Off the Beaten Path—
Porous Pavements for Recreation

Northwest Pavement Management Association
Fall 2013 Meeting

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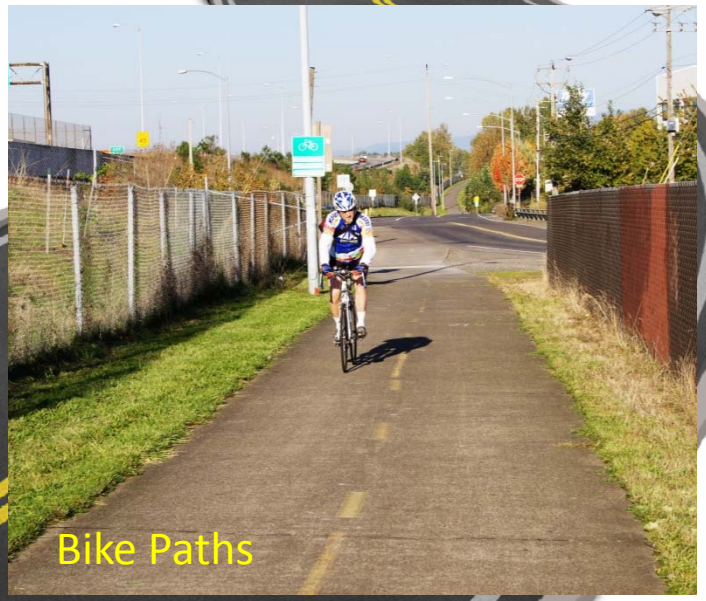
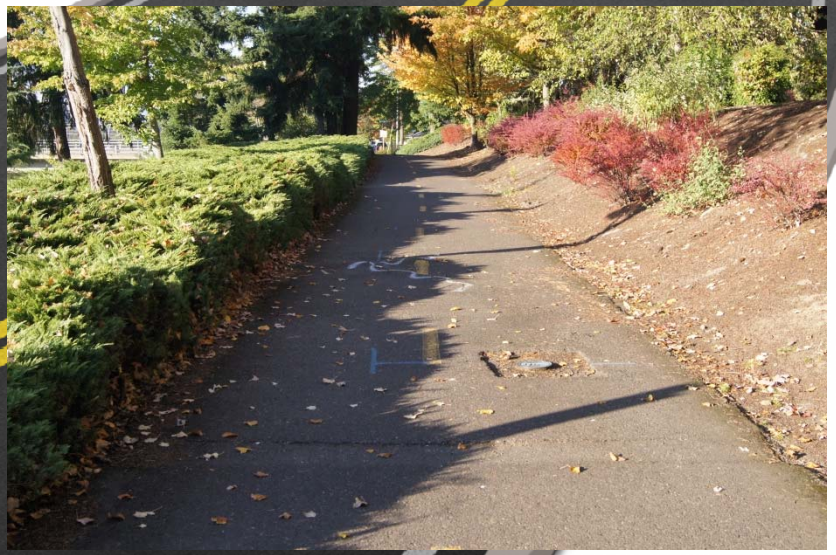
John Duval, P.E.
Principal Engineer
PAVEMENT SERVICES, INC.

Porous Pavements in Recreation



Overview

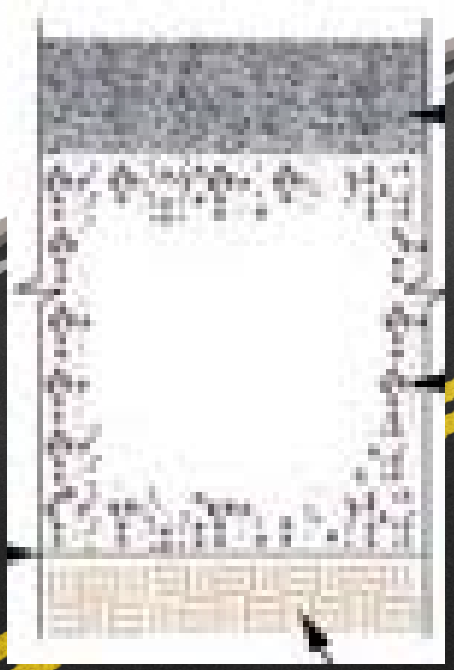
1. Introduction
2. Design
3. Materials
4. Construction Guidelines
5. Project Opportunities



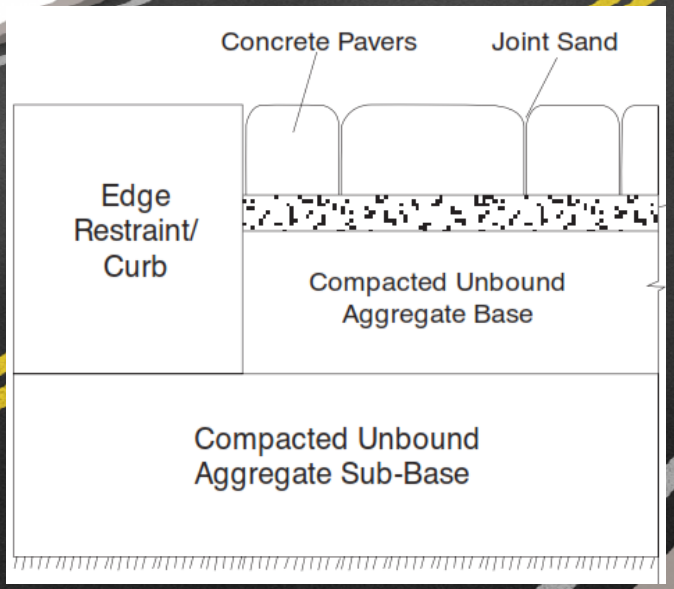
Introduction

What's in a Name?

