National Stormwater Calculator
Webcast sponsored by EPA’s Watershed Academy

Wednesday, October 23, 2013
1:00pm – 2:30pm Eastern

Instructors:
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Olivia Odom Green, ORISE Fellow, National Risk Management Research Laboratory, U.S. EPA’s Office of Research and Development

Webcast Logistics

• To Ask a Question – Type your question in the “Questions” tool box on the right side of your screen and click “Send.”

• To report any technical issues (such as audio problems) – Type your issue in the “Questions” tool box on the right side of your screen and click “Send” and we will respond by posting an answer in the “Questions” box.
Overview of Today’s Webcast

• Introduction
  – Urban stormwater impacts
  – Green infrastructure solutions
  – Overview of the application

• Live demonstration of the National Stormwater Calculator application

• Case Study
  – Comparison of stormwater utility credit programs in the United States

NATIONAL STORMWATER CALCULATOR
Urban Stormwater

Tamara Mittman, MS
Environmental Engineer
US EPA – Office of Wastewater Management

Urban stormwater is one of the biggest problems facing our waterways today

- Urban stormwater is listed as the “primary” source of impairment for 13% of all rivers, 18% of all lakes, and 32% of all estuaries. (NRC 2008)
- In 2010, stormwater caused more than 8,700 beach closing and advisory days; sewage spills and overflows caused more than 1,800. (NRDC 2011)
- Insecticides often occur at higher concentrations in urban streams than in agricultural streams. (USGS Circular 1225)
- Total phosphorus concentrations in urban streams exceed EPA’s goal for nuisance plant growth in 70% of streams. (USGS NAWQA Program)
- Fecal coliform bacteria commonly exceed recommended standards for water recreation. (USGS NAWQA Program)
Urban Stormwater Impacts

Urban stormwater is a fast growing water resource concern

- U.S. developed land is projected to increase from 5.2% to 9.2% of the total land base by 2030. (Alig et al. 2004)
- Development increases the amount of impervious cover in the landscape.
- Small increases in impervious cover lead to large impacts in receiving waters.
- Development upstream can cause downstream impacts.

Causes of Stormwater Impacts

Urbanization causes changes in hydrologic cycle:

- Soils and vegetation are replaced with impervious surfaces
- Impervious surfaces are connected to dense drainage networks
- Runoff drains directly into streams, lakes, wetlands, and coastal waters
- Even small storms generate significant runoff
Causes of Stormwater Impacts

Changes in the urban hydrologic cycle increase runoff volumes and rates

Increased runoff volumes and rates are the most significant cause of stormwater impacts, causing:

- Flooding and sewer overflows.
- Stream erosion and channel degradation.
- Increased property damage.
- Loss of habitat and aquatic life.
- Increased pollutant loads.
Types of Urban Pollutants

Pollutants in urban stormwater include sediment, nutrients, oil and grease, trash, heavy metals, fertilizers, pesticides, and pathogens.

Sources of Urban Pollutants
Traditional Stormwater Management

Traditional Approach
- Drain stormwater quickly from site to receiving water or detention pond
- Manage peak flows for flood control and channel protection
- Neglect the most frequent precipitation events

Green Infrastructure: An Emerging Solution

Green infrastructure practices use or mimic natural processes (interception, infiltration, evapotranspiration) to retain and treat stormwater on site.

Green Infrastructure Approach
- Integrate practices into the site to manage stormwater at its source.
- Treat stormwater as a resource, not a waste.
- Manage the full range of precipitation events.
Additional Benefits of Green Infrastructure

- Reduces heat island effect
- Improves air quality
- Provides wildlife habitat and recreational space
- Improves energy efficiency
- Improves urban aesthetics
- Increases property values
- Often less expensive than conventional approaches

Lincoln Mercury Headquarters Green Roof, Irvine, CA. Photo courtesy of Roofscapes, Inc.

Non-Structural Practices

- Protect sensitive areas such as wetlands and riparian areas
- Preserve natural vegetation and soils (minimize soil compaction)
- Reduce impervious footprint (minimize street widths and parking area)
- Disconnect impervious area
Structural Practices

- Bioretention
  - Rain gardens
  - Bioswales
  - Planter boxes
- Infiltration basins
- Green roofs
- Compost amendments
- Permeable pavement
  - Green streets
  - Green parking lots
- Rainwater harvesting

Rain garden in parking lot island.

