BOWERS MASONRY

PERMEABLE PAVING SOLUTIONS

INSTALLATION GUIDE

NEW ZEALAND MADE ®

VERSION 5 | WWW.BOWERSBROTHERS.CO.NZ

INTRODUCTION

The Bowers Permeable Paver Systems allow stormwater to percolate and infiltrate the surface areas traditionally impervious to the soil below. These systems can control stormwater at the source, reduce runoff and improve water quality by filtering pollutants in the substrata layers which are detrimental to our waterways. Permeable Pavers are one of the solutions for storm water management in the Auckland Unitary Plan.

This installation guide is solely for the Bowers Permeable Paving range. Permeability rates are based on the full system and product requirements. This guide can be used to submit consents for the installation of Bowers Permeable Paver Systems. The application on these products is suitable for parking areas, driveways, access roads into townhouse developments and can be adapted to replace detention tanks. The systems can also be installed with an additional storage base course when required and can also be used with a suitable geogrid to provide a stabilising platform for soft sub-grade situations.

TECHNICAL SUPPORT

Should you require any technical support on the Bowers Permeable Paving Systems, contact Bowers on:

0800 207 374

technicalsupport@bowersbrothers.co.nz

www.bowersbrothers.co.nz

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WHAT EXACTLY IS THE BOWERS PERMEABLE PAVING SYSTEM, AND HOW DOES IT WORK?

Watch our permeable paving videos on our social media channels, click on the platform you prefer.

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27 INSTALLATION SPECIFICATIONS

Please talk to your local Bowers representative for more information.

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PERMEABLE PAVING

PRODUCT RANGE

AQUACOURT™

Invented for your patio or pathway requirement in a 50mm thick flagstone. Permeability is through the joints with a tested rating of 1,800mm/hr.

Aquacourt entranceway in Irondsands colour

Please talk to your local Bowers representative for more information.

Aquacourt courtyard/patio in Irondsands colour

SPECIFICATIONS	STANDARD COLOURS*	BEST FOR
450mm x 225mm x 50mm 10 units per m² 96 per pallet **Permeability 1,800mm p/ hr**	**IRONSANDS** *Made to order colours and finishes are available on a minimum order quantity.	☑ Residential

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AQUALOK™

A solid unit with enlarged spacer nibs on the sides of the paver to accommodate a 2-7mm clean chip. With this unit the rain water permeates through the clean chip in the joints between the pavers and the bedding layer. The permeability of this system when laid as per the Bowers Permeable System is approx. 5,500mm/hr.

Aqualok and Aquastone are the same size and can be laid in combination with each other so banding or parking bay demarcation areas can be installed.

Please talk to your local Bowers representative for more information.

Aqualok Natural colour, Herringbone pattern with Aquastone Ironsands soldier course border and banding

Aqualok Natural with Aquastone Ironsands band

SPECIFICATIONS	STANDARD COLOURS*	BEST FOR
200mm x 100mm x 80mm 50 units per m² 480 per pallet **Permeability 5,500mm p/hr**	NATURAL IRONSANDS *Made to order colours and finishes are available on a minimum order quantity.	☑ Residential ☑ Commercial

AQUASTONE™

Also, a solid unit with enlarged spacer nibs with an extra "false" joint line to give the impression of a Stone Sett. This "false "joint is large and deep enough to retain the 2-7mm chip. As with the Aqualok the rain water permeates through the clean chip in the joints between the pavers and the bedding layer. The surface is embossed with 24 different variations taken from natural stone to give the stone look. Once the pavers have sufficient chip in all the joints they are sprayed with Aquabind which stabilises the joint chip to resist washing out with a hose pipe, vacuuming and sweeping. See Aquabind application process on page 7. The permeability of this system when laid as per the Bowers Permeable System is approx. 5,500mm/hr.

Aqualok and Aquastone are the same size and can be laid in combination with each other so banding or parking bay demarcation areas can be installed.

Please talk to your local Bowers representative for more information.

Aquastone Rocksalt colour
NOTE: Rock Salt is a mixed blend of Natural and Ironsands.

Aquastone Ironsands colour

SPECIFICATIONS	STANDARD COLOURS*	BEST FOR
200mm x 100mm x 80mm 50 units per m² 480 per pallet **Permeability 5,500mm p/hr**	**ROCK SALT** **IRONSANDS** *Made to order colours and finishes are available on a minimum order quantity.	☑ Residential ☑ Commercial

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GRASSLOK™

This unit has robust spacer nibs to prevent spalling of the edges and maintain the 2-3mm joint space. It also has a chamfer around the perimeter and a groove down the centre for aesthetic appeal. The interlock shape makes laying in all patterns easy and has the added advantage to machine lay the product on large projects. Grass can be grown in the cavities or decorative pebble can be used and sprayed with Aquabind. Permeability rates are dependent on the grass type or decorative infill. Decorative pebbles should be limited to max +- 15mm in size for the best bonding of the Aquabind solution.

Grasslok Natural showing chamfer, spacer nibs & groove

Grasslok Natural with grass

Grasslok Ironsands with white chip

Grasslok Natural with pebble

SPECIFICATIONS	STANDARD COLOURS*	BEST FOR
400mm x 200mm x 80mm 12.5 units per m² 150 per pallet **Permeability:** dependant on grass or type of pebble used	NATURAL IRONSANDS *Made to order colours and finishes are available on a minimum order quantity.	☑ Residential ☑ Commercial

GRASSLOK™

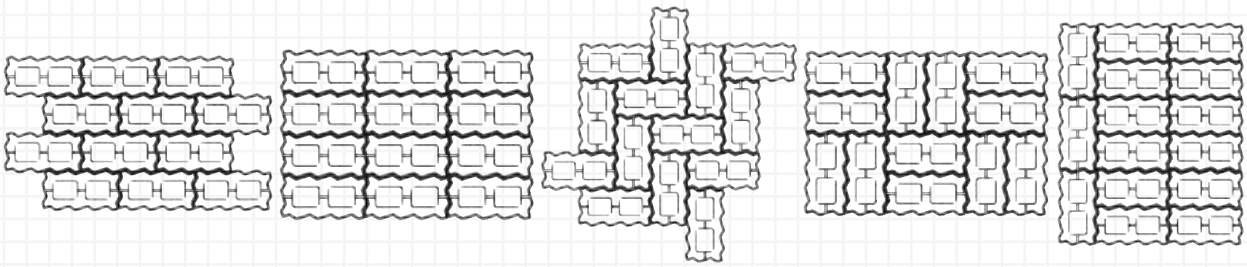
What kind of grasses can be used in the Grasslok?

California green (Tall Fescue) - This is a medium bladed leaf with a dark green colour. It is ideal in high use areas. California Green is becoming a popular choice because of its ability to withstand wear and tear.

Agridark Couch – Extremely hard-wearing draught resistant fine bladed grass. Summer grass that grows over the summer months, in winter Couch goes into a natural dormancy and can turn straw coloured for approximately two months. Excellent in warmer coastal environments.

Grass should be laid with 70% topsoil and 30% lawn mix slightly compacted. Keep the level approximately 10 -15 mm below the top surface of the Grasslok.

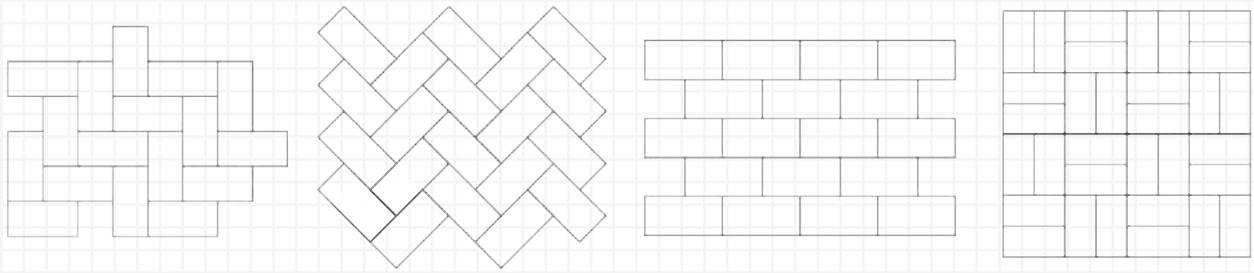
GRASSLOK LAYING PATTERNS



RUNNING BOND | STACK BOND | HERRINGBONE | BASKET WEAVE | MACHINE LAID

AQUALOK, AQUASTONE & AQUACOURT LAYING PATTERNS

Herringbone 90 and 45 degrees to the direction of the traffic is best suited for vehicular applications



90˚ HERRINGBONE | 45˚ HERRINGBONE | STRETCHER BOND | BASKET WEAVE

Please talk to your local Bowers representative for more information.