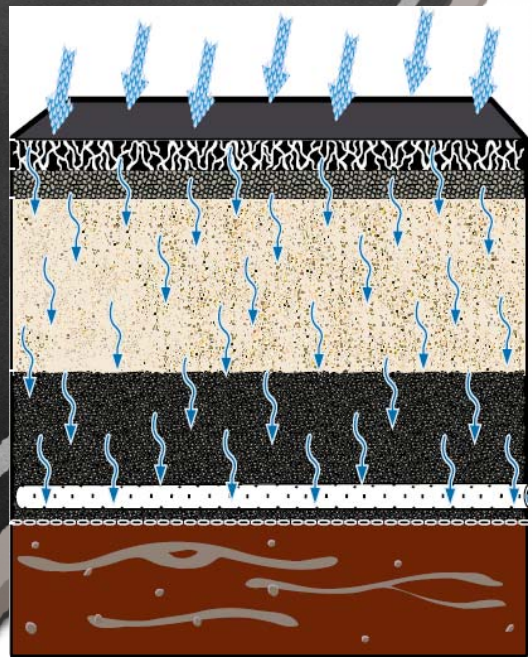
Pervious Concrete



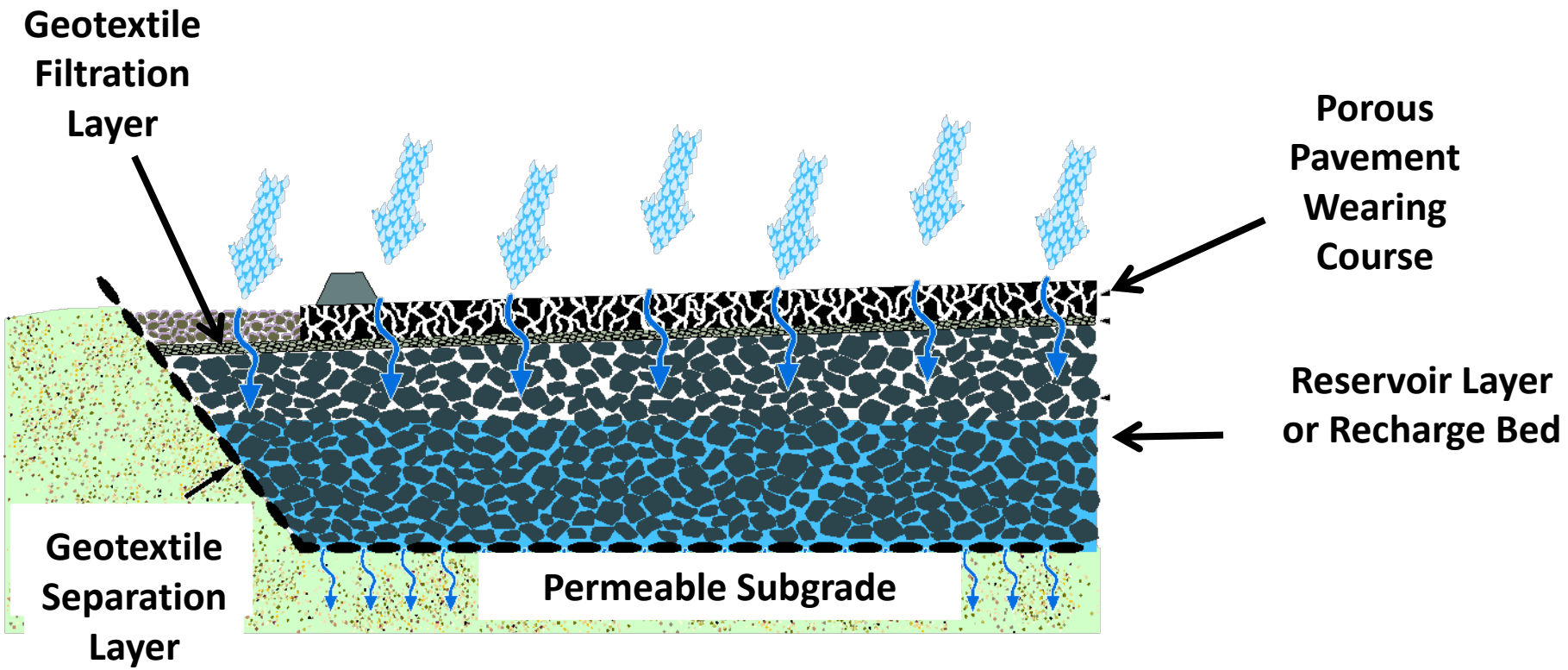
Permeable Pavers



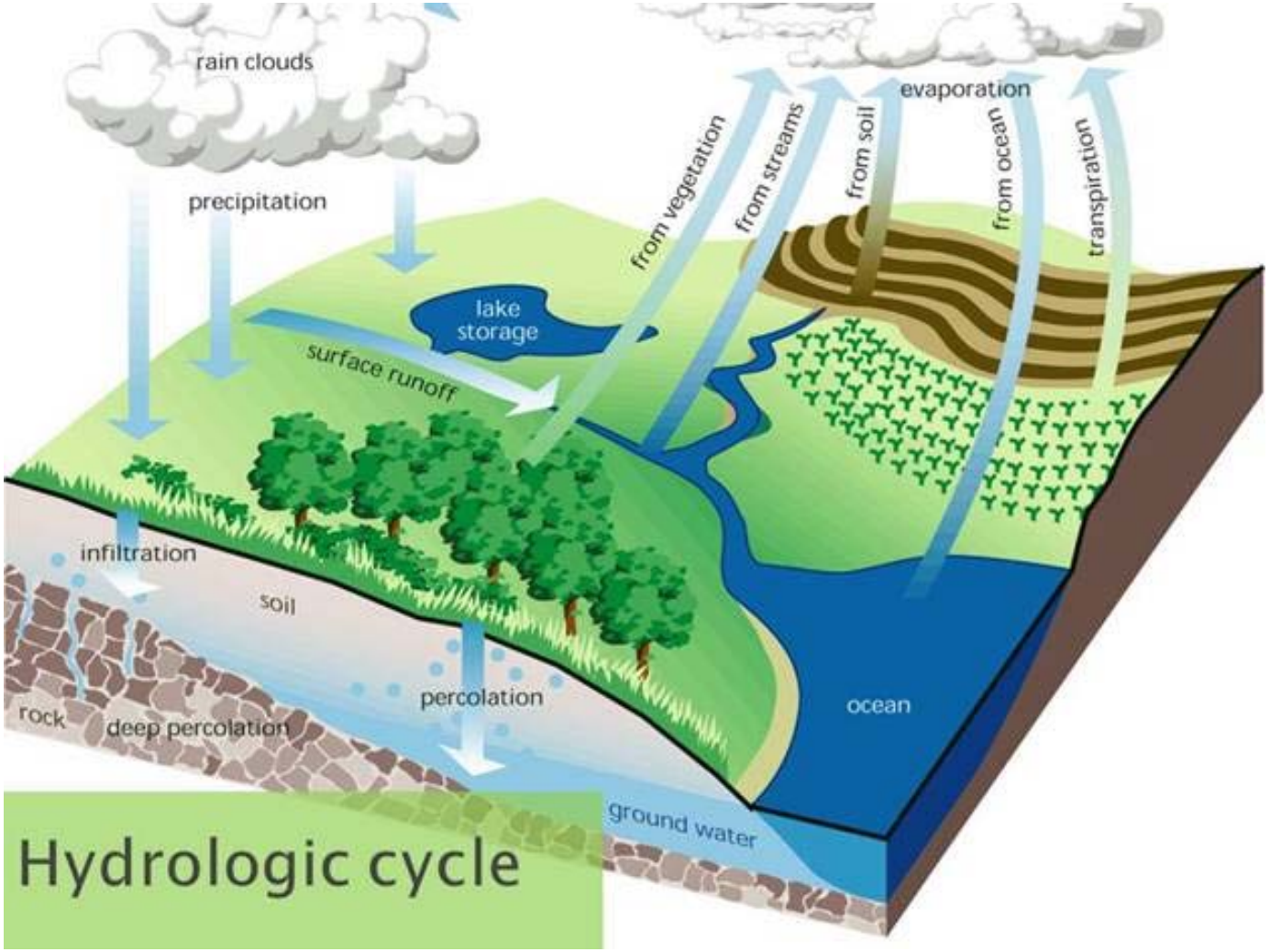
Porous Asphalt



Porous Pavement System

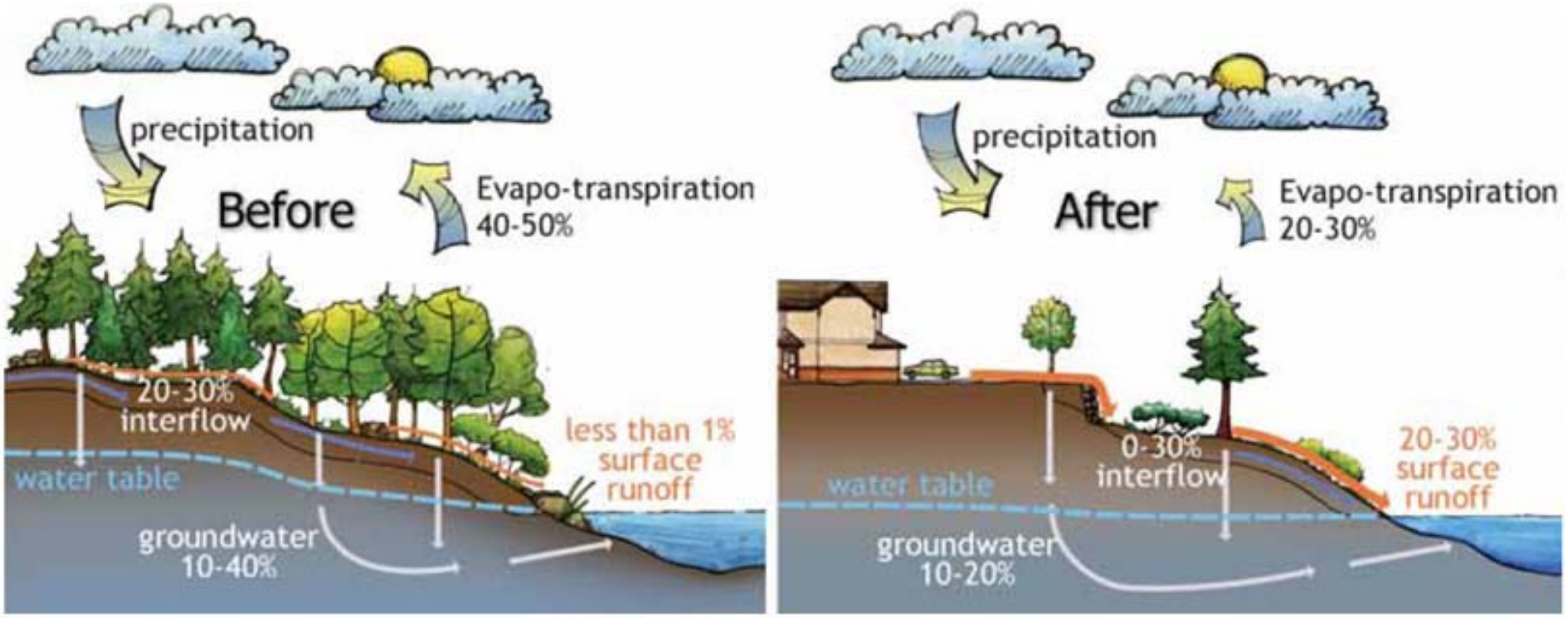


Hydrologic Cycle



Source: North Carolina State University

“Hardscape” Effects Hydrologic Cycle



Impact to Quantity of Runoff

Impact to Water Quality

Source: Puget Sound Partnership

Impact to Water Quality

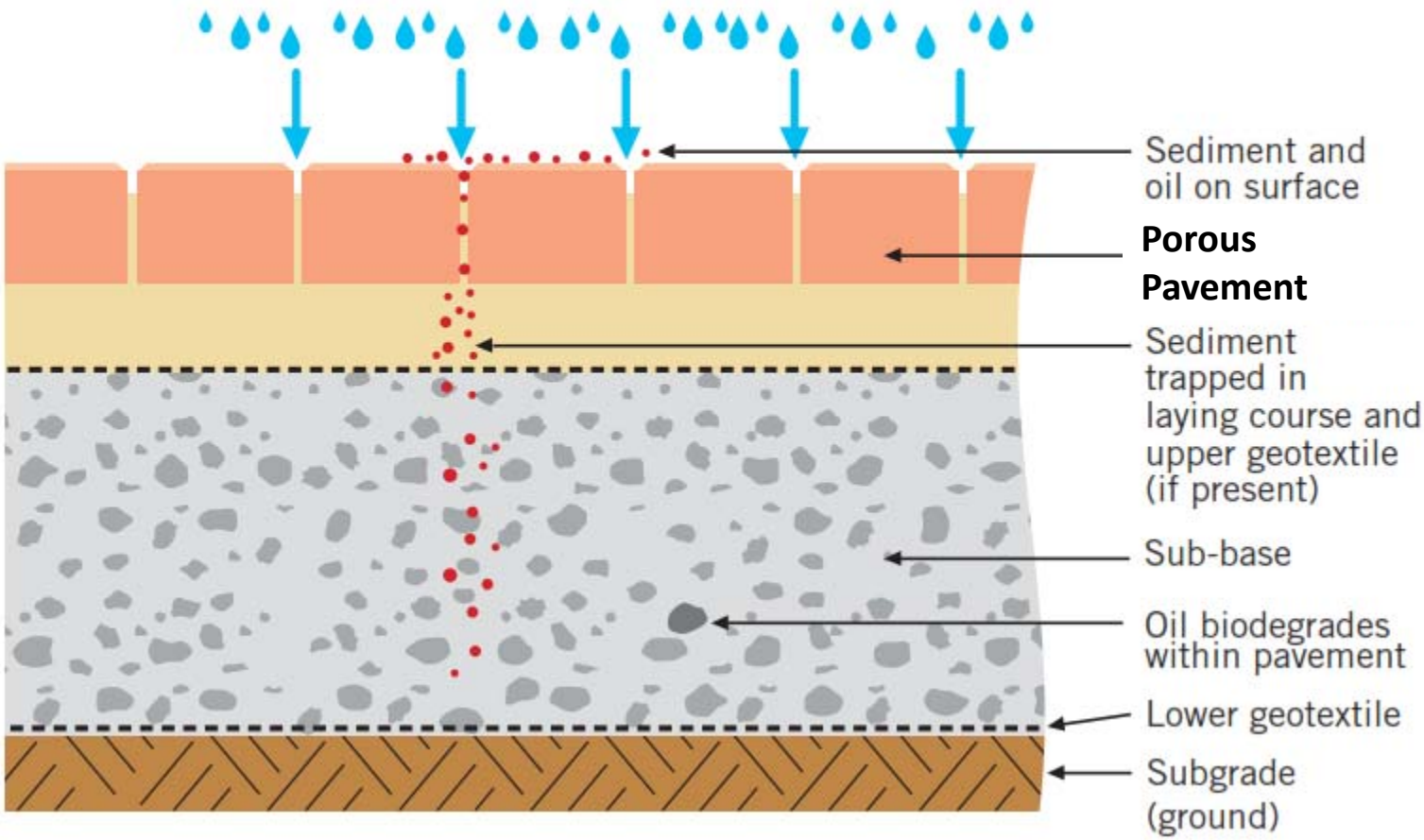
- Human Health
