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CLIMATE RESILIENT CITIES WITH HEALTHY URBAN TREES

sustainable growing sites with stormwater management

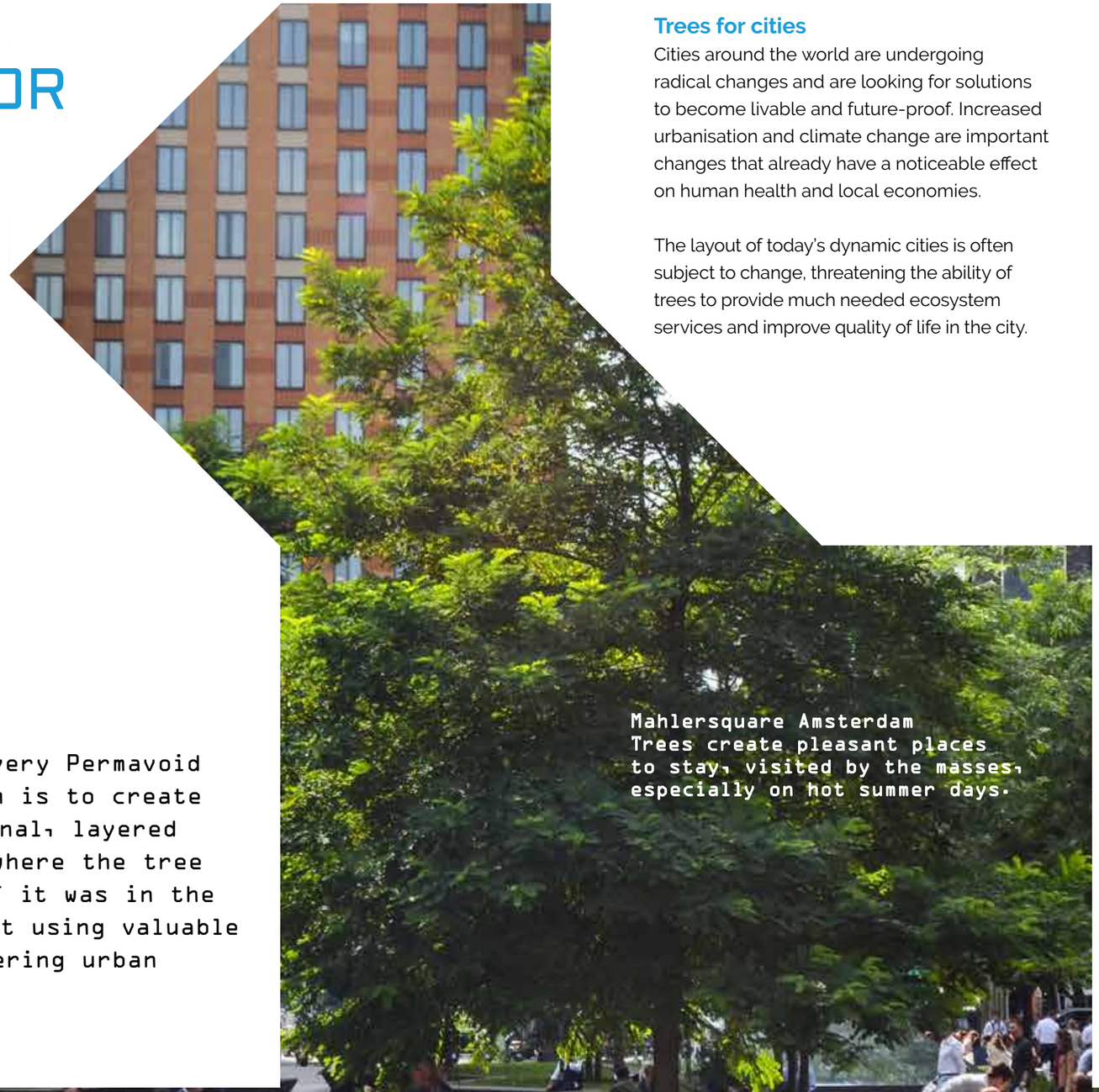
permavoid
the Foundation for our Future

PERMAVOID SOLUTIONS FOR URBAN TREES

Challenges

In the past decade, the multiple functions that trees provide to the urban environment have become much more evident, highlighting the need for suitable growing sites for trees.
A good growing site allows the tree to perform these much-needed functions to the maximum potential. Permavoid systems for urban trees create these sustainable growing sites and have been used in cities since 2000. Based on the experience of countless completed projects, continuous product and system development supported with independent scientific research, future proof and sustainable growing sites can be incorporated and created in the densest of urban situations.

The goal of every Permavoid Subbase System is to create a multifunctional, layered urban design where the tree can grow as if it was in the forest, without using valuable space or hampering urban functionality.



Mahlersquare Amsterdam
Trees create pleasant places to stay, visited by the masses, especially on hot summer days.

Trees for cities

Cities around the world are undergoing radical changes and are looking for solutions to become livable and future-proof. Increased urbanisation and climate change are important changes that already have a noticeable effect on human health and local economies.

The layout of today's dynamic cities is often subject to change, threatening the ability of trees to provide much needed ecosystem services and improve quality of life in the city.

Frequently described and reported positive effects of ecosystem services include:

- Capture of particulate matter (air-filtration)
- Oxygen production (photosynthesis)
- Carbon sequestration (carbon compensation)
- Evapotranspiration (urban cooling)
- Shade (urban heat island reduction)
- Support biodiversity
- Improve human well-being
- Increase real estate value

Urban foresters, architects and project developers experience a growing challenge to give both existing and new trees a fighting chance in the city. The challenge for existing trees is to protect them in the changing city during (re-)construction and for new trees, creating sufficient growth space in the already busy landscape below ground is an increasing challenge.

This has led to the realisation that the core of successful and functional trees in the city lies not in quantity but in quality. This includes the quality of the trees and of both the above ground and sub-surface growing site. The challenge for urban foresters and arborists is to optimise the underground growing site within the given urban circumstances and possibilities, such that above ground, the tree can grow and fulfill its important role by enhancing the climate and future proofing the urban environment.

IN NATURE ALL
MATTER IS RECYCLED
AND NOTHING IS WASTE

NATURE AS SOURCE OF INSPIRATION

The most beautiful growing place for a tree is in uncompacted natural circumstances, just like in a forest. Rainwater can infiltrate and remains available for the tree. Organic material is converted into nutrients in a cyclic process and there is no major soil disturbance in, or compaction of, the rootzone.

In the city rainwater is drained through often overloaded sewers. Consequently, trees lack water during the growing season, the soil is compacted due to traffic loading and regular underground infrastructure maintenance damages roots.

The goal of a future-proof growing site is to create a location for unhampered tree growth for the lifespan of the tree, without sacrificing valuable urban space needed for parking spaces, bicycle paths and walkways. The added goals of the future-proof growing site are to create energy neutral and drinking water saving systems to sustain a healthy urban forest.

