Slow it, Spread it, Sink it using Green Stormwater Infrastructure
Overview

- Defining LID and GSI
- Hydrology and impacts of development
- Getting Specific - practices and methods used
- Resources for your Town
Green Stormwater Infrastructure (GSI) and Low Impact Development (LID)

Terminology:

Planning & Design - Low Impact Development (LID)

Techniques and Best Management Practices - Green Stormwater Infrastructure (GSI)
Low Impact Development
Low Impact Development

• Began in Prince George’s County, MD in 1990
• An innovative land planning and design approach which seeks to maintain a site’s pre-development ecological and hydrological function through the protection, enhancement, or mimicry of natural processes

In other words, let the natural features of the site guide where to build
AVOID

- Mapped FEMA floodplains
- Mapped ANR river corridors
- For streams without mapped river corridors
  - Building envelope set back at least 100 feet from streams with watershed ≥ 2 square miles
  - Building envelope set back at least 50 feet from streams with watershed ≤ 2 square miles
- Wetlands, in conformance with state regulations
- Lake shoreland, in conformance with state regulations

MINIMIZE
River Corridor Protection: Streams are NOT static!
Green Stormwater Infrastructure
Green Stormwater Infrastructure

• Coined by EPA around 2007
• Systems and practices that restore and maintain natural hydrologic processes (physical infrastructure NOT a design process like LID)
• Reduces the volume and water quality impacts of the built environment while providing multiple societal benefits
• Disconnects runoff sources from receiving waters
Manage the “First Flush”

- Pollutants that have collected on impervious surfaces wash off during the first portion of a storm event.
- Capturing and treating the first one inch of rainfall treats about 90% of the pollutants leaving the site (Schueler 2000).
Common GSI Practices

- Bioretention (Rain Gardens)
- Vegetated swales
- Cisterns (Rain Barrels)
- Green Roofs
- Permeable Pavements
- Gravel (or constructed) Wetlands
- Tree Boxes (with infiltration, filtering, or storage)
- Dry Well
Changing Pollution Concerns

In the past, our main pollution concern was Point Source Pollution.

Our current most pressing pollution concern is Non-Point Source Pollution.
Understanding Hydrology

Pre-Development Forest

During winter months much of the precipitation is intercepted by the forest canopy and evaporated while transpiration is relatively inactive. Shallow subsurface flow (interflow) moves slowly down slope over many hours, days or weeks to receiving water. Surface runoff is minimal. As winter progresses, the interflow component of stream flow increases. During the summer and fall, streams are maintained primarily by glacial melt water and/or groundwater flow.
Impacts of Development

Developed Conditions

Surface runoff increases and time of concentration decreases. Less interflow and local groundwater in substrata available to sustain base stream flows. Interflow highly variable depending on development, soil compaction and impervious surface coverage.
<table>
<thead>
<tr>
<th>Hydrologic Process</th>
<th>Pre-Development</th>
<th>Post-Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evapotranspiration</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>Runoff</td>
<td>10%</td>
<td>55%</td>
</tr>
<tr>
<td>Shallow Infiltration</td>
<td>25%</td>
<td>10%</td>
</tr>
<tr>
<td>Deep Infiltration</td>
<td>25%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Impacts of Development

- Impervious cover in Chittenden County increased by ~17,094 acres (or 4.3%) from 1992-2006
- 60.13 miles (or 9%) of all assessed streams in Vermont are considered impaired for aquatic life
- 12% of total acreage of Lake Champlain is considered impaired for aquatic life
- 38% of total acreage of all other inland lakes in VT are impaired for aquatic life

(2012 VT Surface water quality integrated assessment report)
Impacts of Development

1” rain storm over 1 acre

Forest runoff = 2,715 gallons

Urban runoff = 14,934 gallons +

1” storm over Burlington

148,145,280 gallons

225 Olympic size swimming pools
Impacts of Development

Traditional Stormwater Management
Traditional Stormwater Management

• Treats stormwater as a waste, not a resource
• Considers stormwater last in the design process
• Utilizes pipe and convey strategy
• Centralized
• Looks mostly at surface runoff
• Reliant on large infrastructure
Traditional Stormwater Management
Traditional Stormwater Management

- Sedimentation and erosion
- Nutrient loading
- Bacteria
- Trace metals
- Trash and debris
- Reductions in base flow
- Increased runoff volume and duration
LID in Practice