  - Pollutants
- Drinking Water
  - Aquifer Recharge
- Habitat
  - Scour
  - Sedimentation

Source: WA Dept of Ecology, College of William and Mary

Why Porous Pavements?

- **Reduce Quantity** of Runoff
- **Improve Quality** of Runoff

Water Quality Treatment Potential



Water Quality Treatment Potential

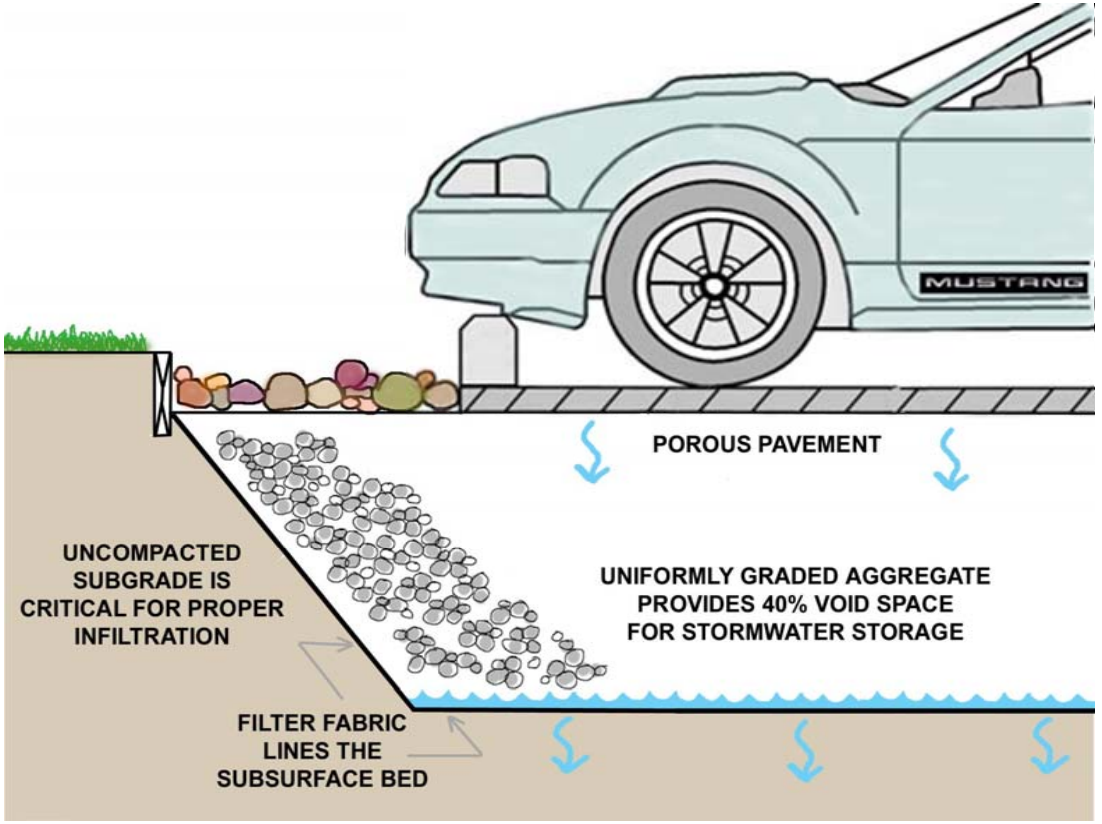
Percentage Removal of Pollutants	
Total suspended solids	60-95%
Hydrocarbons	70-90%
Total phosphorus	50-80%
Total nitrogen	65-80%
Heavy metals	60-95%
(source: CIRIA C609, 2004)	

