

INF-6: Permeable Pavement (concrete, asphalt, and pavers)

Permeable pavements contain small voids that allow water to pass through to a gravel base. They come in a variety of forms; they may be a modular paving system (concrete pavers, grass-pave, or gravel-pave) or poured in place pavement (porous concrete, permeable asphalt). All permeable pavements treat stormwater and remove sediments and metals to some degree within the pavement pore space and gravel base. While conventional pavement result in increased rates and volumes of surface runoff, properly constructed and maintained porous pavements, allow stormwater to percolate through the pavement and enter the soil below. This facilitates groundwater recharge while providing the structural and functional features needed for the roadway, parking lot, or sidewalk. The paving surface, subgrade, and installation requirements of permeable pavements are more complex than those for conventional asphalt or concrete surfaces. For porous pavements to function properly over an expected life span of 15 to 20 years, they must be properly sited and carefully designed and installed, as well as periodically maintained. Failure to protect paved areas from construction-related sediment loads can result in their premature clogging and failure.

<p><i>Also known as:</i></p> <ul style="list-style-type: none"> ➤ <i>Pervious pavement</i> ➤ <i>Porous concrete</i> ➤ <i>Pavers</i> ➤ <i>Permeable asphalt</i>

<p>Permeable Pavement Source: Geosyntec Consultants</p>

Feasibility Screening Considerations

- Permeable pavement shall pass infiltration infeasibility screening to be considered for use.
- Permeable pavements pose a potential risk of groundwater contamination; they may not provide significant attenuation of stormwater pollutants if underlying soils have high permeability.

Opportunity Criteria

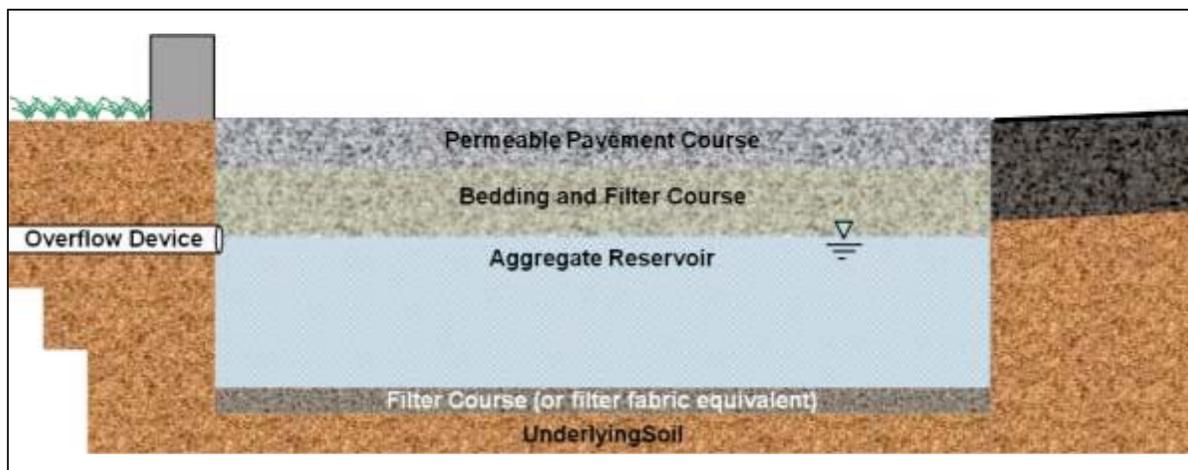
- Permeable pavement areas can be applied to individual lot driveways, walkways, parking lots, low-traffic roads, high-traffic (with low speeds) roads/lots, golf cart paths, within road right-of-ways, and in parks and along open space edges. Impervious surfaces draining to the BMP are limited to surfaces immediately adjacent to the permeable pavement, rooftop runoff, and other nearby surfaces that do not contain significant sediment loads.
- Soils are adequate for infiltration or can be amended to provide an adequate infiltration rate.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

- Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc)
- Minimum separation to mounded seasonally high groundwater of 5 feet shall be observed.

- A biotreatment BMP should be provided for all runoff from off-site sources that are not directly adjacent to the permeable pavement, with the exception of rooftops.
- Permeable pavement should not be used for drainage areas with high sediment production potential (e.g., landscape areas) unless preceded by full treatment control with a BMP effective for sediment removal
- All aggregate used to construct permeable pavement shall be thoroughly washed before being delivered to the construction site.
- The top or wearing layer course (permeable pavement course) should consist of asphalt or concrete with greater than normal percentage of voids, or paving stones.
- A layer of washed fine aggregate (e.g., No. 8) just under the permeable pavement course may be installed to provide a level surface for installing the permeable pavement and also acts as a filter to trap particles and help prevent the reservoir layer from clogging. This layer can also act as interstitial media between pavers.
- Below this layer, the bedding and filter course course should be 1.5 to 3 inches deep and may be underlain by choking stone to prevent the smaller sized aggregate from migrating into the large aggregate base layer.
- The bedding, filter, and choke stone layers, as applicable, are referred to collectively as the bedding and filter course.
- The aggregate reservoir layer should be designed to function as a support layer as well as a reservoir layer the reservoir layer should be washed, open-graded No. 57 aggregate without any fine sands.
- The type of pedestrian traffic should be considered when determining which type of permeable pavement to use in particular locations (e.g., pavers may not be a good option for locations where people wearing high heels will be walking).
- An overflow device is required in the form of perimeter control or overflow pipes. This should generally be set at an elevation to prevent ponding of water into the bedding and filter course.

