Permeable Pavement Demonstration at the Edison Environmental Center

Michael Borst, Thomas O'Connor, Amy Rowe, and Emilie Stander

Urban Watershed Management Branch, Water Supply and Water Resources Division, National Risk Management Research Laboratory (NRMRL),

Office of Research and Development, Edison, NJ

www.epa.gov

Introduction

There are few performance evaluations of replicated, full-scale, real-world permeable pavements. Practitioners need additional studies of permeable pavement systems operating in the intended use (parking lot, roadway, etc.) with climatic events, routine use, and maintenance. EPA's National Risk Management Research Laboratory installed a 1-acre, 110-space permeable pavement parking lot that is instrumented and monitored for water quantity and selected water quality parameters. The working parking lot at the Edison Environmental Center will be used by facility staff and visitors. This parking lot facilitates side-by-side monitoring of porous asphalt, porous concrete, and permeable interlocking concrete paver systems. The lot has three monitored parking rows, each constructed using a different permeable surface. The driving lanes are conventional asphalt. Portions of the permeable pavement parking areas have integral impermeable liners to collect the porous pavement effluent. Alternating sections allow the effluent to infiltrate to the underlying soil. Each monitored parking row has four impermeable and five permeable sections that allows for statistical analyses of collected data. See Figure 1. Some research questions that will be examined during this project include:

- How do surface and subgrade infiltration rates change with time?
- What are the effects of maintenance on the performance of the permeable surfaces?
- How do the permeable surfaces perform in regard to hydrologic and stressor removal functions?

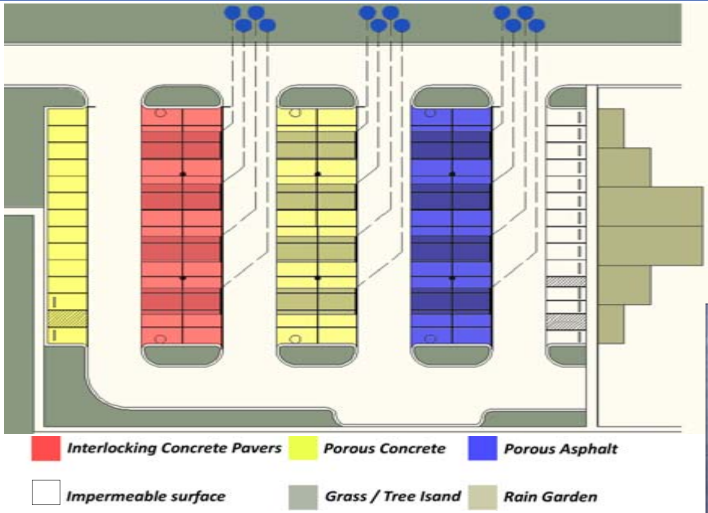

Figure 1 Plan view of the experimental design of the parking lot. The parking lot has a 1.6% slope from left to right.

Pavement Profiles

EPA categorized permeable pavement as a stormwater Best Management Practice (BMP), as it provides stormwater runoff volume reduction through infiltration and can also enhance the runoff water quality after infiltrating the system. In a permeable pavement system, stormwater passes through several bedding layers after draining through the surface. Some stressors may be removed as the water moves through the underlying materials. The most commonly used permeable surfaces are porous asphalt, porous concrete, and interlocking concrete pavers, which are sometimes called porous pavers even though the pavers themselves are not porous. Figure 2 shows the profiles of the three porous surfaces

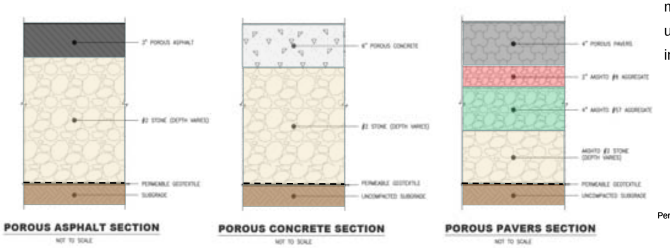

Figure 2. Cross sections of the three porous pavement types at the Edison Environmental Center parking lot. (Drawing from Morris Ritchie and Associates, 2009)

Parking Lot Features

- Three types of permeable surfaces
- Replicates for statistical analysis
- Run-on and runoff control
- Instrumentation for both continuous and event-based monitoring
- Infiltrate collection
- Traditional asphalt driving lanes
- Runoff overflows to rain gardens
- Climatic monitoring

