Stormwater BMPs for Water Quality and Quantity: Making Sure Green is Green

Brandywine Conservancy
Environmental Management Center
Comprehensive Stormwater Management (LID)

- Water Quality
- Peak Rate
- Volume and Hydrology
- Temperature

“...everything is connected to everything else...”
In the midst of....

- PADEP Changing MS4 Requirements
- PADEP Changing Chapter 102
- Possible PADEP Changing the BMP Manual
- EPA New Stormwater Requirements
- EPA New Requirements for Chesapeake Bay

...what’s a municipality to do?
Some Basics:

Penn’s Woods...Land and Water
Two Sides of the Same Coin
Imbalancing Natural Systems....
Some Impacts of Conventional (Unsustainable) Development

- Not just Increased Flooding!
- Increased Runoff Volume
- Decreased Evapotranspiration and Groundwater Recharge
- Increased Frequency of Runoff Events
- Faster Conveyance of Water
- Erosion and Stream Channel Changes
- Decreased Baseflow
- Impacted Aquatic Life
- Pollutants and Temperature Impacts
We all live downstream....
We haven’t understood the basic hydrology of stream and river systems.
Green Valleys Association
Cahill Associates
Environmental Consultants
Land Development Impacts on Stream Morphology:

- Major changes to bankfull flow
- Channel widening, downcutting/undercutting, streambed scouring
- Stream bank erosion
- Imbedded substrate with benthic/other aquatic impacts
- Loss of pools, riffles, aquatic habitat
Manage Stormwater as a Valuable Resource... not a Disposal Problem.

Volume Control Is Critical....

to Minimize Downstream Flooding
to Support Stream Baseflow/Low Flow
to Support Wells and Springs
to Support Wetlands
to Minimize Nonpoint Pollutant Loadings
to Minimize Stream Morphological Impacts
A Word on Vegetation....
IT’S GOING TO BE A HOUSING DEVELOPMENT CALLED AUDUBON WOODS.
Trees as the only **Best** MP...
Impacting Essential Living Soil:

Microscopic View of Soil

- Macropore
- Mesopore
- Capillary Fringe

Water Table

Clay Skins
## Common Bulk Density Measurements

<table>
<thead>
<tr>
<th>Undisturbed Lands</th>
<th>Residential Neighborhoods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forests &amp; Woodlands</td>
<td>1.69 to 1.97 g/cc</td>
</tr>
<tr>
<td>1.03 g/cc</td>
<td>1.69 to 1.97 g/cc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Golf Courses; Parks; Athletic Fields</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.69 to 1.97 g/cc</td>
<td>2.2 g/cc</td>
</tr>
</tbody>
</table>

*David B. Friedman, District Director Ocean County Soil Conservation District*
Solutions:
Best Management Practices
Sustainable Stormwater Management (aka LID or Green Infrastructure):

Non-Structural Approaches
  Preventive

Structural Practices
  Mitigative
## Preventive Non-Structural BMP Categories (LID)

### Protect Sensitive and Special Value Resources from Watershed to Site
- **BMP** Protect sensitive/special value features
- **BMP** Protect/conserve/enhance riparian areas
- **BMP** Protect/conserve natural flow pathways

### Cluster and Concentrate
- **BMP** Cluster uses at each site; build on smallest area possible
- **BMP** Concentrate uses areawide through Smart Growth

### Minimize Disturbance and Minimize Maintenance
- **BMP** Minimize total disturbed area – grading
- **BMP** Minimize soil compaction in disturbed areas
- **BMP** Re-vegetate and re-forest disturbed areas (natives)

### Reduce Impervious Cover
- **BMP** Reduce street imperviousness
- **BMP** Reduce parking imperviousness

### Disconnect/Distribute/Decentralize
- **BMP** Rooftop disconnection
- **BMP** Disconnection from storm sewers
Preventive Non-Structural BMP Categories with Specific BMPs:

*Concentrate and Cluster*

**BMP** Concentrate uses areawide through Smart Growth practices

**BMP** Cluster uses at each site; build on the smallest area possible
Preventive Non-Structural BMP Categories with Specific BMPs:

Protect Sensitive and Special Value Resources

Watershed to Site

BMP Protect sensitive/special value features

BMP Protect/conserve/enhance utilize riparian areas

BMP Protect/utilize natural flow pathways in overall stormwater planning and design
Functions Provided by the 3-Zone Buffer System

- Wildlife habitat
- Flood reduction
- Sediment removal
- Nitrogen removal
- Bank stability
- Shade/food web
Figure 4.5
Use sensitive areas such as natural drainage areas to form boundaries or buffer zones between clusters of housing.
Preventive Non-Structural BMP Categories with Specific BMPs:

Minimize Disturbance/Minimize Maintenance

BMP Minimize total disturbed area – grading

BMP Minimize soil compaction in disturbed areas

BMP Re-vegetate and re-forest disturbed areas, using native species
Minimize soil compaction...
Preventive Non-Structural BMP Categories with Specific BMPs:

*Reduce Impervious Cover*
- BMP  Reduce street imperviousness
- BMP  Reduce parking imperviousness
**Figure 35: Comparison of Headwater Street Widths**

- **10 Foot Pavement Width**
  - (a) Lane
- **20-22 Foot Pavement Width**
  - (b) Access
- **22-26 Foot Pavement Width**
  - (c) STD Headwater Street

Legend:
- **Moving Lane**
- **Parking Lane**
- **Shared Lane**
- **Right-of-Way**
<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Residential Street Pavement Width</th>
<th>Maximum Daily Traffic (trips/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of New Jersey</td>
<td>20 ft. (no parking)</td>
<td>0-3,500</td>
</tr>
<tr>
<td></td>
<td>28 ft. (parking on one side)</td>
<td>0-3,500</td>
</tr>
<tr>
<td>State of Delaware</td>
<td>12 ft. (alley)</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>21 ft. (parking on one side)</td>
<td>---</td>
</tr>
<tr>
<td>Howard County, Maryland</td>
<td>24 ft. (parking not regulated)</td>
<td>1,000</td>
</tr>
<tr>
<td>Charles County, Maryland</td>
<td>24 ft. (parking not regulated)</td>
<td>---</td>
</tr>
<tr>
<td>Morgantown, West Virginia</td>
<td>22 ft. (parking on one side)</td>
<td>---</td>
</tr>
<tr>
<td>Boulder, Colorado</td>
<td>20 ft.</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>20 ft. (no parking)</td>
<td>350-1,000</td>
</tr>
<tr>
<td></td>
<td>22 ft. (parking on one side)</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>26 ft. (parking on both sides)</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>26 ft. (parking on one side)</td>
<td>500-1,000</td>
</tr>
<tr>
<td>Bucks County, Pennsylvania</td>
<td>12 ft (alley)</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>16-18 ft. (no parking)</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>20-22 ft. (no parking)</td>
<td>200-1,000</td>
</tr>
<tr>
<td></td>
<td>26 ft. (parking on one side)</td>
<td>200</td>
</tr>
<tr>
<td></td>
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<td>200-1,000</td>
</tr>
</tbody>
</table>

(Cohen, 1997; Bucks County Planning Commission, 1980; Center for Watershed Protection, 1998)
Figure 41: Five Turnaround Options at the End of a Residential Street
Figure 4.4
Examples of Directly Connected Impervious Areas

Directly Connected Impervious Area Maximized

Directly Connected Impervious Area Minimized
Preventive Non-Structural BMP Categories with Specific BMPs:

Maximize preventive source controls
- BMP Trash/debris collection
- BMP Street sweeping, spills
- BMP Fertilization regulations
- Others
Mitigative Structural Best Management Practices

Runoff Volume/Infiltration-Oriented
Vegetative and Soil-Based
1. Rain/recharge gardens/Bioretention
2. Vegetated filter strips
3. Vegetated Swales (Bio-infiltration, Dry, Wet)
4. Porous pavement with infiltration beds
5. Infiltration basins
6. Subsurface infiltration beds
7. Infiltration trenches
8. French drains/dry wells
9. Outlet control (level spreaders, etc.)
10. Retentive grading techniques, berms

Runoff Volume/Non-Infiltration-Oriented
11. Vegetated roofs
12. Cisterns/Rain Barrels/Capture Reuse

Runoff Quality/Non-Infiltration
13. Constructed wetlands
14. Wet ponds/retention basins
15. Filters
16. Water quality inserts
17. Detention/Extended Detention
18. Special Storage: Parking Lot, Rooftop, etc.

Restoration BMPs
19. Riparian Corridor Restoration
20. Revegetation/Reforestation
21. Soils Amendment
Porous Pavement
DuPont Barley Mills Office Complex
Infiltration Beneath Standard Walkways
Rain Gardens / Bioretention

Rainwater can support the landscape and soils, reducing pipes and basins.
Vegetated Infiltration Beds

Distributing Water to Prevent Sinkhole and Flooding Problems

INfiltration Bed

- Inlet
- Overflow Outlet
- Stone Bed with Geotextile underneath
- Perforated Pipe
- Uncompacted Bed Bottom
- Sediment Trap
...27 years of infiltrating over limestone!

Infiltration Basin – Commerce Plaza 1983
Infiltration Trenches
• **Reduced Disturbance**
Infiltration Berms

- Simple construction along contour
- Capture runoff behind shallow berm
- Allow runoff to infiltrate
- Very little disturbance
Vegetated Swale

**CROSS-SECTION**

- Min. 6" Freeboard
- Average Water Surface Level (12")
- 2'-6' Permeable Soil (Min. 30")
- 12'-24" Clean Washed Uniformly Graded Aggregate (AASHTO #3)
- Maximum Water Surface Elevation (18" - Designed for 10-year storm)
- Side Slopes 2:1 (Or Flatter)
- Dense Vegetation
- Optional Subsurface Infiltration Trench
- Uncompacted Subgrade
- Wrap Trench with Non-woven Geotextile

**PROFILE**

- Average Water Surface Level (12")
- Maximum Water Surface Elevation (18" - Designed for 10-year storm)
- Dense Low-Growing Vegetative Cover
- Permeable Soil (Min. 30")
- 12'-24" Clean Washed Uniformly Graded Aggregate (AASHTO #3)
- 8" Diam. Perf. HDPE (4" From Bottom)
- Uncompacted Subgrade
- Level Infiltration Trench Bottom
ERROR: stackunderflow

OFFENDING COMMAND: ~

ERROR: stackoverflow

STACK:

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