Evolving Research for Stormwater Management
Sally Soule, NH DES
James Houle, UNH Stormwater Center
Providing Data to Protect Water Quality Since 2004
Contributors:

- City of Dover Staff
- UNH Stormwater Center
- NH Department of Environmental Services
- Environmental Protection Agency
- RPCs
- VHB
Impact of Impervious Cover

Adapted from Schueler
Yes, climate change gives us pause to think, but IC is the 800-pound gorilla
Common Pollutant RE’s

Graph showing the removal efficiency of different methods for TSS, DIN, and TP.

- TSS % Removal Efficiency
  - Stone Swale
  - Veg Swale
  - Berm Swale
  - Retention Pond
  - HDS Systems
  - MTD Filter
  - Bioretention
  - Tree Filter (2)
  - Gravel Wetland
  - Porous Asphalt

- DIN % Removal Efficiency
  - Stone Swale
  - Veg Swale
  - Berm Swale
  - Retention Pond
  - HDS Systems
  - MTD Filter
  - Bioretention
  - Tree Filter (2)
  - Gravel Wetland
  - Porous Asphalt

- TP % Removal Efficiency
  - Stone Swale
  - Veg Swale
  - Berm Swale
  - Retention Pond
  - HDS Systems
  - MTD Filter
  - Bioretention
  - Tree Filter (2)
  - Gravel Wetland
  - Porous Asphalt
If we know what the problem is...
...and science informs potential...
...Then how are we doing on implementation?

In many cases implementation competence lags behind technical competence
How do innovations spread through populations?
Diffusion of Innovation

- Diffusion of innovation is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003)
Adapted from Rogers, 2003
Results from Ryan and Gross on farmer adoption patterns of hybrid corn.

Source: Ryan & Gross (1943), “The Diffusion of Hybrid Seed Corn in Two Iowa Communities,” Rural Sociology 8 (March): 15.
Adoption due to Data driven Science

Adoption due to Peer to peer communications

Need peers to move adoption forward

Time
The 3 things we fundamentally do wrong that ensures BAU – or – what we have learned through 15 years of implementation
1.) We don’t sweat the small stuff
2.) We tend to target the finish line as opposed to the starting line.
3.) We hold on to relatively insignificant details that prevent transferring ownership.
The Small Stuff

The purest form of insanity is to leave everything the same and the same time hope that things will change.

Albert Einstein
Population Growth & Quality Problem

Last 20 years

Percent Increase, Great Bay

Population Growth, 19%

Impervious Cover, 120%

Next 30 years

Population Growth, 26%

From 1990 to 2010 (Source: US Census; UNH earth systems research center; PREP; 2010-2040 Projections, UNHSC)
MODEL STORMWATER STANDARDS FOR COASTAL WATERSHED COMMUNITIES

Prepared by the University of New Hampshire Stormwater Center and The Rockingham Planning Commission
December 2013

This project was funded under the Coastal Zone Management Act by NOAA’s Office of Ocean and Coastal Resource Management in conjunction with the New Hampshire Coastal Program.
Estimated Effect on Future TN Load (lbs/yr) In Each Town Due to Stormwater Regulations

- Barrington: 832 lbs/yr w/o regs, 464 lbs/yr w/ regs
- Dover: 1,071 lbs/yr w/o regs, 543 lbs/yr w/ regs
- Durham: 4,785 lbs/yr w/o regs, 2,154 lbs/yr w/ regs
- UNH: 1,140 lbs/yr w/o regs, 2,192 lbs/yr w/ regs
- Lee: 555 lbs/yr w/o regs, 405 lbs/yr w/ regs
- Madbury: 415 lbs/yr w/o regs, 282 lbs/yr w/ regs
- Nottingham: 94 lbs/yr w/o regs, 64 lbs/yr w/ regs
Potential Reduction Credits

Pollutant Load Reduction Credit per permit term (5 yrs)

<table>
<thead>
<tr>
<th></th>
<th>% Reduction of Total Existing Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>2.0%</td>
</tr>
<tr>
<td>TP</td>
<td>1.5%</td>
</tr>
<tr>
<td>TN</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
Assumes Oyster River Watershed Ratios are consistent throughout the GB.
Are we at the Finish Line or the Starting Line?
Typical Project Approach

• Develop a watershed management plan (a-i)
• Optimize placement of BMPs for maximum gain
• Implement
• Model
• Outreach and education on project results
• Report
FINAL
BERRY BROOK WATERSHED MANAGEMENT PLAN
DOVER, NH

