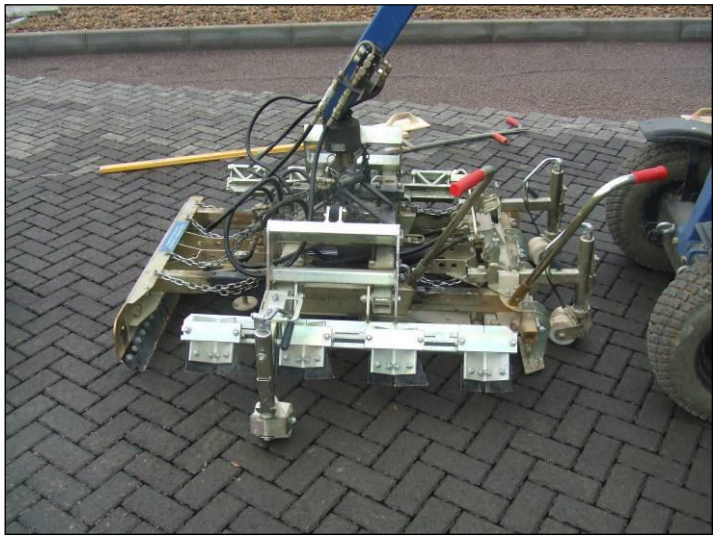
Marshalls



MARSHALLS WATER MANAGEMENT

PRIORA PERMEABLE PAVING DESIGN

Residential Development Kirton Lindsey

Prepared for J D Associates
Our Ref: DR006428
Date: 17/03/17

CONTENTS

DESIGN SUMMARY

CRITERIA

When designing a permeable pavement, two aspects of the pavement design are considered. These are the structural performance and the hydraulic capability of the pavement. Both of these designs will provide a depth of permeable sub-base, with the greater of the two leading the design.

The following are considered in the designs.-

Hydraulic Design

- Rain catchment area
- Sub-grade (soil) infiltration conditions
- Site topography
- Local rainfall characteristics
- Storm return period
- Environment Agency restrictions

Structural Design

- Type and Frequency of traffic
- CBR Values

The structural depth of the pavement has been calculated using the design methodology developed by Professor John Knapton of Newcastle University for Marshalls. The hydraulic depth of the pavement has been calculated using the Microdrainage software.

PARAMETERS

The permeable pavement design is for Station Road, Kirton Lindsey. It is based on information provided by J D Associates Ltd in March 2017. Where information is unknown or assumptions have been made, these are clearly highlighted in the design. If any of the information has changed or the assumptions are inaccurate, please contact the author so that the design can be reassessed.

Hydraulic Information

Hydraulic Data		
Storm Return Period	M100+30%	Given
Ground Infiltration Rate	N/A	Tanked
M5-60 Rainfall	18.1	From Charts
Rainfall ratio r (if known)	0.4	From Charts
Specified Outflow l/s	0	Assumed
Factor of Safety (Tanked)	1	Assumed (CIRIA C697)
Depth of Water Table	>600mm	Assumed

Structural Information

Structural Data		
CBR Value	1-5%	Assumed
Traffic Load Conditions	1 HGV per week	Given
Level of Certainty	Well Informed	Assumed

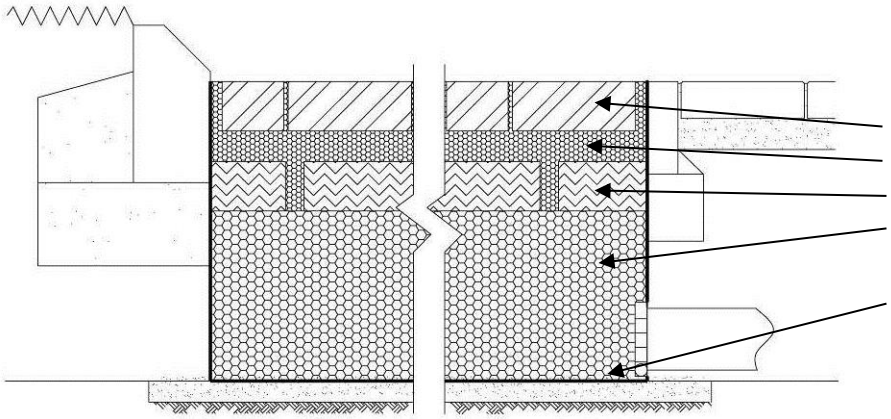
Areas Considered

AREAS		
Catchment Area	435	Sq.M
Pavement Area	435	Sq.M

Areas are only estimates and are provided in good faith, but must be checked by the customer prior to ordering. No responsibility can be accepted for shortfall or excess of materials.

