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

VERMONT LEAGUE OF CITIES & TOWNS

VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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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)

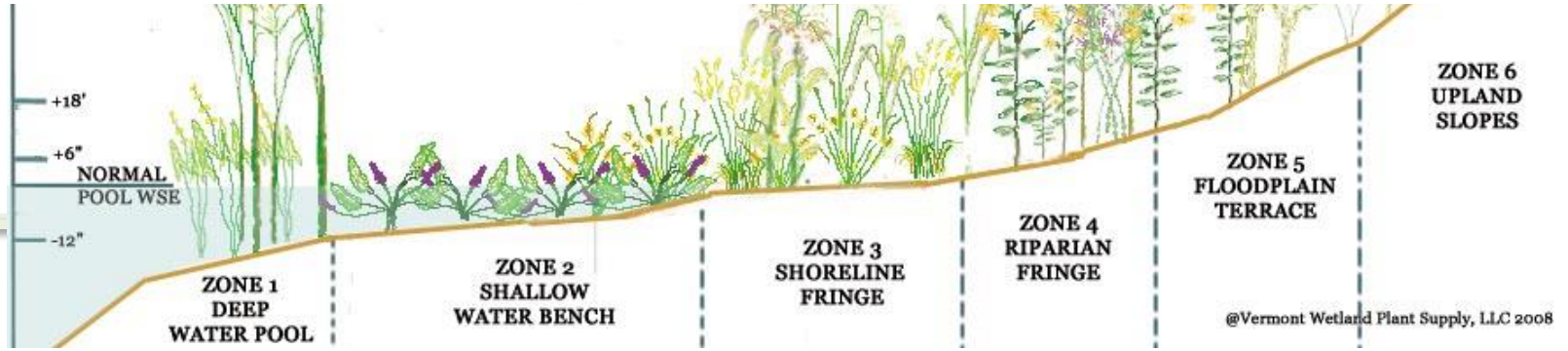
Techniques and Best Management Practices - Green Stormwater Infrastructure (GSI)