• Conservation and protection of natural areas
LID in Practice

• Narrow road widths
LID in Practice

- Clustering
GSI in Practice – Infiltration/Treatment

- Bioretention
- Rain Gardens
Bioinfiltration Cross Sections

TYPICAL RAIN GARDEN

- Drainage flow
- Water storage
- Gravel blanket
- Soil
- Native plants
- Drainage outlet

Times graphic by Lisa Mueller, lmueller@stcloudtimes.com
GSI in Practice – Conveyance (infiltration)

• Vegetated Swale
Bioswale Cross Section
GSI in Practice – Storage/Reuse

- Rain barrels and cisterns
Rain Barrel & Cistern Examples
GSI in Practice – Volume Reduction/Evapotranspiration

- Green roofs
Green Roofs in VT
GSI in Practice - Infiltration

• Porous pavements
Technology Performance
Quantity Retention

Mean of Site Means – % Volumetric Reduction

% Volumetric Reduction

Stormwater Technology Type

PP - Porous Pavement: 72.0%
BR - Bioretention: 64.8%
GR - Green Roof: 52.3%
SW - Swale: 25.7%
D - Detention Pond: 15.5%
W - Wetland: -10.7%
MF - Media Filter: -11.6%
R - Retention Pond: -12.4%
Phosphorus Capture
LID/GSI Tools for Your Town

1. DEC/ LCSG Green Infrastructure Collaborative
2. VAPDA/VANR GI Toolkit
3. VLCT Model LID/GSI Bylaw and Simplified Sizing Tool
4. Forthcoming update to the VT Stormwater Manual
VT Green Infrastructure
Collaborative Resources

dec.vermont.gov/watershed/cwi/green-infrastructure

• Fact sheets, links to additional resources, case studies
VT GI Toolkit

- www.vpic.info/greeninfrastructuretoolkit.html
- One stop shop for GI Resources
  - Policy (regulations, plans, case studies, permits)
  - Resources (education, outreach, tech assistance, and $)
  - Technology (calculators, sizing tools)
- Links to local, regional, and national resources
VLCT Model LID/GSI Stormwater Management Bylaw and Guidance/Tools (in a nutshell)

• Model bylaw
  – focuses on site design and GSI practices on small sites where the proposed change or increase in impervious cover is below the thresholds for State stormwater permitting.

• Guidance and sizing tools
  – help applicants and review boards understand what GSI practices are, and how they can be sized to meet the performance standards included in the model bylaw.
GSI Simplified Sizing Tool for Small Projects – Overview

Set of 11 fact sheets:

1. Introduction
2. Post-Construction Soil Depth and Quality
3. Retention or Planting of Trees
4. Cisterns and Rain Barrels
5. Rooftop Disconnection
6. Non-Rooftop Disconnection to Filter Strips
7. Drywells
8. Bioretention and Rain Gardens
9. Vegetated Swales
10. Infiltration Trenches
11. Permeable Pavers

Microsoft Excel-based Sizing Tool
Green Stormwater Infrastructure - Best Management Practices (BMPs)

1. Soil Quality and Depth

- Applies to disturbed areas not covered by an impervious surface
- Retain duff layer and native topsoil in undisturbed state when possible
- In areas requiring grading, remove and stockpile duff and topsoil and reapply to other portions of the site
2. Retaining and / or Planting Trees

- Capture and hold precipitation (interception)
- Convey water in the soil through the tree to the atmosphere (transpiration)
- Absorption of water in the root zone (infiltration)
- Trees take up nutrients and trace amounts of chemicals from the soil along with water (pollutant removal)
3. Cisterns and Rain Barrels

- Store rainwater from rooftop downspout systems for later use
- Locate relative to intended water use
- Come in sizes from a 55 gallon barrel to a 1,500 gallon cistern (100 sq. ft. roof surface will fill a 55 gallon barrel)
- If cistern cannot hold the full rooftop runoff, multiple cisterns can be linked, or overflow can be diverted to another GSI practice
Green Stormwater Infrastructure - Best Management Practices (BMPs)

4. Rooftop Disconnection

• Directs flow from residential or small commercial rooftops to vegetated areas where stormwater can soak into the ground

• The rooftop area draining to any one downspout should not exceed 1,000 square feet