PAVEMENT DESIGN

Using the hydrograph method of design (inflow – outflow = storage), it is evident that the structural design has insufficient capacity for the hydraulic requirement for an M100+30% storm. Therefore, it is evident that the hydraulic requirement is dictating the depth of construction. The following design will be suitable both hydraulically and structurally.
Due to the underlying ground conditions, the area is not suitable for an infiltration type system, therefore we have included an impermeable membrane within the construction to prevent water saturating the clay and a reduction in the bearing capacity.



Final Pavement Design					
CBR Subgrade %	**1%**	**2%**	**3%**	**4%**	**5%+**
80mm Priora Blocks	80	80	80	80	80
Laying Course 6mm Washed (mm)	50	50	50	50	50
DBM Layer – 50pen (mm)	70	70	70	70	70
Open Graded Crushed Rock OGCR (mm)	340	340	340	340	340
Capping layer (see specific design notes)	110	0	0	0	0
Marshalls M380 Impermeable Membrane	1	1	1	1	1
Total Construction Depth (mm)	**650**	**540**	**540**	**540**	**540**
Priora Laying Course estimated Tonnage	0	0	0	0	0
Priora OGCR estimated Tonnage	0	0	0	0	0

Capping/course graded adjustment specification:
For tanked systems, the capping layer needs to be MOT type 1 or open graded crushed rock (If using the capping depths from Table 3 of the new design document) or 6F2 (if using the capping depths from table 5 of the new design document)

Priora Aggregates:
Priora aggregate tonnages are calculated by using a compacted material density of 1.8 Tonnes per cubic metre. This is a guide only and different quarries may have stone with different densities it will also vary with compaction. On site testing can be conducted to confirm compacted material density.

- **Priora Aggregates Sales Line:** 0845 451 0797
- Standards: All aggregates comply with **BS 13242, BSEN 12620 and the Priora aggregate specification**

You must have a Marshalls Priora Quote Number to qualify for the discounted rates.

FEATURES

The Priora Blocks

Tegula Priora

Priora

Olde Priora

Mistral Priora

Priora blocks are presently produced in a variety of rectangular modules. This allows the appearance of traditional rectangular and sett block paving to be maintained despite the innovative nature of the product being employed.

The structural interlocking capability is achieved by having a joint profile offering protruding nibs. These interlock throughout the depth of the block and when jointed, prevent any displacement, both laterally and vertically, under heavy loadings and dynamic stresses providing the pavement's design is suitable for the intended purpose. This allows loads to be initially distributed over a larger area, reducing the stresses being exposed to the sub-layers.

The unique joint profile allows the surface water to infiltrate into the pavement and its sub-layers. This feature makes this paving differ from traditional paving and aids in achieving the development of sustainable considerations.

The use of the laying course material as a jointing material not only reduces the number of differently graded materials being used, but due to the grading profile allows the aggregate to fully fill the joints enhancing the integrity and interlock offered by the paved system.

Tegula

Bringing Together the aesthetics of Tegula and the environmental benefits of Priora, Tegula Priora provides versatility to compliment conservation projects or enhance distinctive show piece schemes requiring a SUDS Solution. Available in two bond patterns, random course and herringbone.

Priora

Priora, Marshalls original permeable block paving, adds hydraulic capability to the outstanding performance characteristics of Keyblok. The standard Priora also benefits from the ability to be machine laid (see machine lay section of this document) and comes in 60 and 80mm depth block options.