Unlined Sections

The unlined end sections of each permeable surface parking row enables monitoring of the interaction of the infiltrated water with the subgrade soil. A 5-foot diameter, 3-foot high vertical HDPE pipe isolates the water infiltrating downward. See Figure 3. Access pipes at the geotextile-subgrade soil interface allow instrument placement for event-based sampling. Differential pressure level loggers can be inserted into the pipes to measure the accumulated water depth. General water quality parameters (pH, conductivity, etc.) can also be measured at this location using a multi-parameter sonde. Permanent instrumentation installed in the permeable parking rows during construction include time domain reflectometers (TDRs) to monitor the passing of the wetting front and thermistors to measure temperature. In two other unlined sections of each permeable parking row, a cluster of one well and two piezometers is installed to measure water mounding at several depths using water level loggers.

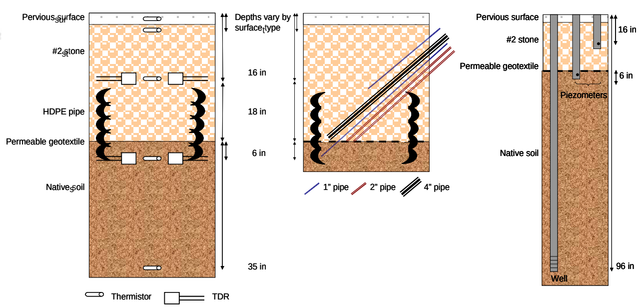

Figure 3. From left to right: instrumentation in the unlined end sections, access pipes in the unlined sections, and well and piezometer locations in the unlined sections.

Acknowledgments

The construction of the parking lot was a joint effort between the Office of Administration and Resource Management, Region 2, and the Office of Research and Development. NRMCA, NAPA, and ICPI, the trade associations representing the three permeable surfaces provided valuable assistance throughout the project.

Lined Sections

Quality science requires replicated experiments. While the weather patterns are random, the parking lot design is divided into separate sections. This allows statistical analysis and the estimation of experimental uncertainty.

Each monitored parking row has four sections underlain with an impermeable EPDM liner to collect the infiltrate that has moved through the permeable surface and subgrade layers. The impermeable sections each have a perforated pipe that drains the accumulated runoff through pipes under the roadway to a dedicated collection tank on the eastern side of the lot. See Figure 4. The lined parking sections are not instrumented, but the collection of the infiltrating water allows for the measurement of infiltrated water volume, infiltration rate, and analysis of selected water quality parameters such as solids, microbes, nutrients, metals, and semi-volatile organic compounds.

Figure 4. From left to right: The perforated pipe in the lined section, the pipes installed in the subgrade, the dedicated collection tanks for each lined section, and infiltrate reaching the collection tank.

Preliminary Data

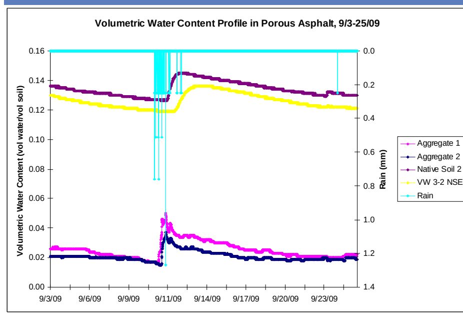

Figure 5. Volumetric water content profile measured under the porous asphalt from September 3 to September 25

Figure 5 shows the passing of the wetting front relative to the rainfall. The wetting front is delayed in the subsurface and the peaks are dampened in the deeper layers of the profile.

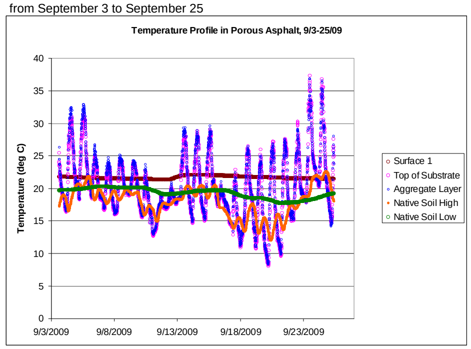

Figure 6. Temperature profile measured under the porous asphalt from September 3 to September 25

Figure 6 shows the temperatures recorded throughout the porous asphalt profile. The deeper native soil temperatures remain relatively steady, while the readings nearer the surface vary diurnally.

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Contact: Michael Borst| borst.mike@epa.gov | 732-321-6631