Green Infrastructure Maintenance from the Ground Up: Key Strategies and Case Studies

Susan Beck, PE
Philadelphia
Susan.beck@Jacobs.com
Green Infrastructure Maintenance Framework

• Why is GI Maintenance Important?
• Barriers to Success
• 3 Elements of a Successful Maintenance Program:
  • Commitment / Funding
  • Planning / Design Strategies
  • Procedures and Training
Why is Maintenance Important?

• Ensure long term performance of Green Stormwater Infrastructure
• Protect capital investments
• Meet regulatory requirements, public and private GI
• Public health issues
• Public/community perception
Barriers to Effective GI Maintenance

• Lack of funding for operations and maintenance
  • Specialized equipment
  • Maintenance staffing requirements

• No training in specialized needs of green infrastructure

• Need for consistent inspection & maintenance procedures and enforcement policies

• Poor public awareness
Commitment to GI Maintenance

• Need institutional commitment for long-term success
  • Regulatory requirements
  • Adopt policies and enforcement (or education) procedures
• Establish responsible agency (staff) and provide adequate funding
• SW fees and credits can provide incentives and reinforce maintenance requirements
  • Offer financing or rebate for installation and maintenance of GI on residential or commercial property
Typical GI O&M Cost Considerations

• Establish a business case - consider the incremental costs of maintaining GI compared to conventional infrastructure or landscape maintenance

• Economies of Scale – the ability to keep maintenance crews busy full time are more efficient

• Size, design complexity, location, public visibility, system age, etc. – maintenance costs can vary dramatically!

• Very little reliable cost data available!
Paying for GI Maintenance

• Stormwater Utilities to Fund O&M
  • Provide a stable revenue source
  • Equitable approach that bases fees on impact
  • Incentivize private investment through credit programs that reduce fees

• Alternative Financing Strategies
  • Public-private partnerships
  • In Lancaster, PA, private recipients of (partial) funding for GI projects must agree to 40 years of O&M
Funding Maintenance for a Large-Scale GI Program: Onondaga County, Syracuse, NY

- O&M funding through combination of strategies
- Integration of GI O&M into existing infrastructure maintenance regime and CMMS tracking system
- Utilization of large-scale O&M contracts (permeable pavements, landscaping, etc.)
- Community partnerships to provide low-cost O&M and provide entry-level jobs and training
- Establishment of incentive program to offset costs through private implementation (10-year maintenance agreement)

Over 170 projects built so far
Remove over 100 MG of stormwater from combined sewers per year
Effective Maintenance Starts with Design

• **Consider maintenance requirements** when selecting types *and locations* of GI technologies for project

• Be aware of **site constraints** that make maintenance difficult and avoid locating GI in these areas (e.g. steep slopes)

• Design adequate **pre-treatment** that ensures long-term functionality

• Design GI techniques for **ease of inspection** and maintenance; include cleanouts and observation ports, as appropriate (ensure structures are accessible)

• Select the **appropriate plants** for the application (e.g. salt tolerant, drought tolerant, suited to the hydrologic zone of the system, etc.)

• **Design for minimal maintenance** where limited resources are available or when located on private property
Effective Maintenance Starts with Design

• Establish design process: when will new BMPs or new materials be confirmed?
Standard Maintenance Procedures

• Some overlap with existing maintenance activities
• Vary based on primary system function, visibility, size, drainage area size, land cover/use, season, etc.
• Highly visible systems and structures require more
• Inspections required to meet regulatory requirements (e.g. MS4)
• GI Systems are dynamic... consider adaptive management
Enforcement and Inspection Procedures

• Establish **Inspection Procedures and Schedules**

• Develop or Require **Inspection Certification and Training Programs**

• Evaluate Opportunities for **Volunteer Inspection Programs**

• Adapt Enforcement Procedures for Green Infrastructure Practices

• **SW Fees and Credits** can provide Incentive and Reinforcement of Maintenance Requirements
City of Lancaster GI Program: Measuring Success through O&M

