Pervious Pavement
An Infiltration BMP – A LID Technique

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Low Impact Development

LID Techniques

LID can be simple and effective. Instead of relying solely on complex and costly collection, conveyance, storage and treatment systems, LID employs a range of economical devices that control runoff at the source.

Representative List

♦ Bioretention (Rain Gardens, etc.)
♦ Cisterns/Rain Barrels
♦ Green Roofs
♦ Porous Pavements (Permeable Pavements)
♦ Grass Swales (plus other biofiltration devices)

Source – EPA
Low Impact Development

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Source – EPA
Porous Pavements

“A porous pavement is one with porosity and permeability high enough to allow water to readily pass and thus significantly influence hydrology, rooting habitat, and other positive environmental effects.”

(Per ASTM - formerly known as the American Society for Testing and Materials)
Porous Pavements

Pervious Concrete
Porous Pavements

- A permeable pavement surface
- Replaces Conventional/Traditional Pavement
- Substantial VOIDS in pavement allow stormwater to infiltrate directly into subsoil – usually through a retention layer first
- Underlying stone reservoir (retention layer) immediately beneath the pavement – in most cases (can vary by geography)
Porous Pavements

Basically the same function and uses as conventional pavements

+ ENVIRONMENTALLY RESPONSIBLE pavement designed to allow stormwater drainage to the sub-grade for:

- Filtration
- Groundwater Recharge
- Reduction in over-all Runoff
EPA Phase II Program


- The EPA's Ph II program requires 6 min. control measures:
  - Education and Outreach
  - Public Involvement
  - Illicit Discharge Detection & Elimination
  - Const. Site Stormwater Runoff Control
  - Pollution Prevention for Muny ops.
  - Post-Const. Stormwater Mgt. - New Devel. & Re-Development
    - 1 Acre or more
    - ON-SITE STORMWATER TREATMENT BEFORE DISCHARGE FROM SITE

- EPA offers a list of Best Management Practices (BMPs) to help owners within regulated areas to control runoff. The effective use of Porous Pavements are an approved BMP for compliance with Phase II Stormwater regs.
Pervious Concrete

Environmental Benefits

Because water is allowed to percolate into ground, nearby vegetation is watered & reduces irrigation needs, groundwater is recharged & stormwater run-off that remains is improved, yet reduced.
Primary Drivers
Porous Pavements

◆ Environmental Responsibility
  ❖ Green Building Movement – Market Forces/PR. – May include LEED$_{tm}$, etc.

◆ Stormwater Regs.
  ❖ US EPA NPDES Phase II, etc.

◆ Favorable Cost Factors
  ❖ Site Optimization Dynamics
Porous Pavements

PRIMARY TYPES
(most commonly used)

- Pervious Concrete
- Porous Asphalt
- Permeable Pavers
Cost Savings & Improved Site Optimization

Pervious Concrete
Completed – Winter, 2005

- 8 Acre Lot – 12 Acre Site – Westminster, MD
- $400,000 SAVINGS – **Underground Drainage Eliminated** - original plan
- 1-1/2 Acre Retention Pond **Eliminated** – original plan
  & space **reclaimed** for facility
Pervious Concrete Pavement

**General Description:**

- Structural pavement: 500-4000 psi
- Components:
  - Coarse aggregate
  - Portland cement
    - Supplemental mtrls.
      - Fly Ash / Slag
      - Fibers, Integral Color, etc.
  - Water
  - Admixtures
- Void content range of 15-30%
- Designed to allow stormwater drainage to the sub-grade for filtration, ground water recharge & reduction in over-all runoff
Low Impact Development – Pervious Concrete Directly Infiltrates Water Through The Pavement

The Pervious Concrete “System” is itself a Dry Detention Pond!

Its secondary use is as a pavement.
Pervious Concrete
New (?) Approach Being Adopted

Not so new!

- 1852 – UK housing
- 1923 – Scotland – 50 two-storey houses
- 1930-1942 – 900 homes in Scotland
- After WW2 – Throughout Europe
- 1960’s – Eastern Canada
- Worldwide – “no fines” concrete for various specialized purposes
- USA SE – More than 30 yrs.
Pervious Concrete
Most Versatile of Porous Mtls.

- Parking Areas
- Driveways
- Sidewalks
- Roadways
- Pedestrian Plazas
- Swales & Ditches
- Erosion Control
- Slope Protection
- Load-bearing Walls
- Etc.
Basic Design Considerations
Load & Hydrology
Pervious Concrete
Elimination of Runoff

Passes water at 3-5 gal. per min. per sq. ft.

or

270 – 450 in. per hour!
Porous Asphalt

A close up comparison shows the difference in void space between conventional and porous asphalt.