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AQUABIND™

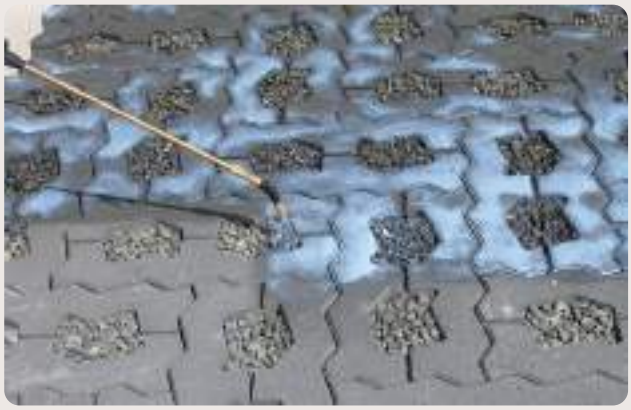
Aquabind is a water based acrylic which has elastomeric properties to flex with the permeable pavement. The diluted solution is applied to jointing chip and decorative pebbles to stabilise the products from washing out on steep driveways or cleaning with a mild water blast or hose.

Aquabind concentrate comes in a 20 litre pail (40 litres of diluted solution).

Mixing ratio: Aquabind is mixed to a 1:1 ratio with water example 1 litre of Aquabind to 1 litre of water

Coverage: 1 x 20 litre pail of Aquabind will do approx. 60m2 of paving when mixed 1:1 with water

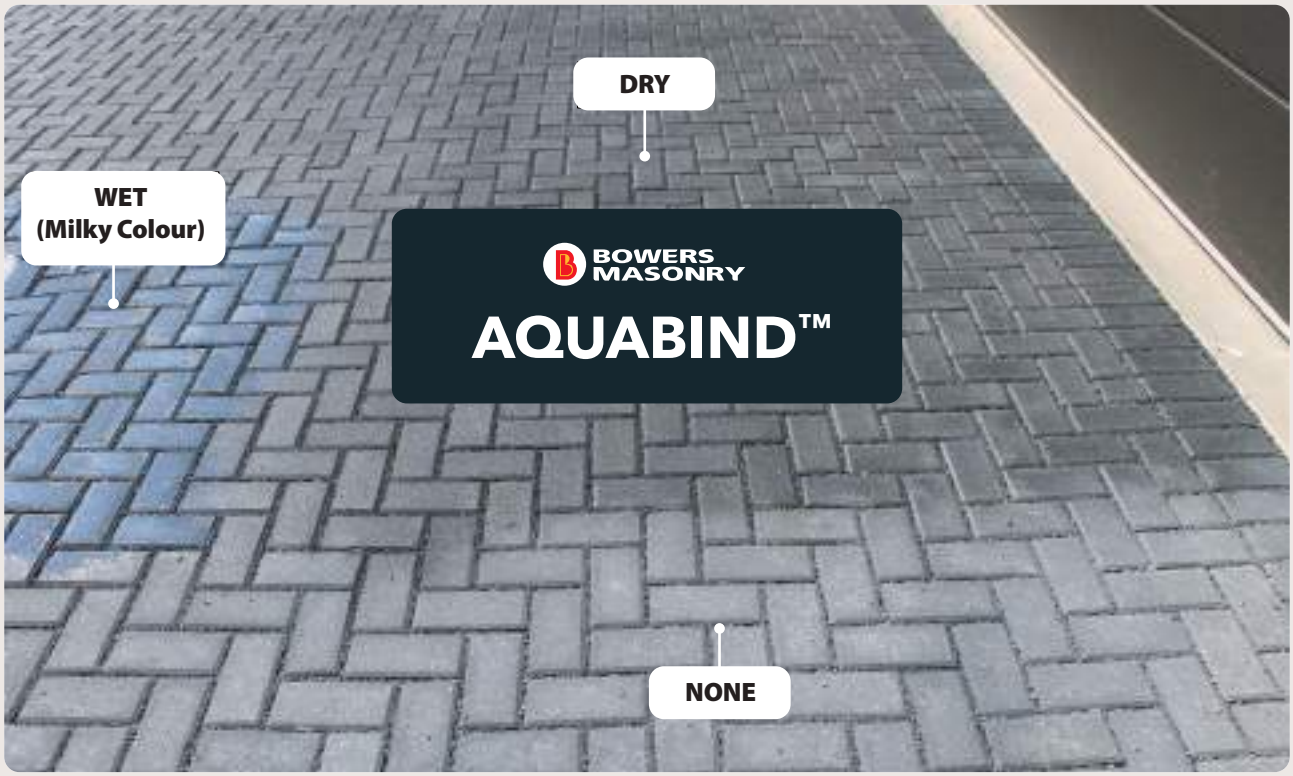
Products: Aquabind is to be used with the Aqualok and Aquastone to stabilise the joint chip and with the Grasslok when using decorative pebbles.



Notice how the Aquabind coats the surface of the pebbles and adheres them together. In this picture not quite dried yet.

INSTALLATION PROCEDURE

- Sweep all access stone chip off the surface of the paving
- Any dirt, marks or efflorescence should be removed prior to spraying
- With the Grasslok pavers ensure the voids are not overfilled. The top of the pebbles should be about 10mm below the surface of the Grasslok paver
- Wear the appropriate protective goggles and gloves before mixing and spraying
- Pour the Aquabind and water into the spray unit in a 1:1 ratio and shake the spray unit to mix the solution
- Timing: Plan the spraying so that the solution once sprayed has at least 1-2 hours drying time. Avoid applying prior to rain. The pavers can be damp but rain will change the dilution.
- Apply the Aquabind solution liberally over the surface of the pavers and ensure enough solution is applied the joints or pebbles to coat the top 10-15mm of the chip/pebble.



- The solution appears milky at this point but will dry to a transparent coating.
  The Aquabind will change the appearance of the pavers making them slightly darker in colour.
- Keep traffic, both pedestrian and vehicular, off the sprayed surface to avoid marking or dirt sticking to the drying solution. A finger touch test will indicate when the solution has dried.
- Avoid spraying the pebbles or chip with a hose pipe for at least two days of good sunshine to give the solution lower down a chance to dry.
- Aquastone: Ensure the false joint has filled with chip prior to spraying. The Aquabind will adhere the chip in the joint giving a uniform look when viewed from above.

Please talk to your local Bowers representative for more information.

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TYPICAL CROSS SECTION OF THE BOWERS PERMEABLE PAVING SYSTEM

TERMINOLOGY

Bedding Layer - Permeable pavers are bedded on 20mm layer of either sand or chip depending on the type of permeable paver used.

Base course - The structural drainage layer underneath the bedding layer, which can be either drainage aggregate or a no fines concrete. This layer is also referred to as "storage medium" as it can act as a storage tank once the storm water runoff has dissipated into it.

Sub-Base - GAP40 or GAP65 to create a stable base in low CBR sub grades.

Sub-grade - The undisturbed soil at the bottom of the pavement system. The strength of this influences the thickness of structural support layer of the base course.

Sub-surface drain - A drainage system which allows water to enter it so it can be directed out of the base course. Assists with removing water in impermeable clay sub-grades and can be designed to reduce the stormwater peak flow by changing the diameter of the pipe.

Filter cloth - Normally a non-woven geotextile which is a polypropylene fabric which allows water to pass through it and prevents the bedding sand from migrating into the sub-base drainage aggregates. Also assists in stopping contamination of the sub base drainage aggregates when surrounded by clay soil.

WHAT PRODUCTS CAN BE USED FOR THE VARIOUS APPLICATIONS

Application, Unit Type choice, indicative base course thickness and suitable filter cloths.

Note: These base course thickness are a structural guide based around the bearing capacity of the sub grade. For sub-grades of a CBR of 5 and upwards a base course thickness (for single residential driveway) of 150mm maximum is recommended. Due to storm water runoff quantity requirements and extra layer of aggregate can be installed for storage. This layer of cheaper material can be included under the first layer of drainage aggregate. See cross section dwg " Weak CBR applications".

Please talk to your local Bowers representative for more information.

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BASE COURSE THICKNESS GUIDE

PEDESTRIAN RESIDENTIAL

SUB-GRADE	PERMEABLE BASE COURSE	FILTER	PERMEABLE PAVING SYSTEM
California Bearing Ratio Soaked	**Thickness**	**Cloth Type**	☑ AQUACOURT™ 
Weak CBR 5	100mm compacted	Class C	☑ GRASSLOK™ 
Medium CBR 10	100mm compacted	Class B	☑ AQUALOK™ 
Strong CBR 15	100mm compacted	Class A	☑ AQUASTONE™ 

These tables are a guide and do not replace the use of engineering advice.

LIGHT TRAFFIC RESIDENTIAL SINGLE UNIT DRIVEWAY

SUB-GRADE	PERMEABLE BASE COURSE	FILTER	PERMEABLE PAVING SYSTEM
California Bearing Ratio Soaked	**Thickness**	**Cloth Type**	☑ GRASSLOK™ 
Weak CBR 5	150mm compacted **(Maximum)**	Class B	☑ AQUALOK™ 
Medium CBR 10	100mm compacted	Class C	☑ AQUASTONE™ 
Strong CBR 15	100mm compacted	Class D	

These tables are a guide and do not replace the use of engineering advice.
Grasslok pavers are suited for residential parking areas for light and medium size vehicles.

