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Challenging Sites: 4 Porous Walkways & Patios

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Porous pavement (also known as permeable and pervious pavement) is a stormwater management facility that allows people to walk or drive on a hard surface while still allowing water to move through void spaces within the pavement and eventually infiltrate into underlying soils. In many cases, it can be used instead of conventional, impervious pavements. Porous pavements reduce the volumes of stormwater runoff that would otherwise be produced by impervious surfaces such as asphalt, concrete, and conventional pavers.

Disclaimer: This fact sheet addresses only porous walkways and patios, which have a much lower potential for structural failure and can be implemented with hand tools, if desired. Porous pavements for vehicular traffic and parking, other the hand, should be designed and constructed only by licensed practitioners. Porous walkways and patios we will consider include boardwalks and decks, mulch paths, gravel paths, and permeable pavers (manufactured, salvaged, and poured-in-place).

Location

Porous pavements have fewer location restrictions than many other stormwater facilities and can be used almost anywhere impervious pavements are used; however, avoid locating them on slopes that exceed 10%.

Except for boardwalks and decks, to prevent surface clogging, careful site design should ensure that landscapes uphill from the pavement are stabilized with vegetation or stepped walls and not draining bare dirt areas onto the pavement. In addition, impervious areas like driveways should not drain toward the walkway since sediment will inevitably be carried, quite frequently even during small storms, on the pavement surface.

Protecting Existing Trees

When locating a new porous walkway under an existing tree, limit the area of disturbance underneath the tree canopy to less than 40% and located at least five (5) feet from the trunk. Do not dig more than six (6) inches into this root area and dig by hand. Do not place fill dirt under the tree canopy to a depth of more than twelve (12) inches.

Overall Pavement Section Design

There's more to a porous walkway than just the surface material. A properly designed porous walkway or patio incorporates three elements in its cross-section:

1. Relatively uncompacted soil that allows water to drain through it (aka infiltration). Many urban soils are so compacted or disturbed that clays form a seal on the top surface so that they don't infiltrate, but instead, generate runoff.
2. Crushed (i.e. angular) aggregate (i.e. rock) base to store rainfall until it can be infiltrated.
3. A surface that allows water to pass through it directly (Xeripavers are one example of a paver that allows water to pass right through it) or indirectly (conventional pavers are placed far enough apart with rock between them so that when rainfall hits them, it runs across the surface and down into the aggregate base.

Standard porous walkway pavement section designs can be found below.

Test the Soil Suitability for Infiltration

The soil must be tested to ensure it will allow water to drain at a rate of at least 0.1 inches/hour. There is a simple test that almost anyone can perform, as follows:

1. Dig a hole about twelve (12) inches deep where the porous walkway will be installed. If the area is seasonally flooded, test it at a time of year when it's not inundated with water. If, after digging the hole, water starts to fill up the hole, come back at a drier time of the year.
2. If it's the rainy season, cover the hole so that water can't fall into the hole.
3. Place two inches of pea gravel or other rock that is all the same size without a lot of small rocks to fill up the voids (i.e not ¾" minus, described below).
4. Fill the hole to a depth that is two (2) inches above the rock.
5. Come back in 20 hours and look for any visible water still ponded above the rock. Is there water visible, ponded above the rock?
   No => If there is no visible water, your site is suitable for a porous walkway and will perform very well to reduce runoff and pollution to our waterways.
   Yes => Your site is not suitable for a porous walkway and the money should be spent on other best practices to reduce runoff, included in this suite of fact sheets.

Separation Filter Fabric

A geotextile fabric to separate the native soils from the aggregate base is needed on the very bottom of the cross section. Without it, water infiltrating through the cross section will cause soil particles to migrate up into the voids of the aggregate, filling them and reducing storage volume for stormwater.

Material Specification: Non-woven geotextile (drainage filter fabric) should conform to the following criteria:

- Minimum flow rate of 95 gal/min/ft2 ASTM D-4491-85
- Grab tensile strength min 115 lb ASTM D-4632-86
- Burst strength min 150 psi ASTM D-3786-80a
- Puncture resistance min 45 lb ASTM D-4833-88
- Apparent opening size 60-90 U.S. Standard Sieve

The presence of this material requires that the aggregate base be delivered clean and washed on-site before placement, if necessary. Otherwise, as water moves through the cross section, it will carry dirt particles down to the fabric and clog it, creating an impervious layer beneath the path you intended to be porous. One successful method for this is to hose the rock off in the delivery truck when it arrives. Another method might be to dump the rock and wash off the pile, pulling rock from the top and applying water again, depending on the size of the pile. Inspect it visually on a regular basis for small rocks and dirt to know at what point in the pile you should start washing again.