Rain Gardens

- Rain gardens are landscaped depressions either excavated or created with bermed sides.
- Runoff from impervious surfaces is conveyed into the rain garden, where it is temporarily stored until it infiltrates into the ground.
- Important design parameters include the drainage area to surface area ratio, ponding depth, rooting layer depth, and storage layer depth.
- Overflow or underdrain structures may also be included.
Street Planters

- Street planters are structures or containers with open bottoms to allow stormwater to infiltrate into the ground.
- Planters are ideal for space-limited sites.
- Important design parameters include the drainage area to surface area ratio, ponding depth, growing medium depth, and storage layer depth.
- Overflow or underdrain structures may also be included.

Green Roofs

- Green roofs are vegetated systems placed on roof surfaces that capture and temporarily store rainwater in a growing medium.
- Green roofs typically consist of a waterproof membrane, drainage material, a lightweight layer of soil, and a cover of plants.
- The most significant design parameter in determining runoff capture is the growing medium thickness.
- A typical green roof has a growing medium thickness of 3 to 6 inches.
Permeable Pavements

- Permeable pavements may be constructed from pervious concrete, porous asphalt, permeable interlocking pavers, and several other materials.

- Permeable pavements are particularly cost effective where land values are high and where flooding or icing is a problem.

- Permeable pavements typically consist of a surface pavement layer and a stone aggregate storage layer (often 6-18 inches thick).

- Important design parameters include the drainage area to surface area ratio and the aggregate layer thickness.

Modeling Green Infrastructure Performance

- To meet environmental and regulatory goals, designers must be able to model the impact of green infrastructure on runoff volumes.
  - Stormwater runoff volumes are a key driver of urban stormwater impacts.
  - Many states and municipalities are adopting volume-based regulatory standards.

- Continuous simulation modeling is a robust approach to hydrologic modeling that takes into account the sequence of precipitation events.

- Many continuous simulation models are available, however most are not readily accessible to designers and engineers.
  - Data requirements
  - Modeling expertise
The National Stormwater Calculator

Goals
- Predict runoff from a site given different land cover scenarios and green infrastructure controls
- Analyze site hydrology over a continuous, long-term meteorological record
- Be intelligible to users without prior modeling experience or hydrology expertise
- Require only a minimum amount of readily available site information
- Produce technically sound and defensible results for screening level analysis

Intended Users
- Site developers
- Landscape architects
- Urban Planners
- Homeowners
- Others

Intended Uses
- Screening level analysis.
- Assess long term performance of stormwater management practices.
- Identify practices that can help meet stated performance goals.
- Not intended to be used for construction-level design.
The National Stormwater Calculator

**Basic Features**

- SWMM modeling engine
- Simple map-based user interface
- Automated retrieval of meteorological, soil, slope data
- Automated calculation of rainfall and runoff statistics

**Hydrology Modeled by the SWC**
Download Instructions

- Downloading the National Stormwater Calculator is simple and only takes a couple of minutes.
- Visit the page below to download the Calculator to your computer and access the User’s Guide:

  http://www.epa.gov/nrmrl/wswrd/wq/models/swc/

Questions?

- [Image of drainage system]
<table>
<thead>
<tr>
<th>29</th>
<th>Live Demo of the Calculator</th>
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<tbody>
<tr>
<td></td>
<td>Lewis Rossman, PhD</td>
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<tr>
<td></td>
<td>Environmental Scientist</td>
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<td>US EPA – National Risk Management Research Laboratory</td>
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<table>
<thead>
<tr>
<th>30</th>
<th>Overview of the Demo</th>
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<tbody>
<tr>
<td></td>
<td>Site Description</td>
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<td>Pre-Development Hydrology</td>
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<td>95\textsuperscript{th} Percentile Storm</td>
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<td>Post-Development Hydrology</td>
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<td>Sizing a Rain Garden</td>
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<td>Comparison with Porous Pavement</td>
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Questions?

Applying the Calculator: Evaluating Stormwater Utility Credit Programs

Olivia Odom Green, JD and Ruben Kertesz, PhD
ORISE Fellows
US EPA – National Risk Management Research Laboratory
Research Questions

How do projected reductions in stormwater runoff from a standard home lot compare between cities offering green infrastructure discount programs?

What relation is there to runoff reduction and size of discount being offered?