GEOTEXTILE FABRICS AVAILABLE

Class A – Bidim A14 and Duraforce AS240
Class B – Bidim A19 and Duraforce AS280
Class C – Bidim A29 and Duraforce AS410
Class D – Bidim A39 and Duraforce AS440

Please talk to your local Bowers representative for more information.

BASE COURSE THICKNESS GUIDE

LIGHT TO MEDIUM TRAFFIC RESIDENTIAL MULTI UNIT DRIVEWAY

SUB-GRADE	PERMEABLE BASE COURSE	FILTER	PERMEABLE PAVING SYSTEM
California Bearing Ratio Soaked	**Thickness**	**Cloth Type**	☑ GRASSLOK™  ☑ AQUALOK™  ☑ AQUASTONE™ 
Weak CBR 5	**Specific Design**		
Medium CBR 10	150mm compacted **(Maximum)**	Class D	
Strong CBR 15	100mm compacted	Class C	

These tables are a guide and do not replace the use of engineering advice.
Grasslok pavers are suited for residential parking areas for light and medium size vehicles.

FOOTPATH PUBLIC HIGH IMPACT

SUB-GRADE	PERMEABLE BASE COURSE	FILTER	PERMEABLE PAVING SYSTEM
California Bearing Ratio Soaked	**Thickness**	**Cloth Type**	☑ AQUALOK™  ☑ AQUASTONE™ 
Weak CBR 5	100mm compacted	Class D	
Medium CBR 10	100mm compacted	Class C	Aquastone and Aqualok pavers comply with a 3.5 Abrasion resistance as per test method AS/NZS 4456.9:2003
Strong CBR 15	100mm compacted	Class B	

These tables are a guide and do not replace the use of engineering advice.

NOTES:

On Site CBR values can be determined using a Scarla Penetrometer as per NZS 4402:1986 These base course thickness are a structural guide based around the bearing capacity of the sub grade. Due to storm water runoff quantity requirements and extra layer of aggregate can be installed for storage. For expansive clays, impermeable liners can be installed to limit the amount of water penetrating the sub grade. An Engineer should be consulted to assist with this. For situations where there a very weak CBR's i.e. below CBR 5 refer to Page 28 which explains how a stabilising layer of material with a suitable geogrid can be installed to alleviate this problem.

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PERMEABLE PAVERS SPECIFICATIONS

All products should comply with NZS3116: 2002 Table 1 for strength, dimensional properties, abrasion resistance and slip resistance.

Note: Bowers Aqualok™ product complies with the high impact mean abrasion resistance for Public footpaths.

TABLE 1 - PAVER SELECTION

Applications	Characteristic breaking load (1) (kN) per 100 mm width	Minimum thickness (2) (mm)	Shape (3)	Dimensional tolerances (4)	Edge detail (5)	Abrasion resistance (6) at 56 days mean	Minimum slip resistance classification (8)
Relevant AS/NZS	**4456.5**	**–**	**–**	**4455/4456.3**	**–**	**4456.9**	**4586**
1 **Residential**							
Pedestrian	3.0	40	Any	DPB1	SQ/SC/R/CH	Not required	W
2 **Residential driveways**							
Light Traffic	5.0	50	Any	DPB2	CH/R	Not required	W
Medium Traffic	Follow provisions of application 4 Roads: Minor						
3 **Public footpaths**							
Low Impact	5.0	50	Any	DPB2	SQ/SC/CH	6.0	W
High Impact	5.0	50	Any	DPB2	SQ/SC	3.5	W
4 **Roads**							
Minor	6.0	60	Rr/Dd	DPB2	CH	Not required	W
Local	12.0	80	Rr/Dd	DPB2	CH	Not required	W
Main	12.0	80	Rr/Dd	DPB2	CH	Not required	W
5 **Industrial pavements**	Specific engineering design (7)	80	Rr/Dd	DPB3	CH	See Note (7)	W

NOTES TO TABLE 1.

(1) The characteristic breaking load to AS/NZS 4456.5, as amended by clause 202(b), is carried out on a 150mm actual paver width in mm. The figures quaoted are based on a 100mm width, i.e. actual breaking load x the ratio of 100mm divided by the actual paver width mm. The modulus of rupture value of any paver shall not be less than 4 MPa. Where pavers may be subject to chemical/environmental exposure e.g. marine, swimming pools, thermal pools etc. it is recommended that they be subjected to the resistance test contained in AS/NZS 4456.10 to demonstrate an acceptable performance at 50 cycles of test.

JOINTING MATERIALS

JOINTING CHIP

Jointing chip shall be in the graduation of the following two products.

Note: Jointing chip is used with the Aqualok™, Aquastone™ and Aquacourt Systems.

1. Grade 6 roading chip
2. WPB 7 is a clean 2 – 7mm aggregate (or similar to grading envelope)

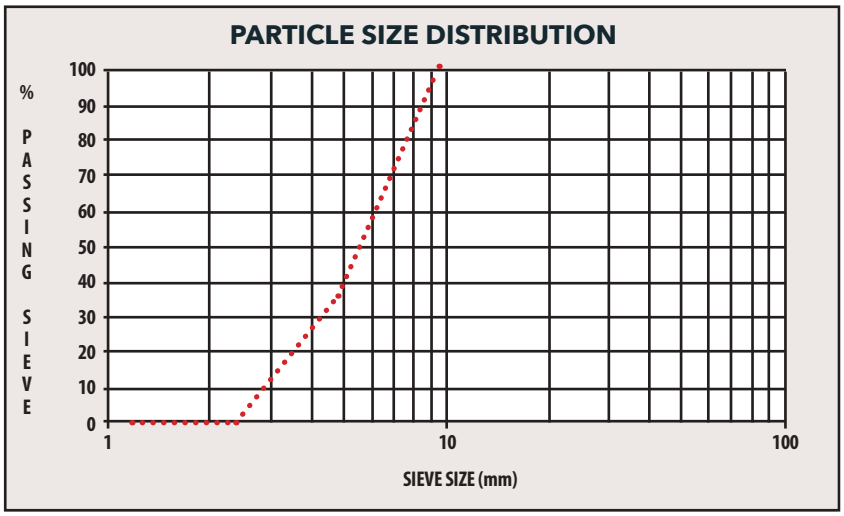
Clean Grade 6 chip

GRADE 6 CHIP

TEST RESULTS			
Material:	**Grade 6**	Test No.:	**172895**
Source:	Stevensons Drury Quarry	Date Sampled:	24th November 2017
Job:	Production Quality Control	Reference No.:	-

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution - Dry Sieve	**See Below**	See Below
Density & Absorption		
Desity SSD Basis	**2690 kg/m³**	**-**
Overdry Basis	**2690 kg/m³**	-
Absorption	**0.7%**	-
Unit Mass of Aggregate (Loose poured)	**1330 kg/m³**	-
Void Content	**50%**	-

Sieve Size (mm)	13.2	-	6.7	4.75	2.36	2.00	1.18
Percent (%)	**-**	**100**	**-**	**36**	**1**	**1**	**0**
Grading Limits (%)	-	-	-	-	-	-	-



Please talk to your local Bowers representative for more information.

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BEDDING MATERIALS

BEDDING CHIP

Bedding chip shall comply with the above gradings for Grade 6 clean chip and WBP 7 (or similar - see envelope on page 16).

Note: Bedding chip is used with the Aqualok™, Aquastone™ and Aquacourt™ Systems and is the same product as the jointing chip (see grading of jointing chip)

BASE COURSE MATERIALS

Suitable types of base course aggregates related to the application.

WPB 12 GRADING ENVELOPE

Sieve Size	Upper Limit	Lower Limit
19.0mm	100	100
13.2mm	95	100
9.5mm	75	90
6.7mm	50	75
4.75mm	30	50
2.36mm	0	10

WPB 7 GRADING ENVELOPE

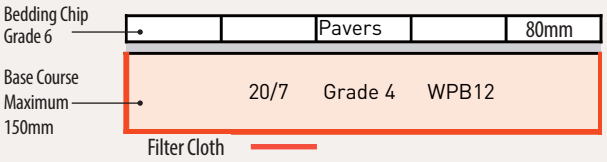
Sieve Size	Upper Limit	Lower Limit
19.0mm		
13.2mm		
9.5mm	100	100
6.7mm	100	90
4.75mm	55	25
2.36mm	3	0

20/7 GRADING ENVELOPE

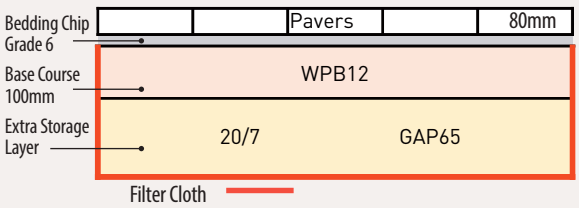
Sieve Size	Upper Limit	Lower Limit
19.0mm	100	100
12.5mm	39	100
9.5mm	5	3

NOTE: Other base course aggregates can be used if they comply with this grading envelope.

