

### Overview

**With the onset of increased urbanisation and the impact of changing climate on the built environment there is increasing pressure being placed on installed drainage and sewage systems to the point where we are seeing increased flood events within cities throughout the UK.**

Regulatory authorities, developers, architects and designers must now consider strategies of how to mitigate such flood events as part of a wider SuDS strategy that shall increase the resilience of our cities to the point where we shall be able to live successfully with water run-off.

### The Principle of Source Control

As part of the overall SuDS strategy for an environment, the principle of source control is becoming more prevalent. Put simply, this means managing rainwater at the point at which it falls. Traditionally we have tried to remove rainwater as fast as possible to an underground drain/sewer however with increased intensity rainwater events this is now placing stress on our underground infrastructure. With source control the rainwater is captured, stored and released at a controlled rate.

### Source Control at Roof Level

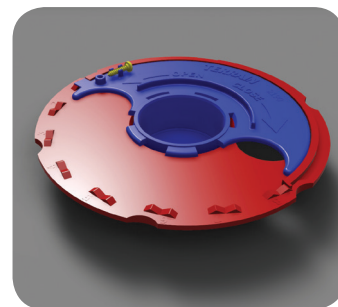
There are two broad engineered SuDS solutions for source control at roof level. The first is a blue roof whereby water is captured, attenuated and released at a known reduced flow rate back in to the underground system. The second is a green roof whereby water is captured, stored and re-used to promote growth of plants at roof level. This solution is often limited due to the amount of water that can be stored in the roof build up. There is now a new system available that promotes a third method of source control at roof level – Blue/Green roof. In this method water is captured, stored at a requisite level and through a patented passive irrigation method, rainwater is used to promote growth in a more efficient way, akin to a natural environment; by early introduction in to the design process additional benefits of biodiversity replacement and creation of amenity can be easily achieved providing a sustainable soft landscape roof environment for current and future generations.



### Permavoid Rainwater Interception System

The Polypipe Permavoid system is capable of being used in both a blue roof and a blue green roof system. At it's core are two polypropylene attenuation cells of 85mm and 150mm depth which allow for shallow attenuation at roof level; the void ratio of each cell is 95:5. The cells come as individual units but can be connected together to form a structural raft where the water is to be stored. They can be stacked to form deeper areas of attenuation or weir areas and, once the attenuation build up is complete the roof area can be given over to amenity spaces such as pathways, mechanical/ electrical plant such as PV cells (with our unique bolt down attachment) or green environments – or a mixture of all 3. As can be seen, the system is flexible, allowing architects, landscape architects, consultants and contractors to achieve the desired spaces.

Controlled drainage to the underground drain is through the Terrain flow control outlet which has been designed to provide reduced flows in to a rainwater pipe. The outlet has several flow restriction positions and can be adjusted and then fixed to meet the required prescribed Environment Agency flow rate from the building.



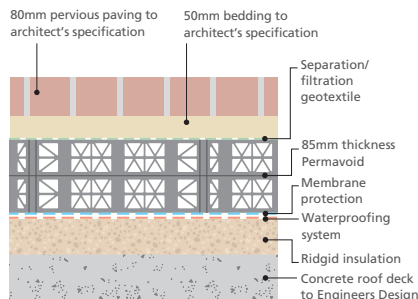
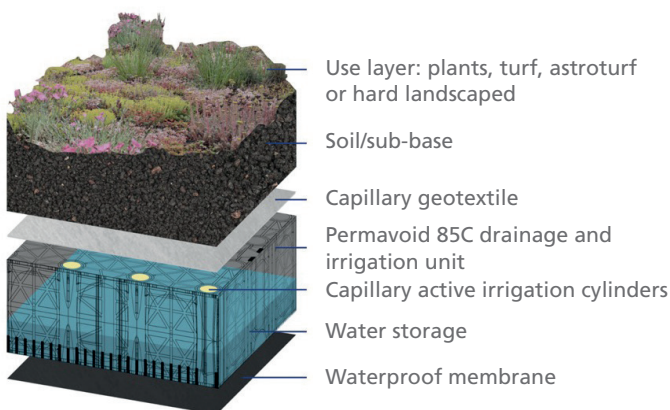
### Permavoid for Blue Roofs

In this application the permavoid system is used to create a volume void where rainwater is stored at roof level before being returned to the underground drain through the Terrain Flow Control Outlet.

As the image above shows, the system can be installed in both warm and cold roof build ups and because the system forms a structural raft, the build up above the units can be as little as 50mm for un-trafficked paved areas. In addition, as the connected Permavoid Cells form a structural raft, the Permalock system allows for roof furniture - railings and plant, such as photovoltaic cells, to be fixed to the structural Permavoid raft without detriment to the roof waterproof membrane.

### Blue/Green Roof

In this application the Permavoid passive irrigation system is used to create a natural green roof environment that provides water to plant roots as it would be provided in a natural environment, creating soft landscaped areas.



The passive irrigation method of growing plants and grasses uses an inert porous medium to deliver water and oxygen to the root zone by capillary action. The Permavoid system is again used to create a volume void where the captured rainwater is stored. This rainwater can then be used to irrigate the soil held above the void which in turn allows the plant roots to take up the water as and when required. During installation the Permavoid passive irrigation cell raft is covered with a proprietary wicking geotextile that shall supply water, on demand, across the structural raft to irrigate the growing medium. The flora and vegetation planted within the growing medium shall still have access to minerals and nutrients which help to develop a healthy root system.

As an engineered blue/green roof system we work closely with landscape architects to ensure that the planted landscape's requirement with water is matched to the volume of water stored and the delivery rate through the irrigation system.

### Conclusion

It is clear that our urban environments now require careful consideration in design and an integrated SuDS approach to the management of surface water. By controlling water at source we are preventing problems occurring downstream of the source where, typically, flood events occur.

The Polypipe Permavoid system can be utilised as a source control system at roof level for both Blue roof applications – capture, attenuate and control blue/green roof applications and capture, store and re-use as nature intended. In both instances the structural Permavoid raft allows the use of Permafix couplings to provide fixing to the raft for railings, roof furniture and mechanical plant. As such it is an essential part to the overall SuDS train which, if co-ordinated with other SuDS principles shall significantly mitigate the effect of uncontrolled surface water within our built environment leading to less flood water damage and increased city resilience.



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