Stormwater Utilities

- Fee charged per IA
- >1400 identified
- Avg SFR fee = $4.57/mnth
- Median = $3.75
- No correlation to politics, affluence, tax burden
- Product of state law (NB, MD)
Stormwater Utility Credits

- Discount for reducing runoff
  - *Curb opposition* - solution to problem
  - *Ability to reduce fee* may be factor in state law
- Single family residences & rain gardens
- Efficacy & Sustainability:
  - Economy
    - Financial incentives
    - Municipal finance
  - Community
    - Outreach & Accessibility
  - Environment
    - Hydrology

Hydrologic Research Question

- Treating x% of impervious area, results in y% discount and z% runoff reduction
  - Treated IA and Discount % are products of administrative rules
  - % Runoff reduced is modeled
Methodology

- Identify programs
  - Bioretention (rain gardens) for single family residences
- Model runoff pre- vs post-treatment
  - Follow instructions for designing/installing rain garden
  - Vary site conditions
  - Compare reduction in annual runoff between all factors
- Compare reduction in runoff to financial discount

EPA SWC: Pre-treatment

<table>
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<tr>
<th>Land Cover Distribution:</th>
<th>Land Cover</th>
<th>% Forest</th>
<th>0</th>
<th>25</th>
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<tbody>
<tr>
<td>% Meadow</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Snow</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Desert</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Impervious</td>
<td>47</td>
<td></td>
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</table>

Land cover affects the amount of rainfall captured on vegetation or in natural depressions and determines surface roughness.

Enter the percentage of the site’s area covered by each type of pervious surface. The remaining area is considered to be impervious (roads, sidewalks, streets, parking lots, etc.).
EPA SWC: Post-Treatment

Adjusted Parameters

<table>
<thead>
<tr>
<th>Utility</th>
<th>Slope %</th>
<th>Ponding Depth (in.)</th>
<th>Soil Group*</th>
<th>Ksat* (in/hr)</th>
<th>% Roof Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland</td>
<td>5, 10</td>
<td>6, 12</td>
<td>a, c</td>
<td>2, 0.25</td>
<td>66, 100</td>
</tr>
<tr>
<td>Cleveland (NEORSD)</td>
<td>4, 6, 10</td>
<td>f(slope)</td>
<td>sand (a), silt (c), clay (d)</td>
<td>1.4, 0.57, 0.06</td>
<td>25, 100</td>
</tr>
<tr>
<td>Ft. Myers</td>
<td>2, 5</td>
<td>6, 12</td>
<td>a, b</td>
<td>5, 1.5</td>
<td>10, 100</td>
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<tr>
<td>Lynchburg*</td>
<td>2, 5</td>
<td>6</td>
<td>a, b</td>
<td>1.5, 1</td>
<td>50, 100+</td>
</tr>
</tbody>
</table>

*Conductivity (Ksat) related to soil type by USDA NRCS National Engineering Handbook: Part 630 Hydrology – Note that in Portland, 2 in/hr minimum for full credit; Lynchburg, 1 in/hr minimum without requiring underdrain. Ft. Myers shows higher required infiltration rate due to proximity of water table to the ground surface.

*Garden depth is prescribed, 18-36 inches.
Results – Minimum Treatment

Results: 2/3 of Lot Impervious
Conclusions

- **Hydrology**
  - Prominent factors
    - % captured roof area, Soil
  - Less prominent factors
    - Slope, Depth, Site imperviousness

- **Economics**
  - % runoff reduced v. % discount
    - Efficiency based on perspective
      - Even a windfall to a citizen (% discount > % runoff reduction) may be efficient to municipality
      - Especially when goodwill, social contagion considered
Questions?

Future Developments

Lewis Rossman, PhD
Environmental Scientist
US EPA – National Risk Management Research Laboratory
Calculator Enhancements

- Climate Change Extension (January 2014)
- LID Practices Cost Estimates (June 2014)
- Interactive Site Characterization Tools (TBD)
- Conversion to a Web-Based Application (TBD)

Climate Change Extension

- Will allow the SWC to evaluate the effects of climate change predictions for both precipitation and temperature.
- Uses a set of three different climate scenarios at two different future time points that spans the set of results in the WCRP Phase 3 projections (CMIP3).
- Statistically downscaled changes in monthly average precipitation, monthly average evaporation rate, and annual daily maximum rainfall have been associated with each precipitation station location (>7,000) in the calculator.
- Will be part of the Climate Resilience Toolkit being developed as part of the President’s Climate Action Plan.
Climate Change User Interface

- National Stormwater Calculator Website
  [http://www.epa.gov/nrmrl/wswrd/wq/models/swc/](http://www.epa.gov/nrmrl/wswrd/wq/models/swc/)

- Address Any Follow-up Questions to:
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Next Watershed Academy Webcast

Volunteer Monitoring

Date TBD

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You can type each of the attendees names into the PDF and print the certificates.