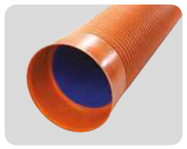


Ridgidrain

A high strength HDPE surface water drainage piping system, used for surface and sub-surface drainage applications.

Polysewer

A PVCu sewer pipe system available in sizes 150mm-300 mm.

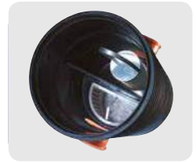


Ridgisewer

A highly durable and versatile polypropylene sewer pipe system, available in sizes 400mm-600mm.

RIDGISTORMCheck

Flow control chambers available with pre-fabricated vortex flow controllers and orifice plates.

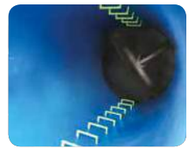


RIDGISTORMSeparate

A range of upstream catchpits and silt traps to separate slit and other particles before entering a drainage system or the environment.

RIDGISTORMControl

A range of pre-fabricated chambers with flow control components such as Gate Valves, Flap Valves and Penstocks.



RIDGISTORMAccess Manholes

Pre-fabricated manholes to provide easy access into a pipeline.

RIDGISTORM-X4

Advanced 4 stage water treatment system.

Landcoil

A land drainage system for the management of excess land water.

Cable protection

Protects cables and conduits carrying power, motorway communications, lighting and utilities in almost every application.

Enabling sustainable building technology

At Polypipe, we provide plastic piping systems that enable the effective installation and performance of sustainable building technology, helping meet the twin global challenges of carbon reduction and water management.

Water management solutions

Roof to River

Offering a comprehensive range of standalone and modular SuDS products, rainwater harvesting and surface water treatment solutions plus legislative and technical support services, our Water Management Solutions Team address the requirements of every construction and civil engineering project.

Carbon efficient solutions

Sustainable indoor environments

Ever stricter building regulations and ever more environmentally conscious customers are driving the demand for greener building products and technologies. We fulfil that demand with a full range of systems that enable collection, transmission, emission and control in heating, ventilation and cooling systems.

Sector focus

Our product systems respond directly to sector-specific requirements thanks to focused Technical and Development Teams with hands on expertise in the following areas:

Civils and infrastructure

Delivering performance and sustainability, our surface water drainage and cable management systems, supported by our in-house Fabrications Team, offer civils and infrastructure project planners a complete suite of solutions.

Residential

We offer the broadest range of residential product and service solutions for both new build and RMI applications, as well as innovative solutions in response to legislative and industry targets for more sustainable housing.

Commercial

Major commercial projects from car parks and high rise office blocks to hospitals, educational premises and shopping centres have all benefited from our range of value engineered products and comprehensive service support.

Literature and website

Literature

All of our literature is available at www.polypipe.com/toolbox

Product literature

Civils & Infrastructure Product Guide

Civils & Infrastructure Pocket Guide

Ridgistorm-XL Technical Manual

Polystorm Technical Guide

Solutions literature

WMS Sector Brochure

Rail Solutions Brochure

Market sector literature

Additional market sector literature is available, please visit www.polypipe.com or contact the telephone numbers appearing under each brochure.

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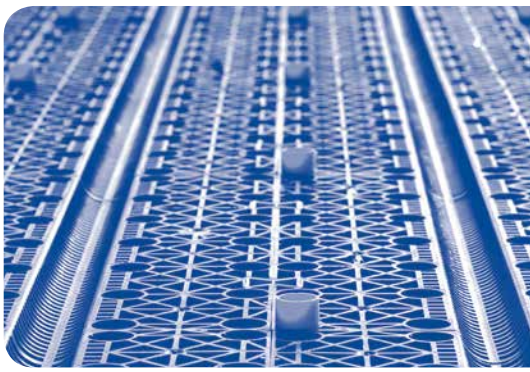
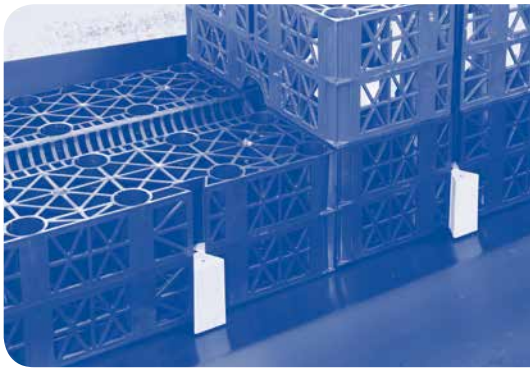
Permavoid System Technical Manual





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