Water Quality Treatment Potential	
Removal of total suspended solids	High
Removal of heavy metals	High
Removal of nutrients (phosphorus, nitrogen)	High
Removal of bacteria	High
Treatment of suspended sediments & dissolved pollutants	High
(source: CIRIA C697, 2007)	

Source: Interpave "Understanding Permeable Pavements"

Why Porous Pavements?

- Reduce impervious surface
- Recharge ground water
- Improve water quality
- Eliminate need for detention basins
- Provide useful purpose in addition to storm water management (parking lot, trail, street)




Design

Design Considerations

- Structural Design
  - Traffic
  - Subgrade
- Hydrologic Design
  - Percolation Rate
  - Recharge Bed

Traffic

- Porous Pavements are Suitable for
  - Automobiles/Light Trucks
  - Recreational Facilities
    - Bike Paths
    - Trails
    - Parking Lots
    - Driveways
- Not Recommended for Heavy Trucks

Subgrade

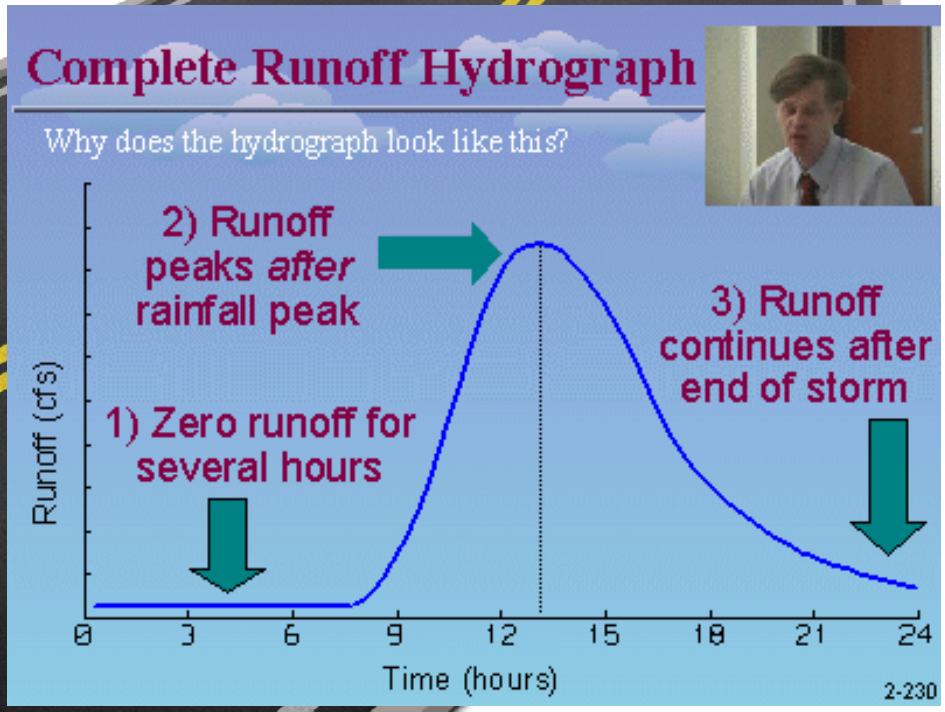
- Pervious Concrete
  - Resilient Modulus, M_R
- Permeable Pavers
  - CBR
- Porous Asphalt
  - CBR

Hydraulic Design—Subgrade

- Soil percolation rate
- EPA → 0.5”/hr !!
- Local → 0.1”/hr okay
- Depth to bedrock > 2’
- Depth to high water > 3’
- Fill – not recommended
- Frost

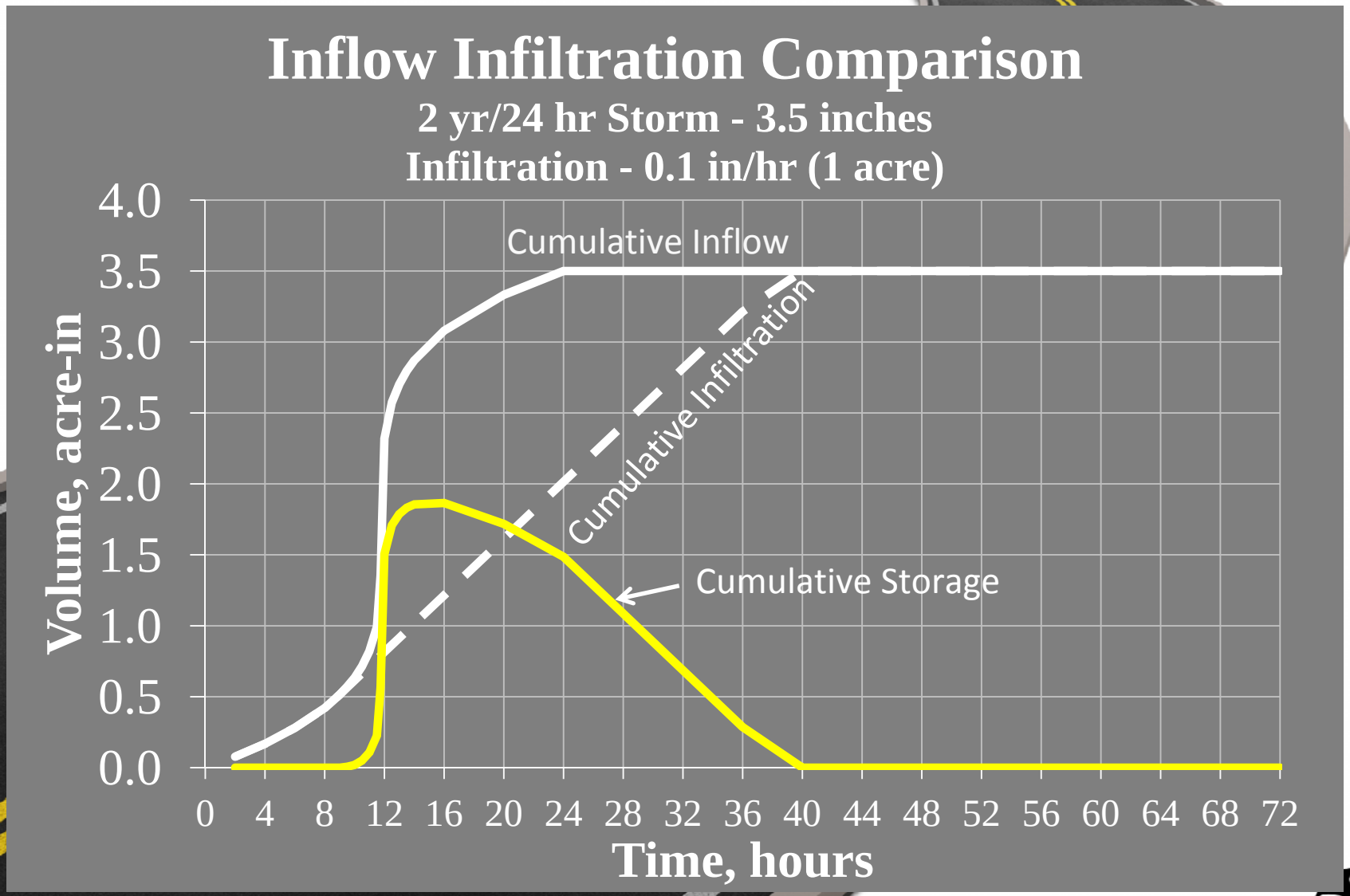
Hydraulic Design

- Storm Intensity
  - Typical designs for 2 year/24 hr storm
  - Conservatively design for 10 year/24 hr storm
- Meet Local & State wastewater mitigation requirements.



