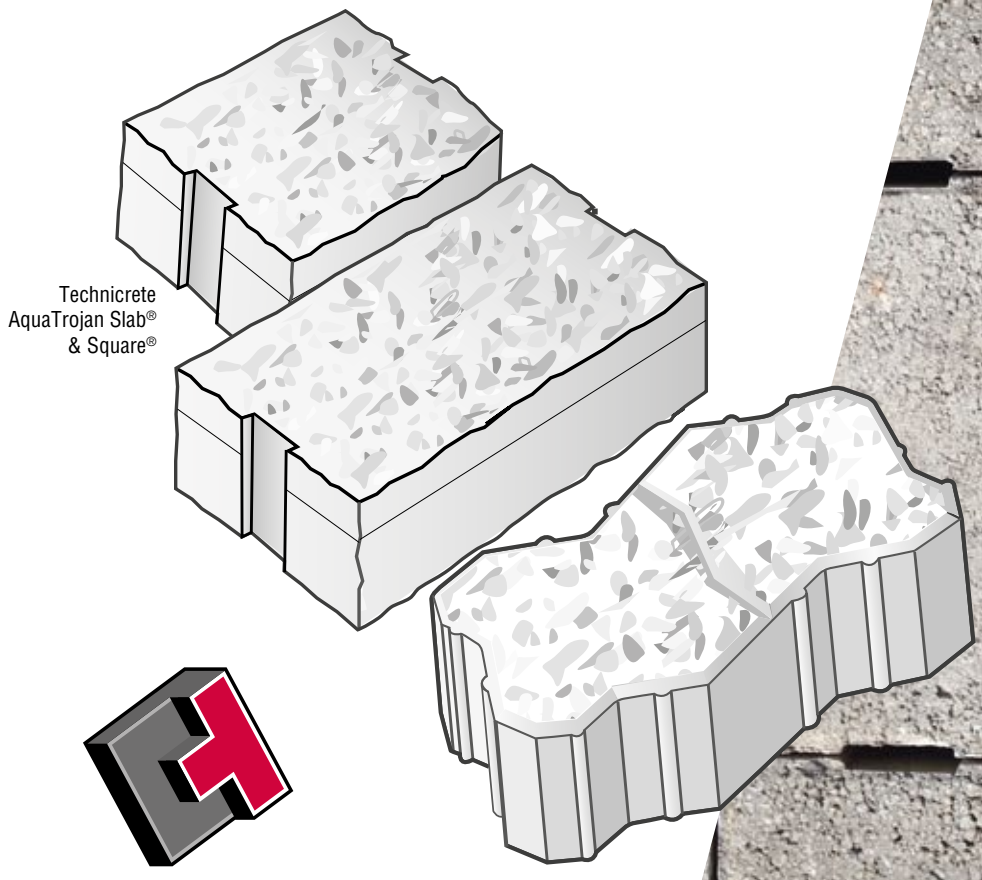
TECHNICRETE

Permeable Paving: Aqua Trojan Slab® & Square® & Aqua Zig-Zag®

Aquaflow permeable paving

Sustainable Urban Drainage Systems (SUDS) are increasingly being used to prevent run-off and flooding, and as a method of collecting, attenuating and cleaning storm water.

The Technicrete sustainable urban drainage system allows heavy rain to infiltrate through a permeable concrete block paved surface into a unique sub-base before being released in a controlled manner into sewers or water courses.



Technicrete AquaTrojan Slab® & Square®

Technicrete Aqua Zig-Zag®

TECHNICRETE
quality support

PAVING • SPECIAL PRODUCTS • KERBS • MASONRY • SHOTCRETES
EROSION PROTECTION BLOCKS • MINING • TRAFFIC CALMING BLOCK • PREBAGGED PRODUCTS
PRECAST PRODUCTS • RETAINING WALLS • STOPE SUPPORT SYSTEMS • HEAVY DUTY PAVEMENTS

Sustainable urban drainage system

The problem
Increasing urbanisation and rapid run-off have put a tremendous strain on conventional storm water drainage systems. This has resulted in sewers and culverts becoming overloaded during periods of heavy rain and contamination of streams and rivers.

Heavy metals, hydrocarbons, rubber dust, silts and other detritus are all deposited on impermeable surfaces during dry weather. These are scoured off such surfaces during periods of heavy rain and transported at best into expensive treatment works, or directly into rivers and streams where they cause severe environmental damage.

The solution – Source control
Sustainable Urban Drainage Systems (SUDS) are increasingly being used to prevent run-off and flooding, and as a method of collecting and cleaning storm water.

The Technicrete sustainable urban drainage system allows heavy rain to infiltrate through a permeable concrete block paved surface into a unique sub-base before being released in a controlled manner into sewers or water courses.

Discharge rates as low as 2.5 litres/hectare per second are easily achieved. Alternatively if the underlying subgrade is suitable the water can be infiltrated directly into the subgrade.