Most Porous Walkways Need an Aggregate Base to Store Stormwater

Except for mulch paths, as mentioned below, porous walkways would all benefit from incorporating an aggregate base of rock (even boardwalks & decks).

Material Specification: Use a crushed (angular, not round) aggregate mix of rocks with diameters of all the same size (aka open graded). Some examples of mixes you might find commonly in the Pacific NW include 1" to 1.5", 3/8" to ¾" or ¼"x10. Your rock supplier will be able to confirm whether the material is "open-graded".

Minimum Rock Depth to Manage Rainfall: You can either choose a depth based on your budget or hire a civil engineer to estimate the depth needed to mange rainfall at your particular site, considering the infiltration rate and your rainfall patterns.

The voids in the rock provide approximately 40% storage for rainfall, so where soils drain (as described above) in Portland, a six (6) inch deep aggregate base will store and infiltrate the very large 10-year frequency storm, restoring storage in the watershed and managing rainfall. A minimum of 6 inches is also recommended for structural stability; however, when using manufactured pavers, follow the manufacturer's guidelines.

Rock Depth to Relieve Flooding: For areas that flood, you might consider installing a greater depth of rock to provide additional storage in the watershed during these large storm or seasonal events. This method worked extremely well at the Pringle Creek Community, where an additional two feet of rock was installed below porous pavement; when the Willamette Valley received ten inches of rain in three days and Salem was flooding in other places, the Pringle Creek development, located with a stream running down the middle, did not flood. During a large storm or seasonally, the groundwater level rises up, into the voids in the rock and then slowly drains away, as it naturally would have, from the system, over time.

Choose the Right Surface

There are a variety of porous walkway & patio surfaces to choose from depending on your budget and aesthetic preference, which may vary from location to location around your site.

Boardwalks & Decks

Boardwalks and decks are ideal for steep slopes and muddy areas. These can be an effective means of getting around your site without compacting soil.

An aggregate base is recommended below these to ensure adequate storage for rainfall before it can be fully infiltrated in your slow draining clayey soils. If you don't want to incorporate the aggregate base, avoid lining below it with plastic, as this is an impervious barrier that will generate runoff and don't line it with a weed barrier either, which could clog over time and become impervious.

Material specifications: Boardwalks and decks tend to be made out of either, recycled content plastic composite boards such as Trex, or wood. Plastic boards don't have as must structural integrity as wood and must be supported more often than wood; however, they are more durable than wood, especially in harsh environments (such as the side of the structure that receives the most wind during the rainy season). If wood is desired, naturally durable untreated cedar lumber or equivalent is best the best blend of durability and water quality. Treated lumber, even "environmentally friendly" treated lumber, is saturated with copper, which is a potent water quality pollutant of concern both for ground and surface water quality. Over time, this can wash off from your boardwalk.

Maintenance: Maintenance of boardwalks & decks is generally just to keep them clean, using soap and water or pressure washing. For composite plastic boards, follow the manufacturer's guidance. Avoid acetone, solvents, or soaps containing phosphates, which are all pollutants that can be carried down to the waterways during a rain

event. Weeds shouldn't be too numerous if the area under the deck is well shaded and you've opted for the aggreagate base; however, pull weeds from the gravel area every May and October.

Mulch Paths

Material Specification: Mulch is a very cost-effective porous walkway and can be made of wood or bark chips. Asplundh will deliver a large pile of wood chips free if they're trimming street trees in your neighborhood. These materials are easiest to maintain since weeds blowing in on the air or dropped by birds are less likely to establish in these materials. Bark chips don't have a lot of nutrients and wood chips tend to rob the soil of nitrogen, a nutrient many plants need to grow (except dandelions, which will still need to be pulled from these areas).

