Bioretention and Permeable Pavement Maintenance

Fouad H. Jaber, PhD, PE
Associate Professor and Extension Specialist
Biological and Agricultural Engineering
Texas A&M AgriLife Extension
Dallas Research and Extension Center
Trees are a form of LID.
Chicago Alleys Project
Anatomy of a Green Street

Pedestrian friendly
1000 cf soil volume for street tree tree boxes

Landscape areas

Permeable sidewalks

Transit oriented

Shielded, Energy efficient street fixtures

Recycled materials used

Mature Street Trees

Compost amended soils

Permeable pavement in parking lane

Bike Rack

Bioretention

Interpretative signs

Permeable pavement in transitway

Bike Lane
Bioretention is Low Maintenance…

…but not *NO* maintenance
Most common cause of bioretention failure…..

BIORETENTION IS NOT A SEDIMENT BASIN!!!
I. Slow Distributed Inflow
Internal Erosion from poor water delivery
Curb cut
Rip rap
Gravel verges and grass filter strips = Treatment train
Bioretention Forebays
II. Clogging
Clogging Causes

- Berm erosion into mulch and media
- Unstable catchment
- Unmaintained forebay
- Media mix is wrong!
Asphalt Generates Sediment
Clogging

- Media chosen for **specific porosity**
- Fines occupy pore space in media
- Reduces infiltration rate significantly (goal = 1 in/hr rainfall event)
- Useful lifespan of bioretention found to be limited by clogging (Li and Davis, 2008)
Key Maintenance Test

- Visit site within 24 hours of 1 inch rain event (avg 11-12 /yr)
- If water is still ponded site has clogged
- Action needed
- Do this once or twice per year
Unclogging

- Excavate top 5-20 cm
- Replace with clean media
- May need deeper if severe failure occurs
- Can be expensive $$$

[Location needed]
Remove mulch, move plants, dig out clogged soil
III. Trash Removal

- Unsightly, poor aesthetics
- Safe harbor for mosquitos
- Can clog drawdown
- Takes up volume in forebay

Fort Bragg, NC
IV. Overflow Structure Maintenance

- Urban areas, overflow structure *can* be matter of **public safety**
- Certain outlets more apt to clog than others
- Private firms specialize in outlet maintenance on SCMs
Clogged outlet
V. Underdrain Maintenance?

- Surprisingly uncommon
- Clogging potential: filter fabric vs choking stone
- Cleanouts make it easy

Fill Soil Media:
- 85 – 88% Washed Sand
- 8 – 12% Fines (Silt + Clay)
- 3 – 5% Organic Matter

<table>
<thead>
<tr>
<th>Material</th>
<th>Depth</th>
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</thead>
<tbody>
<tr>
<td>Washed Sand</td>
<td>2 to 4 inches</td>
</tr>
<tr>
<td>Choking Stone (typically #8 or #89 washed)</td>
<td>2 inches</td>
</tr>
<tr>
<td>Washed #57 stone or similar, and underdrain pipe.</td>
<td>6 to 8 inches</td>
</tr>
</tbody>
</table>

In-situ soil

4” Dia. Corrugated Perforated HDPE Pipe

Washed 57 Stone Envelope

2” ASTM No. 8 Stone
Underdrain Cleanouts

Bad

Better
VI. Plant Selection

- Plant palette has grown as BR soils have improved
- Natives are good
- Avoid invasives and ‘spreaders’
Plant Density

Keep it open!
Maintenance Trigger: Plant replacement

• Replace dead plants ASAP with more tolerant plants or plant new plants on higher ground in the bioretention bed
Vegetation Maintenance

Fort Bragg, NC
Vegetation Maintenance

- **Irrigate**
  - 2 to 3 days for first few months
- Once established, should sustain themselves
- Vegetation selection is key here
- Droughts

![U.S. Drought Monitor](image)

<table>
<thead>
<tr>
<th>Drought Conditions (Percent Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
</tr>
<tr>
<td>Last Week (09/16/2013 map)</td>
</tr>
<tr>
<td>3 Months Ago (03/20/2012 map)</td>
</tr>
<tr>
<td>Start of Collateral Year (09/16/2013 map)</td>
</tr>
<tr>
<td>Start of Current Year (09/15/2012 map)</td>
</tr>
<tr>
<td>One Year Ago (09/15/2011 map)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>4.29</td>
<td>55.71</td>
<td>63.78</td>
<td>65.65</td>
<td>64.79</td>
</tr>
<tr>
<td>Last Week</td>
<td>3.04</td>
<td>66.02</td>
<td>67.00</td>
<td>65.39</td>
<td>35.03</td>
</tr>
<tr>
<td>3 Months Ago</td>
<td>17.80</td>
<td>63.80</td>
<td>68.38</td>
<td>31.79</td>
<td>18.88</td>
</tr>
<tr>
<td>Start of Collateral Year</td>
<td>3.04</td>
<td>66.02</td>
<td>67.00</td>
<td>65.39</td>
<td>35.03</td>
</tr>
<tr>
<td>Start of Current Year</td>
<td>9.13</td>
<td>60.07</td>
<td>78.73</td>
<td>57.41</td>
<td>24.61</td>
</tr>
<tr>
<td>One Year Ago</td>
<td>0.01</td>
<td>69.89</td>
<td>67.63</td>
<td>64.61</td>
<td>67.32</td>
</tr>
</tbody>
</table>

