

VERSION 1.0

Stormwater Solutions for Residential Sites

Section 7 – Permeable Paving

Prepared for

EcoWater Solutions

A Department of Waitakere City Council
113 Central Park Drive
Henderson
WAITAKERE CITY
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7.1 Introduction

Permeable paving has the potential to provide a number of beneficial functions within a stormwater management system. Potential benefits are primarily associated with stormwater treatment and lesser runoff rates and volumes being generated than conventional pavement due to infiltration and storage of stormwater within the sub-base.

The design information provided in this document has been developed to assist with both the design and review of permeable paving proposals. Permeable paving does not suit all sites and it is important that site characteristics are reviewed carefully. It is also important to define what the objectives are for using this type of system. Key considerations and design steps are outlined below.

7.2 What is Permeable Paving ?

It is important to note that these guidelines cover permeable surfacing only. The following distinction is made between permeable and porous pavements:

- “Porous surfacing is a surface that infiltrates water across the entire surface of the material forming the surface. Examples include grass and gravel surfaces, porous concrete and porous asphalt. “
- “Permeable surfacing is a surface that is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration through the pattern of voids. An example is the concrete block paving”.

Both kinds of pavements have different service and maintenance requirements as well as surface designs. The demands for porous pavements are higher, because the failure usually results in reconstruction of the surface after removing a completely section.

In general three different configurations of these permeable paving are used (Interpave, 2003) as shown in Figure 7-1. The type of system is selected based on sub-grade conditions.

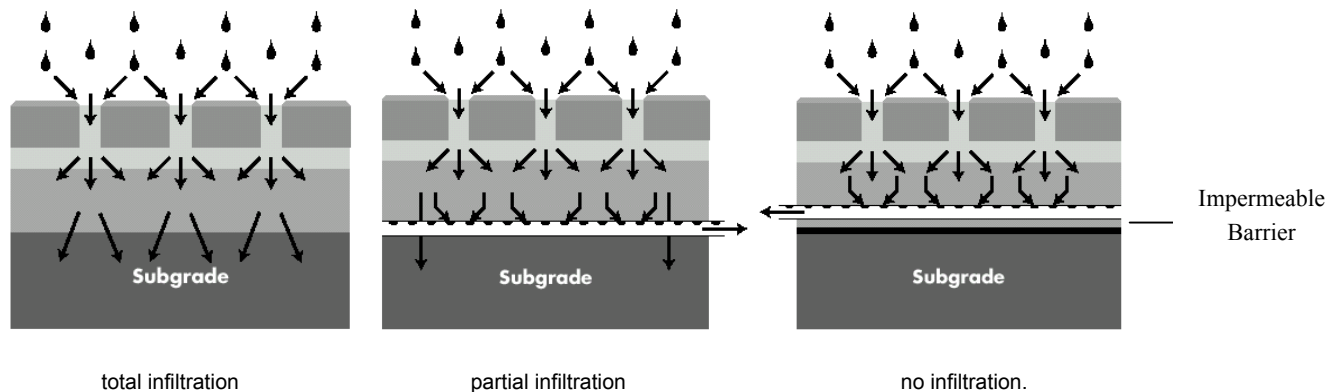


Figure 7-1 - Principal system configurations for permeable pavements (Interpave, 2003)

For Waitakere City the underlying soils in many locations are clay and have limited infiltration. The “total infiltration” system will therefore generally not apply. The benefits of using permeable paving in these areas is primarily associated with passage of stormwater through the pavement structure itself (“no infiltration” case).

Potential benefits include:

- Removal of contaminants by filtration, allowing adsorption, microbiological breakdown and settlement; and
- Attenuation of runoff.

7.3 Use

The situations where permeable paving might be used on a residential site include:

- Car parking areas;
- Walkways; and
- Residential driveways.

Some examples of these applications are shown in Table 7-1:

Table 7-1 - Permeable Paving Applications

Application	Example
<p>Carparks</p>	<div data-bbox="711 472 1254 936" data-label="Image"> </div> <p data-bbox="874 1003 1155 1037">Waitakere City Carpark</p> <div data-bbox="639 1189 1390 1682" data-label="Image"> </div> <p data-bbox="810 1691 1219 1724">sourced from -www.petrusutr.com</p>

Driveways and Low Traffic Residential Roads



(sourced from www.europeanpaving.com)

7.4 Types

Permeable paving can be separated into the following broad categories:

- Grass paver /open cell paver:
- Small surfacing blocks with joints (gaps):
- Interlocking concrete blocks with voids: and
- Permeable blocks.

7.5 Limitations

Key parameters to consider for permeable paving placement include slope, traffic volumes, subgrade, land use (types of contaminant), and stability. The issues to consider with each of these parameters are outlined below:

7.5.1 Slope

The use of permeable pavement is restricted to gentle slopes up to about a 1 in 10 grade (or about 5 degrees). On steeper slopes the potential for water to seep out of the pavement surface limits use.

