green infrastructure

UNDERSTANDING

Porous Asphalt

WHAT IT IS

With roads and parking lots accounting for a high percentage of impervious surface, porous asphalt can be an ideal Best Management Practice in the right location. It essentially eliminates the impervious surface that would otherwise be created. Porous asphalt uses a standard asphalt mix with no sand or fines and a polymer binder to provide strength and stability. The void spaces of this mixture allows rain and snowmelt to pass through to a subbase of stone aggregate that both supports the asphalt layer and provides storage for and treatment of rainfall or snowmelt.

Unlike many other stormwater management facilities, porous asphalt requires no additional land or space, functioning within the footprint of the roadway, parking lot, alley, or sidewalk. By promoting infiltration, filtration, and recharge of groundwater, porous asphalt significantly reduces runoff volume and peak flows, decreases runoff temperature, and improves water quality. The University of New Hampshire Stormwater Center (UNHSC) reports that it also speeds snow and ice melt, reducing the salt required for winter maintenance. While porous asphalt is most recommended for low volume and low speed applications, U.S. Environmental Protection Agency has noted that porous asphalt has performed well in all highway pilot projects in the United States. Maine DOT has recently used porous asphalt on a high volume road in South Portland (see more information about this project under Examples).

WATER QUALITY TREATMENT

The porous asphalt design tested at UNHSC, being widely promoted now in New England, uses coarse sand as a subbase filter course that enhances effectiveness in pollutant removal rates. The facility at UNHSC has demonstrated the following:

Pollutant	% Removal
Total Suspended Solids (TSS)	99
Total Petroleum Hydrocarbons in the Diesel Range	99
Dissolved Inorganic Nitrogen (NO3)	No treatment
Total Zinc	75
Total Phosphorous	60
Average Annual Peak Flow Reduction	82

Source: University of New Hampshire Stormwater Center 2009 Annual Report

DESIGN CONSIDERATIONS

Stormwater design parameters – Three to five feet of vertical separation is needed from seasonal high groundwater. U.S. EPA also notes, "The load bearing and infiltration capacities of the subgrade soil, the infiltration capacity of the porous asphalt, and the storage capacity of the stone base/subbase are the key stormwater design parameters. To compensate for the lower structural support capacity of clay soils, additional subbase depth is often required. The increased depth also provides additional storage volume."

Quality control – Careful assessment of site conditions, and quality control for material production and installation methods are essential to success.

Protect porous surface from sediment and fines – To minimize clogging and promote continued good infiltration rates over time it is critical to protect the surface and base from sediment and fines during and after construction. Pretreatment BMPs, such as filter strips and swales, may be important considerations where water is flowing from upland areas onto the surface. Devices such as chatter strips at parking lot entries can also help reduce clogging. Sanding during the winter months should be discouraged.

Specifications - For guidance on design, see specification provided by UNHSC at: http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/UNHSC%20PA%20Spec%20update-%20FEB-2014.pdf.

The specification shown in Figure 1 (at right) is intended for:

1. porous asphalt pavement in parking lot applications;

2. a cold climate application based upon the field experience at the UNHSC porous asphalt parking lot located in Durham, New Hampshire. They note that the can be adapted to projects in other climates provided that selection of materials and system design reflects local conditions, constraints, and objectives.