A further advantage of the system is that roof water can be drained directly onto the subbase via a rodable sump, or if siphonically drained, through a dispersion chamber.

Suitability
Technicrete's sustainable urban drainage systems and Aquaflow permeable paving products are suitable for use on: Car parks • Industrial estates • Retail centres • Pedestrian areas • Domestic drives • Motorway services • Airport service areas and aprons • Garages • Truck stops, Container terminals and other heavy duty applications.

Aquaflow blocks, the permeable paving products designed to be used with the Technicrete sustainable urban drainage system, let through 2.5 litres/sec/m^2

There are 3 basic system designs, see below. Each design can be tailored for infiltration or tanked according to requirements.

1 Full Infiltration
The system is underlaid with a pervious geotextile and is suitable for use where it is proposed to infiltrate the water directly into a suitable subgrade.

2 Part Infiltration
Controlled attenuation into the main drainage system AND infiltration.

3 Tanked
- Capture and store the water for reuse (grey water).
- Capture and harvest the water for reuse (potable water).

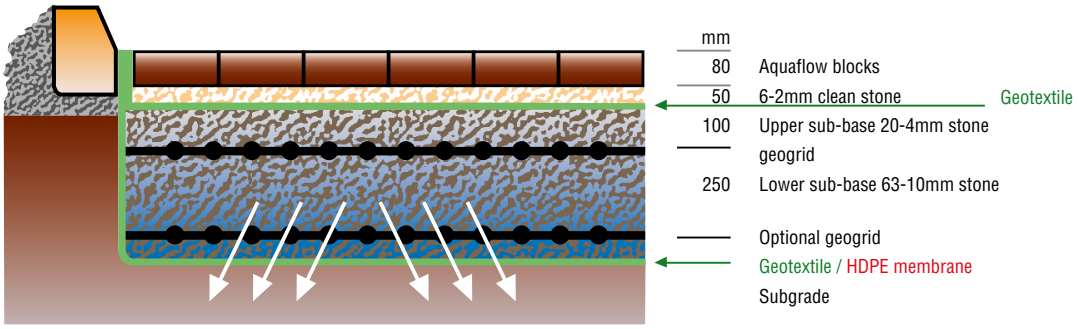
The system is underlaid by an impervious HDPE membrane and is suitable for use where it is proposed to attenuate storm water before releasing it in a controlled manner, harvest the water for re-use or where difficult or contaminated subgrades are encountered.

The type of membrane used and the method of sealing will depend upon the application. In some circumstances the membrane will require additional protection from puncturing and specialist advice should be obtained.

The impervious membrane restricts water entering the subgrade, and preserves subgrade structural integrity. This is very important where clay subgrades are encountered and in dolomitic areas.

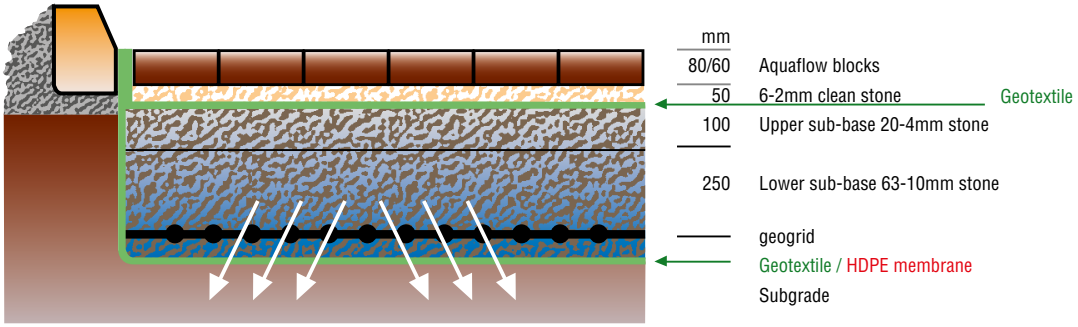
Typical Infiltration system

Areas subject to trafficking by heavy vehicles



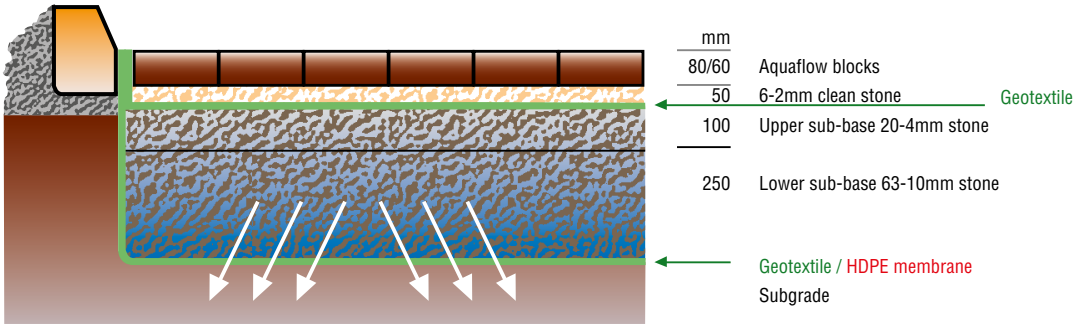
Typical Infiltration system with a sub-grade CBR of between 2-5%