Figure XIV.1: Schematic Diagram of Permeable Pavement without Underdrains



Simple Sizing Method for Permeable Pavement

Permeable pavement that manages only direct rainfall and runoff from adjacent impermeable surfaces less than 50 percent the size of the permeable pavement are not required to conduct sizing calculations. These areas are assumed to be self-retaining for the purpose of drainage planning. For permeable pavement with larger tributary area ratios, sizing calculations must be performed.

If the Simple Design Capture Volume Sizing Method described in **Appendix III.3.1** is used to size permeable pavement, the user calculates the DCV, designs the geometry required to draw down the DCV in 48 hours, then determines the area that is needed for the BMP. The area of the porous pavement itself as well as the area of the tributary areas should be considered in calculating the DCV. The sizing steps are as follows:

Step 1: Determine Permeable Pavement DCV

Calculate the DCV using the Simple Design Capture Volume Sizing Method described in **Appendix III.3.1**.

Step 2: Determine the 48-hour Effective Depth

The depth of water that can be drawn down in 48 hours can be calculated using the following equation:

$$d_{48} = K_{\text{DESIGN}} \times 48 \text{ hours} \times 1 \text{ ft}/12 \text{ inches}$$

Where:

d_{48} = pavement effective 48-hour drawdown depth, ft

K_{DESIGN} = basin design infiltration rate, in/hr (See **Appendix VII**)

This is the maximum effective depth of water storage in the aggregate reservoir to achieve drawdown in 48 hours.

Step 3: Determine the Aggregate Reservoir Depth

The depth of water stored in the gravel reservoir should be equal or less than d_{48} . Determine the reservoir depth such that:

$$d_{48} \geq (\eta_R \times d_R)$$

Where:

d_{48} = trench effective 48-hour depth, ft (from Step 2)

η_R = porosity of aggregate reservoir fill; 0.35 may be assumed where other information is not available

d_R = depth of trench fill, ft

Step 4: Calculate the Required Infiltrating Area

The required infiltrating area can be calculated using the following equation:

$$A = \text{DCV} / (\eta_R \times d_R)$$

Where:

A = required footprint area, sq-ft

DCV = design capture volume, cu-ft (see Step 1)

η_R = porosity of trench fill; 0.35 may be assumed where other information is not available

d_R = depth of trench fill, ft

This area is equal to the required pavement area.

The ratio total tributary area (including the porous pavement) to the area of the porous pavement should not exceed 4:1.

Capture Efficiency Method for Permeable Pavement

If BMP geometry has already been defined and deviates from the 48 hour drawdown time, the designer can use the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs (See **Appendix III.3.2**) to determine the fraction of the DCV that must be provided to manage 80 percent of average annual runoff volume. This method accounts for drawdown time different than 48 hours.

Option 1: Pavement Geometry is Predefined

Step 1: Determine the Drawdown Time Associated with the Selected Pavement Geometry

$$DD = ((n_R \times d_R) / K_{DESIGN}) \times 12 \text{ in/ft}$$

Where:

DD = time to completely drain pavement, hours

n_R = porosity of reservoir fill; 0.35 may be assumed where other information is not available

d_R = depth of reservoir, ft

K_{DESIGN} = basin design infiltration rate, in/hr (See **Appendix VII**)

Step 2: Determine the Required Adjusted DCV for this Drawdown Time

Use the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs (See **Appendix III.3.2**) to calculate the draw-down adjusted DCV that the basin must hold to achieve 80 percent capture of average annual stormwater runoff volume based on the pavement drawdown time calculated above.

Step 3: Determine the Pavement Infiltrating Area Needed

The required infiltrating area can be calculated using the following equation:

$$A = DCV / (n_R \times d_R)$$

Where:

A = required footprint area, sq-ft

DCV = design capture volume, cu-ft (see Step 1)

n_R = porosity of reservoir fill; 0.35 may be assumed where other information is not available

d_R = depth of reservoir, ft

If the area required is greater than the selected pavement area, adjust reservoir depth and recalculate required area until the required area is achieved.

Configuration for Use in a Treatment Train

- Permeable pavement may be preceded in a treatment train by HSCs in the drainage area, which would reduce the runoff volume to be infiltrated by the permeable pavement
- Permeable pavement areas can be designed to be self-retaining to lessen the pollutant and volume load on downstream BMPs.

Additional References for Design Guidance

- SMC LID Manual (pp 84):
http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCal_ID_Manual_FINAL_040910.pdf

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 5:
http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- City of Portland Stormwater Management Manual (Pervious Pavement, page 2-40)
<http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883>
San Diego County LID Handbook Appendix 4 (Factsheets 8, 9 & 10):
<http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf>
City of Santa Barbara Storm Water BMP Guidance Manual, Chapter 6:
http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf