Lessons from the Illinois Green Infrastructure Study

Martin Jaffe
University of Illinois at Chicago
Minnesota Sea Grant
Innovative Stormwater Management Conference
Duluth, MN
Issues

• Project examined issues mandated by P.A. 96-26, the 2009 Illinois Green Infrastructure for Clean Water Act

• Three issues emphasized:
  – Performance of green infrastructure practices
  – Local perceptions of barriers to adoption
  – Economics of green infrastructure use

• Also looked at other state/local programs (e.g., Minnesota’s watershed management districts)
Issues (con’t)

• Want to briefly discuss why we focused on these research issues and what concerns (as generated by reviewer comments of drafts of the report posted on-line by IEPA) arose in doing so

• Want to also briefly highlight our specific recommendations and how they related to our examination of these issues and concerns
Green Infrastructure Performance

• UIC Science Team decided to see if the relative effectiveness of GI practices, compared to conventional detention, could be determined

• Focused on a review of the peer-reviewed literature in the ISI Web of Science database

• Also looked at USEPA’s/ASCE’s International Stormwater BMP Database
Performance (con’t)

• Science Team focused on five GI practices:
  – Bio-infiltration,
  – Permeable paving,
  – Filtration,
  – Green roofs, and
  – Constructed wetlands

• Team analyzed data on reduction of stormwater discharge volume and rates and on TSS and TN removal effectiveness by these practices
Performance (con’t)

• Team found 490 peer-reviewed journal articles addressing Green Infrastructure practices
• Sample narrowed down to 236 articles with replicable data on GI effectiveness (e.g., pollutant concentration data)
• Literature further narrowed to 57 articles (covering 173 sites) that had enough information to be able to calculate GI effectiveness
Performance (con’t)

- Literature review found that, although possessing greater variability, GI BMPs worked, on average, about as well as conventional stormwater collection/detention systems in removing TSS and TN.
- The GI practices were, also, generally effective in reducing runoff volume by 52-70% and peak flow rates by 57-85% for the storm events reported.
Performance (con’t)

• Variability in GI BMP effectiveness probably due to:
  – Differences in site and BMP design,
  – Scale and sizing of BMPs used,
  – Geographic variability of sites identified in literature review (e.g., cold vs. warm winters),
  – BMP maintenance
Preliminary Results

Peak Flow and Runoff Volume

- Infiltration
- Pavement
- Green Roofs
- Buffers
- Wetlands

Percent Reduction

Peak Flow

Runoff Volume
Preliminary Results
Total Nitrogen

- Infiltration
- Pavement
- Wetlands
- Detention
- Filtration

Removal Efficiency (%) vs Green Infrastructure
Preliminary Results
Total Suspended Solids

![Bar chart showing removal efficiency for different green infrastructure methods.]

- **Infiltration**
- **Pavement**
- **Buffers**
- **Wetlands**
- **Detention**
- **Filtration**
Performance Issues

• The team’s GI effectiveness calculations generated considerable comment from reviewers and our “expert advisory group” since range of pollutant load removal, and not removal effectiveness, is the metric used in the USEPA’s BMP Database

• Geosyntec critique of removal effectiveness:
  – Removal efficiency affected by influent volume and quality,
  – Analyses ignore bypassed BMPs and irreducible concentrations,
  – Variability in % removal larger than uncertainty in effluent concentrations (and wide variability in how calculated)
Performance Issues (con’t)

• Science Team referenced, but did not use, the BMP Database because:
  – Data needed to calculate weighted average removal effectiveness was missing from most BMP Database sites
  – Over half of the BMP Database’s 238,292 data points were from 24 sites in only 20 states
  – Over half of the data points were from sites in only four states -- CA, FL, TX, VA – all with year-round warm climates
Economics

- Center for Neighborhood Technology (CNT) examined economic literature on GI costs and benefits
- When preliminary BMP effectiveness data became available from Science Team, we decided to stress **cost-effectiveness** of GI, rather than undertake a benefit-cost analysis of Green Infrastructure practices (though CNT had also done a study on GI benefit valuation)
Economics (con’t)

- CNT examined BMP life cycle cost data from published studies, from data in its own Green Values Stormwater Calculator® and from GI programs used elsewhere in the nation.
- Analyzing three scenarios in its Calculator, CNT found:
  - GI construction costs were 4% less for an urban commercial building, 23% less for an urban townhouse project and 31% less for a suburban residential development.
  - GI life-cycle savings were 20% for the retail, 29% less for the townhouse and 24% for the suburban project.
Economics (con’t)

• Our position is that, if GI BMPs offer comparable pollutant removal and hydrologic performance with and are cheaper (in both their construction and life-cycle costs) than conventional collection/detention practices, GI BMPs ought to be the preferred urban stormwater management option for municipalities and landowners

• You might not need the cost and complexity of undertaking a sophisticated BCA if the use of GI BMPs can be justified on the basis of their cost-effectiveness alone
Implementation Models

- CMAP staff examined use of GI BMPs in existing urban stormwater management programs in Illinois:
  - Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will Counties
  - Cities of Aurora, Chicago and Crystal Lake, and Village of Homer Glen
  - Downstate communities also examined (Peoria, Decatur, Bloomington, Moline, and Rantoul)
Implementation (con’t)

• CNT staff examined GI BMPs standards adopted by other states: Maine, Maryland, Minnesota, New Jersey and Wisconsin

• Also looked at whether state Energy Portfolio Standard programs (where an increasing percentage of state energy needs are met by alternative sources over time) can be used as model to phase-in GI BMPs in MS4 permits
Implementation Barriers

• Barriers identified by CMAP in local interviews:
  – Most counties in Illinois are not legislatively authorized nor funded sufficiently to establish their own stormwater management commissions or agencies
Implementation Barriers (con’t)

– Lack of long-term GI BMP performance data in Illinois’ diverse soils and during winter months

– More specific guidance needed on long-term BMP maintenance practices and costs

– Concern with groundwater contamination risks caused by stormwater infiltration

– Aesthetics of native plants in rain gardens/swales
Recommendations: Performance Standards

• IEPA should adopt a set of flexible stormwater volume retention performance standards (e.g., requiring that the first inch or half-inch of stormwater be retained on-site) that varies according to conditions at a particular site

• Standards should be phased in using a Green Infrastructure portfolio strategy (maybe linked to IEPA’s 5-year MS4 permit cycle)
Recommendations: Administration

• Counties should work with MS4 municipal permit holders to promote GI BMPs in Illinois
  – Counties are the government unit most consistent with watershed and sub-water scales (that NRC says should be the optimal management scale)
  – State should provide resources to counties to help them with these activities
  – Counties can also turn to local expertise – e.g., soil and water conservation districts – to help them
Recommendations: Applicability

• Proposed new performance standards should initially be phased-in within current areas subject to MS4 permit (then expanded into developing areas later to limit watershed imperviousness)

• Standards should apply to public as well as private development
  – Should use GI BMPs for new public improvements as well as for major maintenance projects
  – State should develop guidance on infrastructure BMPs
Recommendations: Funding

- IEPA should develop guidance for prioritizing and funding GI projects using the Green Project Reserve set-aside funds in its SRFs.
- Costs of constructing GI BMPs should be borne by private landowners (same as with conventional collection and detention systems).
- Residual runoff should be managed by local governments using a fee system (with GI BMPs credited against the fees).
Recommendations: Maintenance, Research and Training

- If fee system used, landowners using GI BMPs to earn credits should annually report on BMP maintenance to retain their GI credits.
- Need more research on GI effectiveness, especially in Illinois soils and conditions, and to explore the use of GI treatment trains.
- If counties are to assist MS4 permittees, need to train county staff to provide such assistance.