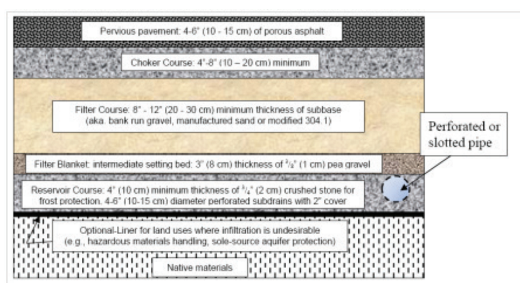
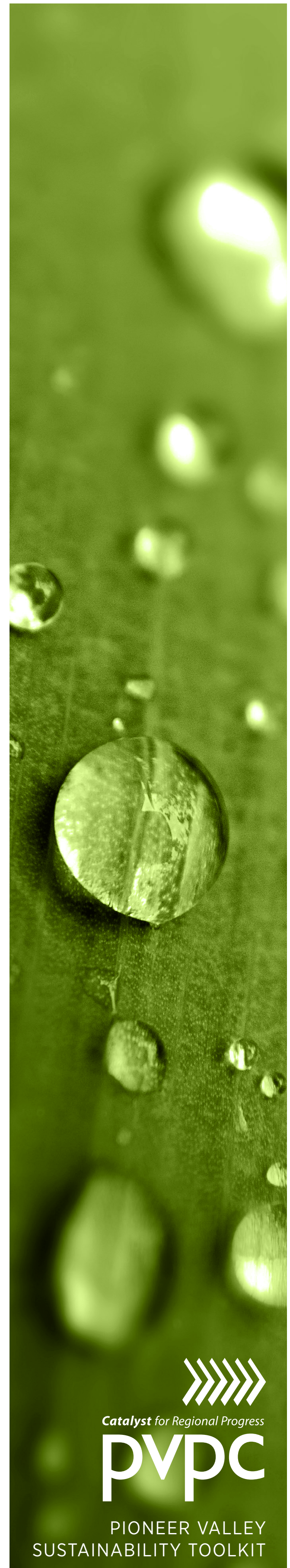


Figure 1: Typical Parking Area Cross Section for Porous Asphalt
Courtesy: University of New Hampshire Stormwater Center

The mix for porous asphalt requires a polymer binder, which may be difficult to acquire for small scale projects. For example, when New England Environmental, Inc. in Amherst, MA constructed its porous asphalt parking lot in 2009 it found that the binder specified by UNH for the asphalt mix is only appropriate for larger-scale jobs, because it is only sold by the trailer truckload. New England Envrionmental, Inc. found a substitute binder that includes polymer fibers, much like what is used for asphalt curbing, that could be acquired by the barrel.

PERMITTING CONSIDERATIONS

The Massachusetts Stormwater Handbook currently does not allow for porous asphalt in Zone IIs, or near any other critical areas, including Outstanding Resource Waters and Special Resource Waters (see Stormwater Management Standard #6). While the stormwater management standards relate to jurisdictional areas under the Wetlands Protection Act, these standards have been applied by reference through local bylaws and ordinances to upland locations as well. MassDEP is currently proposing a revision to its guidance about porous asphalt, and porous pavements generally, as new information has become available on its treatment capabilities. Until this recomendation from MassDEP is accepted, however, any legal actions will be based on the current guidance within the Stormwater Handbook.



BARRIERS TO USE

Concern	Experience
Cost	$10 to $12 per square foot based on costs for MassDOT Park and Ride facility in Whately, MA, including 16 inches of stone for subbase and 5 inches of surface mix. Note that the scale and size of a project can also affect price, with lower per square foot costs on larger projects. The UNH Stormwater Center notes that material costs alone are about 20 to 25 percent more than traditional asphalt, but total project cost for porous asphalt is comparable to those for conventional asphalt projects if one accounts for the stormwater infrastructure costs that are required to manage runoff from conventional asphalt. The University of Rhode Island in building their porous asphalt parking lots in 2002 and 2003 found that the construction costs were comparable to equivalent sized conventional parking lots. While initial costs of a porous asphalt facility may be slightly higher than a facility that uses conventional asphalt, the lifespan of a porous asphalt parking lot can be more than 30 years compared to 15 years for a conventional parking lot. (See: "Pervious Pavements: New findings about their Functionality and Performance in Cold Climates "by J. Gunderson, Stormwater, September 2008.)
Winter performance	Given the well draining stone bed and structural support of porous asphalt, the freeze thaw cycle tends to produce fewer cracks and potholes than on conventional asphalt pavement. (University of New Hampshire Stormwater Center) "Because of the well-drained nature of the porous pavement and reservoir base, issues related to frozen media were minimized. Significant frost penetration was observed up to depths of 71 cm without declines in hydrologic performance or observable frost heave." (Results of a study published in Journal of Environmental Engineering in January 2012 notes) Low to no black ice development, allowing for reduced salt application rates of up to 50 to 75 percent. Best not to use sand at all to avoid clogging of pours. (University of New Hampshire Stormwater Center)
Maintenance	Requires vacuuming twice each year (spring and fall), and perhaps more frequently depending on use, to prevent clogging of pores with sediment and fines. Several contractors in the region offer vacuuming services. Typically, per square foot costs will be lower with larger jobs. A municipality for example may see better value in hiring to have several lots vacuumed at once rather than each vacuumed on separate occasions. Repairs can be made with standard asphalt, not to exceed 10 percent of surface area. (University of New Hampshire Stormwater Center) For winter maintenance tips, see UNHSC recommendations related to plowing and use of salt for general maintenance, during a storm event, and between storm events. See: http://unh.edu/unhsc/sites/unh.edu.unhsc/files/docs/UNHSC%20porous%20winter%20maintenance%20fact%20sheet_1_11.pdf
Clogging	Studies of the long-term surface permeability of porous asphalt and other permeable pavements have found high infiltration rates initially, followed by a decrease that then levels off with time. With initial infiltration rates of hundreds of inches per hour, the long-term infiltration capacity remains high even with clogging. See: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=135&minmeasure=5
Durability	The University of New Hampshire Stormwater Center acknowledges that while porous asphalt is weaker than conventional asphalt pavements, durability can be greatly improved with the proper admixtures and design. It has been effective for both commercial and roadway applications. (UNHSC 2012 Annual Report)