Parking areas subject to trafficking by light vehicles only



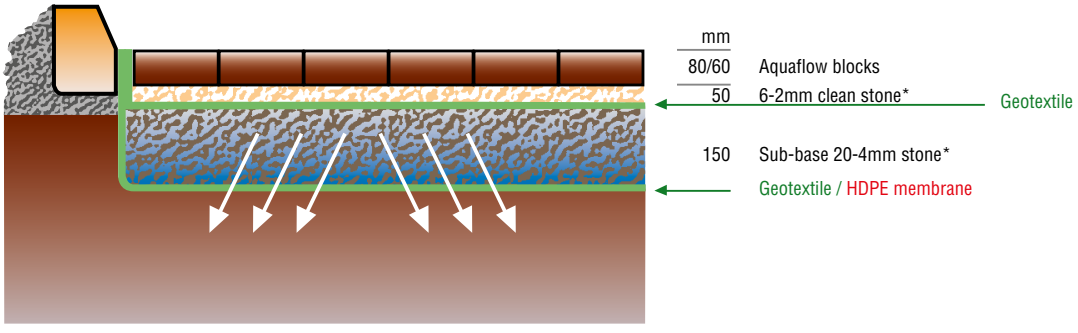
Typical Infiltration system with a sub-grade CBR of 5% or greater

Parking areas subject to trafficking by light vehicles only



Typical footpath construction

For Aqua paving



The Aquaflow range of permeable paving

Technicrete has designed a range of Aquaflow paving blocks to be used in conjunction with either lined or infiltration systems.

The range consists of three blocks of various shapes manufactured from concrete. The blocks comply with the national standard: SANS 1058-2012.

All the blocks provide drainage through vertical channels and will allow water through the surface at a rate of approximately 9000mm per hour (9000 liters per m^2 per hour). The geotextile beneath the laying course will allow approximately 4500 liters per m^2 per hour through and this figure should be used for initial design purposes.

Lower construction costs

From experience it has been shown that total construction costs are lower than conventionally drained surfaces.

When using the Technicrete system it is not necessary to incorporate the gullies, drainage pipes, drain runs, oil and silt traps and flow control mechanisms that are needed for traditional drainage.

When comparing relative costs it is important that all costs associated with traditional drainage are incorporated. e.g. gullies, channels, hydraulic controls, detention ponds, culverts etc.

Control of run-off

Run off during periods of heavy rain is eliminated. Aquaflow products do not require a grade to fall of the paved areas. Kerb inlets and other catchment items are also not required. Aquaflow paving can and should be placed as close to level as possible.

Discharge water

The compacted subbase has a voids ratio of up to approximately 30% which allows storm water to be attenuated within the system and released in a controlled manner over a period of time.

Discharge rates from the system as low as 2.5 litres/second/hectare can be readily achieved if required. Where the underlying subgrade is suitable, water can be infiltrated directly into the ground. Infiltration can be considered even where the subgrade would not be suitable. The reservoir capacity of the subbase allows water to be stored before slowly infiltrating over a period of time.

Approximately 30% of water entering the system is lost through evaporation and does not leave in the form of exit water.

Quality of discharge water

Analysis of exit water from the system has shown it to be as clean as the water discharged from a modern sewage works.

The layers of stone and geotextile act as a type of trickle filter. Organic matter, silt and loam is caught by the geotextile and held within the laying course. Heavy metals have an affinity to particulates; adhering to the surface of organic matter and silt. They are therefore stabilised and retained within the subbase.

Hydrocarbons are digested within the subbase by a population of naturally occurring microbes. Research undertaken at Coventry University on microbial growth has shown that the system is capable of degrading at least 70g of oil per m^2 per annum.

The Environment Agencies in the UK have confirmed that silt traps and oil interceptors are not required as the system catches silts and degrades oils.

An additional advantage is that water exiting the system has a pH of approximately 7.5.

System details – principal benefits

Water harvesting and re-use
Many previous projects are harvesting and re-using water directly from the system.

Some youth hostels and schools are using the water for non-potable purposes such as flushing lavatories and a large garden centre is using this resource to water plants and soft landscapes. It has been found that water from the Technicrete system is kinder to plants than tap water.

Roof water
Roof water can be discharged in to the subbase. *See page 8 for design details.*

With gravity fed drainage it is recommended that the water is introduced into the subbase by means of sump with a manhole cover adjacent to the paved area. Any debris can be easily caught and cleared. The water is then dispersed within the system via a distribution tank.