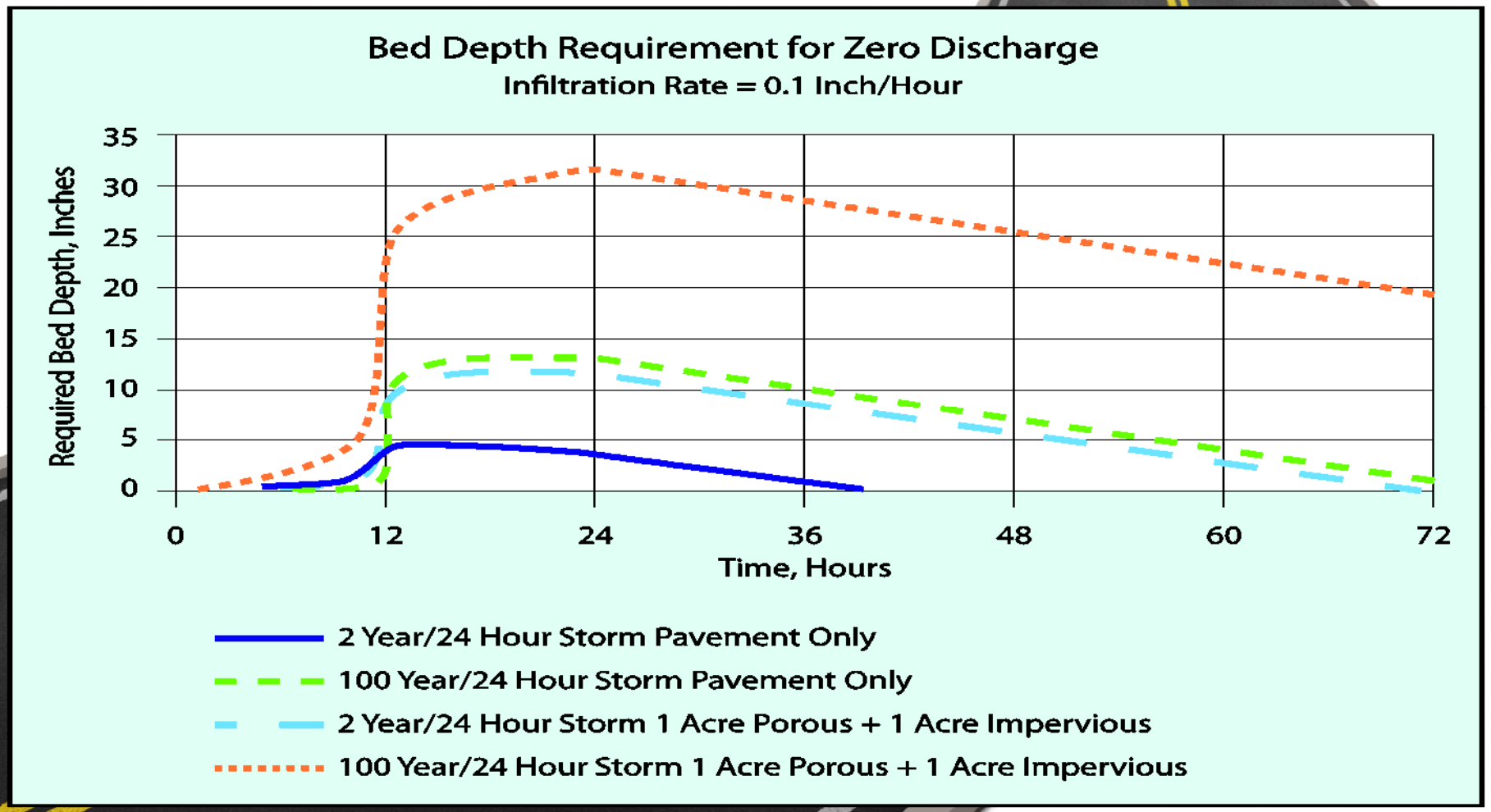
Source: Hydrocad

Hydraulic Design



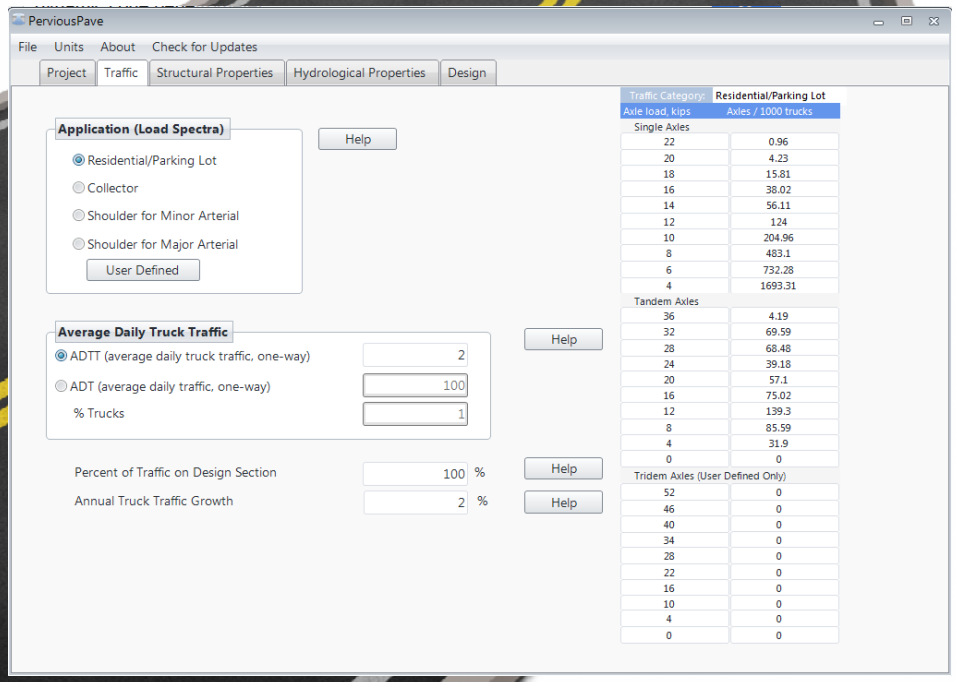
Source: http://www.wsi.nrcs.usda.gov/products/W2Q/H&H/docs/TRs_TPs/TP_149.pdf`