This is achieved by combining and stacking different symbiotic urban functions: rainwater management, root growth, urbanity and the trees ecosystem services are all realised in one and the same place.

permavoid

FUTURE-PROOF GROWING SITES

Fit for trees

In order to create a growing site capable of facilitating healthy tree growth for many decades, the following fundamentais must be considered:

1. Loadbearing capacity; capacity to support the hardscape and traffic loading, without compacting the rootable soil.
2. Water availability; enough during summer but without flooding the root system during rain.
3. Gas exchange; O_2 must be able to enter the soil and CO_2 must be allowed out.
4. Soil organic matter; to release nutrients and support the survival of soil biology.
5. Volume; to support tree growth and stability for the designed lifespan of the tree.
6. Protection; from urban disruptions in the rootzone such as works on underground utilities.

Prevent costly pavement damage

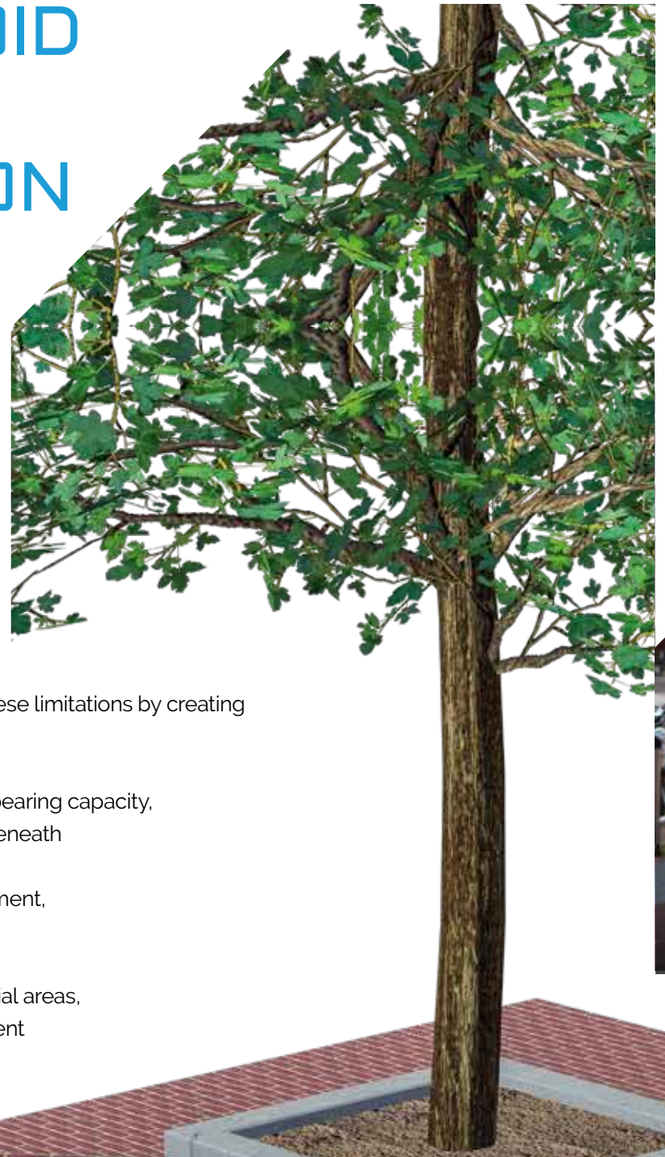
A future-proof growing site is not only about the tree. Permavoid growing sites are designed such that the tree no longer causes costly and potentially dangerous damages to the pave-ment. The nuisance of frequent and reoccur-ring pavement repairs become a thing of the past. With Permavoid roots are prevented to grow where they may cause damage, seperated from the pavement with a layer of air, while providing them a suitable place to develop and flourisch, away from the paved surface.

Schematic overview of ecosystem services and the necessary growing site functions to sustain tree growth in the urban environment.

Prevent pavement damage.

THE PERMAVOID SANDWICH CONSTRUCTION

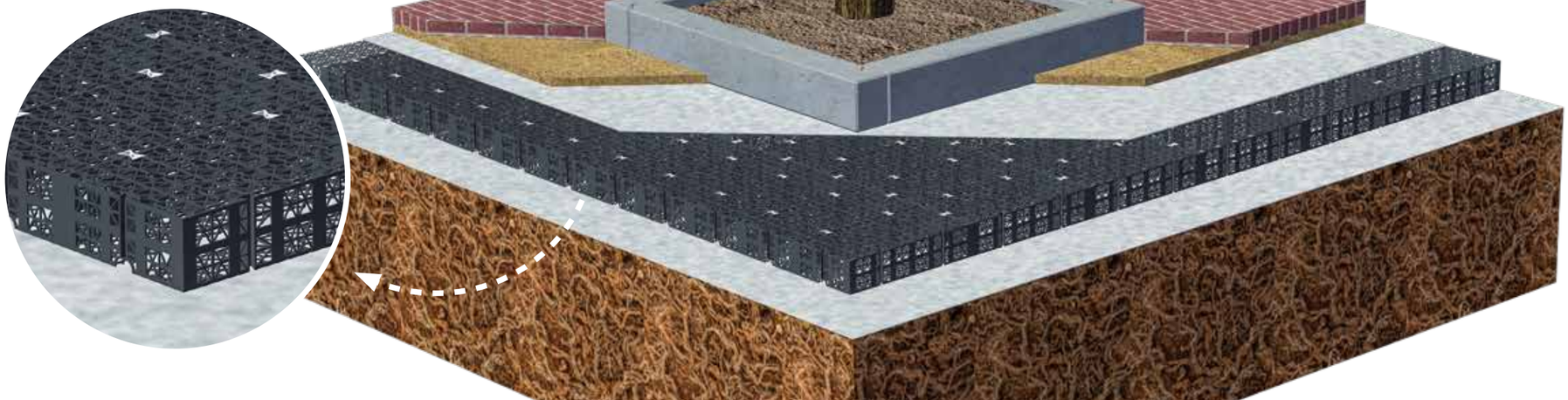
In a situation where trees are expected to grow in a paved environment, compaction of the soil, superficial tree roots damaging the pavement and a greatly reduced gas exchange with the soil are known growth-limiting factors.