Aggregate Base Not Needed: Mulch paths are the only pavement surface mentioned here that wouldn't benefit from a layer of base rock or separation filter fabric below them. As the mulch breaks down, the organic matter would fill the voids of the base rock, reducing storage for stormwater.

Depth of Mulch: Mulch will still store stormwater in the voids and absorb it as well. To maximize runoff reduction, a depth of twelve (12) inches is recommended for storms in the Portland metropolitan region.

Maintenance: When mulched paths are surrounded by lawn, turn your lawnmower off as you cross over the path or wood chips will shoot out the side of your lawnmower and the path will have to be replenished more often. Mulch will likely need to be replenished every three years or so as it breaks down, to keep the path grade similar to surrounding grades. Pull weeds in May and October, which will be easier than removing them from soil and lawn areas.

Gravel Paths

Gravel paths are another useful alternative for porous walkways.

Material Specification: For gravel paths, the six (6) inch recommended depth of aggregate base *is* the pavement.

Avoid rock mixes conventionally used for gravel paths such as ¾"-minus, which has rocks of diameter ¾" down to very tiny particles. The tiny particles allow the path to be compacted, which creates an impervious surface. In addition, of course, the tiny particles will clog the filter fabric. Another common favorite surfacing material to avoid is rounded river rock or pea gravel. This material will roll around and is unsuitable for stable walking paths.

Maintenance: Pull weeds in May and October, which will be easier than removing them from soil, lawn areas, or other gravel areas composed of ¾"-minus.

Permeable Pavers

Pavers can be bought new from a manufacturer, but the most cost effective permeable pavers are those made from salvaged materials such as saw cut concrete pieces from a depaving project (*see 1 Depaving Unused Pavement*) or from poured-in-place concrete.

Pavers should be placed atop a lightly compacted leveling course of course sand. Space between pavers allows runoff to enter the base rock for storage and subsequent infiltration. In between the pavers, in what's called the "infill" space, coarse sand is placed. Both the leveling and infill courses should be clean and washed on-site per the previous discussion of base rock with no fines or dirt.

Construction Specifications: For manufactured permeable pavers, follow the manufacturer's instructions. Light compaction means hand tamping and since compaction is not as critical for walkways as it is for vehicles, don't overcompact. Never compact the subgrade (or you'll be making an impervious pavement at the very bottom) and be careful not to over-compact the leveling course or aggregate storage. Check with the manufacturer to make sure that they will offer a warranty without compaction.

Material Specifications: The course sand in between the pavers and the leveling course is often referred to as AASHTO No. 8 rock and is, again, open graded, or all very similar in diameter. Most homeowners would identify this material as a small gravel before they described it as sandy.

Maintenance: Unclogging a clogged paver installation is relatively easy. Simply vacuum up the No.8 rock in between the pavers and replace. For sustainability and cost reasons, you may also consider vacuuming the rock, piling it up on a tarp in a landscape area that drains to the lawn and doesn't drain towards the pavement area, washing it off, and placing it back.

Construction

Some construction tips have already been provided for specific surface types and when steps apply to them below, this is mentioned (see step 1). Like all stormwater management facilities, special care must be taken to properly construct a porous pavement. The general steps for constructing a gravel or permeable paver are as follows:

1. Call 811 before you dig (for all surfaces!).
2. Since we rely on the native subgrade soils to infiltrate stormwater, the entire porous walkway area should be off-limits to construction traffic, stockpiling activities, and the very bottom of the pavement, at the interface between the separation filter fabric and the rock, should even be protected from foot traffic while it's exposed. In addition, if this soil is exposed to rain, fine soil particles will be picked up and moved around and may clog the native subgrade soils. Let the surface dry and then rake the surface

to loosen the soil before proceeding. Protect them from rain using a jute fabric, available at most landscape supply stores.

3. Excavate to the bottom of the walkway. Construction techniques such as using track equipment and/or excavating from outside of the infiltration area should be used to protect the soils during excavation.
4. Once the native subgrade has been exposed, install geotextile to preserve the voids in the overlying base rock[1]. As you install the geotextile, overlap the sheets at least eighteen (18) inches and lay them across the intended path with an additional one (1) foot beyond to ensure sediment and runoff do not enter the walkway area during construction. (This can be cut at the very end of construction.)
5. Next, place the aggregate base. Light compaction is often recommended, and hand tamping will be sufficient. If you are placing twelve (12) inches of base rock, place it in two separate "lifts" of six (6) inches each, lightly tamping each lift. If using a gravel path or boardwalk with optional aggregate base underneath, this is the last step.

