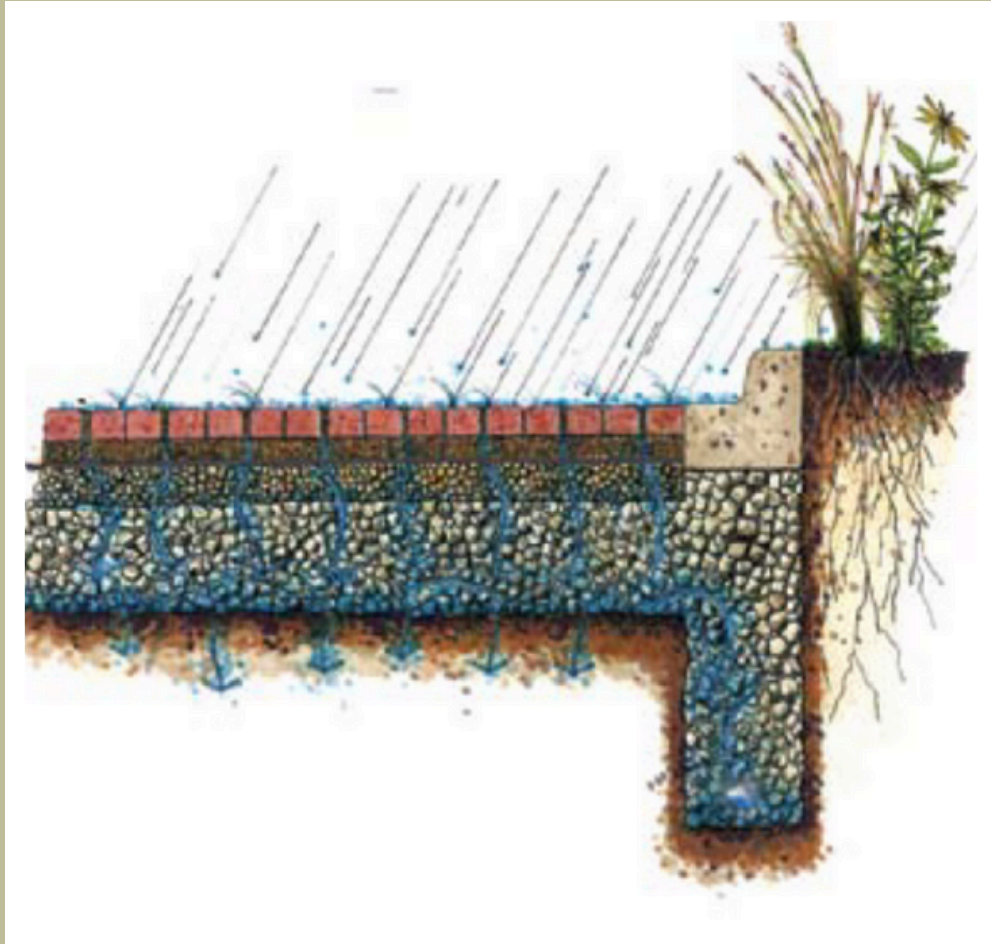


AANYA DHRUV



PERMEABLE SURFACES
HANDBOOK

A STEP BY STEP GUIDE...

What are permeable surfaces?



Permeable surfaces and pavers are innovative solutions designed for effective water management, especially in urban and landscaped areas. Permeable surfaces allow water to pass through them, reducing surface runoff and aiding in groundwater recharge. Modern materials can be porous concrete, permeable asphalt or permeable pavers with spaces for gravel or grass in between them. While simpler surfaces like gravel and pebbles can be part of permeable systems, they must be incorporated within a structured pervious pavement system to qualify as truly permeable surfaces under current waterboard definitions.

These materials help mitigate issues like flooding and water pollution by effectively filtering water through designed systems, though it's important to note these are engineered, not natural, solutions and thus can affect the natural water cycle. Permeable surfaces also aid in erosion control and can be used in driveways, walkways, and patios, offering an environmentally conscious and cheaper alternative to traditional, impermeable paving materials. They combine functionality and aesthetic appeal while contributing to sustainable water management.

Why now?

Ongoing and historical drought along with atmospheric rivers with unprecedented rain due to climate change. Did all this rain serve as a panacea for drought—plenty of clean water for farming, drinking, watering plants, and cleaning? Unfortunately, the answer is no. Major erosion and surface runoff has yet to replenish our underground water tables. There is still a water shortage.