Performance
Assuming a 'worse case scenario' where after say twenty five years, 90% of the surface permeability has been lost through silting. The permeability of the surface is still 9000mm x 10% or 900mm of water per hour per m^2 (900 liters per hour m^2). This would indicate that the surface permeability is still capable to deal with an exceptional rain event.

Design criteria
The subbase has a reservoir capacity of up to approximately 30%. As a quick rule of thumb – 10m^2 of Technicrete system with a depth of 350mm of sub-base will accommodate 1 cubic metre of water.

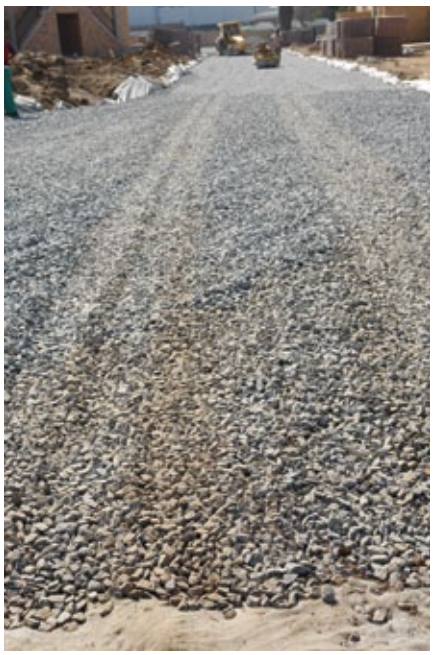
Where it is proposed to drain impermeable surfaces onto areas of Aquaflow it is recommended that a maximum ratio of 2:1 impermeable: Aquaflow is used.

Heavy duty use
Trials undertaken at the Transport Research Laboratory in the UK validated the subbase design for heavy duty use. It is recommended that this sub-base design is used wherever there is a possibility of over-run by heavy vehicles.

The heavy duty subbase design comprises two separately graded layers of stone with a geogrid at the interface between the two layers (a further optional second geogrid may be installed lower down the subbase at the engineers discretion).

The standard details show a lower subbase layer of 250mm of 63-10 stone overlaid by a geogrid and a 100mm depth upper subbase layer of 20-4 stone. The depth of the lower subbase may be varied at the engineers discretion and subject to overall water storage requirements.

Sustainable urban drainage system



Laying course specification
50mm depth of 6.7/2.36mm. single size clean crushed stone to SANS 1083.

Subbase specification
All granular sub-base material shall comprise crushed gravel, rock or concrete possessing well defined edges. It must be sound, clean, non fraible and free from clay or other deleterious matter. The material must be non plastic.

Recommended grading (SANS 1083)

Seive passing	Lower subbase		Upper subbase	Laying course
	53,0	37,5	19	6,7
75,0	100			
53,0	85-100	100		
37,5	0-50	85-100		
26,5	0-25	0-50	100	
19,0	0-5	0-25	85-100	
13,2		0-5	0-50	
9,5			0-25	100
6,7			0-5	85-100
4,75				0-55
2,36				0-25
1,18				0-5

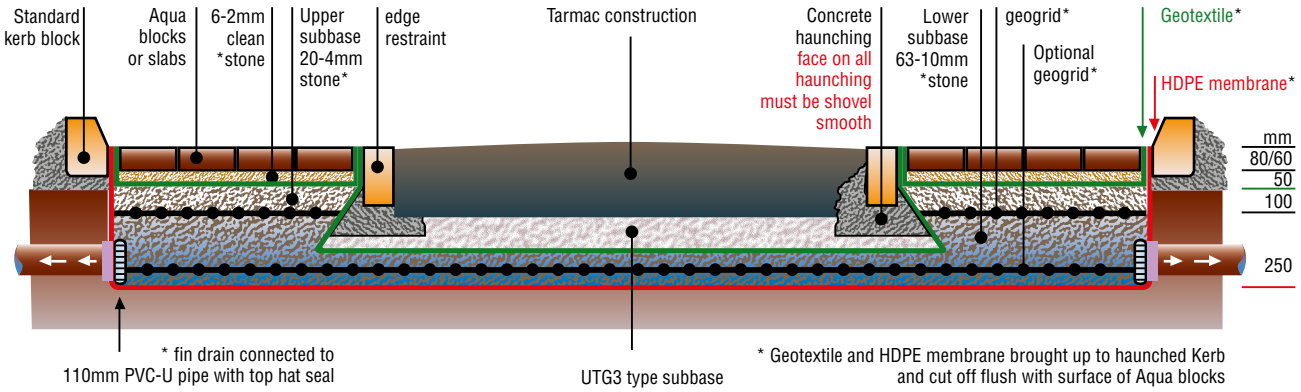
Depth of Sub-base
It is recommended that a minimum subbase depth of 350mm should be used. The depth of subbase may be varied at the discretion of the Engineer.

HDPE membrane
Where methane or a high water table is present in the subgrade it will be necessary to use a heavy duty impervious membrane with a thickness of 750 µm and to weld the joints. The membrane should be protected against puncturing.

