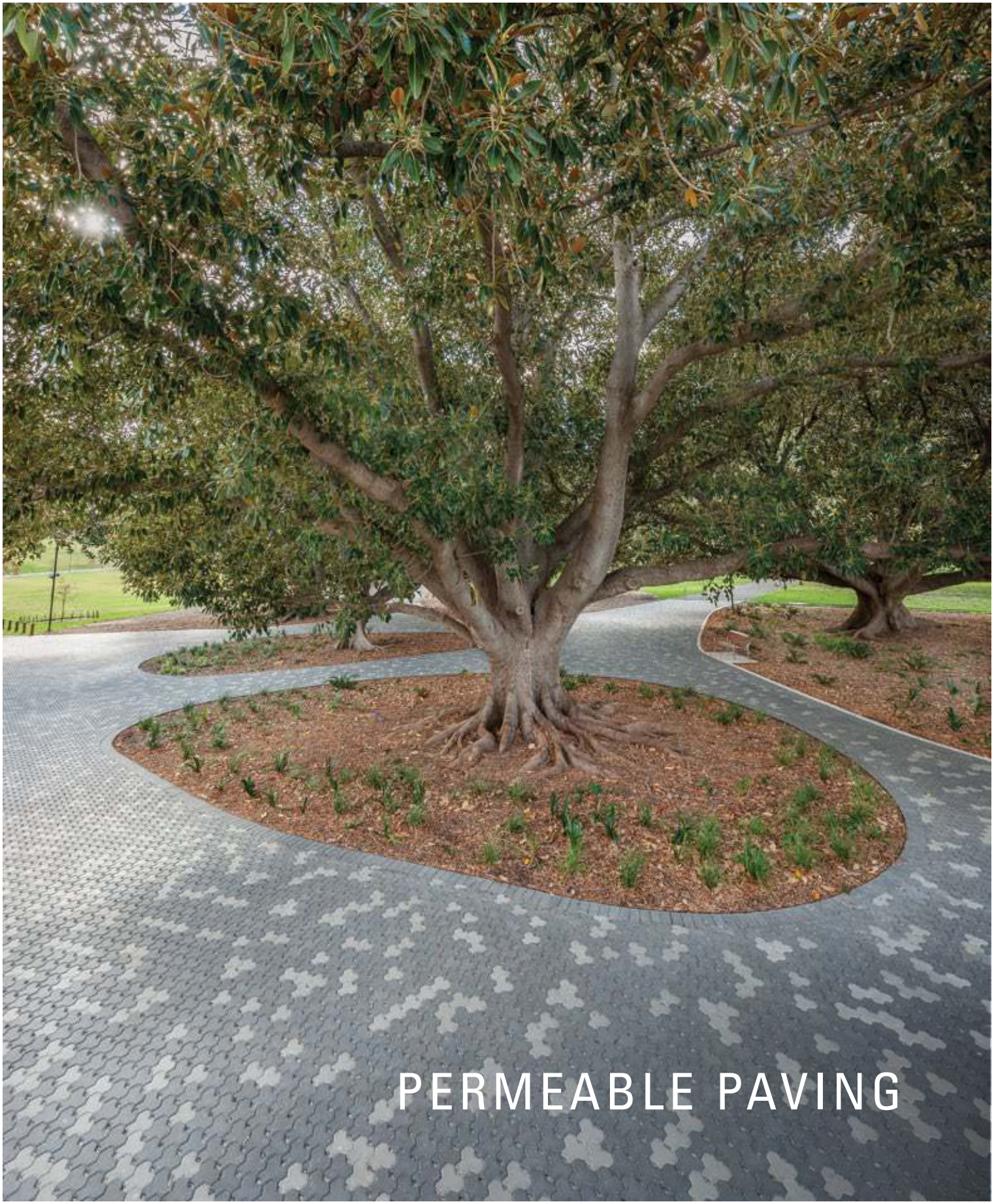
adbri MASONRY

an ADBRI company



PERMEABLE PAVING

ADBRI MASONRY

Adbri Masonry is Australia's leading masonry manufacturer supplying quality concrete bricks, Besser® blocks, pavers, retaining walls, erosion control products and architectural masonry solutions throughout New South Wales, Queensland, Victoria, South Australia and Tasmania. Adbri Masonry is a wholly owned subsidiary of Adbri Limited, a leading integrated construction materials and lime producing group of companies and a member of the S&P/ASX 200 Index.

In addition to supplying a full collection of quality concrete building and landscaping products, there are a range of valuable benefits to working with Adbri Masonry including:

- Access to our Contracting Services Team (in-house design, supply, installation and certification for civil, commercial and industrial projects)
- Confidence that all product lines are tested for quality in our N.A.T.A accredited laboratory
- Our commitment to environmental sustainability and environmental building products
- Support from experienced in-house engineers who can provide technical advice and design solutions for civil, commercial and industrial projects
- The benefit of dealing with knowledgeable local sales teams
- The ability to create customised product and colour solutions specific to individual projects *(conditions apply)*

Brickpave | Ivory and Port Blend

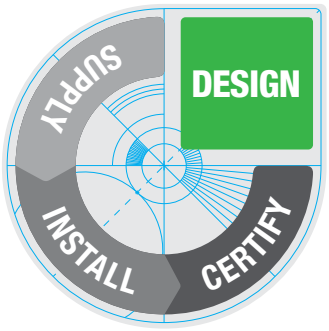
Anchorlok® | Terracotta

Anchor Landmark | Oatmeal

CONTRACTING SERVICES | DESIGN & CONSTRUCT

Adbri Masonry's Contracting Services Division has been providing building solutions for over 25 years and offer a range of construction and project management services, including a complete design, supply, install and certification package for segmental retaining walls, permeable and standard pavements, erosion control and wall cladding products. Operating on the East Coast, the Adbri Masonry team can provide the following civil, commercial, industrial and subdivisional projects;

- The supply and installation of concrete masonry and concrete sleeper products
- Preliminary design and technical assistance
- Preliminary costings
- Certified design by RPEQ and Chartered Professional Engineers
- Ongoing project management
- Access to machine lay technology



By utilising these services, the quality and structural adequacy of the finished project can be professionally managed and officially certified on your behalf.

QLD Building Licence Number - 61929

Available only for civil, commercial or industrial projects

Unipave® | Charcoal

INTRODUCTION TO PERMEABLE PAVING

Permeable paving is a pavement system comprising purpose designed paving units and specially graded base materials to allow water to move freely through the base, or be stored within the pavement.

Permeable paving is already well established, and government regulated, in many countries where development threatens already over-stretched drainage and river systems. As more land is developed and covered with impervious surfaces, our stormwater and river systems are under increasing pressure to manage the high volumes of surface run-off which enters them. This increases the potential for downstream flooding and erosion.

As an alternative to conventional paving (which concentrates water and pollutants within the existing drainage systems) the Adbri Masonry permeable paving series encourages water to infiltrate through the pavement surface and substructure to the ground below, easing the pressure on these already overburdened systems.