Permeable Pavers:

6. If using permeable pavers, place one (1) inch leveling layer (or depth as recommended by manufacturer) of course sand.
7. Hand tamp this layer so it is relatively flat.
8. Place pavers, so that they are spaced in such a way as to provide 8% to 20% space between them. The more space between them, the less likely they are to clog. Larger pavers should be spaced at the upper limits (20%) of this recommendation.
9. Hand tamp pavers into place, so their edges meet to within 1/8 of an inch.

Poured-in-place Pavers:

6. Building a wood frame consisting of 2x4s placed on their sides in a grid.
6. Pour concrete into the openings.
7. After the concrete cures, remove the wood frame.
8. Backfill openings with course sand.

Maintenance for All Porous Pavements

Maintenance activities for all porous walkways include:

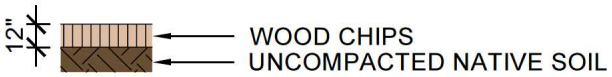
- For those landscape areas that may flow towards the pavement, maintain them to avoid bare soil that may be transported to clog the surface.
- Inspect these areas twice a year and remove trash and litter, which may carry dirt that can also clog pavements, at this time.
- Never stockpile landscape, soil, or other materials on porous walkways.
- Avoid apply pesticides or herbicides to porous walkways. Vegetation removal should be done through integrated pest management approaches such as hand-pulling, pouring boiling water on the vegetation, or by using a torch.

Permits

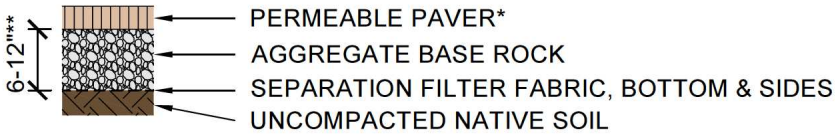
Permitting varies, so check with your local jurisdiction's building or development services department to find out what codes may apply to your project. In Portland, retrofits using porous walkways could require a "Grading and Erosion Control" permit, but probably not a site development or building permit. If information in this guidance conflicts with your jurisdiction's requirements or approach, then follow guidance provided by them instead.

[1] The geotextile fabric functions as a separator whenever storage of rainfall is needed. If soils infiltrate fast, then the base rock may not be needed to provide storage and, in this case, a geotextile wouldn't be needed either.

Standard Porous Walkways Pavement Section Details for Challenging Sites

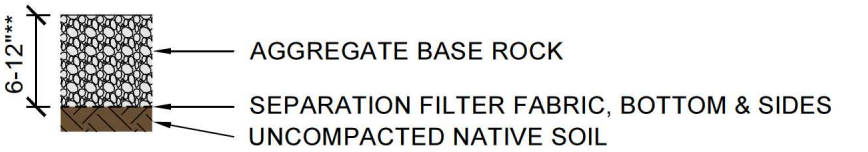


1 PP Mulch Walkway
NTS



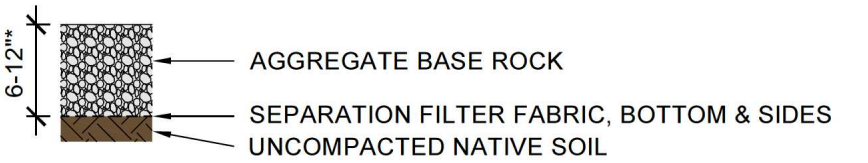
*INCLUDES MANUFACTURED, SALVAGED & POURED-IN-PLACE
** 12" PREFERRED, COULD BE MORE FOR SEASONALLY FLOODED AREAS

2 PP Permeable Paver Walkway
NTS



* 12" PREFERRED, COULD BE MORE FOR SEASONALLY FLOODED AREAS

3 PP Stormwater Storage Beneath Porous Boardwalks & Decks
NTS



* 12" PREFERRED, COULD BE MORE FOR SEASONALLY FLOODED AREAS

4 PP Gravel Walkways
NTS