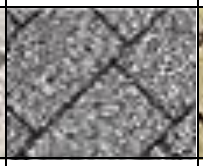
Olde Priora

Olde priora is a sympathetically rusticated block, which carries all the inherent benefits of standard Priora. With subtle texturing, Olde Priora lends itself well to conservation areas.

Mistral

The exposed granite aggregates of Mistral and the environmental benefits of Priora have been combined to create the permeable block paving of choice for modern developments and contemporary public spaces requiring a SUDS solution. Mistral also has the added benefit of being manufactured from 86.7% recycled aggregates.

Priora Swatch

Product	Bond Pattern	Colour		
Tegula Priora				
	Random Course	Traditional	Burnt Ochre	Pennant Grey
				
	Herringbone	Harvest	Red/Charcaol	
Mistral Priora				
	Random Course	Silver Grey	Charcoal	Harvest
Olde Priora				
	Herringbone	Brindle	Burnt Ochre	Bracken
				
	Stretcher Course	Red	Buff	Marigold
				
	Basketweave	Charcoal	Grey	
Priora				
	Herringbone	Brindle	Burnt Ochre	Bracken
				
	Stretcher Course	Red	Buff	Marigold
				
	Basketweave	Charcaol	Grey	

PRIORA PAVING BENEFITS

Priora allows surface water to be controlled at source, with the option of draining directly into the ground, recharging the ground water whilst also controlling the surface water runoff.
The use of a Marshalls Priora permeable pavement offers the following Innovative benefits:

Cost

- Reduced overall project development costs owing to a reduction in storm sewers and drainage appurtenances.
- Immediately available for trafficking once laid.
- Installation speeds can be further improved when adopting the machine lay methods.
- Reinstatement of pavement following any underground maintenance works is achieved reusing materials.

Environmental, legislative compliances and authority restrictions

- Increased recharge of groundwater.
- Allowing new developments in areas restricted by current surface water drainage constraints.
- The filtering and removal of pollutants and suspended solids in any surface water.
- The development of bacteriological breakdown of any hydrocarbons entering the sub-base.
- Reinstatement of pavement following any underground maintenance works is sustainable and undetectable.

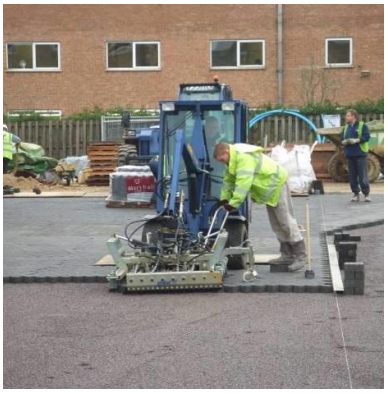
Aesthetic

- Discrete and effective drainage openings allowing the efficient infiltration of surface water runoff.
- A variety of laying patterns are possible.
- A range of ‘high-end’ and functional finishes available

Functional

- High load bearing capacity due to the unique interlocking characteristics. The system can withstand the dynamic stresses offered by vehicular trafficking and point loads.
- Lasting surface water infiltration capacity due to the unique layout of the interlocking spacer profiles.
- Considerable reduction in standing/moving surface water across sites providing a safer environment.

Machine Lay



Priora can be manufactured and packaged in its laid configuration specifically for Machine Lay.

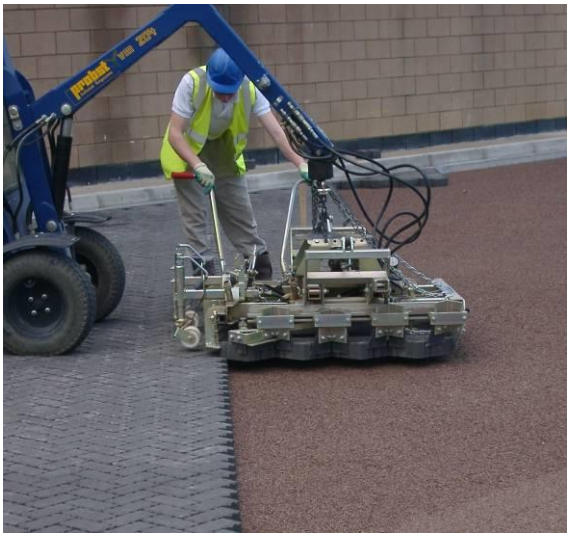
Machine Lay automates all of the installation processes including the screeding of laying course material, installation of the paving, compaction and joint filling. Machine Lay significantly reduces manual handling whilst increasing the speed of installation.