Subgrade
Where the structure is to be over-run by heavy vehicles the subgrade should have, or be improved to have, a CBR of at least 15%. Poor subgrades with low CBR's must be improved to the required strength.

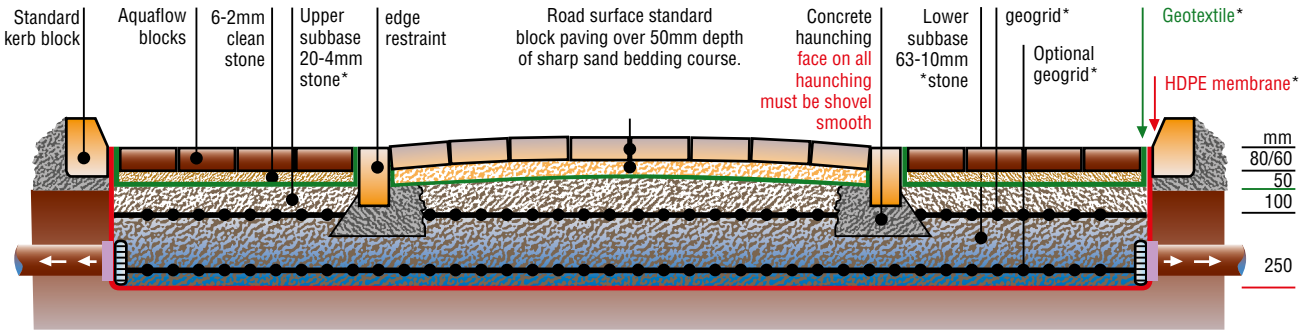
Aquaflow paving in conjunction with tarmac road surface

Tanked system section: Aqua pavement with undersealing membrane



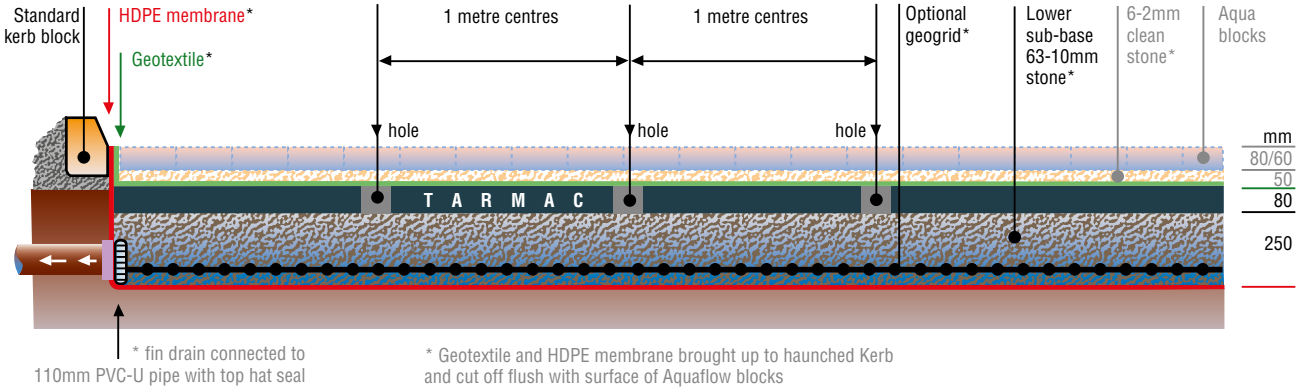
Aquaflow paving in conjunction with standard block paved road surface

Tanked system section: Aqua pavement with undersealing membrane



Construction running surface

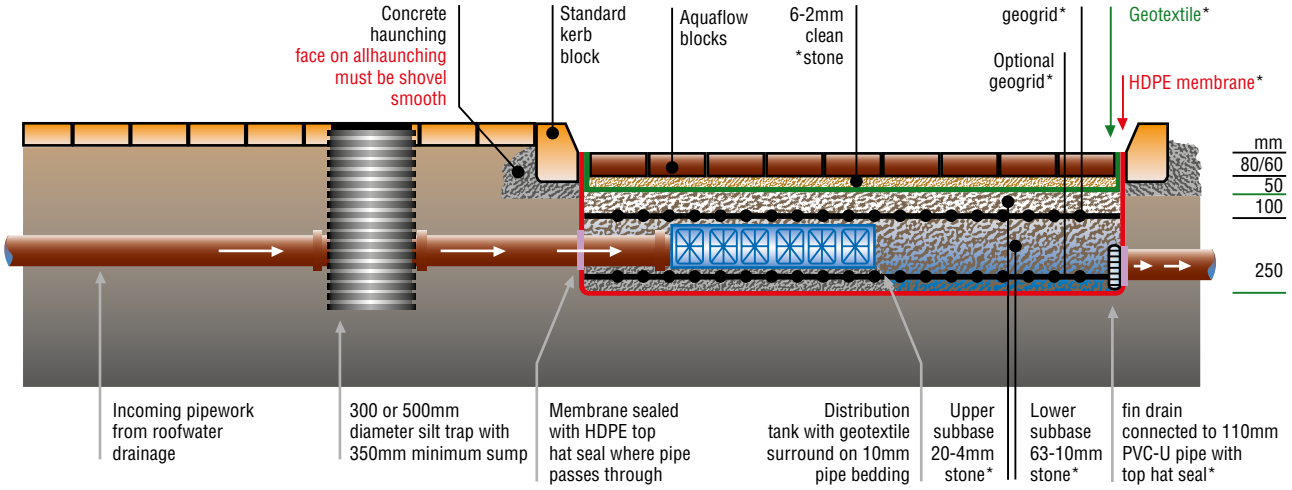
Tanked system section: Aqua pavement with undersealing membrane



- **Lay geogrid 270mm of sub-base and optional additional geogrid**
- **Lay 80mm of dense base course Tarmac over sub-base. After building work is completed. Clean tarmac surface**
- **Cut 20/50mm diameter holes at 1 metre centre through tarmac surface into sub-base**
- **Fill holes with 6-2mm clean stone**
- **Lay Geotextile, 50mm laying course and Aquaflow blocks**
- **Illustrations on this page feature the tanked system. For the infiltration system replace HDPE membrane with geotextile.**

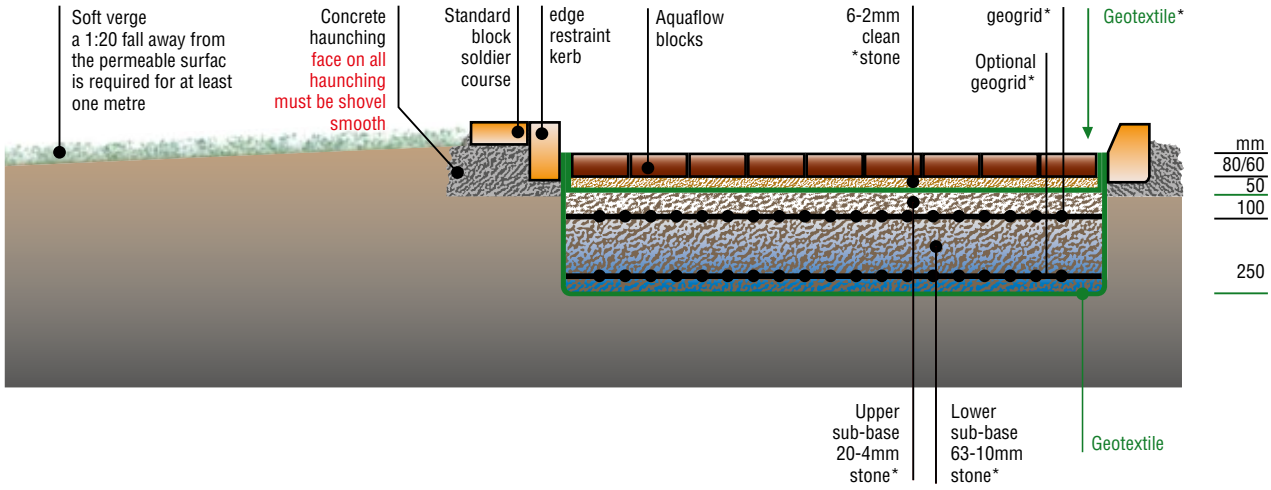
Down pipe drainage into tanked system

Aquaflow pavement with undersealing membrane

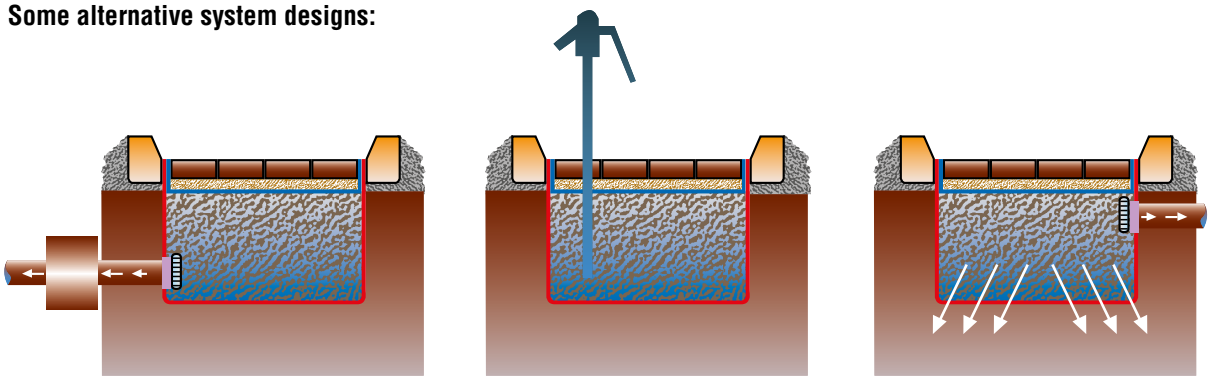


Soft landscaping and Aquaflow paving

Recommended detail: Aquaflow blocks shown with tanked system



Some alternative system designs:



