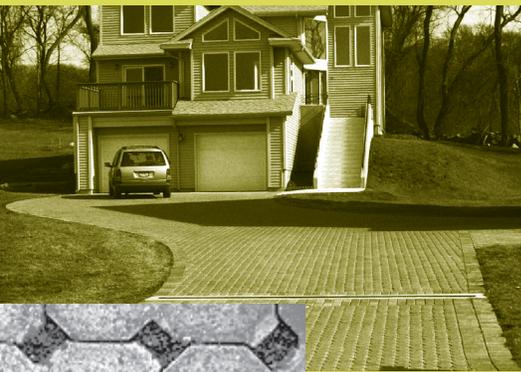


Low Impact Development strategies use careful site design and decentralized stormwater management to reduce the environmental footprint of new growth. This approach improves water quality, minimizes the need for expensive pipe-and-pond stormwater systems, and creates more attractive developments.

MASSACHUSETTS LOW IMPACT DEVELOPMENT TOOLKIT

FACT SHEET #6

PERMEABLE PAVING



Overview

Since impervious pavement is the primary source of stormwater runoff, Low Impact Development strategies recommend permeable paving for parking areas and other hard surfaces. Permeable paving allows rainwater to percolate through the paving and into the ground before it runs off. This approach reduces stormwater runoff volumes and minimizes the pollutants introduced into stormwater runoff from parking areas.

All permeable paving systems consist of a durable, load bearing, pervious surface overlying a crushed stone base that stores rainwater before it infiltrates into the underlying soil. Permeable paving techniques include porous asphalt, pervious concrete, paving stones, and manufactured “grass pavers” made of concrete or plastic. Permeable paving may be used for walkways, patios, plazas, driveways, parking stalls, and overflow parking areas.

Applications and Design Principles

Permeable paving is appropriate for pedestrian-only areas and for very low-volume, low-speed areas such as overflow parking areas, residential driveways, alleys, and parking stalls. It can be constructed where the underlying soils have a permeability of at least 0.3” per hour. Permeable paving is an excellent technique for dense urban areas because it does not

require any additional land. With proper design, cold climates are not a major limitation; porous pavement has been used successfully in Norway, incorporating design features to reduce frost heave.

Permeable paving is not ideal for high traffic/high speed areas because it has lower load-bearing capacity than conventional pavement. Nor should it be used on stormwater “hotspots” with high pollutant loads because stormwater cannot be pretreated prior to infiltration. Heavy winter sanding may clog joints and void spaces.

Management Objectives

- Reduce stormwater runoff volume from paved surfaces
- Reduce peak discharge rates.
- Increase recharge through infiltration.
- Reduce pollutant transport through direct infiltration.
- Improve site landscaping benefits (grass pavers only.)



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Cover: A driveway in Connecticut built with manufactured paving stones. Lower photo shows paving stone detail. Photo: University of Connecticut, Jordan Cove Urban Monitoring Project

Above: A parking lot with concrete grass paver parking stalls. Lower photo shows grass paver detail. Photos: Lower Columbia River Estuary Partnership

Right: A schematic cross section of permeable paving. In some applications, the crushed stone reservoir below the paving is designed to store and infiltrate rooftop runoff as well. Image: Cahill Associates, Inc. 2004