7.5.2 Traffic Volumes

In general only low traffic volumes up to 2,000 ESA, axle loads and speeds less than 30 mph should be considered.

7.5.3 Subgrade

The subgrade should be able to sustain traffic loading without excessive deformation. Section 4.2 discusses this in more detail.

7.5.4 Land Use

Permeable pavement may be considered for light vehicle loading including parking areas and driveways. A common cause of permeable paving failure is clogging resulting from excessive sediment discharges on to the permeable surface. For this reason, permeable paving is not suitable for use in catchments where potential for sediment generation is high. This applies equally to hard surface catchments where frequent sediment tracking is expected (e.g. access roads within construction sites). In this regard construction sequence of permeable paving is important. Preferably, all pervious areas and high-sediment hard surface areas must be excluded from the catchments treated by permeable paving.

7.5.5 Stability

Slope stability issues are exacerbated by water infiltrating and saturating the soil. In areas where there is sloping land downstream of a development, geotechnical advice is essential for the design of permeable paving. It may be necessary to use an impermeable flexible membrane liner (FML) and a protective heavy geotextile to exclude infiltrated water from the soil, or in some cases, permeable paving may not be a suitable option for sloping land. When the basecourse is tanked using an FML, a suitable sized piped outlet is necessary to drain the basecourse at the required rate.

7.5.6 Limitations Check

In order to confirm that permeable paving is suitable for a given site complete the check below.

Table 7-2 - Limitation Check

Parameter	Check	Yes	No
Slope	Slope Exceeds 1 in 10		
Traffic Volume	Traffic Volume Exceeds 2000 ESA		
Subgrade	¹ CBR is less than 3		
Land-Use	Site downstream of areas where sediment generation potential is high		
Stability	¹ Site has stability issues		

Notes 1. Permeable Paving may still be suitable - needs geotechnical investigation.

Where 'No' is indicated alternative systems should be considered.

7.6 What to Do

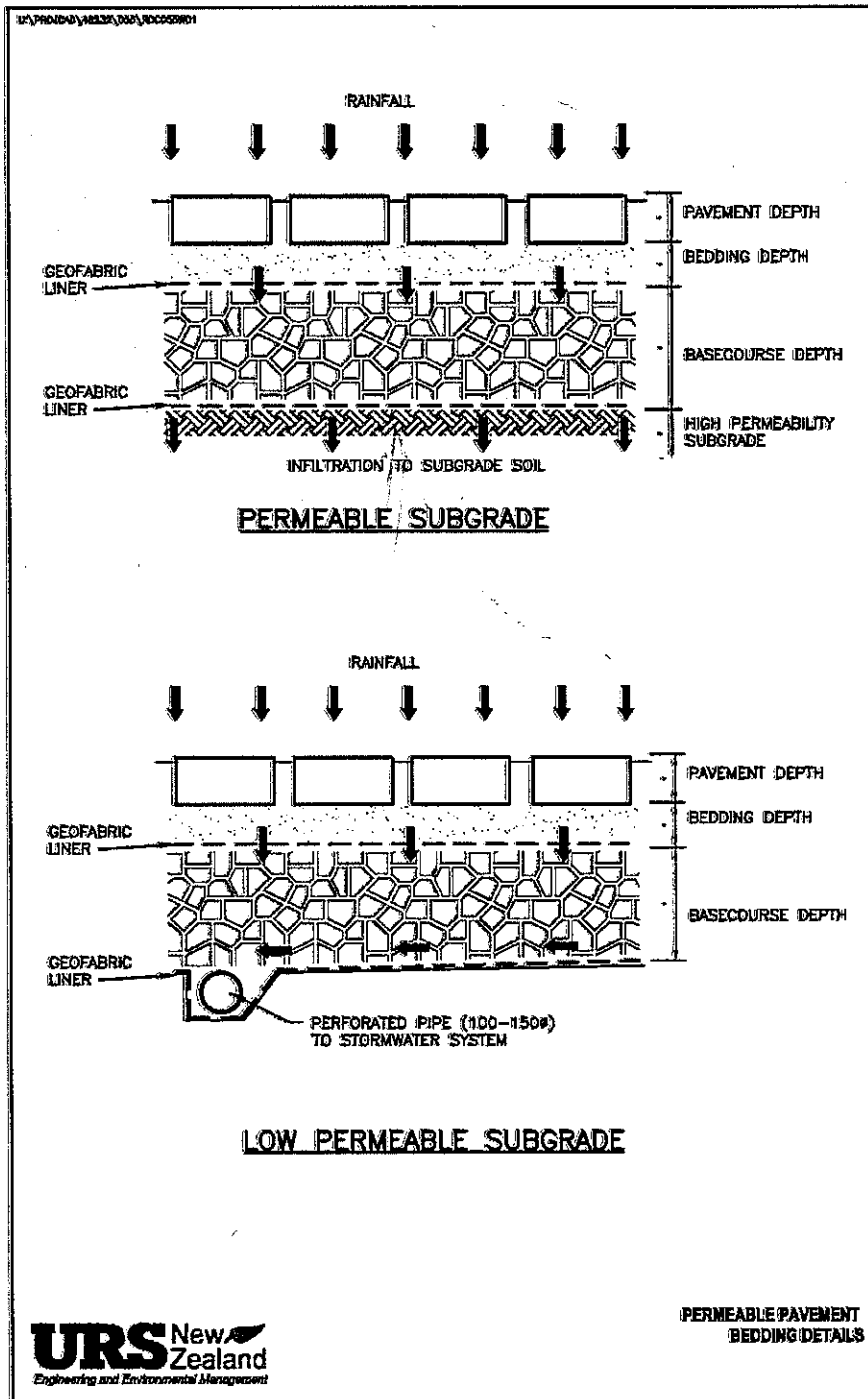
- Step 1 Review site characteristics and check constraints (Table 7-2) do not apply.
- Step 2 Obtain service plans for the site from Council and identify where stormwater from permeable paving is to be discharged.
- Step 3 Confirm location of any overland flow paths on or adjacent to the site. Assess the layout of the proposed paving area in relation to overland flow paths.
- Step 4 Design the permeable paving using the appropriate specifications described in this document.