The Permavoid Sandwich Construction eliminates these limitations by creating a stable and open raft underneath the pavement to:

- Ensure optimum load distribution and high load bearing capacity, preventing compaction of the rootable volume beneath
- Optimise gas exchange with the rootable soil
- Prevent roots growing directly beneath the pavement, thus preventing pavement damage

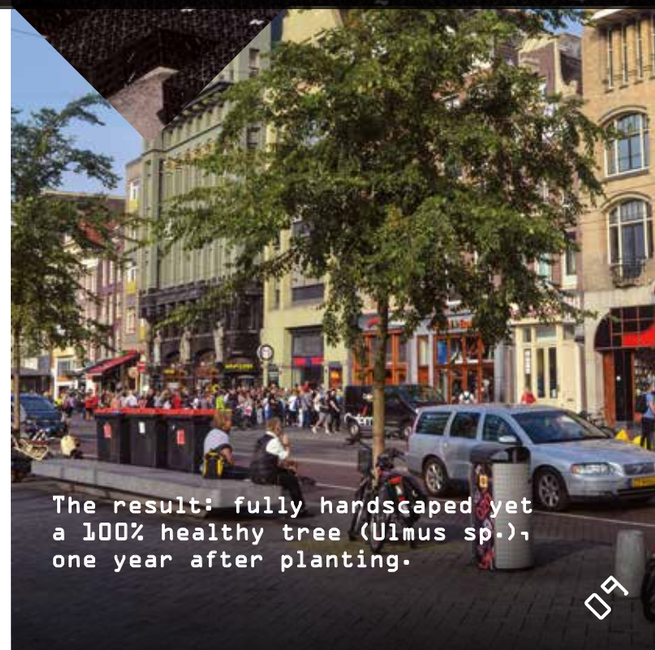
The system is therefore used in parking lots, residential areas, malls and bicycle paths, with a free choice of pavement systems like block pavers, concrete or asphalt.



The Permavoid 150 mm units have been specially designed with a very high compressive strength and rigidity for the application almost directly beneath the pavement, making the Permavoid Sandwich Construction ideally suitable in shallow applications for parking spaces, urban squares and other hardscapes. A typical detail for car parking, bike paths and walkways comprises 50 mm of bedding and 80 mm of pavement on top of the Permavoid units. Due to the system of individual and conically connected units, the system can be used in all possible forms and sizes, with minimal excavation and material movement to and from the construction site.

Permavoid Sandwich Construction used in a streetscape with newly designed and created elevated soil levels in the village of Geldrop, The Netherlands.

Construction of the shallow Permavoid Sandwich Construction beneath the Damrak pedestrian area along one of the main touristic routes in Amsterdam.



The result: fully hardscaped yet a 100% healthy tree (Ulmus sp.), one year after planting.

Suitable soil

The Permavoid Sandwich Construction has to be used in combination with a suitable soil. This soil is characterised by a narrow bandwidth in grain size distribution, enabling it to transfer applied loads to the subgrade below the rootzone without further compacting the rootzone. It has sufficient organic material to provide the tree with nutrients for a longer period of time, enables rootgrowth in the entire volume and facilitates soil gas exchange. These types of soils are referred to as (Amsterdam) Tree Sand or Sand Based Structural Soils depending on the country of installation.

The quality of the applied Tree Sand and correct application are essential and integral requirements of a successful growing site for trees with the Permavoid Sandwich Construction. These soil mixes can be acquired from a local soil distributor based on generalised non-proprietary functional characteristics. More details on the soil specifics are available upon request.

Mulching, just like in the forest

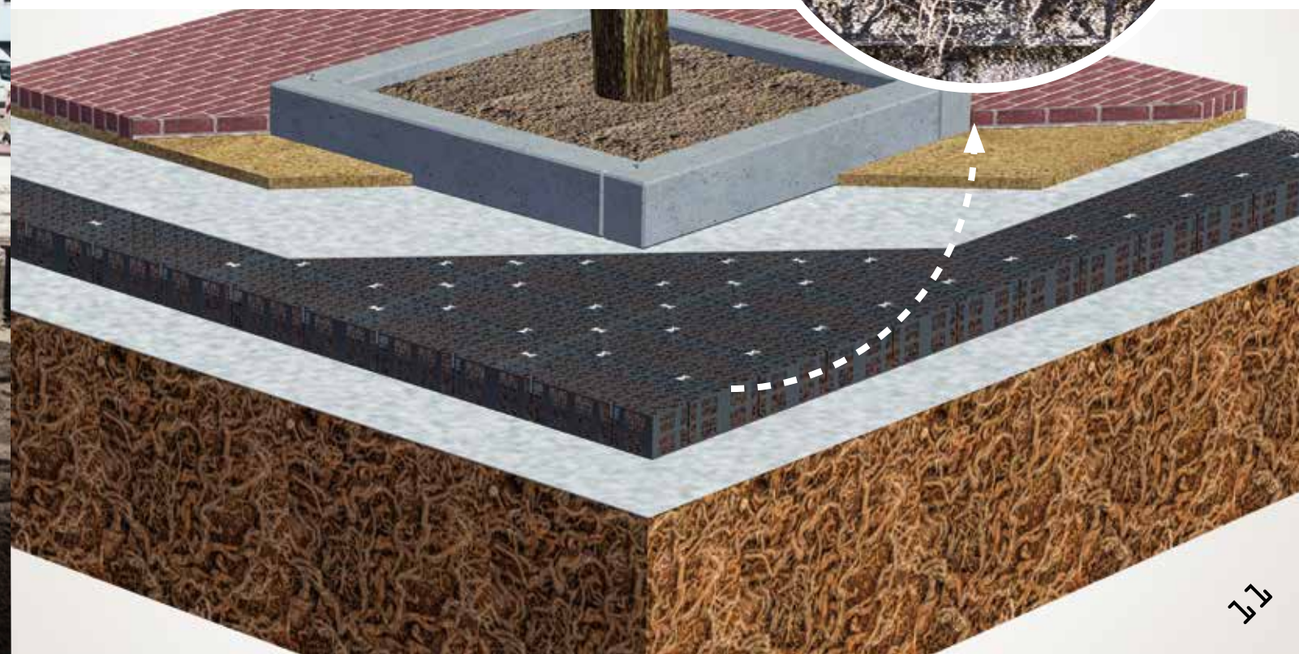
It is possible to fill the Permavoid units with a very organic rich soil. This soil will simulate the natural mulch layer in a forest and slowly release nutrients to the substrate as rainwater passes through, for absorption by the tree roots. Certainly, in profiles with limited rootable volume due to restricted depth or high groundwater levels, this option optimises the available space to sustain tree root development under the hardscape.

Six and ten years after construction a part of the Permavoid Sandwich Construction with a mulch infill was excavated to monitor soil conditions and root growth in de Jan Olphert Vaillantlaan in Amsterdam.

In the mulch only fine roots were found and soil compaction underneath the Permavoid units remained stable at 2.0 MPa (same as during construction). No damage to the hardscape was detected anywhere. The growth of the planted elm trees surpassed expectations, necessitating pruning every 3 years instead of once every 5 years.

The Permavoid Sandwich Construction placed on top of Tree Sand.

In Emmeloord a tree lined car-parking is being created. The difference between normal subbase material (yellow) and specific tree sand (brown) is clearly visible.