**Intensity:**
- D0: Abnormally Dry
- D1: Drought - Moderate
- D2: Drought - Severe
- D3: Drought - Extreme
- D4: Drought - Exceptional
- D5: Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, January 10, 2013
David Simmeral, Western Regional Climate Center
Importantly…

**Think** *clean water, not lush*

[Image of a person working in a yard]
Vegetation Maintenance

1 to 2 times/yr
VII. Mulching: Benefits

- Prevents weeds from sprouting
- Adds organic matter, active zone for microorganisms
- Conserves moisture during dry periods
- Cools soil
- Attractive
Mulching

- Use double or triple-shredded hardwood
- Renew if needed due to oxidation or discoloration
- Do not over-mulch and fill water storage pool with mulch
- "Hot Spots"
## Bioretention Maintenance Task Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Frequency</th>
<th>Maintenance Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRUNING</strong></td>
<td>1 – 2 times/yr</td>
<td>Nutrients in runoff often cause bioretention vegetation to flourish</td>
</tr>
<tr>
<td><strong>MOWING</strong></td>
<td>2 – 12 times/yr</td>
<td>Frequency depends upon location and desired aesthetic appeal</td>
</tr>
<tr>
<td><strong>MULCH REMOVAL</strong></td>
<td>Once every 2 – 3yrs</td>
<td>Mulch accumulation reduces available water storage volume. Removal of mulch also increases infil. rate</td>
</tr>
<tr>
<td><strong>WATERING</strong></td>
<td>Once every 2 -3 days for first few months. Seldom after establishment</td>
<td>During droughts, watering after initial year may be needed</td>
</tr>
<tr>
<td><strong>FERTILIZATION</strong></td>
<td>Once initially</td>
<td></td>
</tr>
<tr>
<td><strong>REMOVE AND REPLACE DEAD PLANTS</strong></td>
<td>Once per year</td>
<td>&gt;10% of plants may die, survival rates increase over time</td>
</tr>
<tr>
<td><strong>MISCELLANEOUS</strong></td>
<td>Monthly</td>
<td>Trash collection, spot weeding, removing mulch from overflow</td>
</tr>
</tbody>
</table>
Permeable Pavement Design Steps

- 1. Siting and feasibility
- 2. Pavement course
- 3. Discuss PP with owner
- 4. Layout site drainage system
- 5. In-situ soil testing
- 6. Infiltration vs. detention system
- 7. Subgrade grading design
- 8. Depth of aggregate base
- 9. Safe conveyance of 10-yr storm
- 10. Observation wells
- 11. Membranes
- 12. Edge restraints
Step 1: Siting and Feasibility

- Constraints with:
  - Seasonal high water table
  - Site slope
  - Buffers and setbacks
  - Stormwater hotspots
  - Redevelopment sites
  - Proximity to water supply wells
Stormwater hotspots

Vehicle maintenance/fueling areas
Public works yards
Trucking & distribution centers
“Heavy” industries
Airport maintenance areas
Railroads and bulk shipping
Solid waste facilities
Wastewater treatment plants
Scrap yards
Structural Calculations

- 2 main functions
  - Support Expected Weight of Vehicles (Structural)
  - Store & Infiltrate a design volume of water (Hydrologic)
Factor 2: Design Precip Depth

- 90% Rainfall Volume?
  - ~1 inch

- Pre-Development Infiltration Volume
  - 0.33-1 inch

- Moderate ARI storm (e.g., 2-, 10-yr)

- Infrequent ARI storm (25-, 50- yr)
If not maintained, “permeable” pavement can become Impervious
Permeable Pavement Maintenance:
Clean the Catchment - Street Sweeper
Permeable Pavement - Clean the Catchment: Blowing
Permeable Pavement Maintenance: Sweeper/Vacuum Truck

- Different Types of Sweepers for Different Types of Permeable Pavements:
- Mechanical Sweeper vs. Regenerative Air Sweeper vs. Vacuum Sweeper
Permeable pavement weed control

- Systemic herbicides like Roundup - Preferred
- Flame weed killers – LP gas fueled – Be careful. Could ignite Concrete!
Grassed Permeable Pavement
You might have to mow it!
## Permeable Pavement Maintenance Tasks and Schedule

<table>
<thead>
<tr>
<th>TASK</th>
<th>SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect Lot for Clogging</td>
<td>Semi-annual to Quarterly</td>
</tr>
<tr>
<td>Street sweeping and vacuuming</td>
<td>Per inspection results</td>
</tr>
<tr>
<td>Gravel replacement</td>
<td>Post-Vacuuming</td>
</tr>
<tr>
<td>Oil and grease cleaning</td>
<td>As needed per clientele</td>
</tr>
<tr>
<td>Avoidance of landscape debris (grass clippings, leaves)</td>
<td>Each landscape maintenance</td>
</tr>
<tr>
<td>Spray/Flame Weeds and Moss with Herbicides</td>
<td>Monthly during growing season</td>
</tr>
<tr>
<td>Adjoining land and watershed stabilization</td>
<td>Keep watch</td>
</tr>
</tbody>
</table>
Questions?