Benefits of Permeable Paving

> Reduces surface run-off

> Reduces the risk of localised flooding and downstream flooding

> Reduces likelihood of downstream erosion

> Recharges groundwater tables

> Aesthetic appearance

> Traps pollutants and prevents them from being carried into waterways

> Facilitates biological decomposition of trapped pollutants

> Can be used to replace or reduce size of detention / retention basins

> Allows water and air to access the roots of vegetation

> Water and air circulation can assist in reducing heat island effects

> Can be trafficked immediately following installation

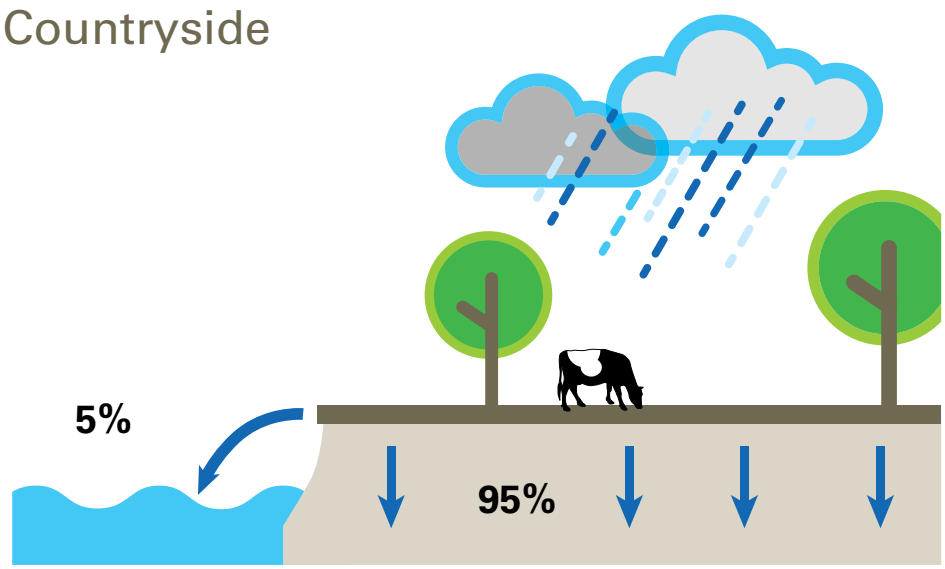
> Paving units are pre-cured preventing shrinkage and removing the need for control joints

Acknowledgements

Adbri Masonry would like to acknowledge Interpave and CIRIA for their comprehensive guides on the installation and design of permeable pavements. Information from the SUDS manual (CIRIA 2007) has been replicated in this document.

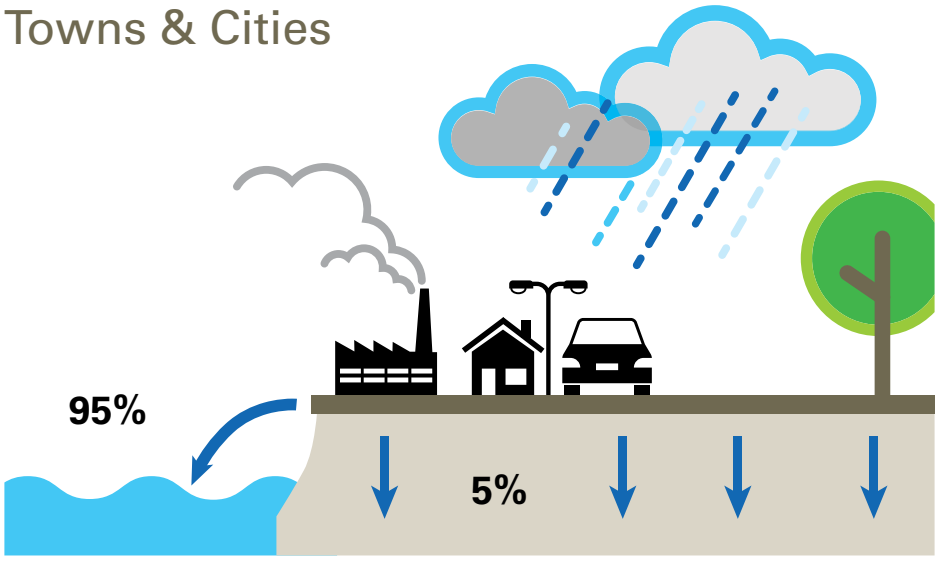
WHY DO WE NEED PERMEABLE PAVING?

Managing the quantity and quality of stormwater runoff is becoming significantly more important. Urban stormwater has traditionally been seen as something to be disposed of as quickly and as cheaply as possible.



In natural environments the majority of stormwater is absorbed back into the ground, recharging the local ground water tables, with very little surface runoff entering the local waterways.

In urban areas the reverse is true. Large areas of impermeable surface result in the majority of stormwater being diverted to the local waterways and very little being absorbed into the ground. Ever increasing urban development has resulted in a rise in the amount of stormwater runoff reaching our waterways via stormwater infrastructure that is already under pressure.



Permeable paving offers an opportunity to restore this balance.

ECOTRIHEX®

PROJECT - Brigidine College - St Ives *New South Wales*

DETAILS - Over 1100m² of Adbri Masonry's Ecotrihex® permeable pavers, in contrasting colour tones, were installed. The non directional and flowing aesthetic of these interlocking pavers perfectly compliments the feature garden planter boxes that double as bench seating throughout the area.

Ecotrihex® pavers are industrial strength interlocking pavers that lend themselves to both high pedestrian and vehicular traffic areas. These versatile pavers have the ability to be utilised to create a dynamic pavement solution.

When used in a permeable paving system, Ecotrihex® pavers are an ideal permeable pavement solution, allowing water to permeate into the subgrade or be collected for future use.

OTHER PROJECTS

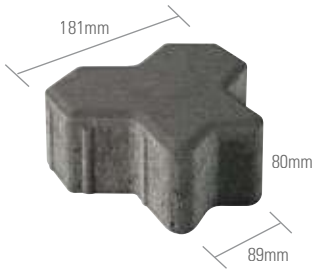
- Bus station and forecourt Moore Park. 9,000m^2 of honed Charcoal coloured Ecotrihex® paving for the bus station set-down area located adjacent to the Sydney Cricket Ground, Sydney Football Stadium and Fox Studios.
- Eastern Water Treatment Plant - 1100m^2 Ecotrihex® Charcoal pavers. Large carpark area for the new eastern water treatment plant in Victoria.
- Adelaide Oval - Ecotrihex was used in 'Fig Tree Plaza' to pave a safe and accessible path while maintaining tree & root health.

APPLICATIONS

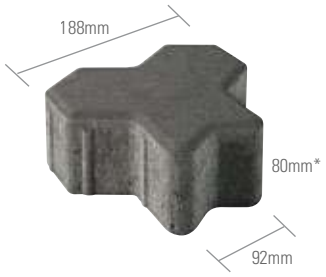
- Carparks
- Streetscapes
- Footpaths
- Heavy industrial traffic
- Government/Council projects
- Road infrastructure
- Machine lay
- Permeable Paver