For new and existing trees

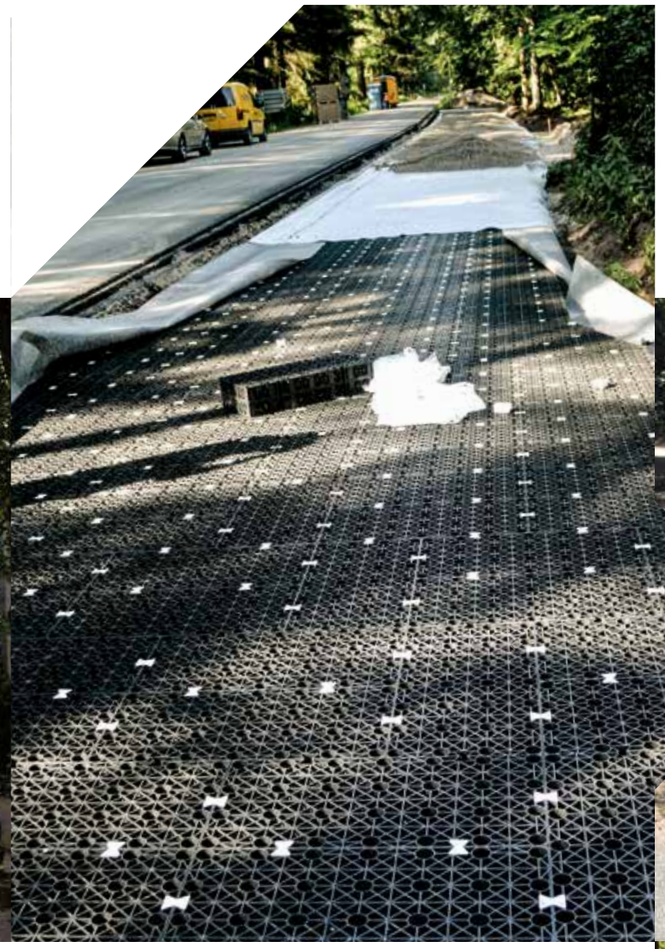
The Permavoid Sandwich Construction can be used with new and existing trees. For existing trees where a previously open growing site is to be converted into a (partial) hardscape, Permavoid's superficial placement is very favorable since the underlying root system in the existing soil profile is not adversely affected. The high-strength, rigid and lightweight Permavoid 'raft' allows for changes in grade, without changing the underlying soil profile, compaction or aeration. Permavoid as shallow subbase replacement has the additional advantage that, when compared with conventional construction techniques, labour and the supply and removal of materials are minimized and no heavy machinery is necessary for construction. In situations with existing trees where the available profile is too shallow for the 150 mm Permavoid units, the Permavoid 85 mm units can be used as an alternative.

Tolhuistuin Amsterdam. The Permavoid subbase is used under a semi-paved surface to protect the roots of a monumental London Plane tree when transforming a former garden into an event area.

Jan Olphert Vaillantlaan, Amsterdam, trees in a fully paved cityscape, 13 years after being planted in the Permavoid Sandwich Construction. Fantastic tree growth and zero pavement damage.

Bicycle paths through city, forest and park

The Permavoid Sandwich Construction is used as a hollow subbase for bicycle paths to prevent soil compaction and permanently facilitate soil gas exchange. It can also be used to infiltrate rainwater harvested from the paved surface as a source of irrigation water. This way the construction of bicycle paths through existing green landscapes does not change the functionality of growing sites, encouraging the continuation of existing tree growth. The shallow application of the system makes it possible to retain the existing soil profile and the root system of the trees and reduces the amount of material that must be supplied and removed for construction.



Bicycle path Oosterhout where water detention and infiltration are of particular importance.

Epe Heerdeweg. A floating bicycle path. For bicycle paths through existing green infrastructure, the shallow application and the lightweight construction are of particular importance in order to prevent damage to the rooted profile.

CHANGES IN STORMWATER MANAGEMENT TREES AND WATER

The combination of urbanisation and climate change has a profound effect on rainwater management in the city. Paved landscapes and real estate developments replace former green infrastructure and impede rainwater infiltration into the soil. Instead, stormwater is forced into overloaded sewer systems, creating urban floods during the increasingly frequent peak rain events.

The fact that trees can reduce the urban heat island effect is known, but the amount of water needed for these trees to actually do so is often underestimated. Without available water, the tree cannot grow or evaporate, where evaporation of water is the important mechanism that produces the cooling effect. In addition, trees often drop part of their leaves in the event of a persistent drought, which in turn reduces shadow (read 'cooling') created by the tree.

If, on one hand the sewers become overloaded during peak rain events and on the other trees in the city fail during prolonged drought, the most elegant solution is to temporarily store that 'excess' rainwater near the tree, so that this water is available to the tree during drought.

Collect, store & return

This is exactly what the Permavoid Capillary Irrigation Systems do. Just like in nature: collect, store and return rainwater to the trees, without the use of energy, pumps or valves. Whether they are growing in open soil or paved circumstances, trees become an integral part of urban rainwater management. The key to Permavoid's success is balancing stormwater availability and potential tree-evaporation with irrigation based on natural capillary rise from below, thus preventing flooding of the growing site each time it rains.

Rainwater is no longer regarded as a nuisance but treated as a valuable resource needed to help strengthen and future-proof the urban forest.

Urban floods as result of peak rain events cause severe economic damage to the city and its inhabitants. Saturating the tree's root system during the growing season directly threatens tree health due to soil-oxygen displacement.

The Beatrix Park in Amsterdam is located on top of an underground parking garage. Stormwater is harvested and stored for natural irrigation of plants and trees with the Permavoid retention and capillary irrigation system. Built in 2016, this photo shows the summer of 2019.