Porous Asphalt

Porous Asphalt

- 3-1/2” placement compacted to 2-1/2” Thickness (typically)
- 12-36” granular reservoir

Diagram – Courtesy: Cahill & Assocs.
Permeable Interlocking Concrete Pavers

Source: Interlocking Concrete Pavement Institute – www.icpi.org
Permeable Interlocking Concrete Pavers

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Conventional vs Pervious
Asphalt Pavement (Left) (Same Site) Pervious Concrete (Right)
Conventional Pavement – Asphalt (Background)

Pervious Concrete (Foreground) - Raining
Pervious Concrete (Foreground) – Heavy Rain
### Asphalt vs Concrete

#### Asphalt (Left)
- Coarse Rock
- Sand
- Dark Color
  - Petroleum based binder
  - Flexible Pavement
  - Lower Light Reflectivity
    - Heat Absorbing - Hotter
    - Night Lighting Increased
  - Service Life – Durability?
  - Environmental Impacts?

#### Concrete (Right)
- Coarse Rock
- Sand
- Light Color
  - Portland Cement based
  - Rigid Pavement
  - Higher Light Reflectivity
    - Heat Deflecting - Cooler
    - Night Lighting Decreased
  - Service Life – Durability?
  - Environmental Impacts?
Comparative Porous Pavements

Most Distinctive Positive Attributes
(Representative List)

♦ **Pervious Concrete** – Long-term durability, light reflectivity, many certified installers, ability to bear loads, maintains its porosity, versatility of applications

♦ **Permeable Pavers** – Great for smaller applications, many different patterns, much of product is pre-manufactured off-site, load bearing

♦ **Porous Asphalt** – Installer availability, consistent color (always black), speed of construction, similar appearance to conventional asphalt pavement
Extensive national survey of past projects by experts concludes: “The installations have not shown any signs of freeze-thaw damage.”

Portland Cement Pervious Concrete Pavement: Field Performance Investigation on Parking Lot and Roadway Pavements

Final Report

Norbert Delatte
Professor

Dan Miller
Aleksandar Mrzagic
Graduate Research Assistants

Department of Civil & Environmental Engineering
Fenn College of Engineering
Cleveland State University
Porous Pavements
Siting & Design Considerations

◊ Siting

- Soil Percolation Rate – ½” per hr. min. (Soils Reports!)
  - Supplemental Drainage MAY overcome
- Relative Flatness of Stone Reservoir
- 100 ft. from water wells intended for drinking water & 2-5 ft. above seasonal high water table if near very high contaminate sources (i.e. industrial sites)
- Low-Medium traffic areas – Parking Lots, Residential Rds., Pedestrian Areas, etc.

(Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=71)
Porous Pavements
Siting & Design Considerations
Porous Pavements - Many kinds of uses!
Cost Savings / Site Optimization
Pervious Concrete
Park & Ride Parking Lot (4 acres)
Pervious Concrete Parking Lot - 2 ½ Acres

K-8 School – Meridian (Boise), Idaho
Frequent Commercial Apps.
Branch Bank - Bank of America
Prime Outlets – Williamsburg, VA

- 7.6 acres Pervious Concrete
- 3.5 acres Conventional Concrete
20 year old retention pond behind the mall
Pervious Concrete Over Former Detention Pond
Prime Outlets – Williamsburg, VA

- Infiltration system design includes water harvesting
- utilizing underground stormwater chambers
Pervious Concrete Parking Stalls
Conventional Concrete Drive Lanes
Residential City Streets
Composite Design – Portland, Oregon
Pervious Concrete – Portland, Oregon
Architectural Pervious Concrete
Univ. of Calif. - Berkeley
Along Mississippi River – Minneapolis Metro
Architectural Pervious Concrete
Progressive Concrete Works - Phoenix
China – S. of Shanghai (3 mil.+ sq. ft.)
Quil Ceda Creek Casino
Tulalip Tribe

Marysville, WA (N. of metro. Seattle)

Parking Lot Expansion – 200,000 sq ft (4.6 acres)

Tulalip’s heritage deeply rooted in fishing
  - Good stewards of Land and Water
  - Concerned about potential impacts of pollutants and water temp. increase on fish and habitat
  - Concerned about petroleum based pavement materials – (the most commonly used conventional product)
  - Needed to expand their existing parking lot
Stormwater Environmental Perspective
Conventional Stormwater Mgt.

*Impervious* parking lots (conventional pavements), roads, and roof tops cause more stormwater runoff & *thermal pollution* greatly affecting fish and aquatics habitat plus vegetation – ALL bodies of water.
Quil Ceda Creek Casino
Tulalip Tribe
Pervious Concrete
Filters Water in Excess of 270 Inches of Rain Per Hr.

Quil Ceda Creek Casino – Marysville, WA
Porous Pavements

Online Resources

- www.epa.gov
- www.perviouspavement.org
- www.icpi.org
- www.hotmix.org
- www.concretethinker.com
- www.usgbc.org
Porous Pavements

Q & A

Dan Huffman
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Pervious Concrete
Porous Pavements

Thank You

And other friends attending!

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