High precipitation + impermeable surfaces = high levels of surface runoff

Why?

- 1) Watersheds get full quickly due to lack of storage capacity.
- 2) Our cities, often composed of concrete, glass, and steel, repel rather than absorb water and most of the freshwater just flows back into the ocean.
- 3) The most commonly encountered pollutants in urban runoff include sediment from construction and earthwork, which can carry hazardous materials such as PCBs, lead, and dioxins. Effective management and treatment of these pollutants are critical for environmental health.

This runoff water is often polluted with

- Oil, grease, and metals from cars
- Chemicals from asphalt
- Insecticides, pesticides, and other “-cides” from conventional landscapes
- Pet waste containing bacteria and viruses
- Numerous unknown and untraceable urban pollutants

The result: health risks to the people and planet!



Jason Giannelli (a fourth generation farmer) says that the rainfall they receive throughout the year is helpful for growing crops like tomatoes, almonds, pistachios and more. However, he says farmers like himself are concerned about water storage, with 95 percent of the water going from the delta directly back into the ocean.



Ruth's town (in San Joaquin valley) faced water quality issues, including brown, muddy water. Ruth suffered from birth defects and attributes the health problems of her children (born with one kidney and asthma) to exposure to pesticide remnants in water through the grape orchard where they lived.

Benefits...



Reduced Pollution and Flood Risk

During heavy rains, they reduce surface runoff by allowing water to permeate and be naturally filtered through the ground, mitigating pollution and flash flood risks.



Ease of Installation and Lower Cost

While initial installation costs for permeable pavers may be higher due to the specialized materials used, they can offer long-term financial benefits. These include reduced stormwater management infrastructure and potential eligibility for tax rebates in certain regions. Financial benefits may vary based on local conditions and installation practices.

For smaller projects or those in residential areas, permeable pavers can sometimes be installed without professional help, especially simpler systems like grass or gravel pavers. However, for optimal performance and durability, professional installation is recommended for more complex systems or large-scale applications.



Energy Cost Savings

Permeable surfaces can contribute to a cooler urban environment by reducing heat common with traditional concrete and asphalt surfaces, mitigating and lessening urban heat island effect. This can potentially lead to savings in energy costs, particularly in cooling buildings during hot weather.



Reduced Carbon Footprint

Permeable surfaces with drought tolerant ground cover on top can reduce carbon footprint and enhance environmental benefits without compromising durability, leading to potential LEED certification.

Benefits...



Effective Water Storage

In drought conditions, these surfaces aid in groundwater recharge, conserving water that becomes critical when rainfall is scarce. By imitating the natural water cycle, they effectively store rainwater for future use.



Reduced Stormwater Management Costs

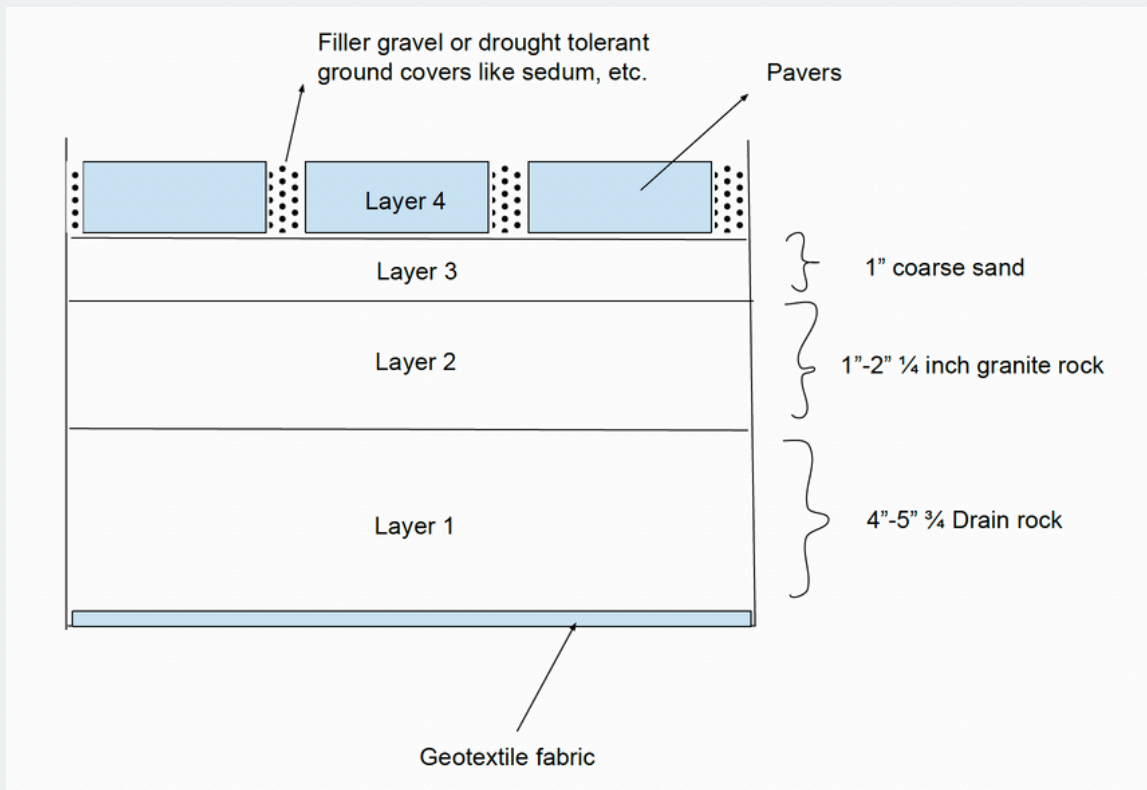
By effectively managing rainwater onsite, permeable surfaces can reduce the need for extensive stormwater management systems, such as drainage pipes and storm sewers. During heavy rainfall, storm drains are not overwhelmed. This can lower infrastructure costs in urban developments.