EXAMPLES OF WHERE STRATEGY HAS BEEN IMPLEMENTED

New England Environmental, Inc. headquarters, Amherst, MA

As part of developing their new LEED platinum rated office building, New England Environmental, Inc. included porous asphalt in a suite of stormwater management strategies that also includes rain gardens and grass pavers. They used porous asphalt for all travel lanes (about a 10,000 square foot area), while grass pavers were used in all parking stalls. The porous asphalt has been in place since 2008 and is performing beyond expectations with vacuuming occurring twice each year to remove sediment and fines. Owner Mickey Marcus reports that the cost for the parking lot as a whole was equivalent to the cost of a conventional parking lot with attendant stormwater management facilities. For the future, Marcus discourages the use of grass pavers in combination with porous asphalt as the pavers become too easily damaged with winter plowing. See figure 2.

Figure 2: New England Environmental, Inc. with porous asphalt drive in foreground and grass paver parking stalls in middle ground | Courtesy: Mickey Marcus, NEE

MassDOT Park and Ride facility, Routes 5 and 10, Whately, MA

At the request of the local conservation commission, which was concerned about the parking facility's proximity to a wetlands area, MassDOT used porous asphalt in the 40 parking stalls at this new Park and Ride facility in Whately, MA. The porous area has 16 inches of stone in the subgrade and 5 inches of surface mix. Construction costs ran $10 to $12 per square foot for the porous asphalt area. MassDOT used traditional asphalt in the travel lanes for this facility.

Maine Mall Road, South Portland, ME

Maine DOT used porous asphalt on this four lane (75-foot wide) high-volume road (16,750 AADT) as part of a larger effort to restore a local creek to its water quality classification. They installed porous asphalt on 850 linear feet and used a specification that included a 3-inch open graded friction course, followed by 6 inches of asphalt treated permeable base, 15 inches of stone reservoir, and 6 to 12 inches of porous filter material (see project location in Figure 3 and cross section in Figure 3 below.) Total project costs were $90 per square yard and the project was funded entirely through the American Recovery and Reinvestment Act monies.1