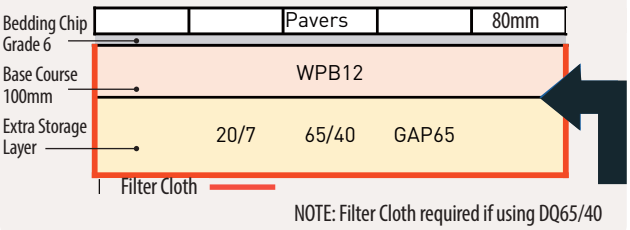
RESIDENTIAL DRIVEWAY SINGLE LAYER BASE COURSE
Suitable types of permeable aggregates



PARKING LOT EXTRA STORAGE LAYER
Suitable types of permeable aggregates



RESIDENTIAL DRIVEWAY EXTRA STORAGE LAYER
Suitable types of permeable aggregates



NOTE: Filter Cloth required if using DQ65/40

BASE COURSE MATERIALS

GRADE 4 GRADING ENVELOPE

Sieve Size	Upper Limit	Lower Limit
12.5mm	100	100
9.5mm	85	77
4.75mm	2	1
2.36mm	0	0

NOTE: GAP 65 - Has very low storage and permeability rates but provides good structural support properties

			Design Pro Software Generated			
Product	**Bulk Density Kg/m³**	**Specific Gravity t/m³**	**Porosity**	**Permeability m/s**	**Void ratio**	**Structural Layer coefficient**
BASE COURSE						
WPB 12	1460	2.73	0.465	0.147	0.87	0.075
20/7	1405	2.7	0.48		0.92	0.075
Grade 4	1340	2.67	0.498		0.99	0.075
SUB BASE						
GAP65	1594	2.72	0.414	3.459-E03	0.17	0.09
65/40	1360	2.71	0.498		0.99	0.075

STRUCTURAL LAYER COEFFICIENT

Dense graded **Base Course** Material 0.10-0.16 (Ave 0.13)
Dense graded **Sub Base** Material 0.06-0.12 (Ave 0.09)
Open graded **Base Course & Sub Base** 0.09-0.06 (Ave 0.075)

19MM NO-FINES CONCRETE

No Fines concrete typically consists of cement, water, sand and coarse aggregate. The quantity of cementitious material is approximately 300Kg/m3 with a water to cement ratio of 0.30 – 0.40. The density of the product will vary with the density of the aggregate used but will typically range between 1600Kg/m3 – 2160Kg/m3. The degree of permeability depends on the compaction of the no fines and should be restricted to pouring layers of 100mm and hand tamping to create a flat surface to lay the pavers.

Vibrating pokers should not be used for compaction

FILTER CLOTH

Refer to the tables for the different applications to use the correct class of filter cloth for the relevant loading and Sub grade strength classification (CBR).

- Pedestrian Residential
- Light Traffic Residential Single Unit Driveway
- Light to Medium Traffic Residential Multi Unit driveway
- Footpath Public High Impact

Please talk to your local Bowers representative for more information.

BOWERS MASONRY

PRODUCT SPECIFICATIONS

DRAINAGE

EDGE RESTRAINTS

STORMWATER MANAGEMENT

SUB SURFACE DRAINS

NOTE: By sloping the excavation slightly to one side when installing on impermeable clay sub grades you can direct the water to one location to save on the number of sub surface drains. See cross-section drawings.

novaflo™

400 Series (punched)
500 Series (unpunched)

NOVAFLO™ is a single wall corrugated high density polyethylene land drainage pipe. NOVAFLO™ has been a leading brand name in the rural New Zealand land drainage market for over twenty years. During this time farmers have learned to rely on this quality product for delivering excellent drainage results. Such proven benefits as improved soil structure, larger root systems, better fertiliser uptake and reduction in surface pugging has made the use of NOVAFLO™ an integral part of the New Zealand farmer's search for greater productivity. Novacoil is the unslotted version of NOVAFLO™.

FEATURES AND BENEFITS

Economical	NOVAFLO™'s single wall construction, light weight and ease of installation, makes this product the cost effective choice for land drainage.
Reliable	NOVAFLO™ has a long track record of being a quality product in New Zealand.
Durable	NOVAFLO™ is made from tough high density polyethylene.
Flexible	NOVAFLO™'s single wall corrugated construction gives it excellent flexibility and strength.
Versatile	NOVAFLO™ and NOVACOIL's diameter and coil size range, together with a range of compatible fittings, provide drainage solutions for a wide range of situations.
Compatible	NOVAFLO™ and NOVACOIL are compatible with the NEXUS™ range of pipe as well as a number of PVC pipeline products manufactured by Iplex Pipelines.
Quality	NOVAFLO™ and NOVACOIL are manufactured in New Zealand by Iplex Pipelines using a quality system accredited to ISO 9002:1987.
Visible	NOVAFLO™ and NOVACOIL are colour coded for easy identification.

PRODUCT RANGE

	Diameter OD (mm)	Length of Coils (metres)	Colour of pipe & stripe
NOVAFLO™ (Punched)	65	15, 30, 150	Black, no stripe
	110	15, 30, 50, 100, 450	
	160	15, 45, 185	
NOVACOIL (Unpunched)	65	15, 30, 150	Black with white stripe
	110	15, 30, 100	
	160	15, 45	

NEXUS™/NOVAFLO™ FITTINGS

Compatible range of PVC and PE fittings designed for use with the NEXUS™ and NOVAFLO™ range of pipes.

BOWERS MASONRY

BEDDING MATERIALS

Edge restraints are no different to normal paving requirements.
NZS 3116:2002 Section 306

306 KERBS AND EDGE RESTRAINTS

306.1
Edge restraint shall be provided at the perimeter of the paved area to confine the pavers and flagstones. Kerbs and edge restraints shall extend at least 50 mm below the bedding sand, and other details shall meet the requirements of the territorial authority.

C306.1
Edge restraint may be in the form of a kerb, kerb and channel, edge having mortar bedded solid course or existing foundation structure.

Please talk to your local Bowers representative for more information.

STORMWATER RUNOFF MANAGEMENT SYSTEMS

Bowers Permeable Pavement Systems can function in two ways.

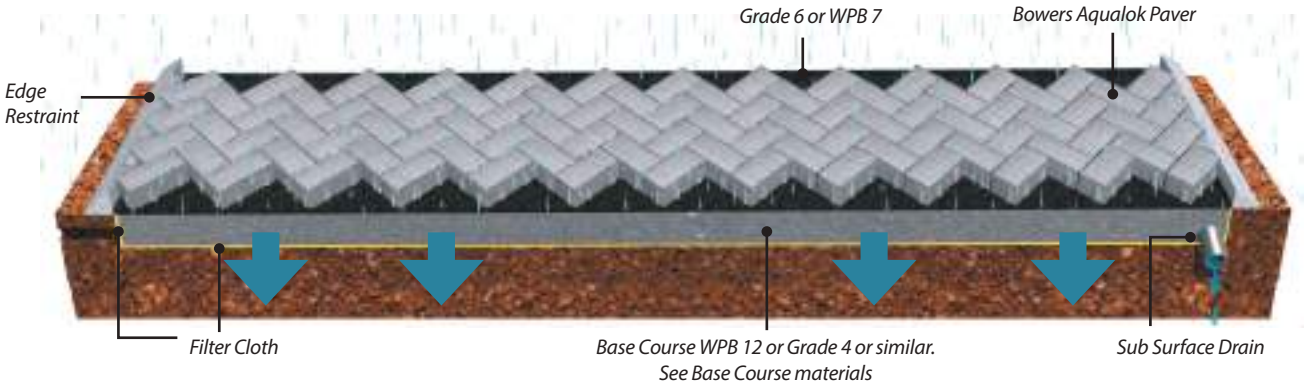
Retention - the process of absorbing and continuing to hold run off water so it can be utilised for another purpose.

Detention - stormwater detention is the ability to store rainwater from roofs, drives, paths and other impervious areas. The water is then discharged to the stormwater system from the permeable pavement through a small diameter orifice pipe at a rate the stormwater system can cope with.