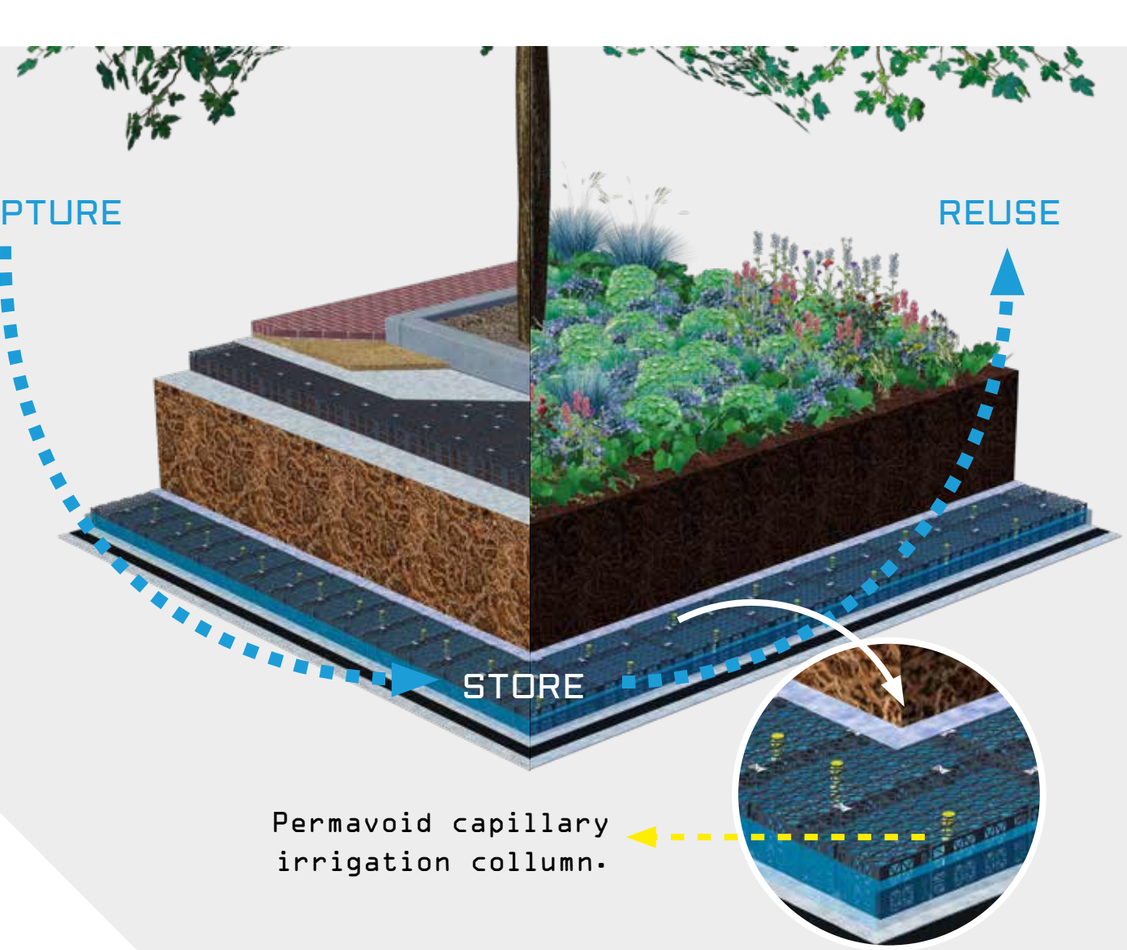
THE PERMAVOID CAPILLARY IRRIGATION SYSTEM

Experience with conventional rain garden design has shown that repeated infiltration of large amounts of rainwater through the surface of the growing site 'drowns' the root system with serious growth reduction as a consequence. Therefore, the Permavoid Capillary Irrigation System is based on a rainwater retention buffer located beneath the tree's rootable soil volume.

Mimicking nature

With the Permavoid Capillary Irrigation System an artificial groundwater level is created beneath the rootzone, mimicking the natural situation, enabling the growing site to capture, store and reuse stormwater for irrigation. In this arrangement, the trees help to prevent stormwater entering the sewer whilst simultaneously providing a water reservoir as a buffer to sustain growth during prolonged dry spells using capillary action.

The Permavoid Capillary Irrigation System is equipped with specially developed fibre cylinders that provide capillary transportation of water from the Permavoid retention buffer to the rootable soil above. This natural irrigation system uses no energy and is immune to silt. It maintains a consistant soil moisture content such that the tree experiences a very stable, steady groundwater level, allowing it to perform its functions and thrive even in prolonged periods of drought. Water to fill the buffer can also be harvested from adjacent hardscapes or rooftops.



Permavoid capillary irrigation collumn.

Orlysquare, Summer 2018.

Orlysquare, the former bus station on the roof of the Sloterdijk Train Station was converted in 2014 into a rooftop park with the Permavoid Capillary Irrigation system as drainage and water management system.

City trees and stormwater management: Integral part of climate proof urban water design

The Permavoid Capillary Irrigation System is a perfect addition to the Permavoid Sandwich Construction. The combination of these systems makes tree growth possible in paved situations, maximizing the tree's urban functionality. An important aspect of this combination is that the growing site is no longer exclusively for the benefit of the tree but is now designed and implemented as an integral part of the urban stormwater management system.

The water retention capacity in the system can be set, monitored and controlled by both the municipal arborist and water manager, since both parties have a vested interest in the ability to check, manage and control water going into the growing site, and ensuring availability for the tree in the growing season. No more guessing of available soil moisture, which all too often results in potentially dehydrating or overwatering of the tree and at the same time wasting valuable irrigation water.

The open Permavoid system can be checked with actual water level readings, visually or fully automated digital online, offering water management options for all parties involved.

In 2017, a completely paved growing site was created at the Oude Markt in Weert under a waterproofed pavement. With the Permavoid Capillary System in combination with the Permavoid Sandwich Construction, the trees have a growing site with a sufficient and reliable source of water for growth and urban cooling whist at the same time the rootable volume is protected from compaction and open for gas exchange.

Photo taken in August during the extremely dry summer of 2018.

Schematic representation of the difference between retention and detention, both of whom can be created in the Permavoid sub surface water management system.

Balancing tree growth and stormwater management

Due to its modular structure, the Permavoid system can be sized to meet the site-specific requirements of the architect and engineer. The retention and/or detention reservoir can be designed to be up to 300 mm deep in growing sites where the Permavoid Capillary Irrigation System is used. The civil engineer has the option to design the system to fit the local soil profile and available space with either smaller and deeper, or shallower and larger Permavoid reservoirs.

The urban forester or city arborist is key when determining the volumetric requirements of the reservoir to balance potential evapotranspiration with rain-water availability. The required buffer volume should be optimized to be a small as sensibly possible but sufficiently large to prevent excessive use of back up drinking water for irrigation during prolonged periods of drought.

Where the civil engineer and the arborist meet, a win-win design can be created by matching the surface area from which rainwater is harvested, with the size of the buffer and the evapotranspiration potential of the tree. The best climate-proof designs allow for both a retention and a detention volume in the buffer, to maximize the systems impact on urban flood prevention during peak rain events.

If so desired, monitoring and on-line water management controls can be added to the system to remotely monitor and control water levels and water availability to the tree. With this option a true SMART-city ready and climate proof water management system can be created.

In urban water management, a clear distinction is made between retention and detention. Retention means the permanent collection and storage (and use) of rainwater on-site, without it being drained to the sewer, groundwater or open water. Detention refers to the temporary collection and buffering of rainwater, for later soil infiltration or discharge to the sewer or open water, usually with a specified flow rate, or within a set time limit.

In Emmeloord The Permavoid Capillary Irrigation System functions both as a detention and as a retention system for the invisible management of rainwater in the growing site of the trees.

CLARIFYING YOUR OPTIONS

Every location for a tree has its own specific requirements for soil, volume, water management and urban challenges, which is why the design of the growing place is tailor-made, taking the environment, the groundwater level, the above-ground design and the available underground space into account. The system-decision-aid helps you on your way.

URBAN TREE

LANDSCAPE

GROUNDWATER AVAILABLE

Natural
situation.

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NO GROUNDWATER AVAILABLE

Permavoid Retention and
Capillary Irrigation System.

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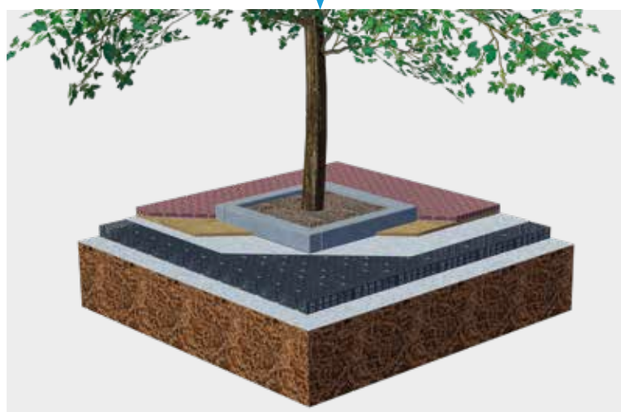
HARDSCAPE

GROUNDWATER AVAILABLE



Permavoid Sandwich
Construction.