AVAILABLE SIZES

Queensland / Tasmania



New South Wales / South Australia / Victoria

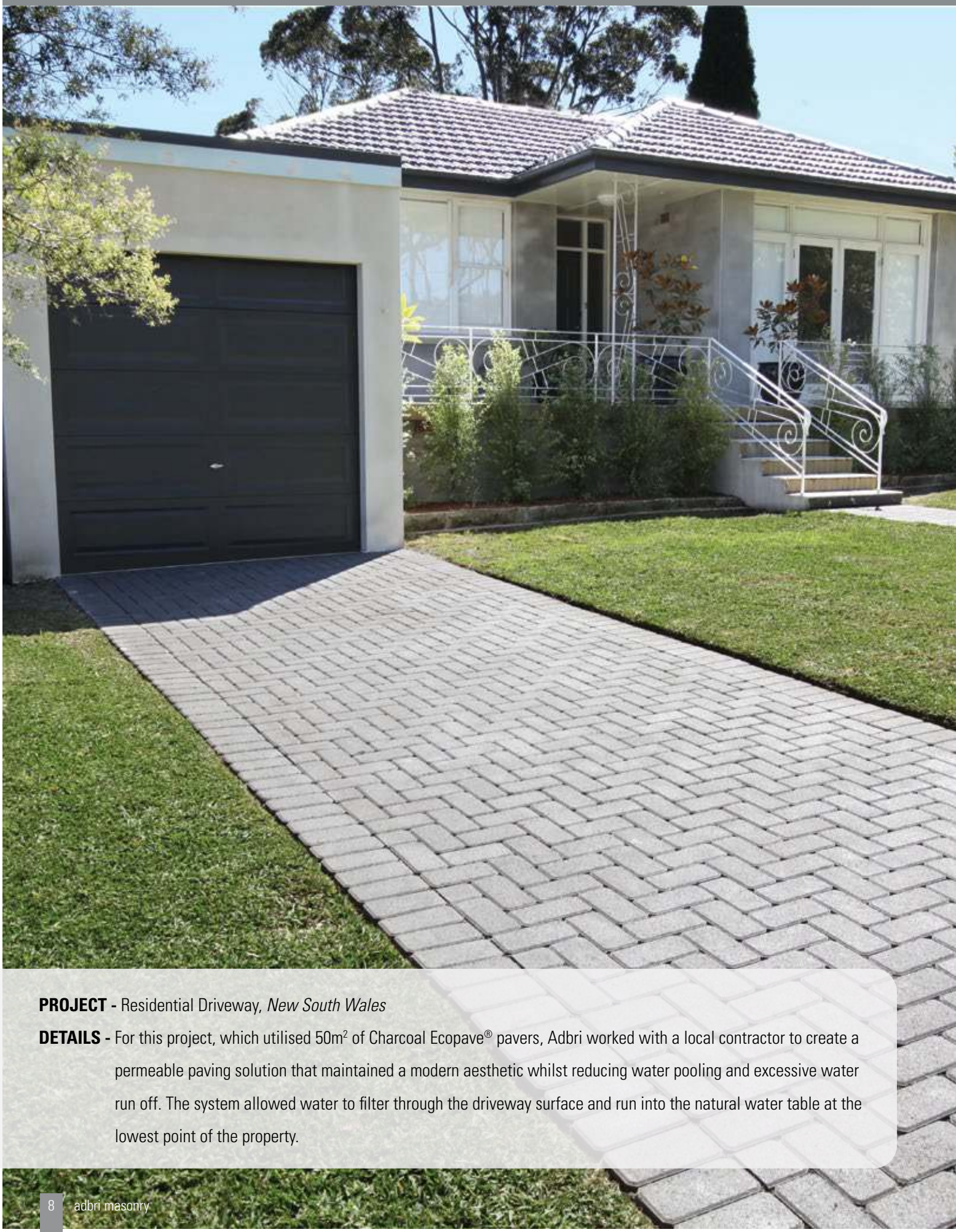


Note: Pavers can be produced in a smooth, honed or shotblast finish.

Please note: Size and thickness vary in each state this is a Made to Order Product.	Dimensions (mm)	Bullnose available	No. per m^2	Unit Weight (kg)	Shape type (per CMAA Ref T35)	Breaking Load (kN)	Slip Resistance (standard)	Slip Resistance (honed)
QLD EcoTrihex® 80mm	89 x 181 x 80	N	43.5	3.5	C	10	P5	P5
NSW EcoTrihex® 80mm	92 x 188 x 80	N	43.5	3.9	C	10	P5	P5
VIC* EcoTrihex® 80mm	92 x 188 x 80	N	43.5	3.9 / 2.93*	C	10 / 6*	P5	P5
SA EcoTrihex® 80mm	92 x 188 x 80	N	43.5	3.9	C	10	P5	P5
TAS EcoTrihex® 80mm	89 x 181 x 80	N	43.5	3.5	C	10	P5	P5

**60mm available, however minimum quantities apply, please ask your local Adbri Masonry representative for more details.*
Note: Greater breaking loads can be achieved for industrial paving if requested. Please refer to your local representative for details.

ECOPAVE®



PROJECT - Residential Driveway, *New South Wales*

DETAILS - For this project, which utilised 50m^2 of Charcoal Ecopave® pavers, Adbri worked with a local contractor to create a permeable paving solution that maintained a modern aesthetic whilst reducing water pooling and excessive water run off. The system allowed water to filter through the driveway surface and run into the natural water table at the lowest point of the property.

The Ecopave® permeable paver is a small format Type C segmental concrete paver designed for use in residential, multi-residential and commercial paving applications where sustainable water management must be considered. The Ecopave® paver is available in an easy to install 50mm thickness for residential applications and an 80mm version for commercial and industrial applications with both versions capable of being machine laid.

APPLICATIONS

- Permeable Pavements
- Low speed roads
- Car parks and driveways
- Streetscapes
- Footpaths
- Heavy Industrial traffic
- Government/Council projects
- Road infrastructure

AVAILABLE SIZES

Queensland / New South Wales / Victoria / South Australia

Ecopave® 50

Ecopave® 80

PRODUCT	Ecopave® 50	Ecopave® 80
Avg. Weight	2.8kg	4.2kg
No. per Tonne	357	238
No. per m²	39.8	39.8
Slip Resistance	P5 - Very Low Risk	P5 - Very Low Risk
Paver Type	C	C

TURFGRID™

PROJECT - Bahan Carpark, Trinity College, University of Melbourne, *Victoria*

DETAILS - Adbri Masonry's Turfgrid was tinted to a sandstone colour to match the facade of the 1930s heritage building, creating an attractive, permeable landscape solution to a carpark space traditionally seen as utilitarian. The carpark now functions as a water catchment for the building's grey water reservoir.

Adbri Masonry's Turfgrid™ product is an ideal solution for agricultural, livestock, commercial and residential erosion control projects. These easy to install permeable pavers also maintain an even ground level, whilst stabilising land and allowing water to filtrate through the surface layer, minimising any water run off.

OTHER PROJECTS

- Roseville Chase Oval, NSW used 95m^2 of Turfgrid™ paving to rejuvenate the turfed area around change rooms, which had previously been reduced to dirt through year round use.
- Waverly residential driveway and parking project, 80m^2 of Turfgrid™ pavers.
- Northbridge Oval, Turfgrid™ pavers used in parking bays as a permeable paving driveway.

APPLICATIONS

- Carparks and driveways
- Permeable pavements
- Revetment blocks for creek or river banks
- Land Stabilisation

AVAILABLE SIZES

New South Wales / Victoria / Queensland / South Australia / Tasmania

Turfgrid™

PRODUCT	Turfgrid™
Avg. Weight	17.9kg
No. per Tonne	55
No. per m^2	7.5
Resistance to Salt Attack	Exposure Category
Paver Type	C

PERMEABLE PAVING APPLICATIONS

Residential

Permeable paving can be used around the home for paths, patios and driveways.

Light/Medium Traffic

Can be used in shared pedestrian/traffic zones, carparks, residential roads and parking at high volume locations such as shopping centres.

Storm Water Retention

Can be used in new developments as a substitute for detention/retention/infiltration basins. Make full use of your land by creating your retention under your roads.

Water Quality Improvement

International research has proven that the use of permeable pavements greatly reduces the occurence of pollutants in the discharge from the pavement base.

Irrigation

The captured water can be harvested and reused for irrigation purposes.

Architectural Effect

The variety of product shapes, colours and finishes available can be used to create visually appealing zones within projects.