There are two types of sub grades:
Impermeable sub grades (Clay) & Permeable sub grades (beach sand, pumice and gravel)

Bowers Permeable Paving System Rainwater Detention (Permeable Sub Grades)

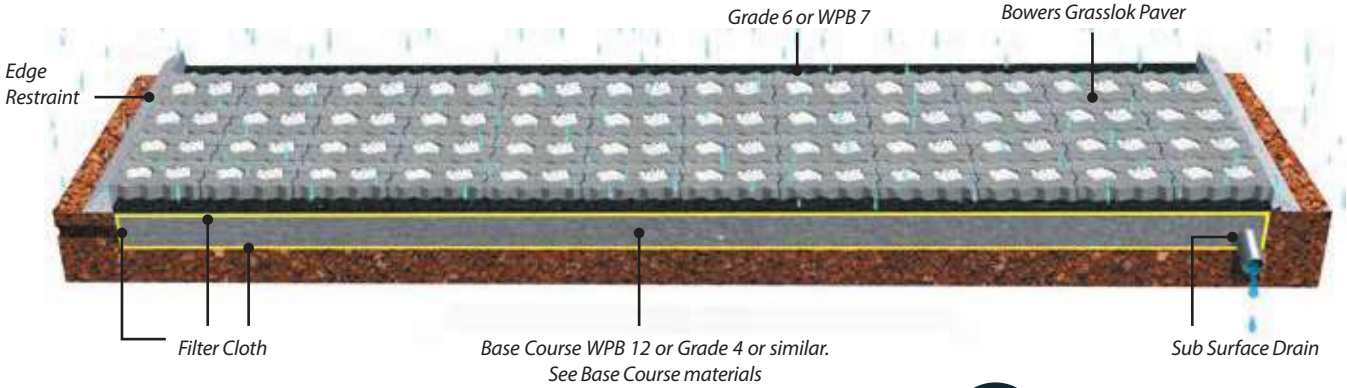
With this system the rain water runoff from the roof and driveway permeates through the pavers and base course and re-charges the ground water beneath the pavement.



PERMEABLE SUB GRADE

Bowers Permeable Paving System Rainwater Detention (Clay / Impermeable Sub Grades)

The rain water runoff with this system has the ability to temporarily store water in the base course and then release it in a controlled manner, by the diameter of the sub surface drain, back into the stormwater system at a rate to help prevent or reduce flash flooding.



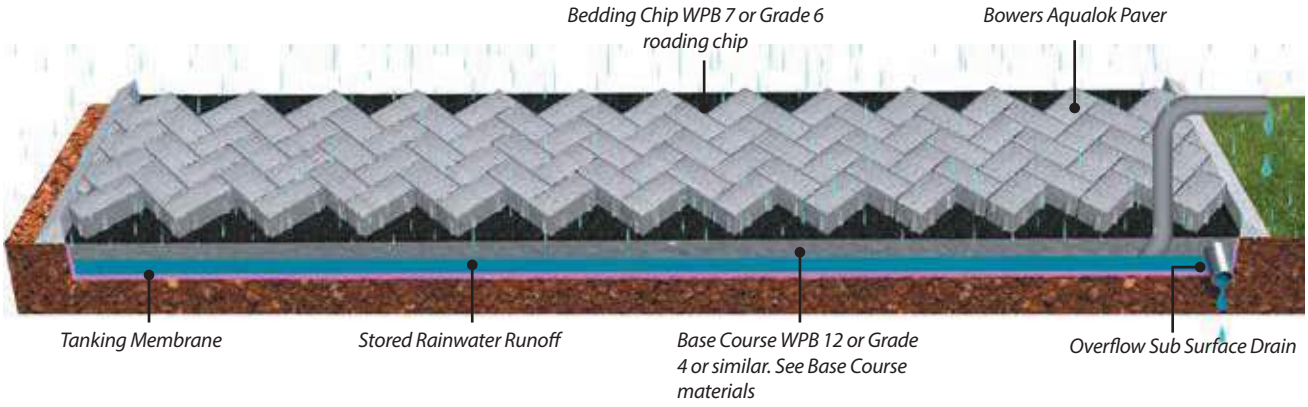
IMPERMEABLE SUB GRADE

BOWERS MASONRY

STORMWATER RUNOFF MANAGEMENT SYSTEMS

Bowers Permeable Paving System for Rainwater Retention

Using a suitable tanking membrane and by adjusting the base course depth for extra storage this rain water could be used to water the garden or flush toilets (non-potable applications). Extra storage materials are listed on Page 18.



TANKING MEMBRANE

A suitable tanking membrane to retain the water in the base course storage which is easy to install and self-healing if punctured is available from Newton systems.
www.newtonsystems.co.nz

NEWTON 403 HYDROBOND

High performance, self-healing, composite sheet membrane, available in two variants; both membranes have a hydrophilic polymer coating sealed and constrained between a layer of waterproof LDPE to the outer face and a polypropelene locking fleece to the inner face. Newton 403 HydroBond-GB however, also includes a further layer of aluminium to provide higher resistance to radon. carbon dioxide and hydrocarbon gases.

Please talk to your local Bowers representative for more information.

INSTALLATION SPECIFICATIONS

INSTALLING A BOWERS MASONRY PERMEABLE PAVING SYSTEM

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TIMING OF INSTALLATION

Plan the installation of the permeable pavement till after any earthmoving operations as tracking mud and clay into the system will render it inoperable.

AQUALOK™, AQUASTONE™ & AQUACOURT™

These three units are installed in the same way. This system uses WPB 7 or Grade 6 clean chip as a bedding and jointing material with no filter cloth between the bedding layer and the WPB 12/DQ Grade 4 base course. See cross section next page. GAP 20 and GAP 40 aggregates are not suitable for the drainage base course.

This installation process is assuming a single base course 150mm thick (WPB 12 or similar). Bowers offer a free design based on your rainfall location and council requirements with regards the typical rainfall event i.e. 10 year.

Excavate the area to a depth of 250mm. That allows for an 80mm paver, 20mm of bedding chip and 150mm of base course.Slope the bottom of the excavation (2%) in clay soils to direct the water to one side of the excavation. This reduces the amount of sub surface drains and the water will run to one side where it will be collected.

Check the sub grade strength with the "foot / heal" imprint test or with a Scarla penetrometeron Page 28. Check the CBR strength is what has been assumed for this application as a weaker sub grade may require more base course. Lay the correct filter cloth (refer to Type of Application tables) along the bottom and up the sides of the excavation.

Install the "novaflo" sub surface drain checking it's the correct diameter. Lay the WPB 12 or similar to the correct thickness. Use a plate compactor to consolidate the layer. The base course aggregate has no fine material in it so it won't consolidate the same way as GAP 20 or GAP40 aggregate. One will find that three passes with the plate compactor is sufficient. The WPB 12/DQ grade 4 or similar on the third pass will start to vibrate loose which means the aggregate has reached its maximum consolidation. Vibrating or static rollers does not work on this type of aggregate.

Note: On inclined pavements the pallets of pavers need to be delivered prior to installing the base course as the delivery truck will be unable to drive on it. Lay the 20mm of WPB 7 / Grade 6 bedding chip and screed off to represent the finished level. Lay the pavers in the required pattern. Herringbone 45 and 90 degrees to the direction of the traffic for vehicular traffic. Lay the concrete haunching if kerbs are not being used. Wait sufficient time to allow the haunching to cure (gain strength). Sweep the WPB 7/Grade 6 chip into the joints and plate compact ensuring the continuation of the process until the joints are full. Don't overfill the joints with chip. The level of the chip should be just below the bottom of the chamfer on the paver.

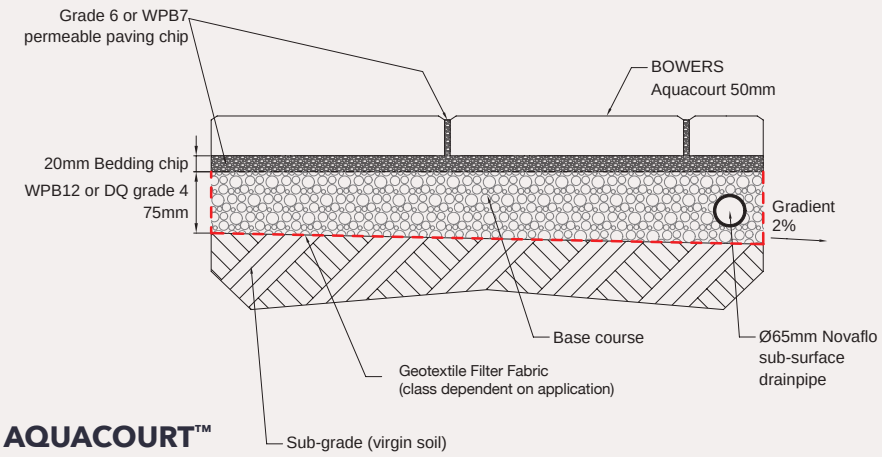
INSTALLATION

Bowers Brothers offer free installation training to contractors as the base course aggregates behave differently and the specific materials like filter cloth, sub surface drains and application of the Aquabind require guidance.

