Permeable Pavements

Permeable pavement (PP) systems can be used for entire parking lot areas or driveways or can be designed to receive runoff from adjacent impervious pavement. For example, the parking spaces in a lot or road can be permeable while the drive lanes are conventional asphalt. In general, the impervious area should not exceed the size of the PP itself. Drainage areas with clean runoff such as roofs may be up to 4 times the pavement area, but should include filtration pre-treatment to remove coarse debris. This drainage can be conveyed directly to the storage reservoir.

PRETREATMENT
In most PP systems, the surface course or joint fill between pavers provide pretreatment to the reservoir below. To avoid clogging, ensure annual vacuum sweeping and apply preventive practices like avoiding storing snow and other materials on the PP.

STORAGE RESERVOIR
Depth must meet both runoff storage and structural support requirements. The STEP LID Planning and Design Guide wiki provides guidance and a tool to allow for calculation of reservoir depth required to store the design storm runoff volume. Aggregate depth required for structural support often far exceeds that required for design storm storage. Clean washed stone is critical as any fines in the aggregate material will migrate to the bottom and clog the native soil. See Specifications for further details.

UNDERDRAIN
Recommended where native soil infiltration rate is <15 mm/h and needed for non-infiltrating designs with impermeable liners. The perforated pipe may be raised in the cross section or placed on the reservoir bottom and connected to an upturned pipe assembly or riser with optional flow restriction to promote infiltration while meeting design drawdown times.

PERFORATED PIPE
Continuously perforated, smooth interior HDPE or PVC drainage pipe, 200 mm interior diameter where possible to reduce risk of freezing and facilitate push camera inspection and cleaning with jet nozzle equipment.

CONVEYANCE AND OVERFLOW
All designs require an overflow outlet connected to a storm sewer with capacity to convey larger storms. This may be achieved with a catchbasin outlet, or water can be directed to a downstream LID practice. Alternatively a gravel diaphragm or trench along the PP’s downgradient edge can drain water to the reservoir below.

DESIGN

GEOMETRY & SITE LAYOUT
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SUBGRADE
For infiltrating pavements, subgrade slopes should be minimized so that runoff will be able to infiltrate evenly through the entire surface. For steeply sloped sites, check dams, berms or weir structures on the bottom of the pavement should be considered. In non-infiltrating systems the bottom should be sloped 1 to 5% toward the underdrain. Subgrades should be compacted to 95% Standard Proctor Density. If a lesser value is desired to promote infiltration, a thicker sub-base should be considered. Subgrade soils should not be scarified.

EDGE RESTRAINTS
Pavers must abut tightly against the restraints to prevent rotation under load and any consequent spreading of joints. The restraints must be able to withstand the impact of temperature changes, vehicular traffic and snow removal equipment. Metal or plastic striping may be used for pedestrian or light vehicle applications. Concrete curbs should be supported on a minimum base of 150 mm of aggregate.

LANDSCAPING
Adjacent landscaped areas should drain away from PP to prevent sediments depositing on the surface. Urban trees also benefit from being surrounded by PP rather than impervious cover, because their roots receive more air and water.

MONITORING WELLS
A vertical standpipe consisting of an anchored 100 to 150 mm diameter pipe with perforations along the part of its length within the storage reservoir, embedded 150 mm into native soil. A lockable cap is recommended for monitoring storm drainage times.

PP Design

<table>
<thead>
<tr>
<th>PP Design</th>
<th>Water balance</th>
<th>Water quality</th>
<th>Stream erosion control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No underdrain</td>
<td>Yes</td>
<td>Yes - size for water quality storage requirement</td>
<td>Partial - based on available storage volume and soil infiltration rate</td>
</tr>
<tr>
<td>With underdrain</td>
<td>Moderate - based on native soil infiltr. rate and storage below underdrain</td>
<td>Yes - size for water quality storage requirement</td>
<td>Partial - based on available storage volume and soil infiltration rate</td>
</tr>
<tr>
<td>With underdrain &amp; liner</td>
<td>No, but some volume reduction through evaporation</td>
<td>Yes - size for water quality storage requirement</td>
<td>Partial - based on available storage volume and soil infiltration rate</td>
</tr>
</tbody>
</table>

