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Comparison of BMP Maintenance Cost, Labor Demands, and System Performance

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The Maintenance Myth

Low Cost, No Maintenance BMP
Imagine the Ultimate System...

Low Cost and NO Maintenance Ever!

100% Removal Guaranteed

eliminating everything in its path since 1776
LID in 2006
LID in Now
Who has primary responsibility for maintenance?

- local governments or public agencies?
- States and the Federal Governments?
- Private property owners and associations?
Who is responsible for maintenance of post-construction stormwater facilities? (# of responses = 94)

- Do not have a regular inspection maintenance program: 50%
- Local government responsibility: 10%
- HOA responsibility: 4%
- Private land owner: 13%
- Hybrid: 18%
- Other: 5%
What is Maintenance

- Often Maintenance only occurs when there is failure
- There is a perception that LID systems require more maintenance
- Some claim LID systems fail and will require expensive repairs
- Our current practices have a high degree of failure and significant cost impacts—however we are familiar with it
Tools of the trade...
Tools of the trade...
A tale of two raingardens
Maintenance solved?
Stormwater Systems Studied

Conventional Systems

- Detention Basin
- Retention Pond
- Stone Swale
- Veg Swale

Low Impact Development Systems

- Porous Asphalt
- Gravel Wetland
- Sand Filter
- Bioretention Unit (3)
Maintenance Complexity is defined as:

<table>
<thead>
<tr>
<th>Minimal</th>
<th>Simple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater Professional or Consultant is seldom needed</td>
<td>Stormwater Professional or Consultant is occasionally needed</td>
</tr>
<tr>
<td>Moderate</td>
<td>Complicated</td>
</tr>
<tr>
<td>Stormwater Professional or Consultant is needed half the time</td>
<td>Stormwater Professional or Consultant is always needed</td>
</tr>
</tbody>
</table>
Adapted from Reese, A.J., Presler, H.H., 2005

Reactive
Episodic maintenance, cheap in short term, expensive in the long term

Periodic/Predictive
Science basis, schedulable activities, more cost effective

Proactive
Cost effective, preventative operations

Adapted from Reese, A.J., Presler, H.H., 2005
Reactive Maintenance

- Crack sealing
- Filling pot holes
- Resetting curbs
- Culvert reinforcement/replacement/renewal
- Pipe lining/repair
- Outlet repair
- Redesign for erosive blowouts
- Massive vegetation removal
- Clogged outlet structures
- Structural repairs or rehabilitation
Periodic/Predictive Maintenance

- Solids or debris removal
- Routine inspection
- Mowing
- Planed vegetation removal

Proactive Maintenance

- Street cleaning and vacuuming
- Snow removal
- Erosion and sediment control
- Reseeding
Economics of Installation vs Maintenance Costs, normalized by area

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Vegetated Swale</th>
<th>Wet Pond</th>
<th>Dry Pond</th>
<th>Sand Filter</th>
<th>Gravel Wetland</th>
<th>Bioretention</th>
<th>Porous Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost ($)</td>
<td>12,000</td>
<td>13,500</td>
<td>13,500</td>
<td>12,500</td>
<td>22,500</td>
<td>21,550</td>
<td>21,800</td>
</tr>
<tr>
<td>Inflated 2012 Capital Cost</td>
<td>14,600</td>
<td>16,500</td>
<td>16,500</td>
<td>15,200</td>
<td>27,400</td>
<td>25,600</td>
<td>26,600</td>
</tr>
<tr>
<td>Maintenance and Capital Cost</td>
<td>17.8</td>
<td>5.4</td>
<td>6.9</td>
<td>5.4</td>
<td>12.8</td>
<td>13.5</td>
<td>24.6</td>
</tr>
<tr>
<td>Personnel (hr/yr)</td>
<td>9.5</td>
<td>28.0</td>
<td>24.0</td>
<td>28.5</td>
<td>21.7</td>
<td>20.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Personnel ($/yr)</td>
<td>823</td>
<td>3,060</td>
<td>2,380</td>
<td>2,808</td>
<td>2,138</td>
<td>1,890</td>
<td>380</td>
</tr>
<tr>
<td>Subcontractor Cost ($/yr)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>700</td>
</tr>
<tr>
<td>Total Operational Cost ($/yr)</td>
<td>823</td>
<td>3,060</td>
<td>2,380</td>
<td>2,808</td>
<td>2,138</td>
<td>1,890</td>
<td>1,080</td>
</tr>
<tr>
<td>Operation/Capital Cost (%)</td>
<td>6%</td>
<td>19%</td>
<td>14%</td>
<td>18%</td>
<td>8%</td>
<td>8%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Conclusions

- All advanced stormwater systems need maintenance
- LID maintenance is often simple, low cost consistent with standard landscaping practices
- Estimations based on % of capital costs not reliable
- Consider requiring permanent sureties
- Fine filter media systems may have reduced service life due to clogging—easily serviced—sand filters and bioretention
- Every site and system is different
- The more system maintenance can be standardized the lower the anticipated maintenance costs.
The Unexpected
Questions?
Result of Maintenance

Infiltration Rate

Pre-maintenance: 0.39 in/hr
Post-maintenance: 28.9 in/hr
Bioretention Parking Lot Retrofit, Durham, NH
<table>
<thead>
<tr>
<th>Maintenance Activity</th>
<th>Minimum Frequency</th>
<th>Estimated Time Commitment</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2 times per year</td>
<td>30 minutes taking time to fill out checklist in UNHSC document¹</td>
<td>1</td>
</tr>
<tr>
<td>Clean Pretreatment Trash Screens and Pick Up Trash in system</td>
<td>1 time per month on average</td>
<td>30-60 minutes per visit</td>
<td>1</td>
</tr>
<tr>
<td>Spring Cleaning</td>
<td>1 time per year</td>
<td>4 hours</td>
<td>2</td>
</tr>
</tbody>
</table>

Total personnel hours per year: 16-21 hours
Estimated $1,500 – $2,000 (30,000 sf of IC Treated)
<table>
<thead>
<tr>
<th>Pollutant (per year)</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>179 lbs.</td>
</tr>
<tr>
<td>Cigarette Butts</td>
<td>4,392</td>
</tr>
<tr>
<td>Misc. Trash</td>
<td>752</td>
</tr>
</tbody>
</table>