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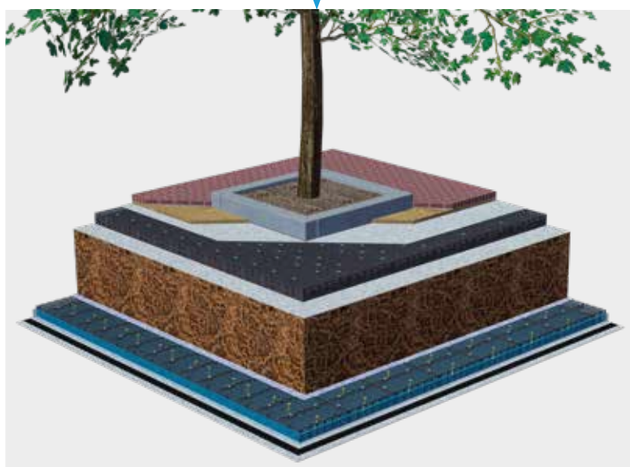
NO GROUNDWATER AVAILABLE



Permavoid Sandwich Construction
with Retention and Capillary Irrigation System.

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A CLOSER LOOK: PROJECT TREESQUARE IJBURG

On the Islands of IJburg in Amsterdam new housing is being created for 65.000 new inhabitants. The project consists of 7 man-made islands. Construction commenced in 1999 and is expected to be finished in 2030. Following 3 years of natural settlement of the sand, the fourth island was ready to be built up in 2017. The centre of the island is formed by a town square, planted with 32 oak trees growing in a grass field and was constructed and planted before the other buildings and infrastructure were built.

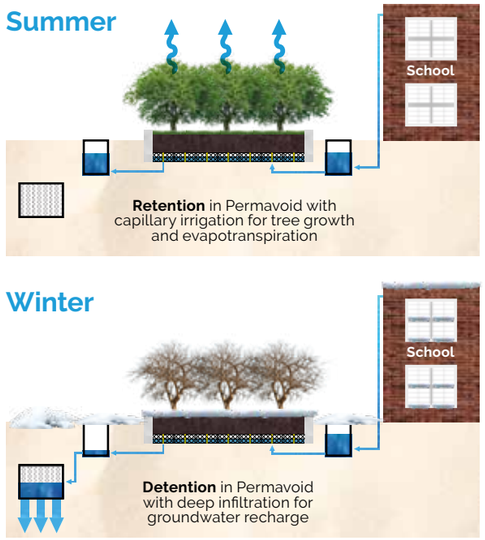
Client : City of Amsterdam
Trees : 32 Turkey Oaks (*Quercus cerris*), 8-10 m high at time of planting
Quantity : 2.500m² Permavoid 85s Retention with Capillary Irrigation System
Water storage capacity : 150.000 litres in the Permavoid Retention and Capillary Irrigation System, plus 600.000 litres as soil moisture
Water management : Intelligent water level control set at 60 mm retention or 60 mm detention, depending on the season, in the 85 mm high Permavoid system,
Applied substrate : 1 m deep Amsterdam sand based structural soil with 4% organic matter Top 20 cm fibre reinforced soil for stabilized turf application
Waterproof membrane : Permavoid Flex 700
Capillary geotextile : PermaTex CAP geotextile, used above and below the Permavoid units
Construction : 2017

Creating a tree-grown square on top of 6 meters of coarse sand is a challenge because of the speed with which rainwater drains to deep groundwater levels. The design challenge was to create a water-neutral system in which:

- The trees would be able to perform to the maximum of their eco-system-services potential
- Water shortages during the growing season are not acceptable
- The tree square was not allowed to consume mains water for irrigation
- No discharge of surplus rainwater to the sewer, at any time of the year

The designed system needed to use as little materials as possible and be reliable for a period of at least 50 years. In order to meet all design criteria, a water balance model in which all factors like precipitation, tree evaporation, tree growth, deep drainage, surface and grass evapotranspiration and rainwater interception were considered for the first 50 years. The core component of the water model is a Permavoid 85 mm rainwater detention system at 1 m depth beneath the entire treesquare. The Permavoid units were outfitted with the Permavoid Capillary Irrigation system to naturally irrigate trees with rainwater from storage. The specified goals were achieved by incorporating a 1.200 m² runoff area from an adjacent school-roof for rainwater harvesting during the growing season, and an on-site deep drainage infiltration unit to drain winter-surplus precipitation back to groundwater.

The water levels are managed by online controlled valves using the Cloud Water Control system. The Permavoid system thereby provides a dual role: water retention and capillary irrigation in summer and water detention and deep infiltration in winter. The deep infiltration unit could be minimal in size because the storage volume in the Permavoid system (200.000 l.) can be used for either detention or retention, depending on the season. The consumption of drinking water for irrigation has therefore been eliminated.



Cross section of the functioning of Tree Square IJburg in Summer and Winter. The intelligent water management system optimizes created volume usage by facilitating retention and capillary irrigation for tree growth and urban cooling in summer and detention and deep infiltration for groundwater recharge in winter.

Healthy green oasis in a desert waiting to be surrounded by new buildings and infrastructure.

A CLOSER LOOK: PROJECT MOONSQUARE HEERLEN

Moonsquare (Maanplein) in Heerlen is the central plaza in the completely rebuilt city-centre, surrounded by high rise apartment buildings. It is one of 3 interconnected rooftop parks sited above the shopping center, Central train station and a parking garage. It is intended as a place where people come together to walk or enjoy public events. Mature trees grow in specially designed mounds of lightweight soil on top of the roof over the shopping center. The entire square functions as a water collection basin with the use of the Permavoid 85 Capillary Irrigation System, and the water made available for the trees using the capillary irrigation system.

Client : Municipality Heerlen
Trees : 5 Japanese Pagoda trees (*Sophora japonica*), 8-12 m high at time of planting
Quantity : 3.500 m² Permavoid 85 Mixed Detention and Retention with Capillary Irrigation System
Water storage capacity : 5.000 liter per tree in the Permavoid retention and Capillary Irrigation System, plus 4.000 liter water storage per tree as soil moisture
Water management : 50 mm retention in the 85 mm high Permavoid system
Applied substrate : 1.2 to 1.4 m deep moderately fine sand mix with lightweight components to create the bespoke lightweight soil for rooftop applications
Waterproof membrane : Permavoid Flex 700
Capillary geotextile : PermaTex CAP geotextile, used above and below the Permavoid units
Construction : Phase I is completed (2016-2017)

Construction

The Permavoid system has been installed on the entire roof as rainwater detention system, doubling as conveyance system to bring excess water to the outflow locations at the edge of the building. The Permavoid high lateral water transport capacity negates the need for deck penetrations and the associated underslung pipework normally needed in multiple places in the middle of the roof.