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- Step 5 Calculate effective impermeable area based on reduction factor from Section 7.9.
- Step 6 Complete Checklists in Appendix A

7.7 Use of Permeable Pavement

Figure 7-2 shows the key structural elements of permeable paving. As identified earlier for Waitakere City the subgrade is expected to be almost impermeable and the low permeable sub-grade design will apply.

Figure 7-2 - Permeable Paving Bedding Details



7.8 Material Specifications

The permeable paving elements are to comply with the following or detail of the proposed alternative must be submitted to WCC for review.

7.8.1 Paving Surface

Grass Block

A grass block or turf paver typically consists of an open cell concrete block with typical dimensions 600 mm x 400 mm x 80 mm thick, filled with soil or porous aggregate. For structural design it is assumed that the resilient modulus of an 80 mm grass block is equivalent to that of an 80 mm concrete segmental paver.

Concrete Segmental Paving

The Concrete Masonry Association of Australia (CMAA) published the Lockpave® computer program for designing segmental pavements. In Lockpave® a resilient modulus of 2500 MPa is used for conventional concrete segmental paver of 80 mm thickness.

In the conventional pavement, the joints are typically 2 to 4 mm wide and when filled with jointing sand, a relatively stiff layer is achieved.

- The pavers must be a minimum of 80 mm thick and the quality and construction thereof must comply with the requirements of NZS 3116: 2002, Concrete Segmental Paving, unless otherwise specified.
- The paver type must comply with the requirements for residential driveways, light traffic (NZS 3116, Clause 302 Paver Selection).
- The pavers must be laid in a herringbone pattern at 90° to traffic flow, with joint widths and jointing sand to sustain a permeability of 50 mm/hour/m² on the completed surface, provided that the joints should not be wider than the D₉₅ of the jointing sand plus 3 mm.
- The bedding sand must be graded between 2mm to 12mm and complying with the requirements of NZS 3116: 2002, Concrete Segmental Paving, Clause 309.1.2 Sand Properties.
- The jointing sand must be graded between 2mm and 5mm and complying with the requirements of NZS 3116: 2002, Concrete Segmental Paving, Clause 311.1.2 and 311.1.3.
- It is anticipated that the permeable segmental pavement with wider joints filled with coarser 2 to 5 mm grit, will result in a more flexible layer with lower stiffness. A resilient modulus of typically 2000 MPa is recommended.

7.8.2 Basecourse

The permeable basecourse must comply with all the requirements of TNZ M/4 AP40, except for the particle size distribution and the additional requirements specified. The particle size distribution of the aggregate must comply with the envelope limits defined below, when the aggregate is tested according to NZS 4407, Test 3.8.1 Wet Sieving Test:

Sieve Aperture	Maximum and Minimum Allowable Percentage Weight Passing
37.5 mm	100
19.0 mm	60 - 75
4.75 mm	3 - 18
2.36 mm	0 - 5

It must have a minimum permeability of 10^{-3} m/s, determined by testing in accordance with Volume 2 Section 10.6 of “The Manual of Soil Laboratory Testing” by K H Head on samples compacted to the specified density for the construction of the basecourse.

The above requirements should produce a durable basecourse with good workability properties which should not segregate during construction.

The basecourse should be a minimum of 200 mm deep.

Pavement layer compaction of at least 95 % of maximum dry density must be achieved. The maximum density of the basecourse must be determined in a laboratory by rodding and vibrating the basecourse under saturated condition

7.9 Reduction Factors

The benefits of permeable paving are associated with the increases in abstractions during the first part of a rainfall event as well as increased infiltration during the event. By using this type of paving the impervious surface being added to a site is effectively reduced.

Where permeable paving is used WCC will accept a 25% reduction in the impervious area calculation for paving.

So for example if 100 m² of permeable pavement is being added, this equates to 75 m² of equivalent impervious surface.