Hydraulic Design



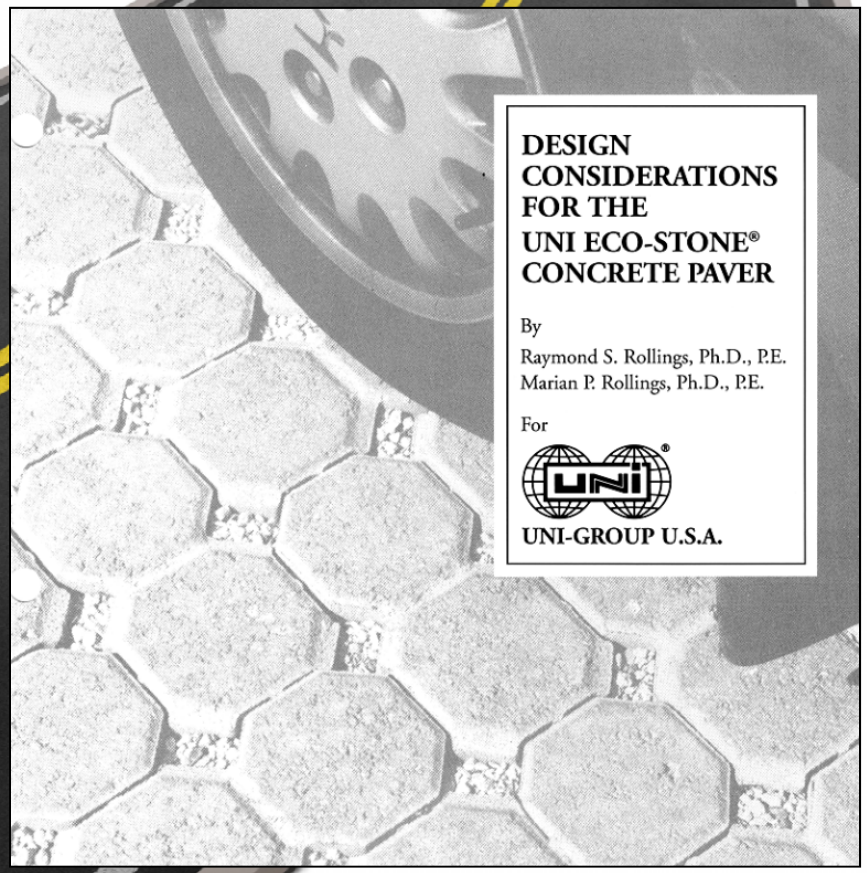
Structural Design Pervious Concrete

- ACPA **PerviousPave** Software
  - Design based on Fatigue Damage
- Traffic
- Subgrade
- Hydraulic Inputs
- Design PCC Thickness and Recharge Bed Requirements



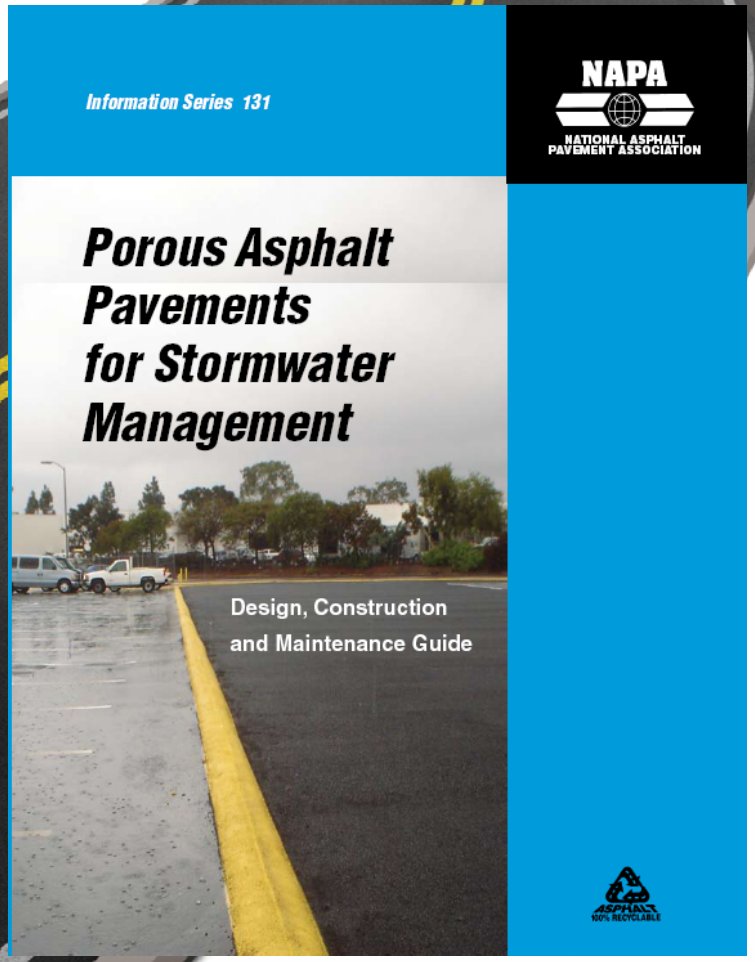
Structural Design Permeable Pavers

- Flexible Pavement Design
- CBR
- Traffic
- Use any method including AASHTO 93, AI SW-1, or PCASE
- Replace AC Layer with Paver Blocks Using Equivalency Factors



Structural Design Porous Asphalt

- Follow AASHTO Design Procedures
  - Layer coefficients
    - Open-Graded 0.40-0.42
    - Asphalt Treated Permeable Base 0.30-0.35
    - Stone bed 0.10-0.14
- Minimum Asphalt thickness
  - 2.5” Parking areas (little or no trucks)
  - 4.0” Residential type streets