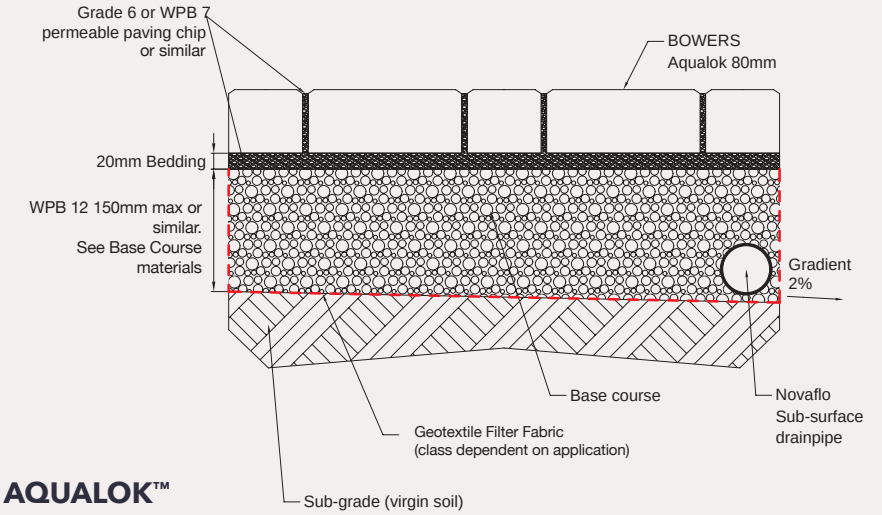
Once contractors have been trained they will be referred to customers for installation of the Bowers Permeable Paving Systems.

DWG and PDF formats on Bowers Brothers website.

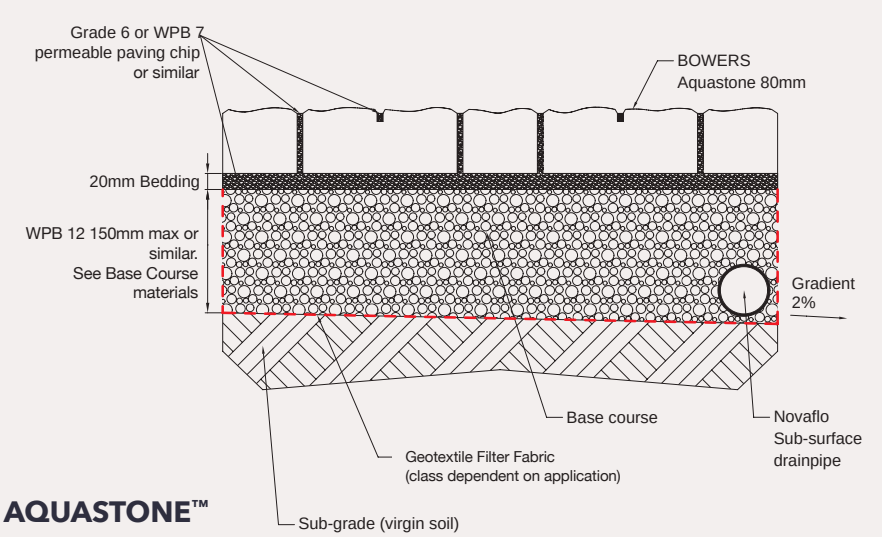
NOTE: During compaction the plate compactor needs to have a carpet attached to protect the uneven surface of the Aquastone.



AQUACOURT™



AQUALOK™



AQUASTONE™

Please talk to your local Bowers representative for more information.

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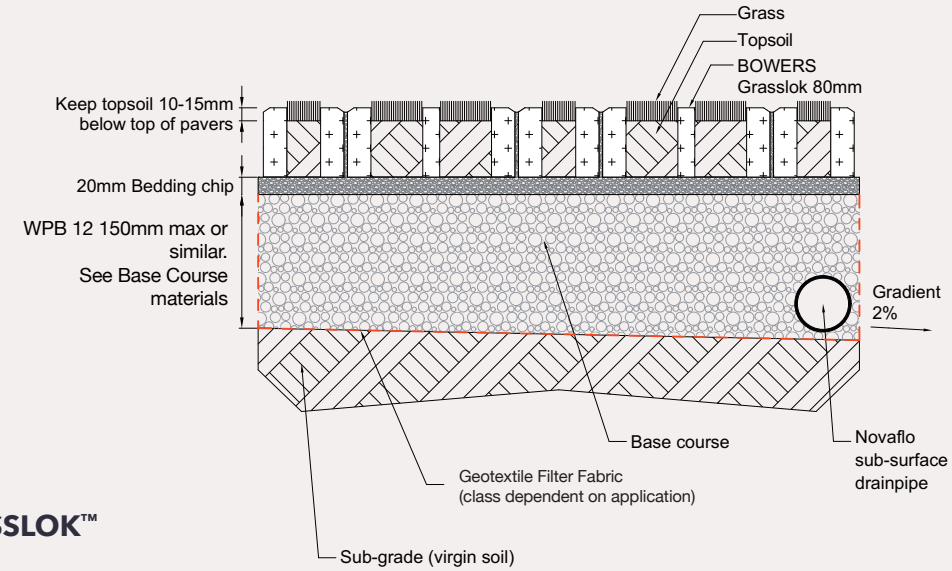
GRASSLOK™

See cross section below. GAP 20 and GAP 40 aggregates are not suitable for the drainage base course.

The installation of the bedding and base course is the same as the Aqualok, Aquastone and Aquacourt process above.

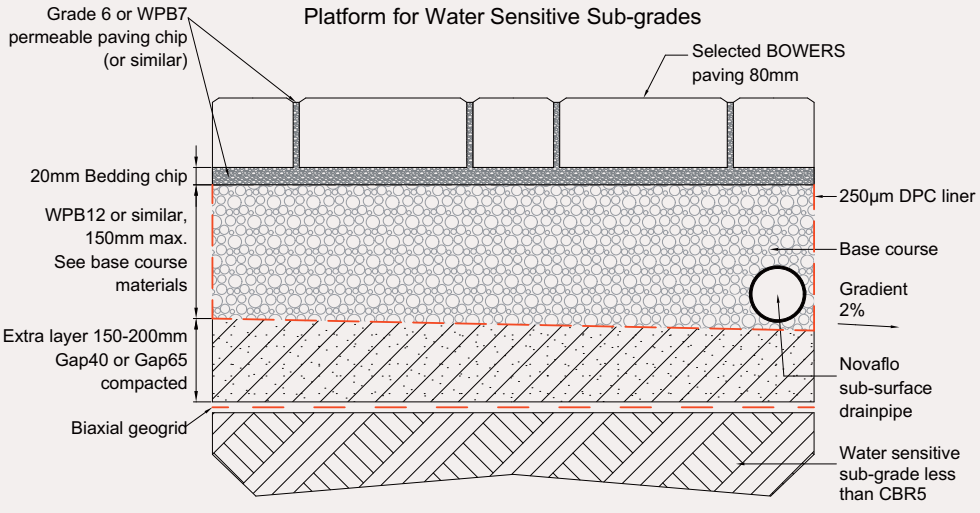
With the Grasslok various decorative pebbles or clean chip can be installed in the cavities and then sprayed with Aquabind to stabilise the pebbles/ chip. Grass can also be grown in the cavities. See Page 10 for suitable types of grass.

The maximum slope for a permeable pavement is 3 - 5%. Inclines steeper than this may require specific design incorporating coffer dams in the base course and transversal ground beam at intervals to prevent the pavers from "shunting". Aquabind must be used for steeper slopes to retain the jointing chip and prevent the chip from washing out.



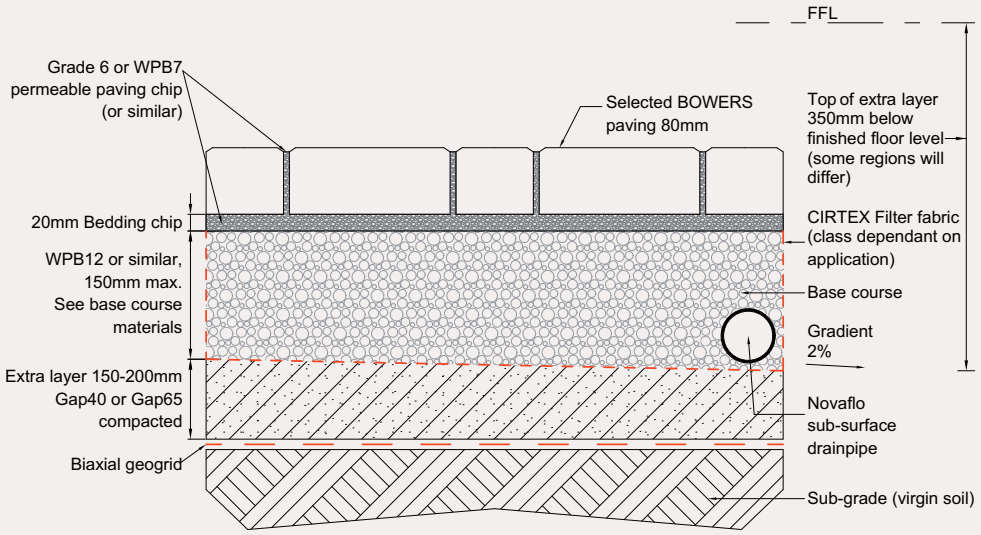
GRASSLOK™

WATER SENSITIVE SUB GRADE



GROUP HOME BUILDERS / NEW BUILD

When building a new house, access prior to installing the driveway is required to deliver all the several types of building materials. Permeable paving should NOT be installed first, as mud and clay will destroy the permeable surface and the only method to fix it would be to uplift the pavers and replace them. A layer of GAP65 100mm thick can be installed 350mm below the finished floor level. This allows for the overall depth of a typical permeable pavement being 250mm. This then allows the paving contractor to install the permeable pavement on top of this layer without having to do any backfill or excavation and will reduce the amount of work and money. **See cross section below.**



WHAT IS MY SUB GRADE STRENGTH (CBR) FOR SMALL PROJECTS LIKE RESIDENTIAL DRIVEWAYS?