Prepared for:
City of Dover
288 Central Avenue
Dover, NH 03820-4169

September 2, 2008
2011 Watershed Restoration Grants for Impaired Waters

Section B: PRE-PROPOSAL APPLICATION FORM
Watershed Restoration Grants for Impaired Waters

I. Proposal Title

Berry Brook Watershed Restoration through Low Impact Development Retrofits in an Urban Environment

II. Contact Information

Primary contact person: Dean Peschel
Organization: Environmental Project Manager, City of Dover DPW
Street address: 288 Central Avenue
City, State, ZIP: Dover, NH, 03820-4169
Day phone: (603) 516-6094   Fax: ( )   Email: dean.peschel@ci.dover.nh.us

Secondary contact person: Robert M. Roseen, Ph.D., D.WRE, P.E.
Organization: Director, The UNH Stormwater Center
Street address: 35 Colvos Road
City, State, ZIP: Durham, NH, 03824
Day phone: (603) 862-4024   Fax: (603) 862-3957   Email: robert.roseen@unh.edu

Signature of Applicant: [Signature]
Date of signature: 9/2/10

III. Project Summary

Berry Brook is a highly urbanized 1st order stream located in Dover, NH, that is classified as Class B waters. The Brook is located in a built-out, 164-acre watershed with 25% impervious cover (IC) and includes medium-density housing with commercial and industrial uses. The stream has been placed on the NHDES 2006 Section 303(d) list and is impaired for primary recreation and for aquatic life. The source of this impairment includes urbanization resulting in an increase of pollutant mass and runoff volumes from stormwater.
And then you implement –
Inside a historic 40,000 sf slow sand filter
... and optimize

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And more implementation...
2013 Watershed Assistance Grants
PROPOSAL FORM

1. PROJECT TITLE
Getting to 10%: Watershed Restoration through Low Impact Development Retrofits in an Urban Environment

Berry Brook/Cocheco River Watershed Management Plan Implementation Phase III.

2. PROJECT LOCATION
A. Town(s): Dover, NH
   Does project involve other states? Yes □ No □

B. What water body does it affect? Berry Brook/Cocheco River/Great Bay
   12-digit hydrologic unit code (HUC): 010600030608

C. Attach a project location map showing the watershed and relevant project site locations (required).

3. GRANT CATEGORY
Please check applicable water quality category:
   a. High Quality Waters □
   b. Impaired Waters □

Please list the designated uses that are impaired and the specific causes of impairments as identified on the 2010 305(b)/303(d) Surface Water Quality Assessment. If the waterbody is not listed as impaired in the 2010 Surface Water Quality Assessment, then describe and attach documentation of the impairment.

Primary Contact Recreation (as a result of high bacteria concentrations) and for Aquatic Life Use due to an NHDES assessment of benthic macroinvertebrate monitoring.

SUBMISSION DEADLINE
4:00pm November 21, 2012

HUC look-up: http://www2.des.nh.gov/SWQA/ or contact your DES project leader for assistance.

2010 Surface Water Quality Assessment:

... and optimize Again...
And more implementation...
Results

• Not one single installation was installed as planned
• The entire project required flexibility in relation to all BMPs installed
• Overall goals of the project (disconnection of EIC) was considered paramount over actual implementation sites.
New Project Approach

• Desktop designs invariably change when in-depth site specific investigations begin.
• Better to quickly and coarsely develop a handful of candidate sites
• Conduct inexpensive site queries of local areas of concern to further develop a practical mitigation approach.
• Implement where and however much feasible
• Municipal implementation efforts adapt or innovate “text book” research-based designs with what is practical for a public works department working in an urban setting leading to lower costs and more effective systems.
What’s the Significance? – or – GI is as GI does...
Complete Community Approach

1. NPDES Phase II Regulated Community? Assumes that externally regulated communities are motivated by compliance.
2. LID Required? Low impact development requirements assume that the municipality is updating regulations in a timely and relevant manner.
3. Mimic Pre Development Hydrology Requirement? Increased measure of the extent of LID adoption. Assumes that the affirming municipality is attempting to manage water quantity and water quality.
4. Maximize On-Site Infiltration? Assumes that the affirming municipality is attempting to prioritize management of increased stormwater runoff volumes in addition to measures to address peak flow and water quality.
5. Surety Required From Developer? This largely assumes that the municipality has procedural requirements of occupancy and defendable oversight procedures for drainage installations.
6. Redevelopment Requirements? This depicts communities that recognize advanced concepts of integrated approaches, including appreciable gains from updating innovative stormwater requirements for redevelopment scenarios.
7. Dedicated Dollars for Stormwater in the Capital Improvements Program (CIP)? This indicates that the local governance body understands, and is committed to, the social, environmental, and economic benefits of advanced stormwater management.
Building Green Infrastructure Through a Complete Community Approach

The following measures outline a comprehensive strategy towards achieving the complete community approach:

- **Adopt ordinances and regulations for new development** that mandate the use of stormwater filtration to clean runoff, and infiltration practices to reduce runoff.