Materials

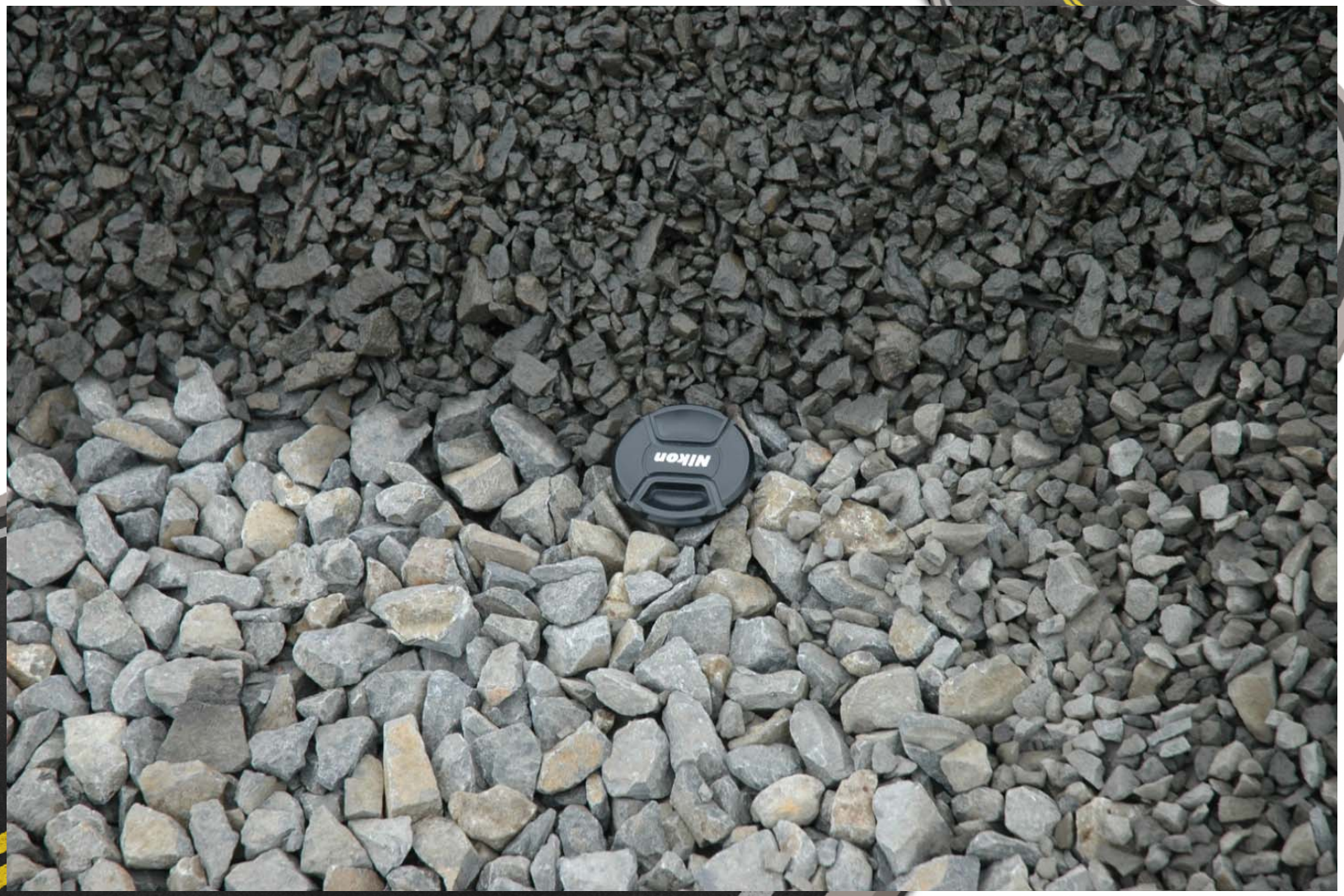
Geotextile

- Separation Layer
- Place on *uncompacted* subgrade

Recharge Bed Materials

Sieve	%Passing	
	Reservoir AASHTO No. 2	Choker AASHTO No. 57
3”	100	
2 ½”	90 – 100	
2”	35 - 70	
1 ½”	0 - 15	100
1”	-	95 – 100
3/4”	0 - 5	-
1/2”		25 – 60
No. 4		0 - 10
No. 8		0 - 5

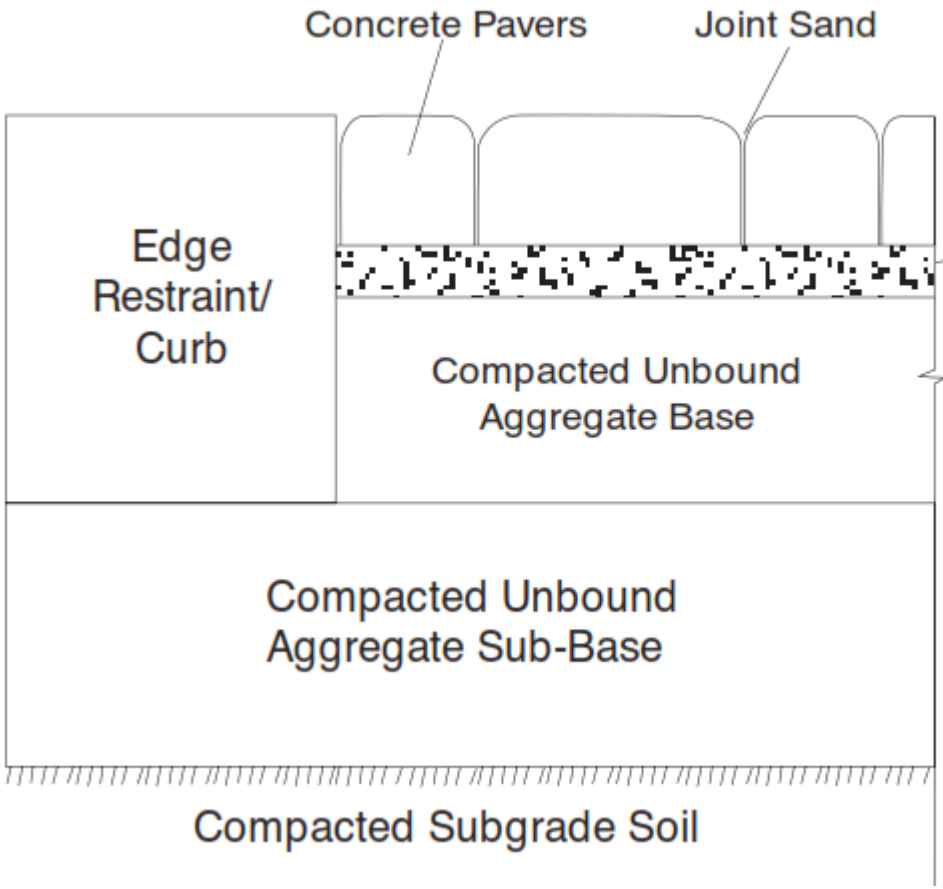
Choker/Reservoir Aggregates



Pervious Concrete

- Zero Slump mix
- Low w/c ratio (0.28 – 0.35)
- Open graded
- Standard Portland Cement
- No Reinforcing Steel
- Fibers okay

Permeable Pavers

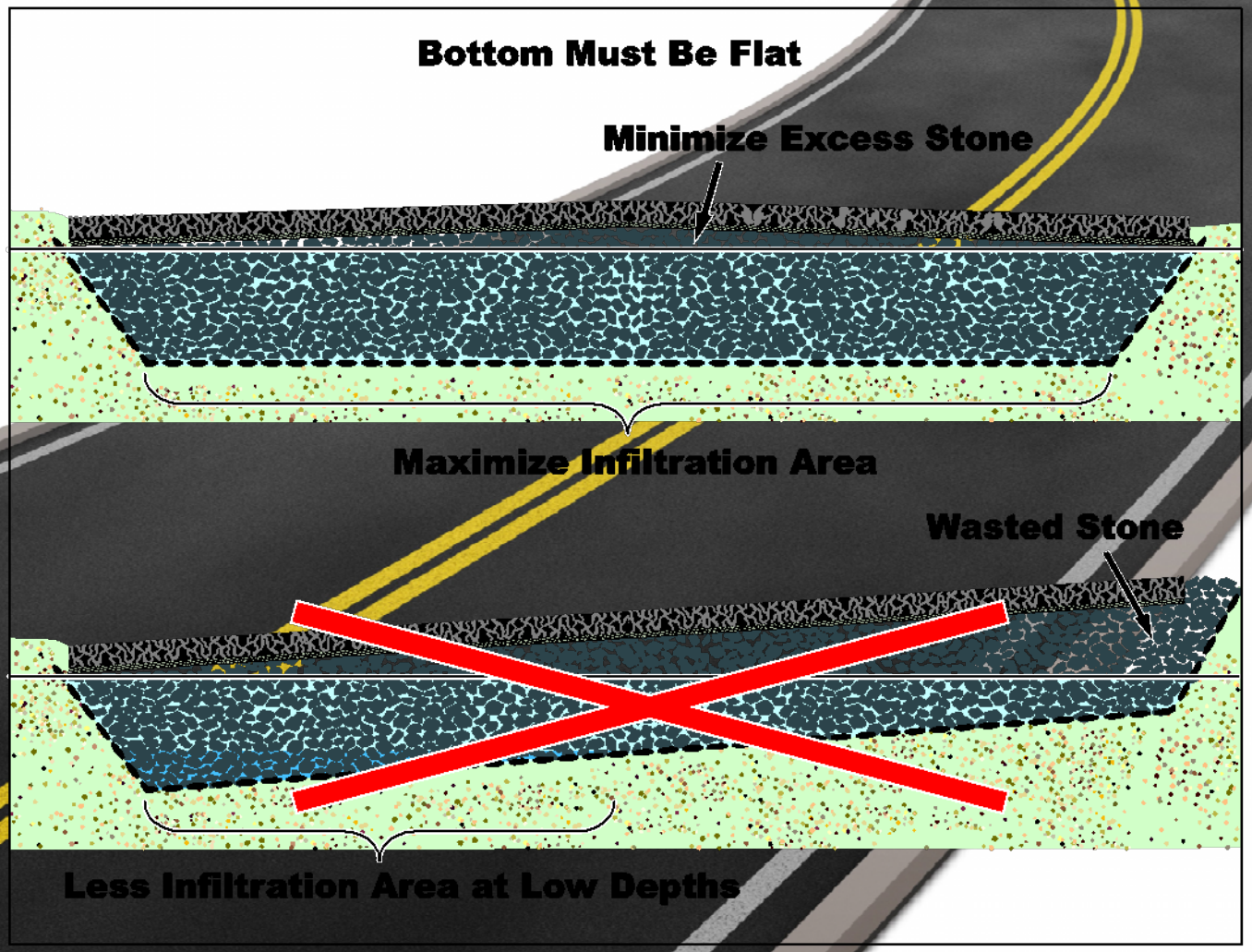


Porous Asphalt

- Open Graded Mix
- Polymer Modified Binder
  - PG 70-22 ER
  - PG 70-28 ER
- Fibers to control draindown
- Va > 16%