Maintenance Costs and Clogging

It is a common misconception that permeable pavers require excessive maintenance. Regular maintenance such as occasional cleaning of the gaps to prevent clogging ensures the longevity and effectiveness of these systems. This maintenance can often be managed with standard landscaping tools.

Cross-section diagram



Installation (Detailed Guidance):

Ensure that installations are accessible for maintenance with necessary easements or permissions included in design plans. Underdrains should be installed with accessibility considerations for future maintenance needs.

1. Dig ½ ft - 1 ft deep and line excavated plot with geotextile fabric
2. Add layers 1, 2, and 3
3. Choose your favorite layer 4 and install

Underdrain Installation:

Install underdrains with perforations facing downward at a minimum slope of 0.5% towards the discharge point to facilitate proper drainage and prevent waterlogging

Total installation time: 1-3 hours per 100 sq ft

Total cost: \$3-\$6* per sq ft

*Based on best value for layer 4

Appendix A – Materials Layers 1-3

Material	Depth	Pounds per sq ft	Cost per sq ft
<p>Layer 1</p> <p>Drain (base) rock (¾ inch crushed drain rock) ensure it surrounds the underdrain, which should be a minimum of 4 inches in diameter and covered by at least 12 inches of drain rock.</p>	<p>4-5 inches for patio or walkway</p> <p>12-14 inches for driveway</p>	<p>Patio/walkway: ~35 lbs</p> <p>Driveway: ~100 lbs</p>	<p>Patio/walkway: ~\$1.60</p> <p>Driveway: ~\$4.50</p>
<p>Layer 2</p> <p>Granite (Sub-base) rock (¼ inch granite rock)</p>	<p>1-2 inches</p>	<p>~11 lbs</p>	<p>~\$0.40</p>
<p>Layer 3</p> <p>Coarse sand (concrete sand) forming part of a biotreatment soil mix with a depth of at least 18 inches and a long-term infiltration rate of 5 inches per hour</p>	<p>1 inch</p>	<p>~8 lbs</p>	<p>~\$0.35</p>

Appendix B — Options for Layer 4

Appendix B.1 – Best value for all surface types		
Material	Cost per sq ft	Installation
<i>Pea gravel filler</i>	~\$0.62	Simply fill the remaining layer with the gravel
Appendix B.2 – Patios/Walkways		
<p>Connecticut Bluestone Flamed Paver (1 inch thick)</p> <p><i>Note: this is a non-permeable surface, with gravel spaces being permeable</i></p>	~\$15.50	Lay the pavers 0.5-1 inch apart and fill remaining space with pea gravel filler
Normal coregrid	~\$5.34	Lay the core grid and fill with pea gravel filler
Appendix B.3 – Driveways		
Heavy duty coregrid	~\$7.47	Lay the core grid and fill with pea gravel filler

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