Tanked with additional treatment before reuse

Tanked storage/reuse

Infiltration/overflow

Construction

Construction

Laying generally
All construction work on pavements should be carried out following completion of general site works **and after topsoiling of adjacent areas** to prevent wash down of fine materials. Where a temporary running surface is required the construction should be in accordance with diagram on page 6. (Construction running surface)

Subgrade
Excavate to subgrade appropriate levels shown on site drawings to provide a minimum fall of 1:1000 to fin drain. Where it is proposed to infiltrate, no falls are necessary.

The subgrade should be compacted with a vibrating plate or roller. Prior to compaction all soft areas should be removed and filled with suitable replacement material to provide a stable subgrade with the required CBR value.

Kerbs/Edgings
The paved areas must be firmly restrained. Where the pavement is designed for heavy use the concrete kerb haunching must extend to a minimum depth of 150mm below the base of the kerb. The haunching must be continuous. The kerb/edging must extend with sufficient height above the haunching to accommodate the full laying course depth and block height.

HDPE membrane
Lay HDPE membrane taking care to overlap the joints by 500mm using double sided tape. Where methane or a high water table is present a specialist heavy duty membrane may be required and the joints should be welded. If it is proposed to drain by infiltration to the subgrade, the membrane should be replaced with a geotextile to stop the ingress of subgrade material into the subbase. The fin drain will not be required.

Sub-base
The lower layer of subbase (63-10mm) should be placed in 2 separate and equal layers, each layer being compacted with a vibrating roller or heavy duty vibrating plate. The final pass should be undertaken with no vibration. Compaction should continue until 97% of the compacted bulk density achievable under laboratory conditions has been reached. This can be measured with a nuclear density gauge. The specified 350mm depth of sub-base may be varied by the Engineer to suit site requirements.

Geogrid
Where required the geogrid should be incorporated at the interface between two layers of sub-base. The geogrid should be laid on the lower subbase and joints should be overlapped by 300mm.

The upper sub-base layer (20mm-4mm) should then be laid on top of the geogrid and compacted as before.

A second geogrid can be incorporated underneath or within the lower subbase at the engineers discretion. This should be laid in the same way as the first geogrid.

Geotextile
Lay Geotextile on top of the sub-base overlapping joints by 500mm. Geotextile should be brought up to the haunched kerb/edging and cut-off flush with the surface of the paving.

Laying course
Lay and screed to level approximately 50mm depth of 6-2mm single sized crushed stone. It is important that the final level of the 6-2mm stone is accurate as the stone will compact down much less than sand when the surface blocks are vibrated. The particle shape of the 6-2mm stone will also affect the degree of compaction. It is recommended that a small trial area should be laid prior to construction to determine the accuracy of final levels.

Block laying
It is advisable to pre-set the block level by 6mm to allow for the effects of settlement when laid against fixed edgings. The blocks and slabs must be tightly butt jointed ensuring that a good fit is achieved.

A single or double stretcher course of Aquaflow blocks must be used around the periphery of the paved areas and also at the edges of any separately restrained areas, such as tree pits.

It is recommended that lateral restraints should be installed in areas where vehicles turn and/or brake, such as bends and junctions and on large areas of paving. The lateral restraints should be properly constructed and continuously haunched with concrete.

Where blocks need cutting, they should be cut to a tight fit and none are to be smaller than 30% of the unit block size. Where Aquaflow blocks are cut they must be cut across the smaller and not the longitudinal dimensions. Blocks should be cut vertically and not underscored. All block cutting should be carried out with a disc cutter.

Surface finish
The blocks should be vibrated with a vibrating plate. Following the first pass with a vibrating plate, 4-2mm clean quartzite or gritstone should be applied to the surface and brushed in. Blocks should again be vibrated and any debris brushed off.

Method of accesssing services and reinstatement

General

It is important that access to services in or underneath the Technicrete Sustainable Urban Drainage System is undertaken in a disciplined and progressive way.

Procedure

Uplift Aquaflow blocks 1m either side of the line of relevant underground services.

Take up the laying course stone and cut the underlying geotextile membrane along either side of the line of services and parallel with them. Dispose of the laying course stone and geotextile.

Excavate subbase stone and place adjacent to the excavation on plastic membrane. The subbase stone can be re-used.

Cut geogrid(s) in the same way as the geotextile and dispose of it.

Cut layer of geotextile or impermeable geomembrane at reduced level along the line of the services in the same way as the higher layer of geotextile and dispose of it.

Excavate material over and around services and put on plastic membrane ready for re-use.