200x100x80mm Priora ML is delivered on returnable pallets and installed by trained, machine equipped installers.

Installation speed can be increased by up to 3 to 4 times over manual installation, significantly reducing the installation window. Additional installation machines can be added to the work face without doubling the labour requirement, the reduction in labour is reflected within the installation cost.

Marshalls Machine Lay Team will be pleased to assess your projects feasibility for machine lay and provide installation quotations via our network of installers.

The Machine Lay process and case studies can be viewed at www.marshalls.co.uk



MATERIAL SPECIFICATION

Laying Course

The large size of the innovative sub-base material aggregate creates an uneven surface when compacted and has an open textured surface. The laying course material provides a flatter platform onto which the blocks are laid, to prevent any rocking or instability of the blocks in-situ. The same material should also be used as the jointing material for the system.

The material should meet the following grading:

Recommended BS EN 12620 aggregate (mm)	2/6.3
Recommended BS EN 12620 grading/tolerance category	Gc 80/20 GTc20/15
Sieve size (mm)	Percentage by mass passing ISO 565 sieve
31.5	
20	
14	100
10	98 to 100
6.3	80 to 99
4	
2	0 to 20
1	0 to 5
0.063	0 to 2

Table 1. Laying Course Grading

Priora Joint Fully Filled

The 5mm to 6mm gaps between the pavers are of a width which causes the jointing material particles to become firmly wedged in the joints and so enhance interlock.

Sub Base Material

Open graded materials are required to allow storage of the surface water within the pavement construction. Therefore, for each site two sub-base designs are carried out, a structural design and a hydraulic design. Of the two sub-base thicknesses designed, the greater one, therefore meeting the requirements of both considerations, will be used for the final pavement design.

The Open Graded Crushed Rock (OGCR) or Open Graded Crushed Gravel (OGCG) sub-base should have a porosity of at least 0.32 to allow void space for water storage. The structural strength of the materials should be adequate for the loads to which it will be subjected. The OGCR or OGCG sub-base should be in accordance with BS EN12620. 'Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction'.

Due to the relationship between the grading curve of the OGCR or OGCG sub-base material and the laying course material, a geotextile between these layers may not necessarily be required.

The material should meet the following grading:

Recommended BS EN 12620 aggregate mm	4/20
Recommended BS EN 12620 grading/tolerance category	Gc80/20 GTc 20/15
Sieve size mm	Percentage by mass passing ISO 565 sieve
31.5	98 to 100
20	90 to 99
14	
10	25 to 70
6.3	
4	0 to 15
3.15	
2.8	0 to 5
1	

Table 2. Sub-Base Gradings

Alternative Sub-base Materials
Should an alternative sub-base material be proposed, such as a blast furnace slag, the material should at least achieve if not exceed the performance requirements of the OGCR or OGCG discussed above, be able to retain its grading curve throughout the pavements life and meet any restrictions imposed by the Environment Agency or relevant party. It will be the responsibility of the originator to prove the suitability of the alternative material and provide any necessary confirmations.

Marshalls M380 Impermeable Membrane
Where the design is of a non-infiltration type the inclusion of an impermeable membrane is required to prevent the saturation of the sub-grade, as this can result in a reduction in its bearing capacity. Where a membrane is required the location of it can be in one of two locations. If a MOT Type 1 or 'Capping' Material is used for capping it is required on the top of this, however, if there is no capping required, or the capping is composed of the open graded aggregate sub-base material, then it must be incorporated below this. When incorporating an impermeable membrane a specified outflow (by design) should be connected via a 'top hat' in order to drain the sub-base between periods of attenuation. Further information is available from Marshalls on the M380 Impermeable Membrane should you require it.