Three Major Types of Permeable Paving

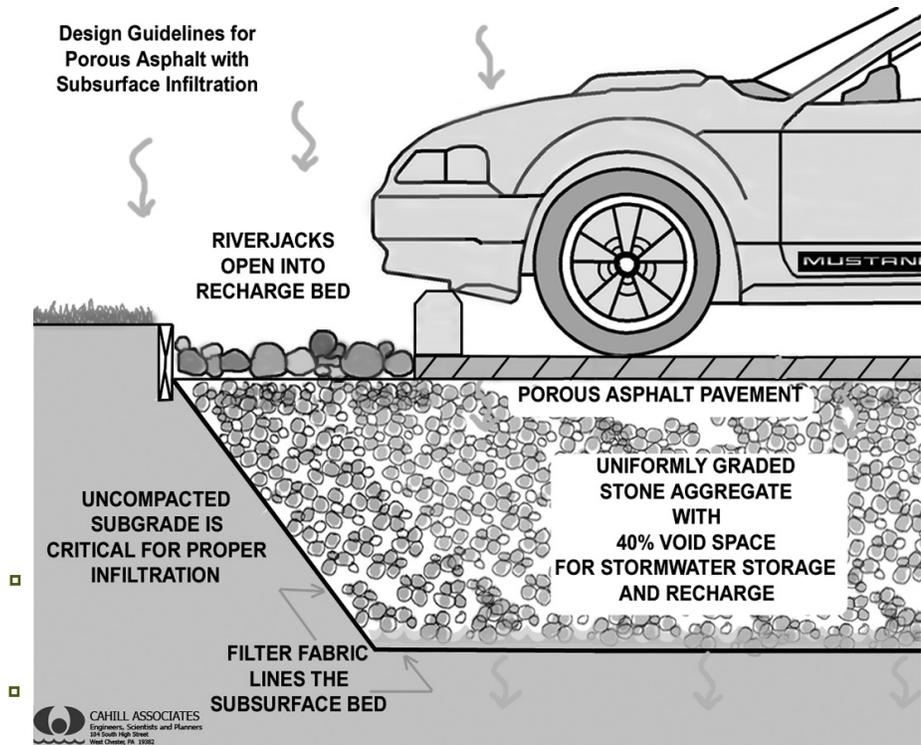
- ▣ Porous asphalt and pervious concrete appear to be the same as traditional asphalt or concrete pavement. However, they are mixed with a very low content of fine sand, so that they have 10%-25% void space and a runoff coefficient that is almost zero.
- ▣ Paving stones (aka unit pavers) are impermeable blocks made of brick, stone, or concrete, set on a prepared sand base. The joints between the blocks are filled with sand or stone dust to allow water to percolate downward. Runoff coefficients range from 0.1 – 0.7, depending on rainfall intensity, joint width, and materials. Some concrete paving stones have an open cell design to increase permeability.
- ▣ Grass pavers (aka turf blocks) are a type of open-cell unit paver in which the cells are filled with soil and planted with turf. The pavers, made of concrete or synthetic, distribute the weight of traffic and prevent compression of the underlying soil. Runoff coefficients are similar to grass, 0.15 to 0.6.

Each of these techniques is constructed over a base course that doubles as a reservoir for the stormwater before it infiltrates into the subsoil. The reservoir should consist of uniformly-sized crushed stone, with a depth sufficient to store all of the rainfall from the design storm. The bottom of the stone reservoir should be completely flat so that infiltrated runoff will be able to infiltrate through the entire surface. Some designs incorporate an “overflow edge,” which is a trench surrounding the edge of the pavement. The trench connects to the stone reservoir below the surface of the pavement and acts as a backup in case the surface clogs.

Benefits and Effectiveness

Porous pavement provides groundwater recharge and reduces stormwater runoff volume. Depending on design, paving material, soil type, and rainfall, permeable paving can infiltrate as much as 70% to 80% of annual rainfall.

Porous pavement can reduce peak discharge rates significantly by diverting stormwater into the ground and away from the pipe-and-pond stormwater management system.





Above: A parking lot with conventional asphalt aisles and paving stone parking stalls. Paving stones are most appropriate for low-speed, low-traffic areas. *Photo: Lower Columbia River Estuary Partnership*

- Grass pavers can improve site appearance by providing vegetation where there would otherwise be only pavement.
- Porous paving increases effective developable area on a site because portions of the stormwater management system are located underneath the paved areas, and the infiltration provided by permeable paving can significantly reduce the need for large stormwater management structures on a site.