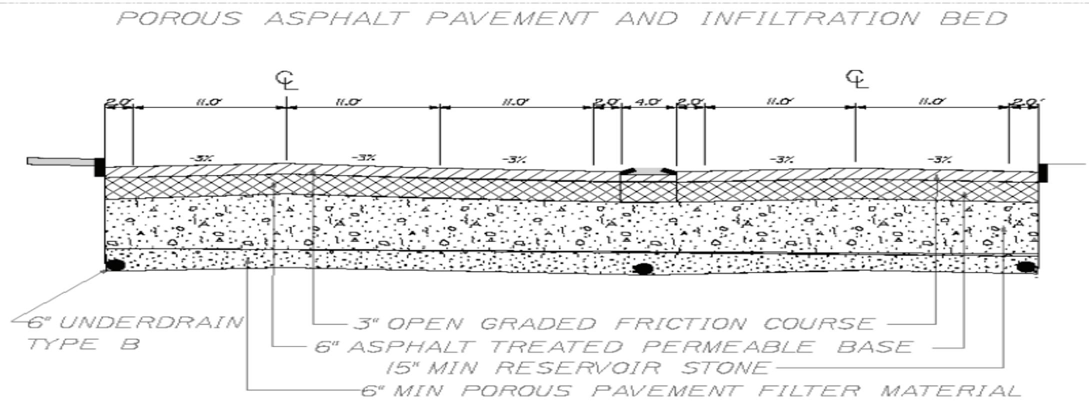


Figure 4: Cross section of porous asphalt system on Maine Mall Road | Source: Maine DOT

University of Rhode Island, Kingston, RI

In 2002 and 2003, the University of Rhode Island built two porous asphalt parking lots over a sole source aquifer. One lot is 5.5 acres and accommodates 800 vehicles while a smaller 1.47 acre lot accommodates 200 vehicles. Due to concerns of potential groundwater contamination and compaction of the asphalt, commercial and industrial vehicles are not permitted to park on these lots. In addition the recharge bed was designed to be 6 to 6.5 feet above seasonal high groundwater. Design of the facility includes a 2.5 thick porous asphalt surface layer, a 1-inch layer of choker course, and 3 to 3.5 feet of crushed rock to temporarily store and infiltrate rainfall and snowmelt. The crushed rock storage reservoir is separated from underlying soils and adjacent subsurface materials by a layer of geotextile filter fabric. Intended to prevent movement of fine soil particles up into the overlying reservoir, the fabric instead captured fines moving down from the overlying layers and became clogged so that water cannot infiltrate and moves laterally across the barrier.

Entrance areas of the parking lots are paved with conventional asphalt to accommodate heavier use and to better receive sediment deposition from tires as vehicles enter the lot. Landscaped parking lot islands act as bioinfiltration areas throughout the parking areas to provide a secondary route of infiltration during intense rainfall and in case the pavement surface gets clogged up. The outer areas of the lot are landscaped with trees and grass to keep windblown dust from nearby agricultural activities from accumulating on the porous asphalt.

During the summer of 2005, a new porous asphalt parking area was constructed expanding the existing lot and increasing the capacity from 814 to 1582 spaces. The new lot covers 5.8 acres. Several changes were made to the new lot to allow for simpler maintenance. They are:

1. Fewer, wider infiltration islands
2. Curb cuts for water entry to island bioinfiltration areas
3. Mowed grass, not meadow grass for islands
4. Fewer wheel stops, where possible, due to wheel stops being moved by cars and plowing

LINKS TO MORE INFORMATION

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ROSEEN, ROBERT M., BALLESTRO, THOMAS P., HOULE, JAMES J., BRIGGS, JOSHUA F., AND HOULE, KRISTOPHER F. JANUARY 2012. "WATER QUALITY AND HYDROLOGIC PERFORMANCE OF A POROUS ASPHALT PAVEMENT AS A STORM-WATER TREATMENT STRATEGY IN A COLD CLIMATE." JOURNAL OF ENVIRONMENTAL ENGINEERING, 81-89.

UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER. OCTOBER 2009. "UNHSC DESIGN SPECIFICATIONS FOR POROUS ASPHALT PAVEMENT AND INFILTRATION BEDS." SEE:
http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/unhsc_pa_spec_10_09.pdf

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http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/porous_ashpalt_fact_sheet.pdf

U.S. ENVIRONMENTAL PROTECTION AGENCY. MENU OF BMPS: POROUS ASPHALT PAVEMENT. SEE:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index
cfm?action=browse&Rbutton=detail&bmp=135&minmeasure=5

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