If you are unsure of the sub grade strength and don't have access to a "scala penetrometer".
The sub grade strength can be determined with this basic test from NZS 3116:2002 section 303.2 and C303.2

303.2

For small projects basecourse may be determined from table 2; other applications may warrant specific design. Subgrade strength classifications in table 2 are as follows:

CLASSIFICATION	TYPICAL MATERIALS	MINIMUM CBR*
Weak	Clay and Silt	4
Medium	Silty or 'Clayey', Gravel or Sand	7
Strong	Dense Sand or Gravel or Old Pavement	15

* California Bearing Ratio (Soaked) in accordance with section 6.1 of NZS 4402.

C303.2

For small jobs, the following subgrade assessment tests may be sufficient. Weather conditions can however significantly influence the test. Generally the test should be carried out under damp or wet conditions:
(a) Weak - walking leaves a strong foot imprint;
(b) Medium - heel pressure leaves an imprint;
(c) Strong - no imprints.

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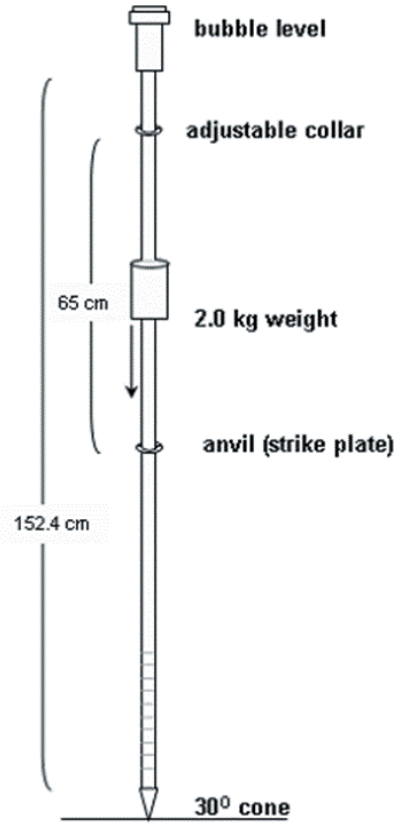
SUB GRADE STRENGTH

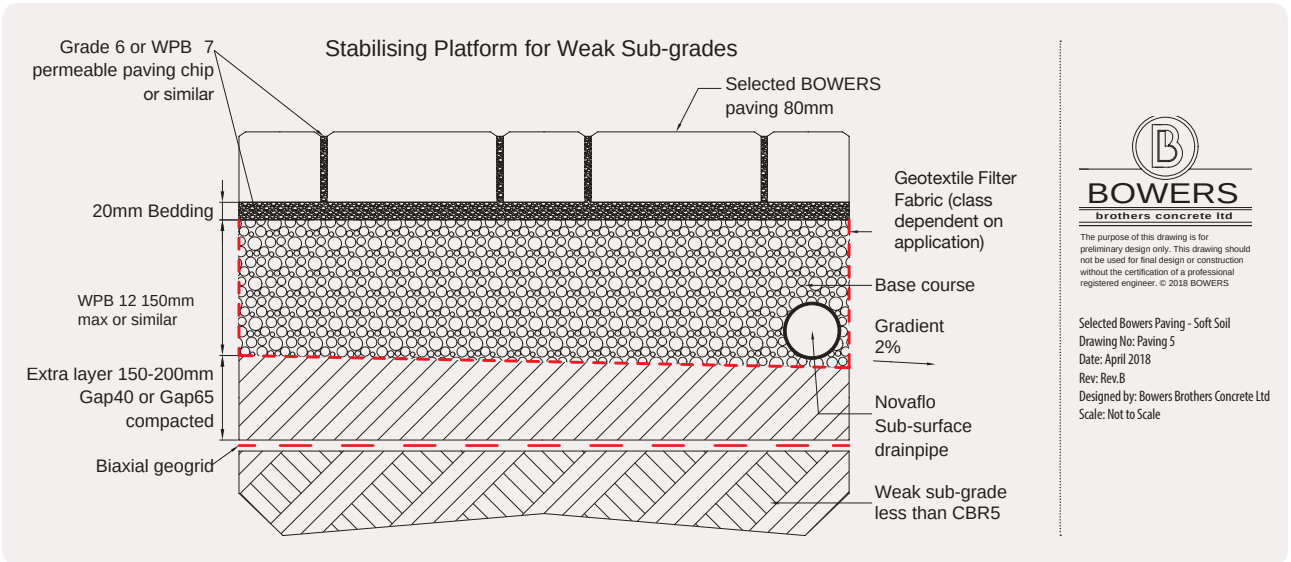
On Site CBR values can be determined using a Scarla Penetrometer as per NZS 4402:1986



SOFT SUB GRADES CBR LESS THAN CBR OF 5

For conditions where there is weak sub grades i.e CBR less than 5 a possible solution is to add a stabilising layer 150 -200mm of compacted GAP 40 or GAP 65 and include a suitable Duragid to create a stable platform for the permeable pavement.

Note: In earthquake zones where liquefaction is an issue a suitable filter cloth can protect the base course layer from contamination and after the "event" any deformations can be easily rectified by uplifting the paving, installing more base course material and re-laying the existing paving.



BIAXIAL GEOGRIDS

The grid grade is a function of the aggregate size and the subgrade CBR but for most applications we would recommend:

SOFT GROUND
Tensar RE540
DuraGrid 30/30

FIRM GROUND
Tensar RE520
DuraGrid 20/20

FEATURES & BENEFITS

- Suitable for reducing aggregate thickness in pavement applications
- Good aggregate interlock
- Can be used with a range of aggregate sizes
- Popular for slip protection on timber board walks

Download the recommended Geogrid Installation Process at:
www.bowersbrothers.co.nz

HOW CAN I TEST THE PERMEABILITY OF MY BOWERS PERMEABLE PAVEMENT SYSTEM?

One of the test methods is ASTM C 170l/C 1701M -09 "Standard Test Method for Infiltration Rate of in Place Pervious Concrete" is simple and easy to conduct in on-site locations.

If you require a permeability test contact Bowers Brothers on 07 889 6774.

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BOWERS BROTHERS PERMEABLE PAVING SYSTEMS MAINTENANCE PLAN

RESIDENTIAL DRIVEWAYS

If the driveway has been sprayed with Aquabind there should be little to no loss of jointing chip. However check the chip and sand on an annual basis and top up the jointing material if required.

In the Autumn months its important to blow or remove leaves that have fallen on the permeable driveway. This organic sediment, if allowed to decompose in the joints, will reduce the permeability rapidly. Regular sweeping/blowing is required.

Annually - general moss/weed removal and cleaning with a Rotary head cleaner or hose.

Environmentally friendly ways of removing killing weeds and moss;

- Steam water blast
- Hot water
- Butane gas torch (Available at Bunnings)

After 10 years you can call Bowers Brothers and get your permeability checked free of charge - 07 889 6774.

Remember wash your car on your Bowers Permeable Paving driveway as the greywacke aggregate in the base will filter and clean the heavy metals like copper (brake pad dust) from the water and recharge the ground water with cleaner water.

PARKING LOTS AND ACCESS ROADS INTO TOWNHOUSE DEVELOPMENTS

Annually – general inspection of jointing chip. Sweep additional material in joints if low and plate compact. Weed and moss removal. (see above for environmentally friendly removal)

Autumn months – sweep or blow leaves off pavement. Don't leave them to decompose on the surface. If the Aqualok and Aquastone have been sprayed with Aquabind commercial street sweepers can be used.

After 10 years check the permeability or observe how long the water stands on the pavement in a rain event. Generally, if the water stands for an hour the permeability should be re-instated by removing the chip using the specially designed Hydrovac Permeable Paving Cleaning head. If a permeability test is done and is around 250mm/hr a clean jointing material will need to be re-instated.

This maintenance plan can be downloaded from www.bowersbrothers.co.nz

AIDS TO DESIGNING YOUR STORM WATER RUNOFF WITH BOWERS PERMEABLE PAVING SYSTEMS

- ICPI design software is available for purchase from www.permeabledesignpro.com or get Bowers to do your design for your location. We can design the pavements to capture the runoff from the roof and driveway and prevent the use of detention tanks using local aggregates.
- Bowers have design software to calculate what will satisfy your requirements for your storm water management in your area (run off from the roof can be included). We can do a structural and hydrological design for light vehicular applications and then get certified contractors to give you a price.
- New Zealand rainfall patterns are included in the software.

icpi

Interlocking Concrete Pavement Institute

info@permeabledesignpro.com
www. permeabledesignpro.com

PERMEABLE DESIGN PRO SOFTWARE

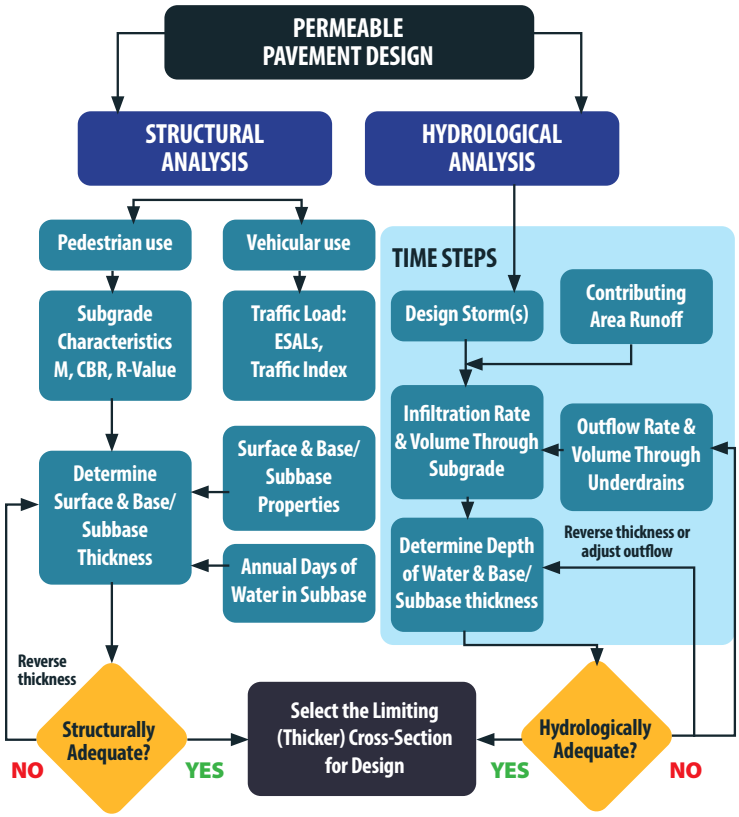
ICPI PERMEABLE DESIGN PRO SOFTWARE

The ICPI Permeable Design Pro Software (www.permeabledesignpro.com) designed by David Hein incorporates:

- State-of-the-art North America practice, supported by Applied Research Associates Inc. (worldwide pavement engineering consultancy);
- Local New Zealand rainfall characteristics.

The benefits of the Permeable Design Pro software is the graphical and tabulated presentation of the required basecourse/sub-base depth and underdrain spacing (where required) for the full range rainfall characteristics, including inputs of:

- Both hydrologic (2, 5, 10, 25, 50 and 100 year rainfall return periods) and traffic loads.
- Porosity and permeability of the basecourse, subbase and subgrade layers.
- Pavement layer surface infiltration rate.
- Sizing, spacing and elevation of underdrain pipes.



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FREQUENTLY ASKED QUESTIONS

What's the difference between the Aqualok™ and Aquastone™ 80mm paver?

Basically they are the same size paver with different aesthetical appearances. Both are laid with bedding and jointing chip (WPB 7 or Grade 6 or similar) without a filter cloth separating the bedding material and base course.

How long does it take before the system clogs up?

What we have found after re-visiting permeable pavements after 10 years + is that even though they have not been cleaned at all they are still functioning with permeability rates higher than the council requirement of 120mm/hr. Obviously permeable pavements should not be located where there will be a high clay content runoff . Regular sweeping and blowing of organic sediment (leaves) is a basic requirement and is the most detrimental sediment for permeable pavements. Leaves should not be left on the pavement to decompose. Remember this system has been designed with permeability rates that far exceed the council requirement to allow for longevity of the system and sediment build up.
Council requirement = 120mm/hr
Bowers Permeable Pavement System = 5,500mm/hr

"Development and Assessment of a Permeable Paving System for Stormwater Quality Management"
by Navin Weeraratne, Degree of Master of Engineering in Environmental Engineering, The University of Auckland, August 2004.

What's the difference between the Aqualok™ and Aquastone™ 80mm paver?

No, the Aquacourt 50mm is not suited for vehicular traffic. Its designed for patios and pedestrian pathways.

How does the drainage aggregate in the base course clean the runoff water?

As the stormwater runoff permeates the permeable surface it passes through the greywacke aggregate base. As the water passes the aggregate heavy metals like zinc and copper are captured through a process called Cationic Exchange Capacity. The best place to wash your car is on top of your permeable driveway. The dust from your brakepads are rich in copper and you will be putting a cleaner water back into the ground or our waterways once its passed through the base aggregate.

For further reading; "Final Technical Report Permeable Pavement for Urban Stormwater Runoff Mitigation"
Submitted by Elizabeth A. Fassman. PH.D.
Samuel David Blackbourn, M.E.
University of Auckland, Department of Civil and Enviromental Engineering. 31 July 2009

What function does the Aquabind have on the system?

The solution is sprayed on to bind and stabilise the chip/decorative pebble to stop it washing out. For further information see "Aquabind Application Brochure" at www.bowersbrothers.co.nz

REFERENCES

FURTHER INFORMATION

Smith, David R. Permeable Interlocking Concrete Pavements, 5thEdition.
Interlocking Concrete Pavement Institute (ICPI). 2017.

"Permeable pavement performance for use in active roadways in Auckland, New Zealand"
by Elizabeth A. Fassman, PhD and Samuel David Blackbourn, ME, Auckland University.

"Development and Assessment of a Permeable Paving System for Stormwater Quality Management"
by Navin Weeraratne, degree of Master of Engineering in Environmental Engineering, The University of Auckland August 2004.

"Sediment Retention by Alternative Filtration Media Configurations in Stormwater Treatment"
Naresh Singhal, Takis Elefsiniotis, Navin Weeraratne, Anthea Johnson.
Department of Civil and Environmental Engineering, University of Auckland 26 September 2007

"The Long Term Performance of Pervious Paving"
by Steve Crossland, Stuart Girvan, David Kettle & Jason Koenen, Auckland, November 2016.

"Field Monitoring and Software Development for Permeable Paving Storm Water Solution"
Sam Blackbourn, Masters degree, Dept of Civil and Environmental Engineering, University of Auckland 2006/07.

EPA United States Environmental Protection Agency "Surface Infiltration Rates of Permeable Surface" six month update (Nov 2009 through April 2010).

"Research into Effective Life of Permeable Pavement Source Control Installations"
Urban Water Resources Centre Division of IT, Engineering and Environment, University of South Australia.

"Optimisation of the particulate and dissolved matter retention capacity of permeable concrete block paving with infiltration pores by using different material in the infiltration pores"
Diploma Thesis by P. Meyer, University of Essen.

"Field Survey of Permeable Pavement Surface Infiltration Rates"
by Eban Z Bean, William F Hunt and David A. Bidelspach, Journal of Irrigation and Drainage Engineering ASCE.

"A Guide to Permeable Interlocking Concrete Pavements"
MA56 November 2010, Concrete Masonry Association of Australia.

New Zealand Standards. Concrete Segmental Paving, NZS 3116:2002.

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IMPORTANT INFORMATION

1. As masonry paving is manufactured using natural products, some variation in the shade/colour, texture and size tolerations should be expected. Paving for each job should come out of the same batch and you should blend off multiple pallets.
   A "Batch" is deemed to be:
   From which plant it is manufactured & The date of manufacture. (this may be over consecutive days due to manufacturing limitations). It is advised that you check the batch details on all pallets prior to commencing installation in case there has been a loading error from the yard or your supplier. It is easier to remedy any issues before the work has commenced. It is also advised that you keep a copy of the batch details in case you run short of product.
2. Product laid is deemed to be product accepted.
3. Concrete products may display 'efflorescence' (whitening) which is a natural occurrence. We have taken all possible steps to minimise this from occurring in our products.

BOWERS MASONRY

0800 207 374

sales@bowersbrothers.co.nz

www.bowersbrothers.co.nz

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