Limitations

- Permeable paving can be prone to clogging from sand and fine sediments that fill void spaces and the joints between pavers. As a result, it should be used carefully where frequent winter sanding is necessary because the sand may clog the surface of the material. Periodic maintenance is critical, and surfaces should be cleaned with a vacuum sweeper at least three times per year.
- In cold climates, the potential for frost heave may be a concern for the use of permeable paving. Some design manuals recommend excavating the base course to below the frost line, but this may not be necessary in rapidly permeable soils. In addition, the dead air and void spaces in the base course provide insulation so that the frost line is closer to the surface.
- Permeable paving should not receive stormwater from other drainage areas, especially any areas that are not fully stabilized.
- Permeable paving can only be used on gentle slopes (<5%); it cannot be used in high-traffic areas or where it will be subject to heavy axle loads.
- Snow plows can catch the edge of grass pavers and some paving stones. Rollers should be attached to the bottom edge of a snowplow to prevent this problem.



Above: A handicap-accessible park pathway made of permeable paving stones.

Photo: GeoSyntec Consultants, Inc.

Maintenance

- Post signs identifying porous pavement areas.
- Minimize use of salt or sand during winter months
- Keep landscaped areas well-maintained and prevent soil from being transported onto the pavement.
- Clean the surface using vacuum sweeping machines. For paving stones, periodically add joint material (sand) to replace material that has been transported.
- Monitor regularly to ensure that the paving surface drains properly after storms.
- Do not reseal or repave with impermeable materials.
- Inspect the surface annually for deterioration.
- Grass pavers may require periodic reseeded to fill in bare spots.

Design Details

- For all permeable paving, base course is a reservoir layer of 1"-2" crushed stone; depth to be determined by storage required and frost penetration.
- Permeable paving require a single-size grading of base material in order to provide voids for rainwater storage; choice of materials is a compromise between stiffness, permeability, and storage capacity. Use angular crushed rock material with a high surface friction to prevent traffic compaction and rutting.
- The design may also include a 2" thick filter course of 0.5" crushed stone, applied over the base course. A geotextile fabric may be laid at the top of the filter layer to trap sediment and pollutants.
- For grass pavers, use deep-rooted grass species whose roots can penetrate the reservoir base course. Irrigation may be required but should be infrequent soakings so that the turf develops deep root systems. Grass pavers are not suitable for every day, all day parking because

the grass will get insufficient sunlight. Better for use as occasional overflow parking.

- The introduction of dirt or sand onto the paving surface, whether transported by runoff from elsewhere or carried by vehicles, will contribute to premature clogging and failure of the paving. Consequently, permeable paving should be constructed as one of the last items to be built on a development site, after most heavy construction vehicles are finished and after the majority of the landscaping work is completed.

Cost

On most sites, permeable paving costs more than conventional asphalt or cement paving techniques. In the case of porous asphalt and pervious concrete, construction costs may be 50% more than conventional asphalt and concrete. Construction costs of paving stones and grass pavers varies considerably and will depend on the application. As with any site improvement or stormwater management structure, property owners should provide a budget for maintenance of permeable paving, at an annual rate of 1%-2% of construction costs.

Permeable paving reduces the need for stormwater conveyances and treatment structures, resulting in cost savings elsewhere. Permeable paving also reduces the amount of land needed for stormwater management and may satisfy requirements for greenspace, allowing more development on a site.

Local Case Study

West Farms Mall – West Hartford, CT

Grass pavers were installed at the West Farms Mall off of I-84 at exit 40, to handle peak-season overflow parking associated with a mall expansion. Over four acres of reinforced turf was designed to accommodate 700 spaces of overflow parking for the peak shopping seasons. There are a few drains installed in the reinforced turf but are only used during very heavy storms. Because the reinforced turf works so well the existing storm drainage system did not have to be enlarged for the additional parking. The overflow parking area needs to be mowed on a regular basis and treated like a regular lawn. The area also needs to be plowed as any parking would be. Rollers were fit to the bottom of the snow plow so the reinforced turf would not be damaged. The manager of the Westfarms facility is satisfied with the turf.

Websites

www.unh.edu/erg/cstev/index.htm

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www.uni-groupusa.org/case.htm

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www.lowimpactdevelopment.org/epa03/pavespec.htm

www.epa.gov/ednrmrl/repository/abstrac2/abstra2.htm

www.forester.net/sw_0503_advances.html

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FOR MORE INFORMATION, VISIT: WWW.MAPC.ORG/LID AND WWW.ARC-OF-INNOVATION.ORG.