Carry out repair on services. Once repairs have been completed replace and fully compact the excavated material around the services.

Cut fresh geotextile or impervious goemembrane to size allowing additional 500mm extra width either side of the remaining geotextile geomembrane. Tape new geotextile/membrane in place.

If a heavy duty welded waterproof geomembrane in installed due to a high water table or the presence of methane the replacement geomembrane will need to be rewelded to the existing geomembrane.

Replace the first 250mm depth of sub-base and thoroughly compact, cut and install fresh geogrid(s) allowing 300mm of extra width either side.

Spread and compact final 100mm depth of sub-base.

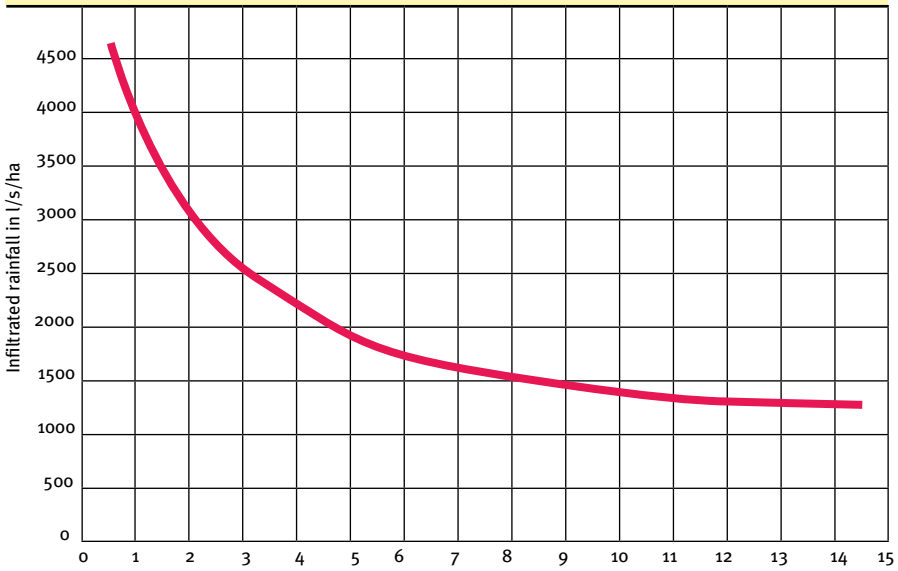
Cut fresh geotextile to size again allowing 500mm overlap using double sided tape.

Lay and screed to level approximately 50mm depth of 6-2mm crushed stone.

Replace surface blocks, vibrate surface blocks to level and dress the surface with 4-2mm clean gritstone and vibrate again.

Brush off and dispose of any debris before final vibration.

Experienced reductiveness in permeability of Permeable Pavements over time



Maintenance

The surface blocks have a design life equivalent to standard block paving.

The surface blocks require routine maintenance and the surface should be brushed at least twice a year. It is recommended that this should be carried out in the spring and after leaf fall in autumn.

Following routine maintenance it may be necessary to re-dress the surface with 4-2mm clean gritstone.

Ultimately, perhaps after 25 years or more, areas of the laying course may become filled with silts and toxins.
If this occurs the surface blocks should be uplifted and the affected areas of laying course material and geotextile disposed of. The existing sub-base can be left in situ. Fresh geotextile and laying course stone should be installed and the uplifted surface blocks re-used.

All permeable interlocking concrete pavements with an open-graded base should have an observation well. The well is typically a 150 mm diameter perforated pipe. It has a screw cap below the surface of the pavers at least 25 mm that can be removed to observe the rate of exfiltration. The cap should lock and be vandal-resistant.
The depth to invert should be marked on the lid. The observation well is located in the furthest downslope position within 1 m from the sides of the pavement.

Some Words of Caution

Although Aquaflow permeable pavements are in its infancy in South Africa, over 25 years experience in Europe and the Americas have shown that failures of permeable concrete block pavements have largely been due to:

- Incorrect grading of the sub-base and/or bedding layer and/or joining material.
- The use of sand as a joining and/or bedding material. It has been shown that there is about a 50% reduction in the permeability of permeable concrete block pavements when sand is used in the jointing and/or bedding, resulting in slow infiltration, ponding, clogging and excessive run-off.
- The use and subsequent clogging of an inappropriate upper geotextile between the sub-base and bedding layer instead of using compatible materials which meet conventional soil-filter course laying criteria.
- Adding fines to the laying and sub-grade layers for better compaction.
- The under-estimation of the run off from impermeable surfaces draining onto the permeable paving surface.
- The specification and/or use of a paving block that is not specifically designed for use in permeable paving. A standard paved surface installed with conventional joints will not provide sufficient permeability for a permeable pavement to function as designed.
- Run-off, which includes mud and other debris due to soft landscaping or construction work, clogging the paving.
- Heavy silt loads from the in-service function of the pave area, e.g. recycling centres, wood chip stock piles etc.

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