Construction Guidelines

Flat Bottom

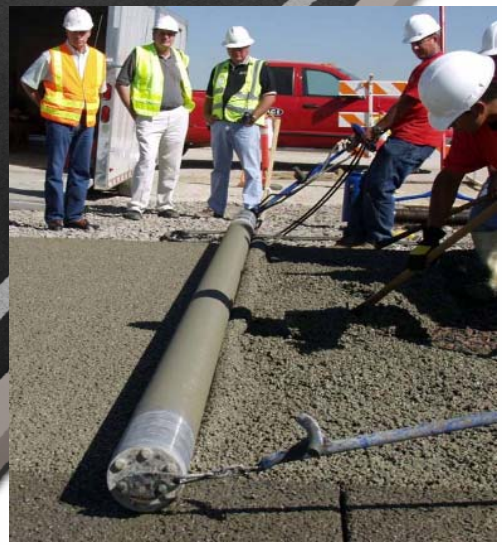

Bottom Must Be Flat
Minimize Excess Stone
Maximize Infiltration Area
Wasted Stone
Less Infiltration Area at Low Depths

Slopes

- Slope – limit surface slope to 5%
  - Terrace when necessary

Ref: Pennsylvania Stormwater Best Management Practices Manual

Pervious Concrete Construction

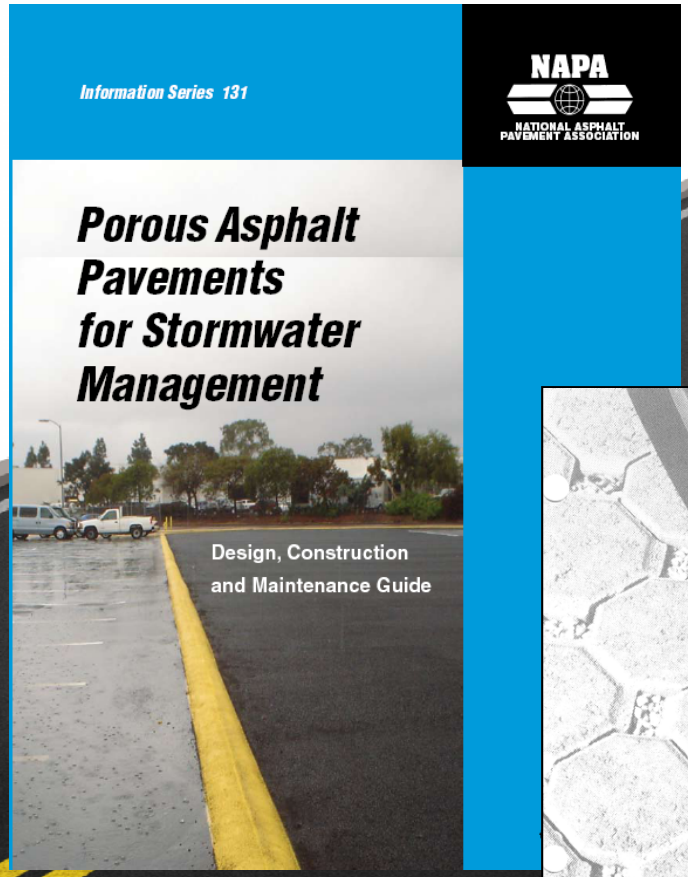


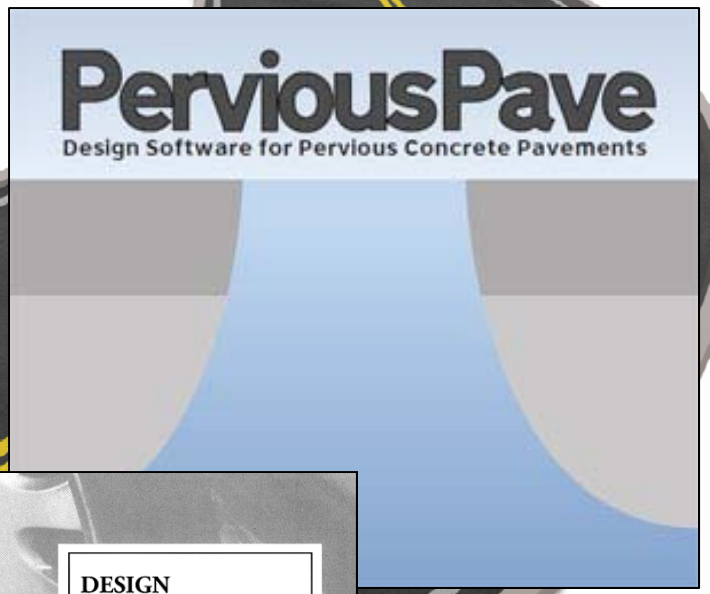
Porous Asphalt Construction

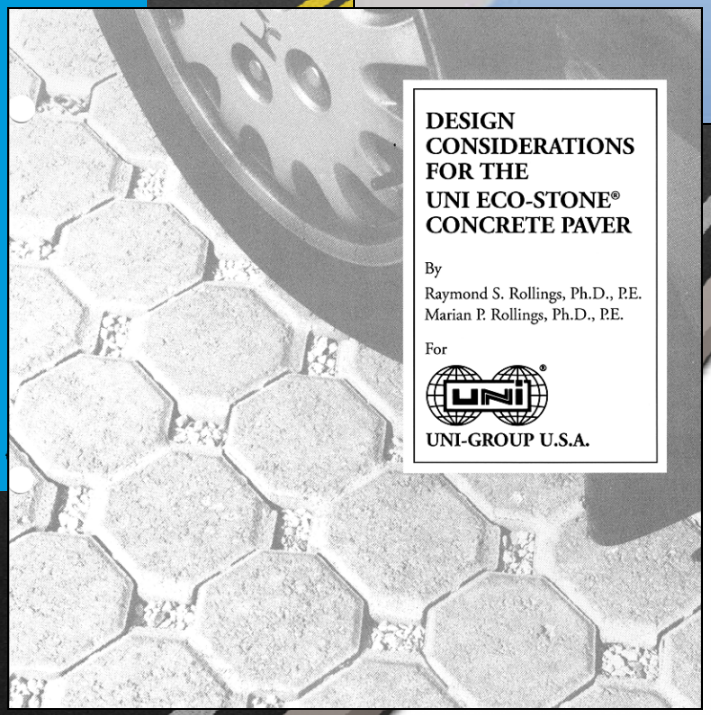
Maintenance/Snow Removal

- Inspect several times first few months during storm events.
- Inspect annually thereafter.
- Pavement surface should be vacuumed and may be flushed or jet washed annually.
- Use liquid de-icing compounds as needed
- Do *not* use sand, ash, or salt for snow or ice

Resources


Information Series 131
NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION
Porous Asphalt Pavements for Stormwater Management
Design, Construction and Maintenance Guide


PerviousPave
Design Software for Pervious Concrete Pavements


DESIGN CONSIDERATIONS FOR THE UNI ECO-STONE® CONCRETE PAVER
By
Raymond S. Rollings, Ph.D., P.E.
Marian P. Rollings, Ph.D., P.E.
For
UNI-GROUP U.S.A.


Thank You!
John Duval, P.E.
PAVEMENT SERVICES, INC.
john@psipdx.com