HYDRAULIC & STRUCTURAL DESIGN

Firstly, consider the thickness of the base from a water storage standpoint. Using Microdrainage WinDes software which offers a volume based upon data produced by H R Wallingford. From this and the site specific details such as areas, outflows and infiltration rates the software will offer a time related design depth for any range of storm parameters.

When designing an infiltration system we use a factor of safety of 1.5 which is applied to the infiltration rate as per CIRIA C697 guidance. There are different factors of safety depending on the consequence of failure. We can increase the factor of safety to suit if required.

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Further References

BS 7533 – Pavements constructed with clay, natural stone or concrete pavers.
Interpave – Guide to the design, construction and maintenance of concrete block permeable pavements. – www.paving.org.uk
Marshalls product information - www.marshalls.co.uk
CIRIA website – www.ciria.org/suds
Environment Agency SUDS website – www.environment-agency.gov.uk

CONTACT DETAILS

Technical Designer

Should you have any queries or require any clarification regarding any aspect of this document or require on-site technical support and advice please do not hesitate to contact the author:

Maeve Cullen 01422 312342

e-mail: maeve.cullen@marshalls.co.uk

Drainage Design Team

Contact Marshalls Drainage Design Team for a rapid response to technical queries, CAD requests and product advice

Direct Line: 0845 3020606

e-mail: drainage@marshalls.co.uk

Regional Pavement Engineer

Pete Tamblin: 07817 881838 (mobile)

e-mail: pete.tamblin@marshalls.co.uk

Commercial Enquires

For enquires regarding pricing, availability and orders please contact your local Account manager or sales office.

Ian Goodbold: 07831 710137(mobile)

e-mail: ian.goodbold@marshalls.co.uk

Sales Office: 0845 302 0400
www.marshalls.co.uk/paving

CASE STUDIES

Martlesham Park & Ride


13,000 m2 continuously paved area.

Park and Ride Project, use of Priora maximising the total number of parking spaces whilst also meeting all SuDS requirements.

Use of Colourtop blocks for marking out parking spaces and marking out ‘Parent and Child’ and ‘Disabled Parking’ spaces.


New Housing Developments


Meeting needs and requirements of PPG3 and PPG 25
Use of Priora on estate carriageways

Use with Impervious Surfacing

Car Park application, Priora used in parking bays, impervious surfacing used in car park's access routes.

Machine Lay Project Factory Extension , Chipping Norton

Large Service Yard area machine laid using two teams on adjacent work surfaces.

Marshalls Design Warranty

Marshalls
Creating Better Landscapes

"Marshalls" means Marshalls Mono Limited, its direct and indirect holding companies and any subsidiary of it or of such holding companies.

1. Copyright in our designs

1.1 This Design has been produced specifically for the site stated in the drawing block title below. All design advice is specific to your Project. The finished Design together with all drawings, plans, specifications and other preparatory material and advice produced by or on behalf of Marshalls is subject to the law of copyright and Marshalls asserts its exclusive copyright in such material and retains all copyright and other intellectual property rights in such materials. This Design and/or design advice may not be copied or used for other projects without the express prior written approval of Marshalls.

1.2 For these purposes "Design" means the design attached to these conditions, any design included in the specification and/or any other design or technical advice provided by Marshalls in writing in connection with the Project, including any revisions, amendments and updates made by Marshalls to these designs and/or design advice, and "Project" means the customer's specified project (where "customer" includes any contractor, architect, specifier or agent who is identified as the customer) in connection with which the Design is supplied.

2. Exclusion of Liability

2.1. This Design and any advice provided to you by Marshalls in connection with this design are specific to your Project. You acknowledge that in preparing the Design and providing the advice we have relied upon information supplied by you and/or your professional advisers, agents and/or contractors relating to the Project site and we take no responsibility for any failure or defect arising directly or indirectly from incomplete, inaccurate or misleading information provided to us, or arising as a consequence of any act, omission or failure by you or any third party contractor, engineer, quantity surveyor, architect or other professional adviser engaged in relation to the Project.

2.2. This Design and any advice provided by Marshalls have been prepared and delivered on the basis that Marshalls products are explicitly specified and will be used. If you use any other manufacturer's products, Marshalls can accept no responsibility whatsoever for the performance of those products, nor can we give any assurance that this Design and/or advice provided by Marshalls will be suitable for use with those products.