• Can be “coupled” with other practices such as rain gardens, infiltration trenches, or dry wells.
Green Stormwater Infrastructure - Best Management Practices (BMPs)

5. Drywells

• Manufactured perforated forms or tanks set in the ground and surrounded with stone
• Provide significant stormwater volume reductions and pollutant treatment in soils that are well drained
• The impervious area draining to a drywell cannot exceed 1,000 square feet
Green Stormwater Infrastructure - Best Management Practices (BMPs)

6. Bioretention / Rain Gardens

- Runoff stored temporarily in landscaped depressions
- Swales, berms or downspout extensions help route runoff to the rain garden
- The bottom of the soil media must be located above the groundwater table
- The impervious area draining to any one bioretention area cannot exceed 10,000 square feet
Green Stormwater Infrastructure - Best Management Practices (BMPs)

7. Permeable Pavers

- Alternative to impervious asphalt, concrete and gravel paving surfaces
- Suited for areas of low traffic, residential driveways, parking spaces, alleys, sidewalks, bike paths and courtyards
- Allow runoff to flow between pavers into a reservoir where it is stored and infiltrates into the underlying soils
VLCT Model LID/GSI Bylaw – October, 2015

– Replaces the 2008 Model LID Stormwater Management Bylaw

– New model adds definitions and expanded section allowing for an “Independent Technical Review”

– Still only 7 pages long!
Model LID / GSI Stormwater Management Bylaw

I. Authority – 24 V.S.A.§4410 and 24 V.S.A.§4414(9)

II. Purpose – capture the first inch of rainfall

III. Scope and Applicability – activities requiring a permit

IV. Definitions

V. Site Design (pre-construction) – LID (avoid and minimize)

VI. Erosion Prevention / Sediment Control – low risk guidance

VII. Stormwater Mgt. Standard (post-construction) – GSI sizing

VIII. Previously Developed Sites – redevelopment encouraged

IX. Post-Construction Soil Depth and Quality

X. Supplemental Application Materials – show compliance

XI. Independent Technical Review – impervious surface exceeds ½ acre
Model LID / GSI Stormwater Management Bylaw

• Stormwater Management Standard - Post Construction – GSI ground rules
  – Applications for development exceeding 2,500* square feet of impervious surface must comply with the stormwater management standards set forth herein. *[Towns choose this threshold – may increase based on local conditions]*
  – Stormwater runoff from impervious surfaces exceeding 2,500* square feet and up to 1/2 acre shall be routed through one or more appropriate BMPs.
  – BMPs are sized and designed to capture 90% of the annual storm events, or the first inch of rainfall. See Simplified GSI Sizing Tool for methods and calculations.
  – Applications for development with impervious surfaces exceeding 1/2 acre (and up to 1 acre – the threshold for state permitting) require an independent technical review.

• Previously Developed Sites: same applicability thresholds and performance standards to the maximum extent possible as new development
GSI Simplified Sizing Tool for Small Projects – Excel Spreadsheet

- Applicants fill in basic project information and use the practice-specific worksheets to size individual practices.
When you need help . . .
Model LID / GSI Stormwater Management Bylaw
Section XI – Independent Technical Review

– Recommended for applications with impervious surfaces exceeding ½ acre (and up to 1 acre – the threshold for state permitting) require an independent technical review.

– “The legislative body may establish procedures and standards for requiring an applicant to pay for reasonable costs of an independent technical review of the application.” [24 VSA §4440(d)].

– You hire the expert, the applicant pays the bill!

– It’s advisable to have technical review provisions in a separate stand alone document including procedures, fee schedules and standards for applying this requirement.
VT State Stormwater Manual Update


### 4.0 Acceptable Stormwater Treatment Practices

- 4.2.3. Disconnection to Filter Strips and Vegetated Buffers
- 4.2.4. Watershed Hydrology Protection
- 4.3. Structural Stormwater Treatment Practices
  - 4.3.1. Bioretention Areas and Rain Gardens
  - 4.3.2. Dry Swales and Wet Swales
  - 4.3.3. Infiltration Trenches and Basins
  - 4.3.4. Filtering Systems
  - 4.3.5. Wet Ponds
  - 4.3.6. Green Roofs
  - 4.3.7. Permeable Pavement and Reinforced Turf
  - 4.3.8. Rainwater Harvesting