- **Require improved stormwater controls for reducing runoff** for redevelopment projects or other significant construction, and for site improvements such as repaving or building renovations.

- **Apply conservation strategies** such as protecting naturally vegetated areas near water bodies and wetlands, and limiting the size or percentage of allowable impervious cover in high value natural resource areas.

- **Reduce existing impervious cover** through targeted site improvements and stormwater management changes in high impact locations (i.e. locations that contribute high amounts of polluted runoff).

- **Make a long-term commitment to fund and maintain stormwater controls** along with an accounting mechanism to track long-term benefits of strategies. Consider innovative funding mechanisms such as impacts fees, exaction fees and stormwater utilities.

- **Provide opportunities for outreach** by sharing plans and progress with citizens and business owners through community newsletters, cable access, and on-site signs that explain what steps are being taken to protect waterways or improve stormwater management.
NH Great Bay Communities (n=42)
Conceptual Model Factors Influencing Adoption
Simplified Solution Model

- Technical
- Social
- Situational
Technical: Elements pertaining to efforts that require technical expertise and understanding
Social: Elements pertaining to efforts that relate to public involvement and civic support for a cultural approach or common social responsibility.
Tale of two raingardens
Tale of two raingardens
NDP!
Maintenance Must be Included in the Design Process

- Not by the designers, but by the people who are expected to do it and pay for it.
Comparison of Pollutant Removal Efficiency
Planted vs Grassed Bioretention

- **TSS**: Planted Bio (Avg. 3) > Grashed Bio
- **TP**: Planted Bio < Grashed Bio
- **DIN**: Planted Bio < Grashed Bio
- **TN**: Planted Bio > Grashed Bio
Average Infiltration Rates of a Planted (blue) versus Grassed (green) Bioretention Systems Over Time
Permeable Pavement
GI: Subsurface Gravel Filter

To Existing Swale
Boulangenator Performance

Grove St : Subsurface Gravel Filter - Water Elevation

- Total Rain (in)
- Depth (ft)
- 6" Pipe Invert
- 12" Pipe Invert
- Pavement

- Inlet
- Stone Reservoir/Filter
- Outlet

Elevation (ft)

Rainfall Depth (in)

1.22 in
1.42 in
1.43 in

System Full Line (1" rainfall)

## GI Implementation Cost Comparisons

<table>
<thead>
<tr>
<th>Costs per disconnected acre of IC</th>
<th>PA</th>
<th>NY</th>
<th>NH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>$250,000.00</td>
<td>$320,000.00</td>
<td>$30,000.00</td>
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</table>
## SGWS Costs

### Site Characteristics and System Treatment Capacity

<table>
<thead>
<tr>
<th>Project</th>
<th>Impervious Area (sf)</th>
<th>Impervious Area (acres)</th>
<th>Best Management Practice</th>
<th>Hydrologic Soil Group</th>
<th>Depth of Runoff Treated from Impervious Area (in)</th>
<th>Total Suspended Sediment</th>
<th>Total Phosphorus</th>
<th>Total Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillcrest IT</td>
<td>39,640</td>
<td>0.91</td>
<td>Infiltration Trench</td>
<td>B</td>
<td>0.10</td>
<td>97</td>
<td>0.35</td>
<td>8.8</td>
</tr>
</tbody>
</table>

### Water Quality Volume

- **Drainage Area (ft²)**: 39,640
- **% Impervious Cover**: 100%
- **Impervious Area (ft²)**: 39,640
- **Conv WQV (ft³) (@ P = 1.0in)**: 3,303

### System Treatment

- **System Area (ft²)**: 10
- **Reservior Storage (ft³)**: 400
- **System Storage (ft³)**: 320
- **Rainfall Depth Treated (in)**: 0.10

### Marginal Extra Materials

- 700 cf stone

### Marginal Cost Difference

- $10,000
Conclusions

1.) Let’s sweat the small stuff
2.) Let’s recognize the we are at the beginning stages of a long journey with many innovations yet to come
3.) Let’s facilitate transferring ownership and see what happens
Questions???