- Full-time staff to support implementation (design & construction), monitoring & maintenance
- O&M Manual
- Integrate Asset Management with CMMS
- Trained parks staff to serve as dedicated bioretention maintenance crew
- Field inspection & performance testing informs future design & construction
  - During construction and post-construction
Bioretention Swale

Description
Similar to vegetated curbs, bioretention curbs are vegetated shallow depressions that temporarily hold stormwater and filter the water through plants and soil before infiltration or release to the downstream storm drain. Bioretention swales may include a thin layer of amended native soil or engineered soil mix intended to provide contaminant removal, stormwater attenuation, and support plant health. Vegetation may consist of grasses, or native wetland plants, shrubs, and trees. Bioretention swales may be distributed throughout a site or roadway and are predictably integrated into the landscape.

Function
Bioretention swales provide both pollutant removal and runoff control and may provide runoff volume reduction through evapotranspiration or infiltration if native subsurface soils allow infiltration.

Key Performance Indicator

<table>
<thead>
<tr>
<th>Key Performance Indicator</th>
<th>Standard</th>
<th>Maintenance Trigger</th>
<th>Required Action</th>
<th>Maintenance Frequency</th>
<th>Recommended Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter</td>
<td>Minimal litter</td>
<td>Visible litter</td>
<td>Remove litter</td>
<td>Annually, particularly after heavy runoff at the end of the wet season</td>
<td>Most remove litter, particularly prior to mowing (if applicable)</td>
</tr>
<tr>
<td>Sediment</td>
<td>Minimal sediment</td>
<td>Sediment accumulating near curbsides and in streamlets should be removed when it builds up to 75 millimeters (3 inches) at any spot, or covers vegetation</td>
<td>Remove sediment</td>
<td>Annually, particularly after heavy runoff at the end of the wet season</td>
<td>Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Minimal nutrients</td>
<td>Visible nutrients</td>
<td>Remove nutrients</td>
<td>Annually, particularly after heavy runoff at the end of the wet season</td>
<td>Remove nutrients, particularly prior to mowing (if applicable)</td>
</tr>
<tr>
<td>Grass or Wetland Plants</td>
<td>Areas permanently stabilized with vegetation have at least 60% coverage</td>
<td>Areas permanently stabilized with vegetation have less than 60% coverage</td>
<td>Add plants or seeds to achieve at least 60% vegetative coverage</td>
<td>Annually, particularly after heavy runoff at the end of the wet season</td>
<td>Periodic mowing (with grass mowed cut shorter than the design flow depth), weed control, watering during drought conditions, removal of tree roots, and cleaning of debris and blockages. Gutters should be removed from the channel and disposed of</td>
</tr>
</tbody>
</table>

Honolulu Inspection Program/LA Training

Green Stormwater Infrastructure (GSI) Academy
Joint Partnership between the City of Los Angeles – LASANITATION and LA Trade Tech College
Balancing compliance, integration, and innovation with opportunity
Training in Green Infrastructure O&M

• Provide practical training on maintenance standards and guidelines
• Established maintenance training programs
  • National Green Infrastructure Certification Program (NGICP)
  • Chesapeake Bay Stormwater Training Partnership Program
  • Montgomery County, MD – Contractor Training
  • Other state and university training programs
    • NC State
    • Washington State University
    • Denver, CO
Linking Green Infrastructure O&M to Green Jobs

• Requires workforce with new skills
• Potential to create long term permanent jobs
• Specially trained professionals for inspections
• Opportunity to create entry level positions to disadvantaged youth (e.g. Onondaga Earth Corps)
**Additional Resources**

Staying Green: Strategies to Improve Operations and Maintenance of Green Infrastructure in the Chesapeake Bay Watershed, American Rivers (2013):


National Green Infrastructure Certification Program (NGICP):

http://ngicp.org/

The Importance of Operation and Maintenance for the Long-Term Success of Green Infrastructure, US EPA (2013):


Stormwater BMP Maintenance, Chesapeake Stormwater Network:

http://chesapeakestormwater.net/training-library/design-adaptations/stormwater-bmp-maintenance/