DESIGN CONSIDERATIONS

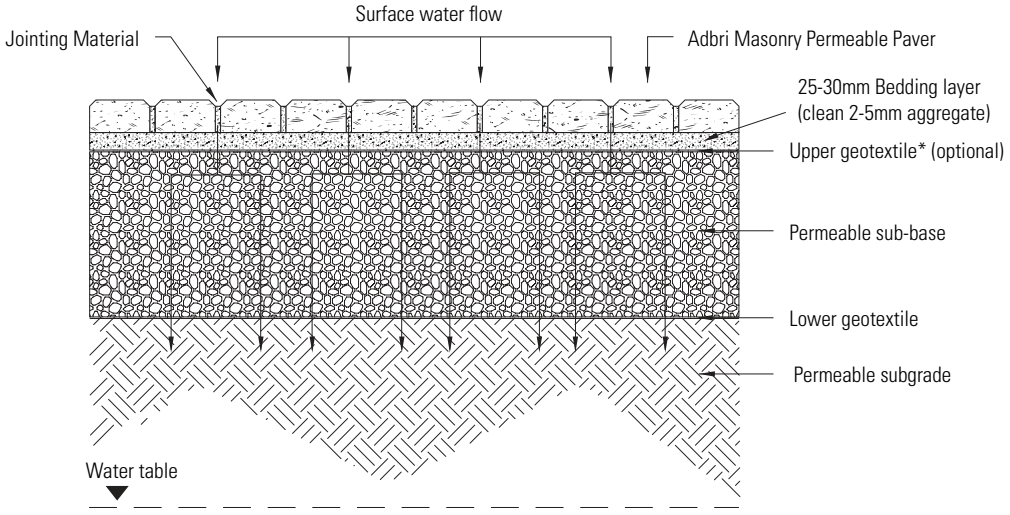
There are three principal systems considered, when designing concrete paving as a wearing surface for permeable pavements. These are designated as Systems A, B and C, and are defined below. The below drawings are for conceptual purposes only and full engineering drawings must be sought before laying commences.

SYSTEM A: TOTAL FILTRATION

System A allows all water falling onto the pavement to infiltrate down through the joint or voids between the paving and pass through the sub-base layers below and into the subgrade. Depending on the design requirement some water may be temporarily stored in the bedding and sub-base layers prior to passing through into the subgrade.

This is also know as a 'Zero Discharge' system, as no additional water from the pavement is discharged into traditional drainage systems, eliminating the need for pipes and stormwater pits. This system is used wherever the permeability of the existing subgrade material is suitable to absorb the captured volume of water, typically where the natural subgrade material has a CBR exceeding 10%.

* Refer notes on Page 22

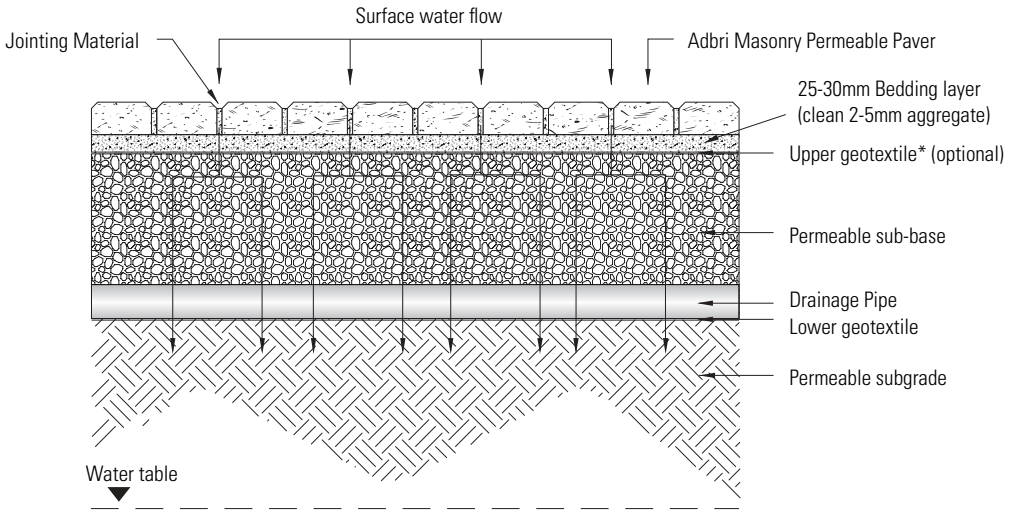


SYSTEM B: PARTIAL FILTRATION

System B will normally be used where the existing subgrade may not be able to absorb all of the water. As you can see below, outlet pipes are connected to the permeable sub-base and this allows excess water that can't be absorbed to be drained into other devices such as stormwater pits, swales or watercourses. This typically applies where the natural subgrade material has a CBR exceeding 6%.

This system normally only allows a fixed amount to infiltrate down through the system, which normally represents large percentages of the design rainfall. The excess is then collected and discharged, in accordance with local regulations, into stormwater infrastructure or watercourses. This is one method that reduces the volume of runoff, and will likely remove the need for long term storage.

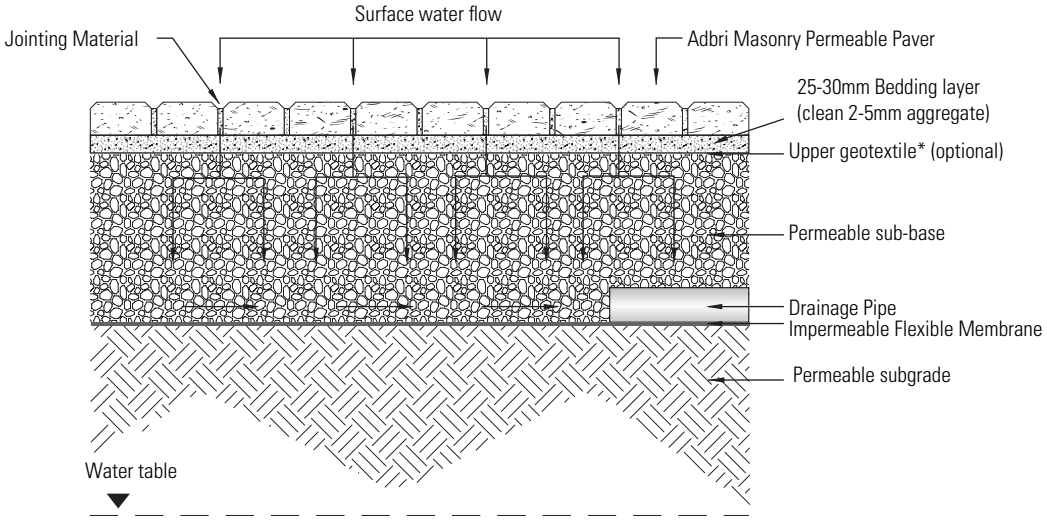
* Refer notes on Page 22



SYSTEM C: NO FILTRATION

System C allows for the complete capture of the water using an impermeable flexible membrane placed on top of the subgrade level and up the sides of the permeable sub-base to effectively form a storage tank. It is used in situations where the existing subgrade has a low permeability or low strength and would be damaged by the introduction of additional water, or where the desire is to harvest the water that enters the system. Outlet pipes are used throughout the impermeable membrane at suitable locations to transmit the water to stormwater infrastructure, treatment plants or watercourses. This system is recommended wherever the natural subgrade material has a CBR lower than 6%.

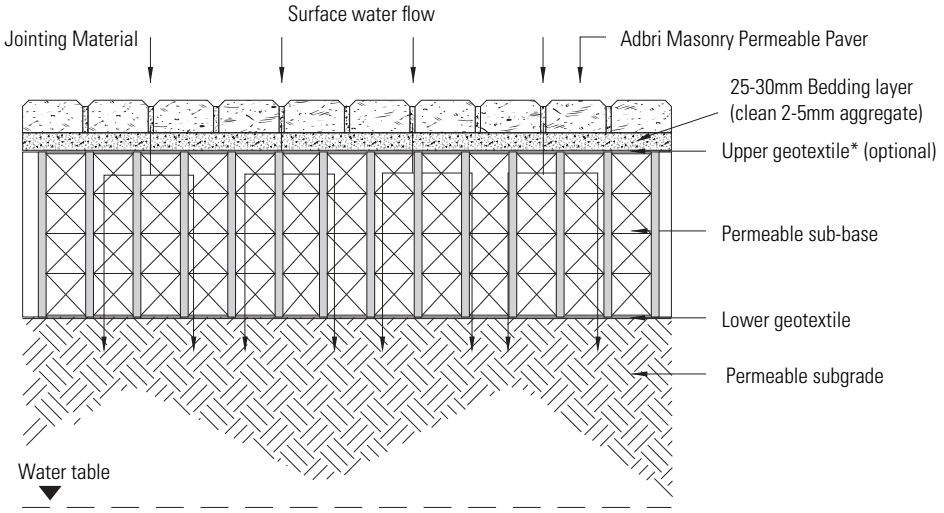
System C works perfectly for contaminated sites, as it prevents pollutants from entering down into the subgrade and eventually getting washed into the groundwater. This system can also act as an underground retention/detention zone, and sometimes the stored or captured water can be harvested and reused for other purposes such as irrigation.



* Refer notes on Page 22

PERMEABLE SUB-BASE REPLACEMENT SYSTEMS

Another option which can be considered is a permeable sub-base replacement system that can be incorporated into the permeable pavement. The permeable sub-base will normally consist of a series of latticed plastic cellular units connected as a modular structure replacing some or all of the permeable sub-base, depending on the traffic load.



* Refer notes on Page 22

DESIGN CONSIDERATIONS

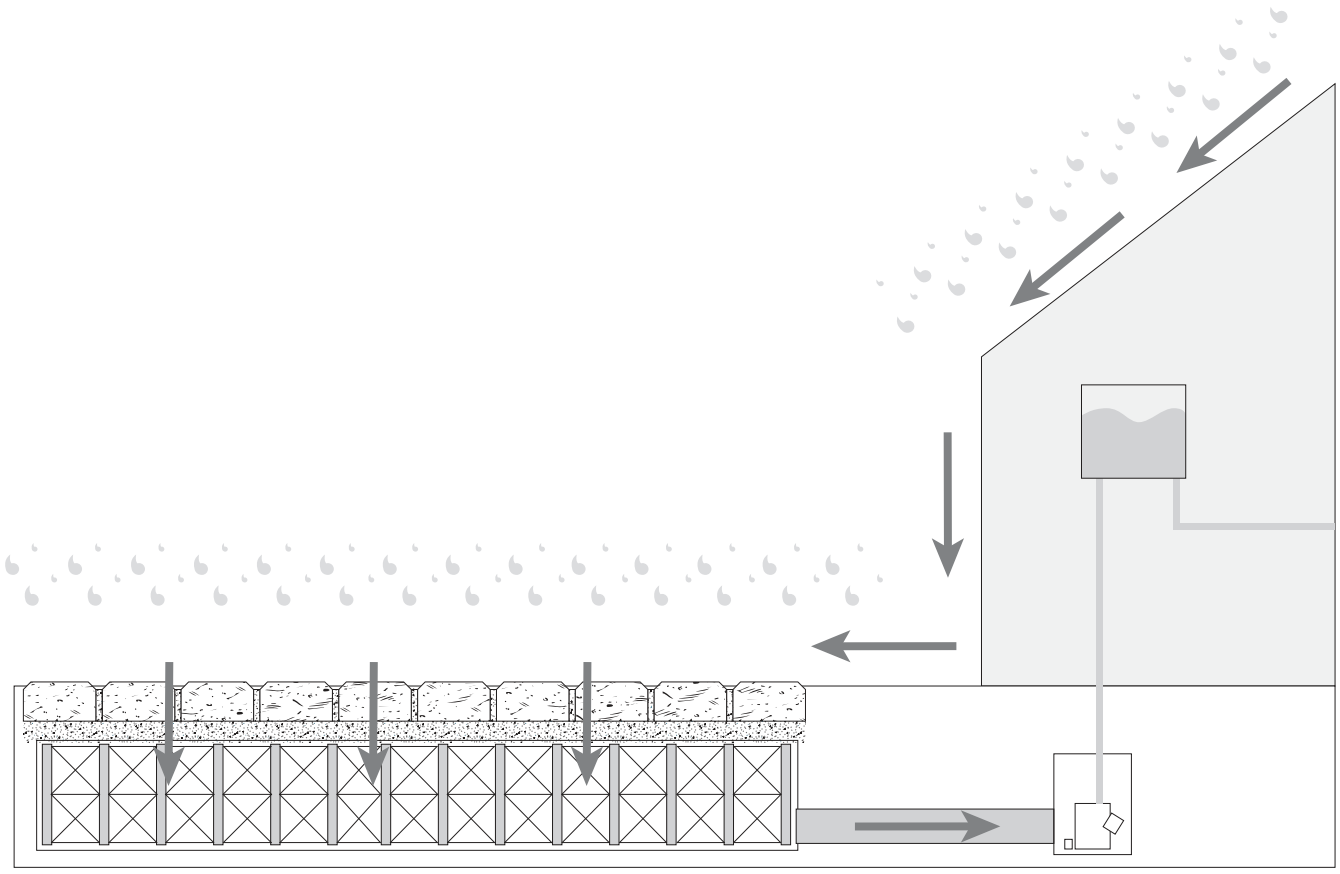
RAINWATER HARVESTING

This system involves harvesting rainwater from roofs and hard surfaces and using it in or around buildings. The water can be used for a large variety of non-potable uses including, but not limited to, landscape irrigation. This runoff however must be of reasonable quality and free from debris and sediments. Permeable pavements will provide filtration to achieve this. The stormwater can then be stored in the permeable sub-base below a permeable concrete block pavement, or in a tank installed specifically for this purpose. Rainfall detention storage volumes are very different to that of reuse volumes as they both have different requirements

Rainwater Reuse - Needs to be full most of the time to allow the water to be readily available.

Stormwater Detention - Needs to be empty to allow it to temporarily store water from the deluge of rainfall events.

The use of a tank in conjunction with the sub-base will accommodate both of these needs. If, however, you opt only to use the base, this will still be effective, it may just result in runoff occurring if numerous rainfall events occur in close proximity to one another.



SELECTING A PAVEMENT SYSTEM

Subgrade Permeability

The most important consideration when selecting a Permeable Pavement System is the permeability of the subgrade, which is able to be determined by appropriate testing of the site itself. An infiltration test should be carried out as close to the final formation level of the pavement as possible, which normally means that a lower head of water is to be used to replicate the performance of the permeable pavement.

		System A Total Filtration	System B Partial Filtration	System C No Filtration
Permeability of subgrade defined by coefficient of permeability k (m/s)	10^{-6} to 10^{-3}	●	●	●
	10^{-8} to 10^{-6}	-	●	●
	10^{-10} to 10^{-8}	-	-	●
Highest recorded water table within 1000mm of formation level		-	-	●
Pollutants present in subgrade		-	-	●

Soil Classification	Typical range of coefficient of permeability K (ms)	Typical range of CBR Values
Heavy Clay	10^{-10} to 10^{-8}	2 to 5
Silty Clay	10^{-9} to 10^{-8}	3 to 6
Sandy Clay	10^{-9} to 10^{-6}	5 to 20
Poorly Graded Sand	5×10^{-7} to 5×10^{-6}	10 to 40
Well Graded Sand	5×10^{-6} to 5×10^{-4}	10 to 40
Well Graded Sandy Gravel	10^{-5} to 10^{-3}	30 to 80

Other Criteria

Concrete block permeable pavement (CBPP) systems are extremely useful where the proximity of trees and other planting is in close contact with the hard surface, as it allows for water and air flow to continue back into the roots of the surrounding flora.

However, as with any drainage system, overflow routes need to be planned in order to cater for extreme circumstances. In addition to this, it is important to maintain statutory service runs in correspondence to the permeable and impermeable paved areas to cater for future maintenance of these specific services

In order to obtain the best possible performance and minimise the issues during construction the following should be considered:

> DO NOT use permeable pavements where there is potential for heavy silty loads from the proposed use.

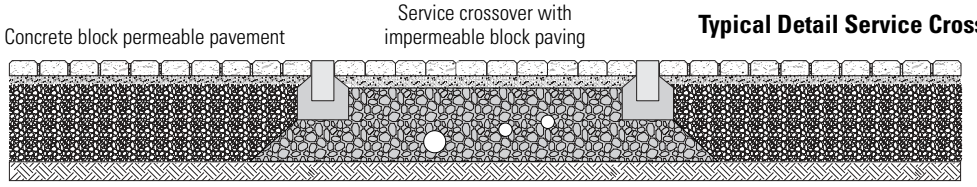
> It is possible to construct part of an area in impermeable materials that will run off onto the permeable pavement.

