Outline and Learning Objectives

• Why use permeable pavement?
• Understand the basic components of the three most popular permeable pavement systems:

  Porous Asphalt

  Pervious Concrete

  Permeable Interlocking Pavers

• Understand available system information sources
• Review construction sequencing for each pavement
• Review maintenance requirements
Why Permeable Pavement?

• Part of BMP mix, supports LID
• Conserves space: a functional pavement and a stormwater management facility
• 100% runoff reduction for high frequency storms, can help meet Ecology’s flow control requirement.
Why Permeable Pavement? (cont.)

• Reduce retention/detention, drainage fees

• Together with subgrade soil, permeable pavement systems can help filter and reduce pollution from stormwater.

• Increase groundwater recharge
Determining Subgrade Soil Infiltration

- Soil maps and soil classification systems (NRCS, USCS)
- Conduct on-site infiltration tests
- Use lowest (conservative) values for preliminary design.
Subgrade Infiltration

- Use site tests for accurate information
- Frequency and location based on geotechnical requirements (consult engineer)
Handling sloped sites

Depending on the slope of the project, use check dams to allow runoff to infiltrate into sub-soil.
Porous Asphalt

- Defined as full depth porous material – all materials in the road section are permeable.
- Historically used as porous friction course (PFC) overlay to reduce highway spray and minimizes traffic noise.
- Limited use on local residential projects, more typical on municipal streets.
Arizona SR-87

Slide courtesy Mark Palmer, City of Puyallup
Typical Porous Asphalt Cross-Section

Slide courtesy Mark Palmer, City of Puyallup
Materials and Specifications

• HMA (hot mix asphalt) complies with NAPA specifications for porous applications (polymer additive, 6%-9% asphalt cement binder). Use fibers and anti-stripping agents in binder to reduce drain-down potential.

• Aggregate for wearing course is typically 1/4” to 3/8”, though larger gradations have been used successfully.

• Choker course gradation depends on reservoir course gradation but is typically 3/4” to 1”. Some projects are eliminating (or minimizing) the choker course.

• Reservoir aggregate is 1” to 2” gradation (WSDOT Section 9-03.9(2) permeable ballast).

• All aggregates are durable, crushed and clean with no rounded rock (90-100% fractured face)
Base and Sub-base Aggregates

- Choker course – well-graded, crushed aggregates (no fines).
- Reservoir course – Larger crushed aggregates (no fines).
Industry publication

- National Asphalt Pavement Association (NAPA)
- Order number: IS-131

www.asphaltpaving.org
Porous Asphalt Construction Sequence

Slide courtesy Mark Palmer, City of Puyallup
Porous Asphalt Construction Sequence

Slide courtesy Mark Palmer, City of Puyallup
Examples of Porous Asphalt Installations
Pervious Concrete

• ‘No fines’ concrete creates void structure that allowing for quick drainage of water.

• Rigid pavement structure (different from asphalt or pavers which are flexible pavement systems)

Photo from www.perviouspavement.org
Typical Pervious Concrete Cross-Section

from Stormwater Management Academy, UCF (2007)
Materials and Specifications

• Rigid pavement typically requires less base aggregate than other systems for structure.
• Contractor certification and educational programs help promote proper installations.
• Differences from standard concrete:
  – stiff mix so no slump or strength testing
  – cannot be pumped
  – compact in place with vibratory roller
  – cover with plastic while curing
Industry Resources

• National Ready Mixed Concrete Association
  www.perviouspavement.org

• Puget Sound Concrete Specification Council
  www.theconcretecouncil.org

• Portland Cement Association
  www.cement.org
  “Pervious Concrete Pavements,”
  product code EB302
Pervious Concrete Construction Sequence

from www.perviouspavement.org
Examples of Pervious Concrete Projects
Examples of Pervious Concrete Projects
Examples of Pervious Concrete Projects
Permeable Interlocking Concrete Pavements ("PICP")

• Unlike other systems, the paving stones that comprise the wearing surface of the pavement are not permeable.
• Permeability is achieved through openings in the pavers or the joint spaces between the blocks.
• Structurally, PICP is a flexible pavement (like asphalt).
PICP Cross-Section

• Permeable paver wearing course
• No. 8 aggregate joint fill
• No. 8 aggregate bedding
• No. 57 ‘choke’ course
• No. 2 reservoir course or ‘permeable ballast’
• Geotextile (if required)
Types of PICP
Infiltration Rates --Surface, Joints & Bedding

• Infiltration rate of stone in openings: 300 to 1200+ in./hr
• Open surface area: varies with paver design/pattern, typically from 8% to 18%

Initial surface infiltration calculation:
1,000 in/hr x 12% open area = 120 in/hr
Industry publication

- Interlocking Concrete Pavement Institute (ICPI)
  www.icpi.org
Construction

No. 57

No. 2
PICP Installation

• During excavation, do not compact native soil
• Compacted soil is 30% to 90% less permeable than un-compacted soil
Keep delivery trucks off of native soil
Spreading Base Material
Final grading of base material
Compacting base material
Screeding No. 8 stone over No. 57 base
Mechanical placement
Mechanical Installation

Mechanical installation of PICP can decrease construction time 20-80% over manual installation

**Manual paver installation:**

1,000 – 2,000 sq. ft. per man per day

**Mechanical paver installation:**

3,000 – 10,000 sq. ft. per machine per day
Edge pavers cut and placed, then compacted.
Compact before sweeping in aggregate
Filling the openings with No. 8 stone, final compaction
Excess stones removed, then final compaction
Keep sediment away from the permeable pavement
Partial Exfiltration Design Option

- When subgrade infiltration rates are low (less than 0.25 in/hr), consider ‘partial exfiltration’ design
- Uses perforated pipe ‘under-drains to route excess water to outfall

Note: Full flow control credit is not allowed when underdrain systems are utilized.
Design Details

Overflow drain

Drain to grass swale
Maintenance

Annually: overall system performance inspection, check observation well, inspect after major storm, vacuum surface (once, twice, or more) to ensure optimum design life performance

Maintenance checklist (specific to each project)
Model maintenance agreement
Monitor adjacent uses
## Inspection Checklist

<table>
<thead>
<tr>
<th>Task</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Vacuum surface</td>
<td>1 to 2 times annually, adjust for sediment loading</td>
</tr>
<tr>
<td>Replenish aggregate in PICP joints</td>
<td>As needed</td>
</tr>
<tr>
<td>Inspect vegetation surrounding pavement perimeter for cover &amp; stability</td>
<td>Annually, repair/replant as needed</td>
</tr>
<tr>
<td>Check drain outfalls for free flow of water</td>
<td>Annually and/or after a major storm event</td>
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</tbody>
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A new O & M document is available from Ecology...

Maintenance

**Sweeper Effectiveness**

- **Best:** Vacuum sweeper (no water)
- **OK:** Regenerative air (broom) sweeper (no water)

Vacuum essential as brush bristles clean ~ ¼ in. into surface.
Restoration Maintenance
Other products available

Grid pavement systems using concrete or other materials
Thank You!

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