Porous Pavement as a Stormwater Management Tool on Urban Streets

Nick Hutchinson, P.E. - City of Ann Arbor, MI
Agenda

- Benefits
- Sylvan Avenue
- Willard Street
- Maintenance
- Analysis
- Alternatives
Benefits of Permeable Pavement

- Improve storm water management
- Reduced downstream impacts
- Improved storm water quality
- Winter Conditions
- Noise
Agenda

- Benefits
- Sylvan Avenue
- Willard Street
- Maintenance
- Analysis
- Alternatives
Sylvan Ave - Background

Sylvan Ave Issues...

- Flat road
- Narrow road
- Narrow ROW
- Ponding
Sylvan Ave - Design

- Initial soil borings
- Deeper soil borings
- To infiltrate or not to infiltrate?

<table>
<thead>
<tr>
<th>Sample No./Type</th>
<th>Recovery (in)</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-1</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>SS-2</td>
<td>18</td>
<td>2</td>
</tr>
</tbody>
</table>

**Description of Material**

Ground Surface Elevation =

- Note 1: 2.0" Bituminous Concrete Pavement
- Note 2: 6.0" SILTY FINE TO COARSE SAND AND GRAVEL FILL - moist - brown - (SM-GM Fill)

- SILTY FINE TO MEDIUM SAND FILL - trace clay and gravel - loose - moist - brown - (SM)
SYLVAN AVENUE CROSS SECTION
1. Filter Layer
   - Free draining sand
   - 6” Underdrain
   - Impermeable liner

2. Reservoir
   - 100 yr design storm
   - 18-24” thickness (35-40% voids)
   - Open graded stone
3. Pavement section & details

- Permeable HMA
  - 3” thick
  - 50 gyratory mix design
  - 75-85% density; 15-25% porosity
  - AC 5.0-6.5%
  - Polymer Binder

- Standard curb & gutter vs. spill-out
3. Pavement section & details
   - Permeable HMA
     - 3” thick
     - 50 gyratory mix design
     - 75-85% density; 15-25% porosity
     - AC 5.0-6.5%
     - Polymer Binder
   - Standard curb & gutter vs. spill-out
Sylvan Ave - Construction

- Subgrade prep
Sylvan Ave - Construction

- Membrane & underdrains
Sylvan Ave - Construction

- Aggregate
Sylvan Ave - Construction

- Curb & gutter and sidewalk
Sylvan Ave - Construction
Sylvan Ave - Construction

- Permeability Test ("bucket test")
Agenda

- Benefits
- Sylvan Avenue
- Willard Street
- Maintenance
- Analysis
- Alternatives
Willard St. - Background

1. Different Challenges
   - Soils
   - Cross Slope
   - Traffic Volumes

2. Different Opportunities
   - Full Infiltration
   - Spill-Out Curbs
Willard St. - Design

1. Stone Reservoir
   - Used different aggregate
   - Minimum 30% voids
   - Grid, but no liner

2. HMA mix
   - 4” thickness
CONSTRUCTION CENTERLINE

10.5’

10’ TO 10.5’

20.5’ 0+80 TO 3+29
21’ 3+90 TO POE

PERMEABLE HMA (4”)

VARIES
0.9 TO 4.5%

BIAXIAL OR TRIAXIAL GEOGRID

EXISTING SUBGRADE (UNCOMPACTED)

4.5’

3’

SPILL-OUT CURB

STONE RESERVOIR
(MDOT 4G)
PER SPECIFICATION

INфиTRATION TRENCH:
MDOT 2NS SAND
Willard St. - Construction

06/23/2012
Agenda

- Benefits
- Sylvan Avenue
- Willard Street
- Maintenance
- Analysis
- Alternatives
Maintenance - General

**Vacuum Road** - twice per year (Fall and Spring)

**Clogged Areas** - Power wash (<200 psi) with detergent, and vacuumed.
Maintenance - General

Exposed Ground - Seed and mulch

Stock Piling Materials - Not permitted

Surface Sealing or Resurfacing - Not permitted

Patching (< 50 square feet) - Standard patch

Patching (> 50 square feet) - Permeable pavement
Maintenance - Winter

**Plowing** - Plow every 2”+ storm with a slightly raised blade

**Salt** - Minimal salt permitted

**Sand** - Not permitted
Agenda

- Background
- Design
- Construction
- Maintenance
- Analysis
- Alternatives
Performance Analysis

- Evaluating Permeability over time
- Custom designed device

- Two years of data now in hand
## Performance Analysis

<table>
<thead>
<tr>
<th>Street</th>
<th>Infiltration 2013</th>
<th>Infiltration 2014 before sweeping</th>
<th>Infiltration 2014 after sweeping</th>
<th>in/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylvan (2010)</td>
<td>0.25</td>
<td>1.00</td>
<td>0.42</td>
<td>in/min</td>
</tr>
<tr>
<td>Wells Alley (2011)</td>
<td>7.27</td>
<td>0.87</td>
<td>0.88</td>
<td>in/min</td>
</tr>
<tr>
<td>Willard (2012)</td>
<td>6.13</td>
<td>0.27</td>
<td>0.30</td>
<td>in/min</td>
</tr>
<tr>
<td>Fuller Lot</td>
<td>24.40</td>
<td>22.41</td>
<td></td>
<td>in/min</td>
</tr>
</tbody>
</table>
Agenda

- Background
- Design
- Construction
- Maintenance
- Analysis
- Alternatives
Alternatives

- Infiltration without permeable pavement?
  - Conventional HMA surface
  - Open graded stone reservoir
  - Storm inlets to connect
- Forest & Fourth Ave in 2013
Alternatives

- Infiltration without permeable pavement?
- Conventional HMA surface
- Open graded stone reservoir
- Storm inlets to connect Forest & Fourth Ave in 2013
Questions?

Nick Hutchinson, P.E.
City of Ann Arbor
nhutchinson@a2gov.org
734-794-6000 x43633