> Design of permeable pavements must take account of the overland flow routes of water when the design capacity is exceeded.

Service Corridors

It is not necessary to design all surface areas as permeable, as CBPP can cope with runoff from adjacent impermeable areas including roofs, up to a ratio of 2:1 impermeable:permeable, depending on anticipated rainfall intensity and base depths.

Typical Detail Service Cross-over



DESIGN CONSIDERATIONS

STRUCTURAL AND HYDRAULIC DESIGN

Design Criteria

Permeable Pavements must be designed in order to achieve two objectives:

> Support the traffic loads

> Manage surface water effectively (i.e. provide sufficient storage)

Design tables have been provided on the following pages for both objectives. The designer should ensure they have used the most conservative value from each table relevant to their design.

Water Storage Design

In the majority of cases it is not plausible to provide a system which will withstand the greatest rainfall that has ever occurred. It is more economical to tolerate a periodic overflow than to design for every intense storm recorded. A periodic overflow would involve the captured storm water exceeding the storage capacity of the base resulting in water flow over the surface of the pavement.

The table below provides the minimum required base depths for the nominated storm events for each capital city. A deeper base depth may be required for structural adequacy (refer to pages 19 and 20)

	Required permeable base thickness (mm)					
Rainfall Data	10% AEP 30 min storm duration	10% AEP 2 hour storm duration	20% AEP 30 min storm duration	20% AEP 2 hour storm duration	50% AEP 30 min storm duration	50% AEP 2 hour storm duration
Location						
Adelaide	100mm	150mm	100mm	120mm	100mm	100mm
Brisbane	220mm	380mm	190mm	310mm	130mm	190mm
Canberra	110mm	180mm	100mm	150mm	100mm	110mm
Hobart	100mm	130mm	100mm	110mm	100mm	100mm
Melbourne	100mm	150mm	100mm	140mm	100mm	100mm
Sydney	180mm	300mm	160mm	260mm	130mm	210mm

Design Notes:
- Thickness assumes base has void ratio of 25% or greater
- Thickness assumes no additional contributing catchment area
- Limited discharge rate of 0.5L/s applies
- Values are based on ARR 2016 IFD's for nominated capital cities
- Values based on no pre-burst event
- Values are based on minimum required depth for nominated storm event and location
- Values indicate required pavement depth to facilitate stormwater storage for nominated storm events
- Designs have been carried out using the Permpave design software, available to download from www.cmaa.com.au as part of the Designpave package

INDICATIVE PAVEMENT DESIGNS

Load Category 1	Load Category 2	Load Category 3
No large goods vehicles	One large goods vehicle per week	Five large goods vehicles per week
Private driveway	Small business parking	Local access only street
Domestic parking	Motel parking	Parking area residential development
Footpath	Major pedestrian thoroughfare	Railway station car park
Patio	Sports stadium pedestrian access	Parking small local shopping centre
Maximum Design: 20 year design life maximum 10 vehicles per day	Maximum Design: 20 year design life maximum 200 vehicles per day	Maximum Design: 20 year design life maximum 500 vehicles per day

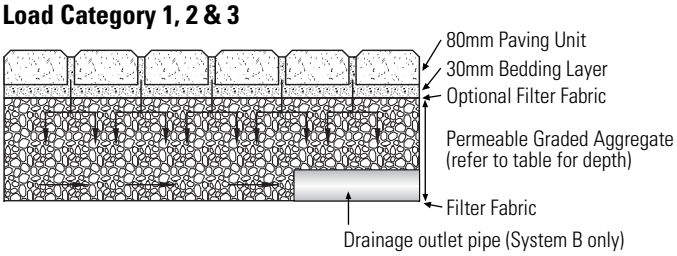
These pavement designs are indicative only and based on conservative assumptions for the nominated design parameters. Adbri Masonry can provide site specific preliminary designs, or preliminary designs for projects where the nominated CBR values or vehicle loadings are not applicable to you projects. To obtain such a design please contact Adbri Masonry on 1300 365 565 and have readily available the following information:

CBR of subgrade material
Required design life
Vehicle types and number of daily vehicle passes
Purpose of using permeable paving (ie water management, water quality, water harvesting)

SYSTEM A AND B DESIGNS

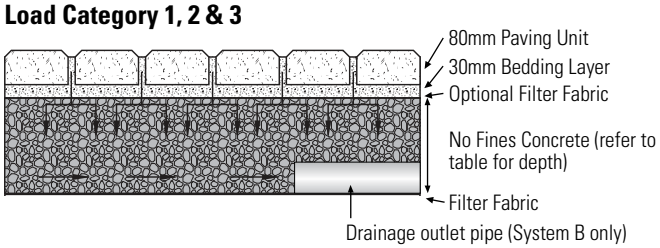
Depth of coarse graded aggregate

Load Category 1, 2 & 3



Depth of No Fines Concrete

Load Category 1, 2 & 3



Mechanistic Design Values

CBR of Subgrade	Depth of Permeable Graded Base and No Fines Concrete					
	Graded Aggregate			No Fines Concrete		
	LC1	LC2	LC3	LC1	LC2	LC3
1%*	400	450	500	200	250	300
2%*	325	375	425	180	225	250
3%*	300	350	375	160	200	225
4%*	280	340	410	150	180	200
5%*	250	310	380	140	170	190
8%	200	240	300	130	165	185
10%	175	220	280	125	160	180
15%	160	200	250	100	135	175

*It is recommended that System C (see page 20) is adopted with an impermeable membrane, due to the potential of reactive clays for CBR of 5% or lower.

Refer table on page 18 for permeable base thickness due to storm water events - if extra depth is required to facilitate anticipated rainfall event, this depth should be utilised in lieu of the mechanistic design values provided above.

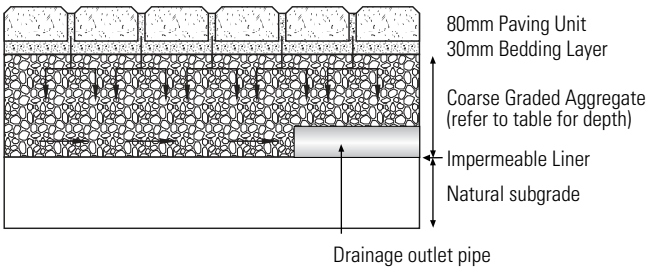
*Designs have been carried out using the Permpave design software, available to download from www.cmaa.com.au as part of the Designpave package

DESIGN CONSIDERATIONS

SYSTEM C DESIGNS

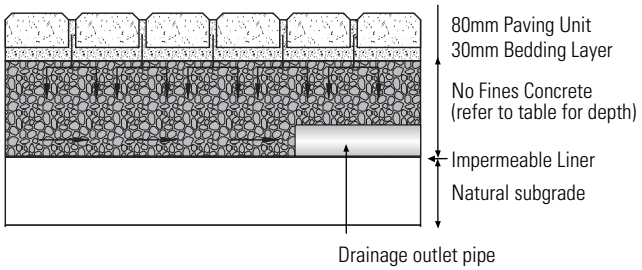
Depth of Coarse Graded Aggregate - System C

Load Category 1, 2 & 3



Depth of No Fines Concrete - System C

Load Category 1, 2 & 3



Mechanistic Design Values

CBR of Subgrade	Depth of Permeable Base (mm)					
	Graded Aggregate			No Fines Concrete		
	LC1	LC2	LC3	LC1	LC2	LC3
1%*	425	475	525	225	275	320
2%*	350	400	450	200	250	280
3%*	325	375	400	175	240	250
4%*	300	360	375	160	220	230
5%*	275	325	350	150	200	215
8%	250	250	325	140	190	200
10%	200	225	310	130	175	190
15%	175	210	300	115	150	180

*Designs have been carried out using the Permpave design software, available to download from www.cmaa.com.au as part of the Designpave package

SPECIFICATIONS OF CONSTRUCTION

SPECIFICATIONS AND MATERIALS

Base Material

A base material with sufficient strength and void capacity to both support the proposed pavement loads, but also allow the water to penetrate through or be captured within the base zone, is extremely important. Base materials may comprise single sized aggregates, or graded permeable aggregates. The higher the proposed loads on the pavement, the more fines will be required to carry the loads, this may result in an increased pavement depth to facilitate water storage in the reduced voids. An alternative method of increasing the strength of the base materials, but maintaining void capacity is to instead use no fines concrete, a cement bound, single - sized 20mm aggregate mix.