2.3. As Marshalls is not involved in the overall management and supervision or the selection of materials or contractors on site we will not be liable for any failure in our products caused by the actions or omissions of third parties or the treatment of our products on site and in use. This does not affect your statutory rights.

2.4. Marshalls will have no liability for loss of profit, loss of use, loss of contract and/or any indirect or consequential loss or for any liquidated damages that may arise in respect of the Project. Our total liability to you arising in connection with the Project in any event will not exceed the lower of the aggregated value of materials supplied by Marshalls to the Project or £500,000.

2.5. To the extent permitted by law, the warranties and remedies set out in this document relating to the Design and any advice provided by Marshalls in relation to the Project are exclusive and in lieu of all warranties and remedies and contract terms, express or implied by law, including any contract terms implied by law as to quality or fitness for any particular purpose provided that this clause does not exclude liability for death, personal injury or fraudulent misrepresentation to the extent such exclusion would be prohibited by law.

3. Design warranty

3.1 In providing this Design and any written advice in relation to the Project Marshalls has used the standard of skill and care which would reasonably be expected from an experienced manufacturer of paving and drainage products of the type supplied by Marshalls to the Project.

3.2 To maintain best practice and in keeping with the BS EN ISO 9001 quality management system, Marshalls has its own internal checking procedure in place which involves a design verification process for work carried out by members of Marshalls'

v1 April 12

engineering teams. It is essential that the qualified individual appointed by the customer agrees with the design data inputs and outputs particular to their Project before installation, as project requirements can change during the lifespan of the Project prior to commencement of the installation stage.

3.3 Marshalls warrants that it will repair or replace or provide a refund (at Marshalls' discretion) in respect of any failure of the Design or of any Marshalls product installed in accordance with the Design to conform to the stated standard within 10 years of installation up to a total aggregated cost of £50,000, provided that:

3.3.1 Marshalls' specification and guidance (as provided by Marshalls in writing) has been followed diligently including our recommendation for all component materials that form part of the Design.
3.3.2 Only Marshalls paving products have been used.
3.3.3 The relevant Design has been checked and signed off prior to the installation stage by a qualified individual associated with the Project acting on behalf of the customer, such as a project/design manager.
3.3.4 The finished Project incorporating the products in the Design must have been installed and maintained at all times in accordance with Marshalls' guidance.
3.3.5 Any claims are submitted to Marshalls in writing within 10 years of the Project having completed (or such part of the Project that includes the Design) and in any event within 2 calendar months of the date on which the claimant became aware or should have became aware of the event or circumstance giving rise to the claim.

If any of the above conditions (a) to (e) inclusive have not been met, the above warranty will be invalid and Marshalls shall have no liability in respect of the Design and/or the products installed in accordance with the Design.

3.3. The above warranty will cover the performance of a sub-base incorporated into the Design. It expressly excludes any liability of Marshalls in respect of workmanship in relation to the sub-base and/or any installation whatsoever, including installation of any Product and/or the sub-base, and/or any defects or damage which occurs as a result of ground conditions (including but not limited to hydrological, climatic natural and/or physical conditions and man-made and other physical obstructions and pollutants).

3.3. The above warranty is for the exclusive benefit of the customer and may not be assigned or otherwise transferred to any other party without the written consent of Marshalls in its absolute discretion.

4. Insurance

Marshalls carries public and products liability insurance to a level of at least £10m and professional indemnity insurance to a level of £5m in respect of its designs.

5. Terms and Conditions

These conditions are in addition to and do not exclude the standard terms and conditions of Marshalls applicable to the sale of products to the Project from time to time. To the extent that any provisions of these design terms conflict with Marshalls' standard terms and conditions of sale, these provisions shall prevail insofar as they apply to the Design and any advice in connection with the Design. These conditions will also prevail over any terms and conditions which any contractor, architect, specifier and/or other customer may seek to impose on Marshalls in relation to the Project.

These conditions will be governed by English law.

v1 April 12