Permeable Pavements are an alternative to traditional impervious pavements that allow stormwater to drain through them and into a storage reservoir below. Depending on the native soil properties and site constraints, the system may be designed for full infiltration, partial infiltration, or as a non-infiltrating detention and filtration only practice. They can be used for low traffic roads, parking, driveways, and walkways, and in areas where space for other surface BMPs is limited. Permeable pavement types include:

- permeable interlocking pavers (concrete or composite materials)
- grid systems (concrete or composite materials)
- pervious concrete (poured-in-place or pre-cast)
- porous asphalt
- permeable articulating block/mat systems

Partial Infiltration
Designed so that most water may infiltrate into the underlying soil while the surplus overflow is drained by perforated pipes that are placed near the top of the drain rock reservoir. Suitable for subsoil permeability < 1 mm/hr.

Partial Infiltration with Flow Restrictor
Where subsoil permeability is < 1 mm/hr, water is removed at a controlled rate through a bottom pipe system and flow restrictor assembly. Systems are essentially underground detention systems, used where the underlying soil has very low permeability or in areas with high water table. Also provides water quality benefits. However this should not be needed if IP's 1 or 2.

Source: Greater Vancouver Sewerage and Drainage District, 2012
### GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pervious concrete</td>
<td>• ND4-RG-57 mix with air entrainment proven to have the best freeze-thaw durability after 300 freeze-thaw cycles.</td>
</tr>
<tr>
<td>Porous asphalt</td>
<td>• Open-graded asphalt mix with a minimum of 16% air voids.</td>
</tr>
<tr>
<td>Permeable pavers</td>
<td>• Permeable pavers should conform to manufacturer specifications.</td>
</tr>
<tr>
<td>Stone reservoir</td>
<td>• All aggregates should meet the following criteria:</td>
</tr>
</tbody>
</table>

### CONSTRUCTION

**Sediment control** | The treatment area should be fully protected during construction so that no sediment reaches the PP system. Construction traffic should be blocked from the PP and its drainage areas once the pavement has been installed.

**Base construction** | The stone aggregate should be placed in 100 to 150 mm lifts and compacted with a minimum 9 ton steel drum vibratory roller. A Light Weight Deflectometer may be used to test compaction of the stone against specifications.

**Weather** | Porous asphalt and pervious concrete will not properly pour and set in extremely high and low temperatures.

**Pavement placement** | Properly installed PP requires trained and experienced producers and construction contractors.

### OPERATING AND MAINTENANCE

Annual inspections of PP should be conducted in the spring to ensure continued infiltration performance. Check for deterioration and whether water is draining before washing. Deicing agents should be used in moderation and only when needed. Research has shown that de-icing salt applied on PS can significantly reduce on PP while still retaining slip resistance. PP should never be plowed for snow removal like any other pavement. Plowed snow piles should not be stored on PP systems. Blow blades can be fitted with rubber to prevent scratching.

**Underdrain** | Underdrain pipes should be CCTV inspected every 5 years and cleaned as needed.

**Heavy vehicles** | Trucks and other heavy vehicles should be prevented from tracking or splashing dirt onto the PP.

**Hazardous materials** | All hazardous material storage and carrier traffic should be prohibited from entering a PP area to prevent groundwater contamination.

**Drainage areas** | Impervious areas draining to the PP should be regularly swept and kept clear of debris. Runoff from adjacent landscaped areas should be diverted away from the pavement unless well stabilized with vegetation.

**Winter maintenance** | Sand should not be spread on PP as it can quickly lead to clogging. Deicers should be used in moderation and only when needed. Research has shown that de-icing salt applied on PP can significantly reduce on PP while still retaining slip resistance. PP should not be plowed for snow removal like any other pavement. Plowed snow piles should not be stored on PP systems.

For more information:
Visit the online LID Stormwater Management Planning and Design Guide for more information including links to all sources cited: [sustainabletechnologies.ca](https://sustainabletechnologies.ca)

LID Stormwater Inspection and Maintenance Guide (TRCA, 2016): [sustainabletechnologies.ca](https://sustainabletechnologies.ca)


The water component of the Sustainable Technologies Evaluation Program is a collaboration of: Toronto and Region Conservation Authority, Credit Valley Conservation, and Lake Simcoe Region Conservation Authority.