Grading recommendations for unbound basecourse for use in permeable pavements

Sieve size (mm)	**Dense Graded Granular Base** Heavy Vehicle loads, high traffic loads	**Open Graded Granular Base** Delivery vehicles, regular access by commercial vehicles	**Single Size (uniform) Granular Base** Carparks, limited service vehicles	**Single Size (uniform) Granular Sub-Base** Pedestrian / residential vehicle loads only
80				100
63				98-100
40			100	85-99
31.5			98-100	
26.5	100	100	-	
19	-	95-100	85-99	20-70
13.2	71-84	70-93	-	
10			20-70	
9.5	-	55-85		0-15
4.75	42-60	20-75	0-15	0-5
2.36	27-45	10-50	0-5	
1.18	-	0-25	-	
0.6	-	0-12	-	
0.425	13-27	-	-	
0.3	-	0-8	-	
0.15	-	0-6	-	
0.075	5-12	0-5	-	

Suggested gradings for no-fines concrete base

Sieve size (mm)	20mm maximum size
25.5	100
19	85-100
13	0-10
9.5	0-5
4.75	0
2.36	0
Typical Cement Content (kg/cu m)	210

SPECIFICATIONS OF CONSTRUCTION

Bedding Layers and Jointing Material

A sufficiently coarse bedding layer is require to allow the vertical flow of water whilst preventing its intrusion into the underlying coarse graded aggregate, yet sufficiently fine to permit the accurate installation of the pavers. The bedding layer and jointing material would fall into the Particle Size Distribution table below.

Sieve Size (mm)	Percentage Passing (%)
9.5	100
4.75	85-100
2.36	10-40
1.18	0-10
0.3	0-5

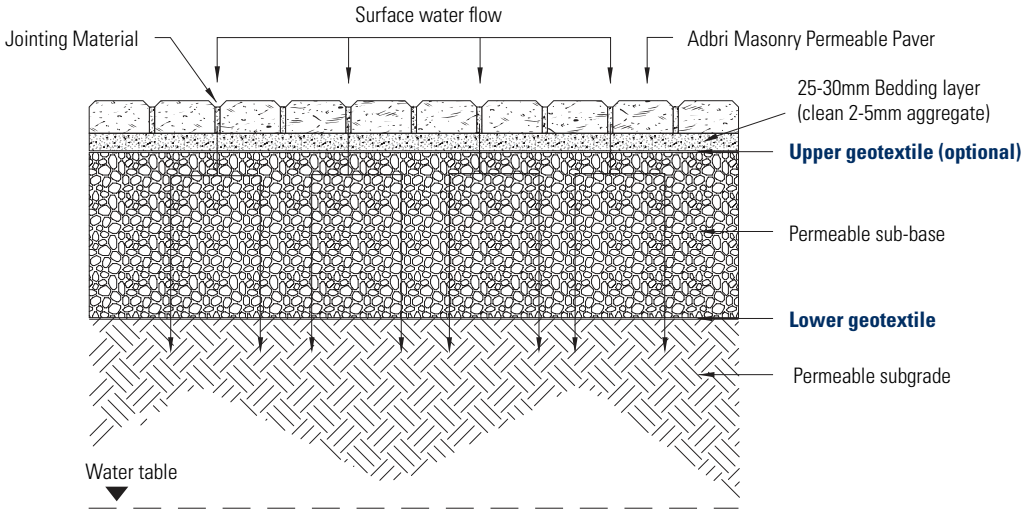
If a geotextile fabric is not used between the sub-base and bedding layer, the different layers of materials must meet conventional soil filter laying course criteria in order to stop the flow of the finer bedding layer material into the sub-base.

Geotextiles

Geotextile fabrics may be used in two locations within a permeable paving system

> An upper geotextile (optional) at the bedding layer to base course intersection may be included. Adbri Masonry do not recommend installation of this layer in pavements subject to vehicular traffic as it can cause or create a lateral slip failure plane.

> Between the permeable subgrade and subbase for type A and B pavements.

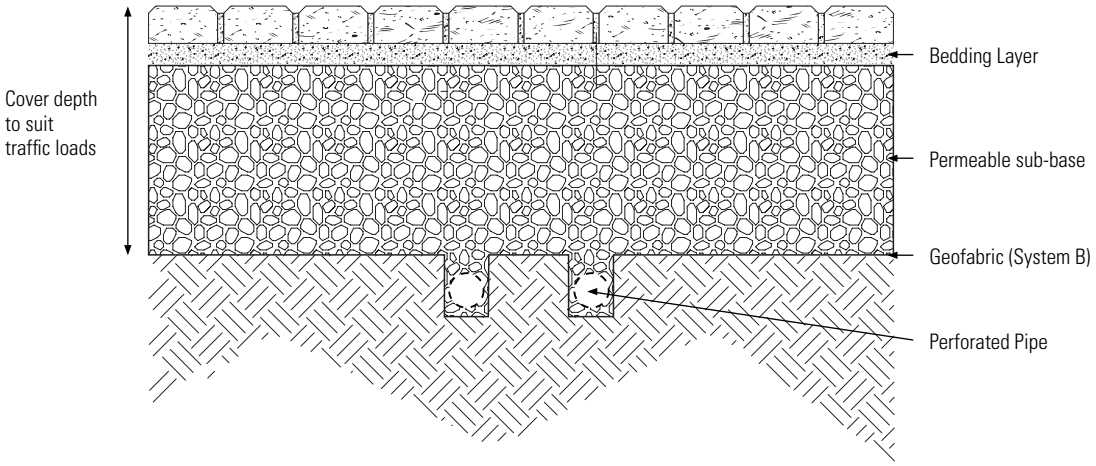


DETAILING

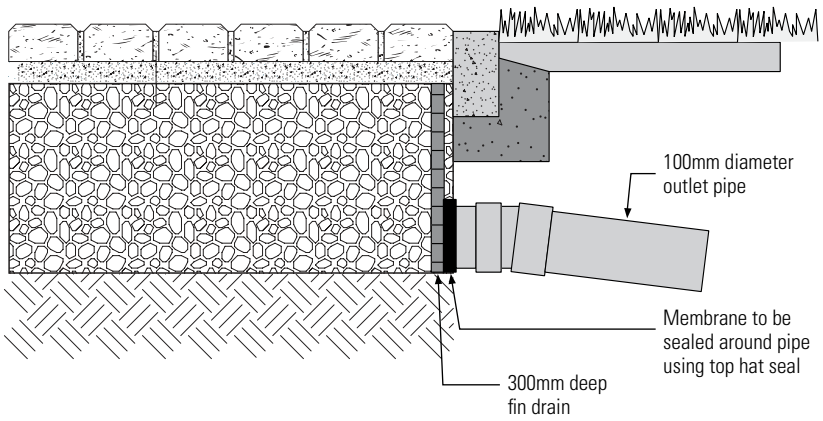
Outlets and Conveyance

In System B and C, the most effective way of connceting the permeable sub-base to the drainage system is to use fin drains or perforated pipes. If using this method however, the pipes will need sufficient cover in order to carry vehicle loads and may need to be installed in a trench below the permeable sub-base to achieve this.

For Large Areas of Permeable Paving Perforated Collector Pipes in Trenches can be used to Collect the Water

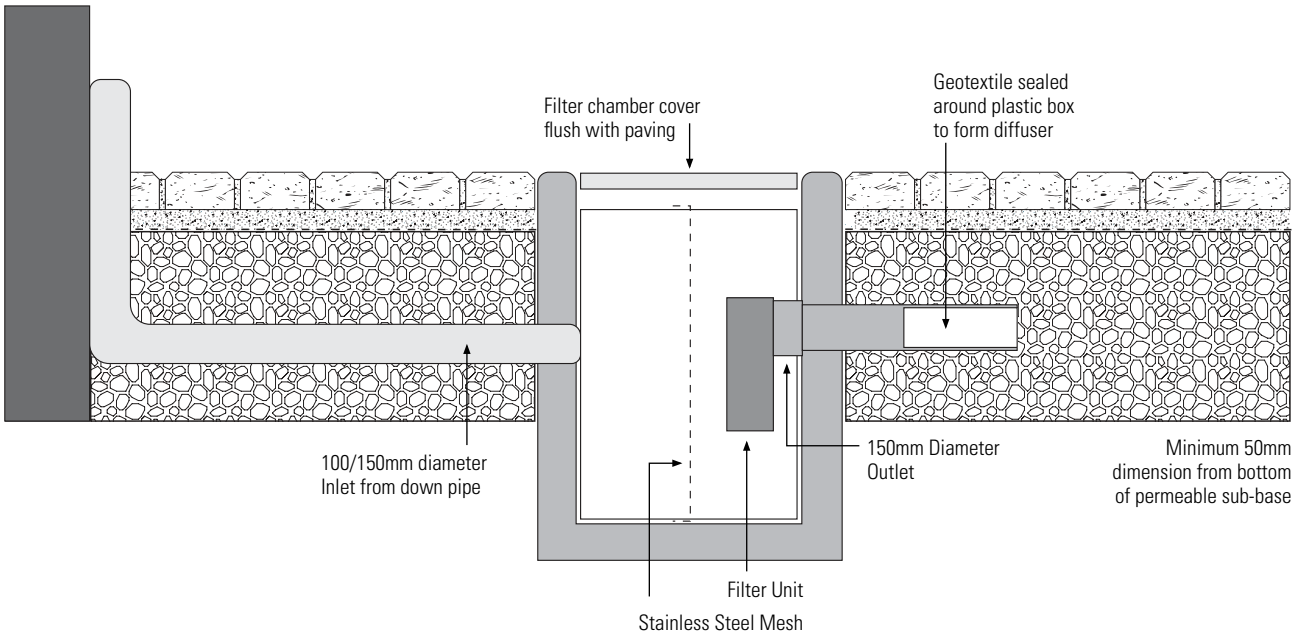


Collection of Water by Fin Drains

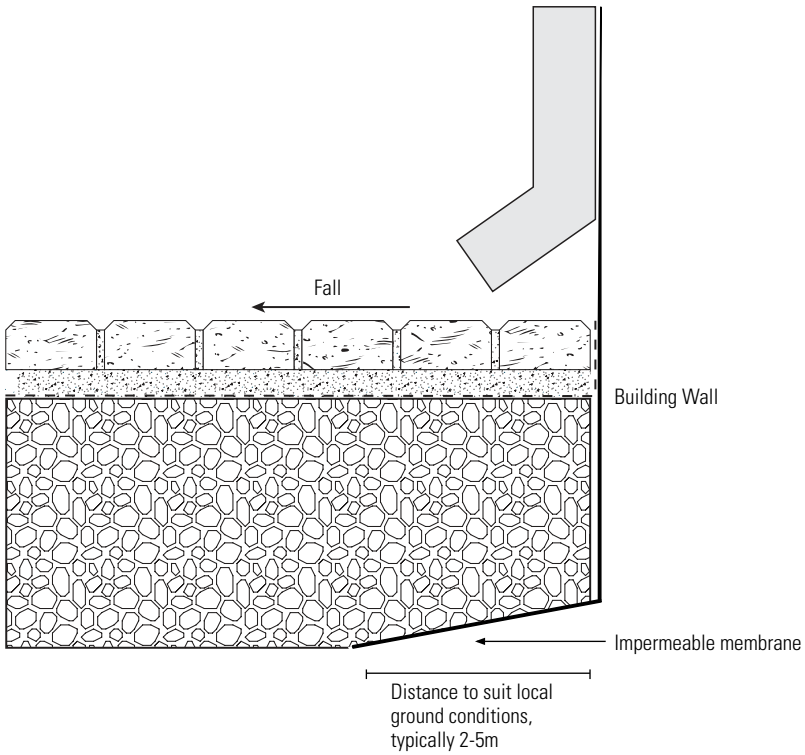


SPACING OF OUTFLOW PIPES

Typical Roof Drainage Outlet



Typical abutment to building



CONSTRUCTION

Permeable Base Materials

Due to the fact that the permeable sub-base materials lack fines, there is a potential for segregation in the aggregates during transportation and construction. Remedial, corrective action is required if this occurs. The best way to minimise the chance of segregation occurring is to use a clean, angular, crushed material with a high surface friction.

The nature of grading of the permeable base materials will vary depending on the source, however it is best to undertake a site trial to determine the best construction methodology.

Laying of the sub-base should be completed in 100-150mm layers and compacted throughout to ensure maximum density is achieved for the particular material type and grading, permeable graded aggregates are usually fairly self compacting so heavy compaction is not normally required.

UNITS OF MEASURE

One of the most common mistakes made when designing permeable pavements is the use of incorrect units. This is because the common parameters are quoted in different units and require conversion when carrying out calculations. The common units and conversions are provided below.

	Units			
Parameter	mm/h	m/h	m/s	l/s/m^2
Rainfall	20	0.02	5.6 x 10^{-5}	0.0056
Infiltration rate of soil	3.6	0.0036	1x10^{-6}	0.001
Flow rate into block surface (through joints) when new	4500	4.5	0.0013	1.31
Adbri's 10yr Design Value	324	0.324	0.00009	0.09

MAINTENANCE

PERFORMANCE CHARACTERISTICS

Surface Infiltration Rates and Clogging

The percolation through joints will vary depending on the blocks laid, and the aggregate used, however a standard value for a newly laid system is 4,500mm/hour. The aggregates in the system will have a much higher value, at least 40,000 mm/hour. The infiltration rates will decrease from the newly laid value, however, this will stabilise with age, due to the build-up of detritus in the jointing aggregate. Through studies the recommended infiltration rate over a 20 year long design life without maintenance will be roughly 10% the initial value, all designs provided in this literature have allowed for this reduced infiltration rate.

MAINTENANCE

Maintaining the Pavers

It is recommended that the paving system be swept down twice a year as a precaution against clogging, which is no greater than what is recommended for a traditional pavement system.

If the pavement does clog completely over time it may be possible to be able to rehabilitate the area using a road sweeper. Through international tests it has been shown that use of a brush and suction sweeper is less effective then a jet wash and suction sweeper, in cleaning silt from the joints between the blocks.

Soil and other fine materials must always be prevented from contaminating the pavement surface. Water ponding on the surface will almost certainly indicate that the filtration has reached an insufficient level and the joints/voids may require urgent attention, either sweeping clean or in extreme cases replacement. Research has proven that most clogging of the joints or openings in permeable paving only occurs in the top 30-50mm. In extreme circumstances the paving units can be lifted and then relaid with fresh jointing material to create an “as new” pavement.

As with all concrete block pavements, depressions, rutting and cracked or broken blocks, that are considered to be of detriment to the structural performance of the system, or a hazard to users, will require appropriate corrective action.

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