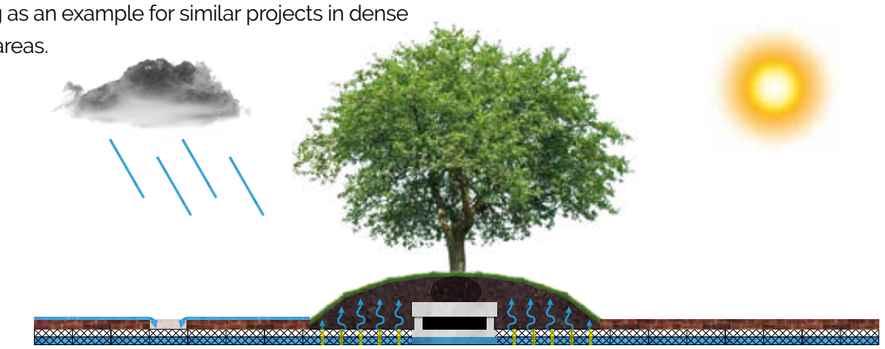
Trees are located strategically above the load bearing columns of the building underneath. Both the load bearing structure of these columns and their foundation have been designed to carry the weigh of a fully mature tree and its growing site. Soil is applied in 2 layers: without organic matter in de lower half and with up to 8% organic matter in the upper halve of the soil profile.

Part of the rainwater comes through the permeable pavement in the Permavoid detention and capillary irrigation system and will be stored underneath the pavement. Capillary fiber cylinders wick the water back to the developed lightweight soil. The trees have a double water buffer at their disposal: in the Permavoid system and as soil moisture. This prevents the trees from running out of water, creating very healthy growth under these optimal water-managed circumstances.

Award winning nature-based solution

The growing site makes tree growth possible in an otherwise almost impossible location and the trees from the connecting element between the architectural ingenuity, the local atmosphere and the quality of life at Moonsquare. Those are the reasons the design won the 'Tree Project of the Year' award in 2017, awarded by the Trade Association for Gardeners and Landscapers in the Netherlands. As a distinctive feature, it was praised that this project is low-tech, nature based, without complicated and maintenance-sensitive technology. The simplistic and climate-proof Permavoid system for rainwater retention, detention, drainage, conveyance and irrigation by capillary action is a sustainable choice, serving as an example for similar projects in dense urban areas.

Cross section of the growing site on the Moonsquare podium deck. The surface acts as a water catchment, to fill the Permavoid detention and capillary irrigation system with water for the trees. The mounds of soil are covered with grass to further increase the green character of Moonsquare.



OUR SUSTAINABLE JOURNEY

Circular thinking forms the basis of all our products and designs. This concerns both the materials used and functionality of our systems. For urban water management we collect, store and reuse rainwater on location as much as possible and minimise use of drinking water.

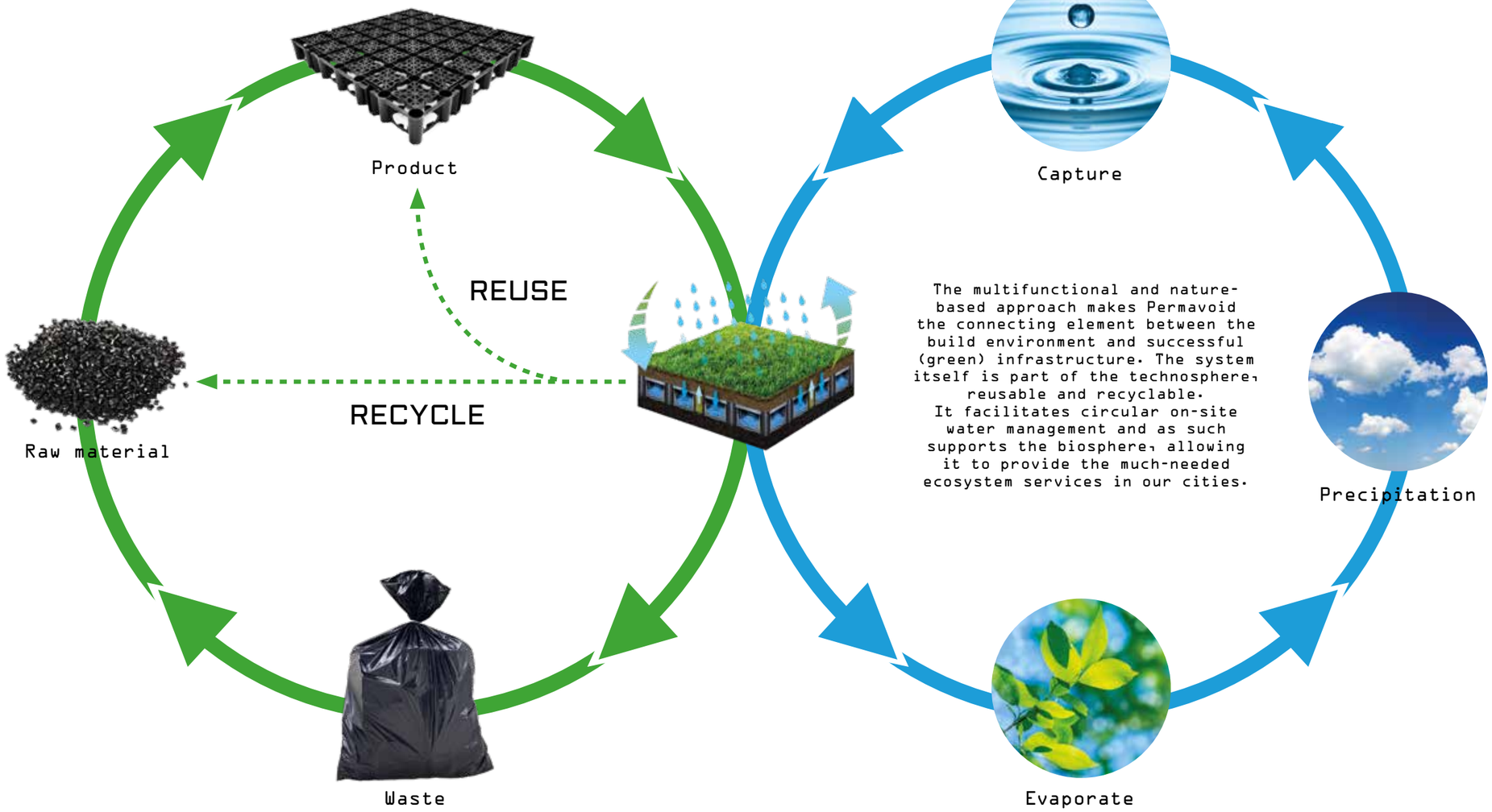
The units are made from high quality recycled materials and therefore fit 100% in the cradle-to-cradle philosophy. The plastics used can be fully recycled, but in practice they rarely are since the units can easily be disconnected and reused elsewhere thanks to their construction and the removable PermaTies. We aim at local manufacturing, preventing unnecessary worldwide shipping, shortening transport distances, further reducing our carbon footprint.

Developing multifunctional systems can only be accomplished in close corporation with valued partners. Based on equality and willingness to share, we work with market leaders in R&D like KWR-Water, STRI, University of Coventry and Wageningen University and Research, manufactures like Veolia, Ten Cate, Sioen and Lapinus and distributors like Polypipe, Optigruen, Perflow, ABT and many others. Together with local stakeholders, governments, cities and institutes we invest in pilot projects to ascertain the local challenges and create perfectly adapted multifunctional solutions.

The solutions designed with Permavoid can function for decades and will continue to fulfil their function for generations. The materials and designs used by Permavoid have been thoroughly tested by independent institutes for strength, reliability, pollution and temperature resistance and have been approved and used for subbase replacement in structural engineering for more than twenty years.

In our vision waste is upcycled to integrated solutions for future-proof cities.
C.H. van Raam, 2020.

MATERIALS (TECHNOSPHERE)



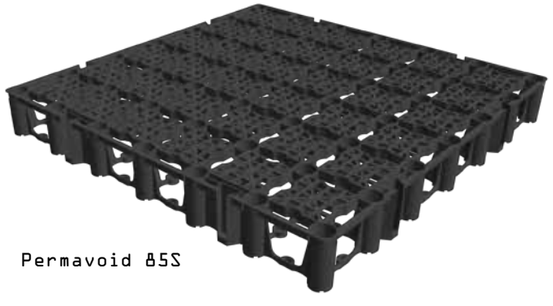
The multifunctional and nature-based approach makes Permavoid the connecting element between the build environment and successful (green) infrastructure. The system itself is part of the technosphere, reusable and recyclable.
It facilitates circular on-site water management and as such supports the biosphere, allowing it to provide the much-needed ecosystem services in our cities.

WATER (BIOSPHERE)

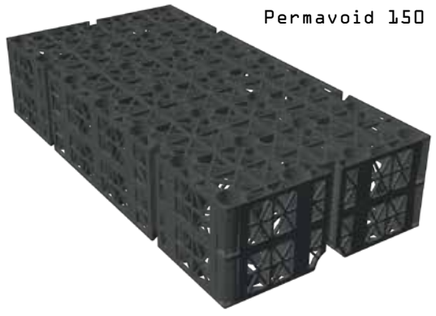
PRODUCTS

Permavoid units

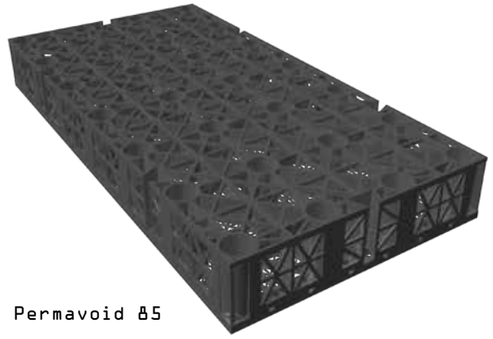
Permavoid units are high strength, lightweight hollow subbase units able to support sports, landscaped and paved surfaces on rooftops, podium decks and at ground level. In combination with the Permavoid capillary columns the system can be used in water sensitive urban designs, enabling stormwater attenuation, conveyance, infiltration and natural capillary (passive) irrigation.



Permavoid 85S



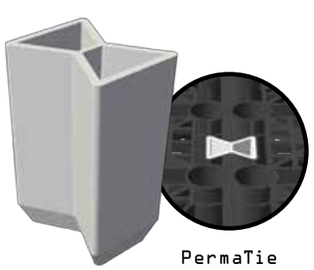
Permavoid 150



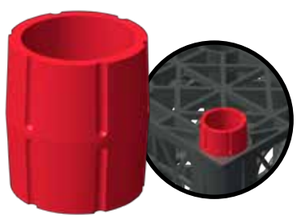
Permavoid 85

Ancillaries

Various Permavoid ancillaries are used to tie units/panels together into stable rafts, create stable stacks, enable capillary irrigation and allow the attachment of components and products directly to the Permavoid units.



PermaTie



Shear Connector

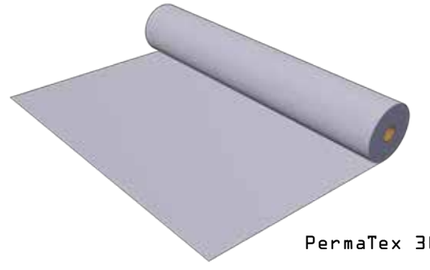
Capillary Column

The products displayed are a selection of the full range of Permavoid products most relevant to the applications discussed in this brochure.

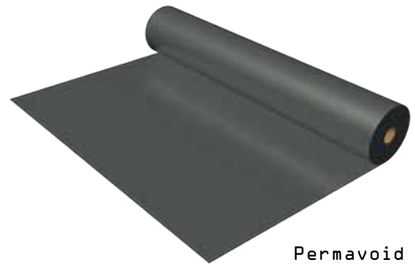
Geotextiles and membranes

Geotextiles are an integral part of every Permavoid design, protecting the waterproof membrane from punctures, determining the water infiltration rates and quality and facilitating successful capillary irrigation. The waterproof membrane is used to determine the attenuation, retention or detention functionality of the designed system.

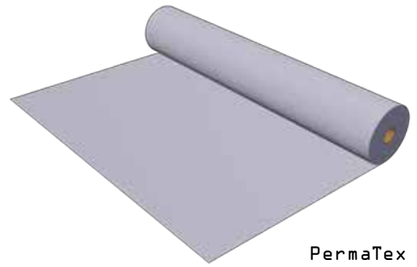
TRC30



PermaTex 300HD



Permavoid Flex 700

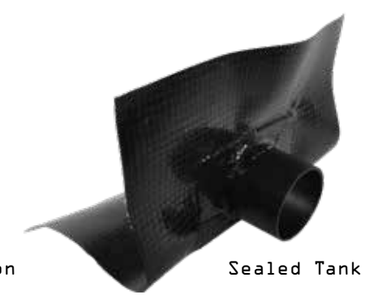


PermaTex CAP

PVOD components

Permavoid "PVOD" components are designed to provide easy to install connections and access points into the Permavoid system, essential for reliable integration in SuDS schemes and access for maintenance.

Saddle Connection



Sealed Tank Adaptor

Full product range information and detailed datasheets are available upon request.

permavoid

THE FOUNDATION FOR OUR FUTURE

The Permavoid range of products and systems are capable of creating circular, nature-based solutions for sustainable water management in metropolitan areas. Solutions encompass urban trees, Blue-Green roofs, podium decks, gardens, sports pitches and SuDS aiming at water-sensitive design.

Permavoid source control ensures that no precious water goes to waste by catching, storing and reusing stormwater for irrigation, evaporation or infiltration. For more information about Permavoid solutions please contact us or visit permavoid.com to find your local Permavoid distributor.

Other solutions by Permavoid

Blue-Green roofs

Permavoid sports

Permavoid civils

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Edition: June 2020

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