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

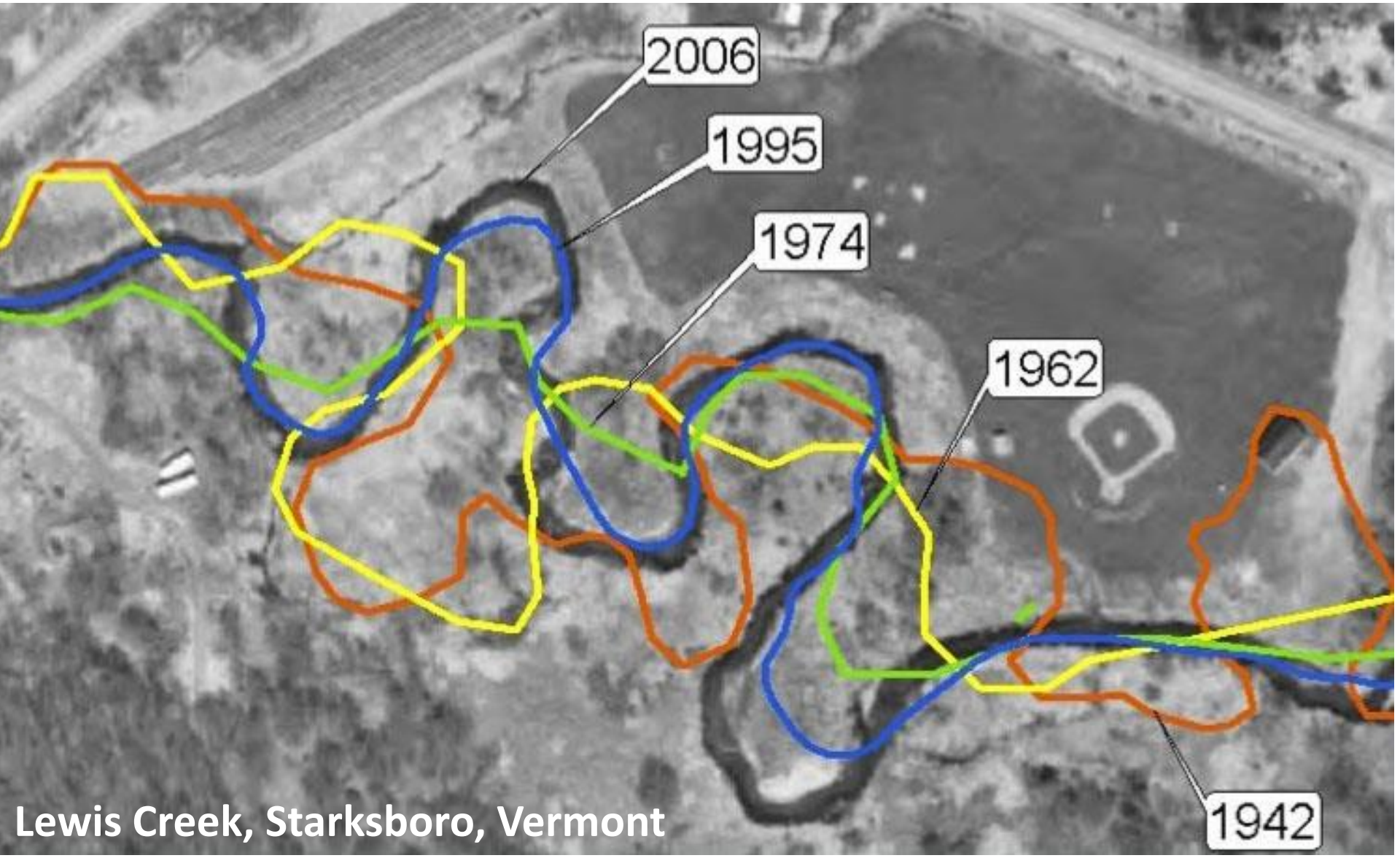


AVOID

- 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

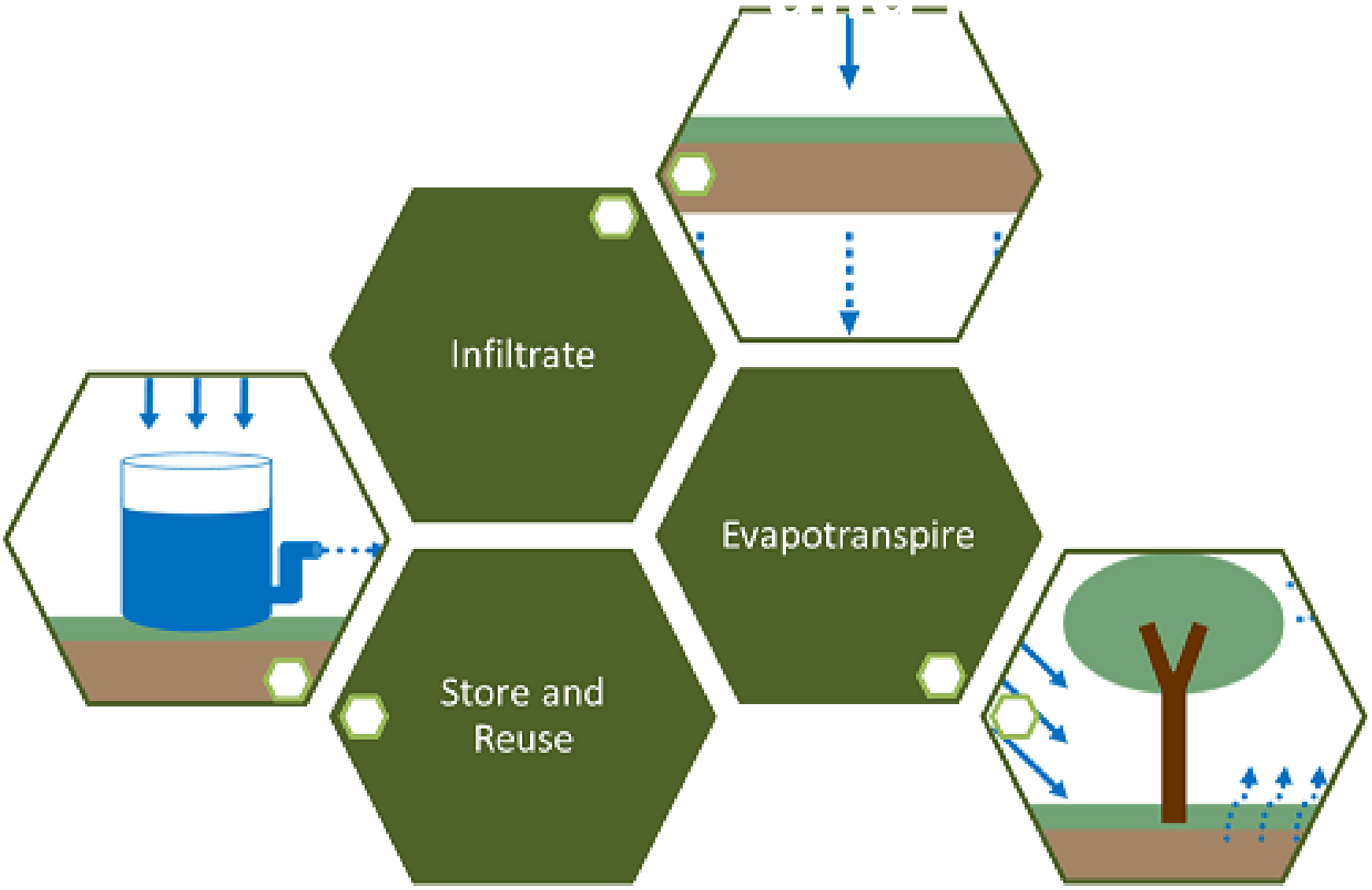
- Coined by EPA around 2007
- Systems and practices that restore and maintain natural hydrologic processes (physical infrastructure NOT a design process like LID)
- Reduces the volume and water quality impacts of the built environment while providing multiple societal benefits
- Disconnects runoff sources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


Infiltrate
Evapotranspire
Store and
Reuse

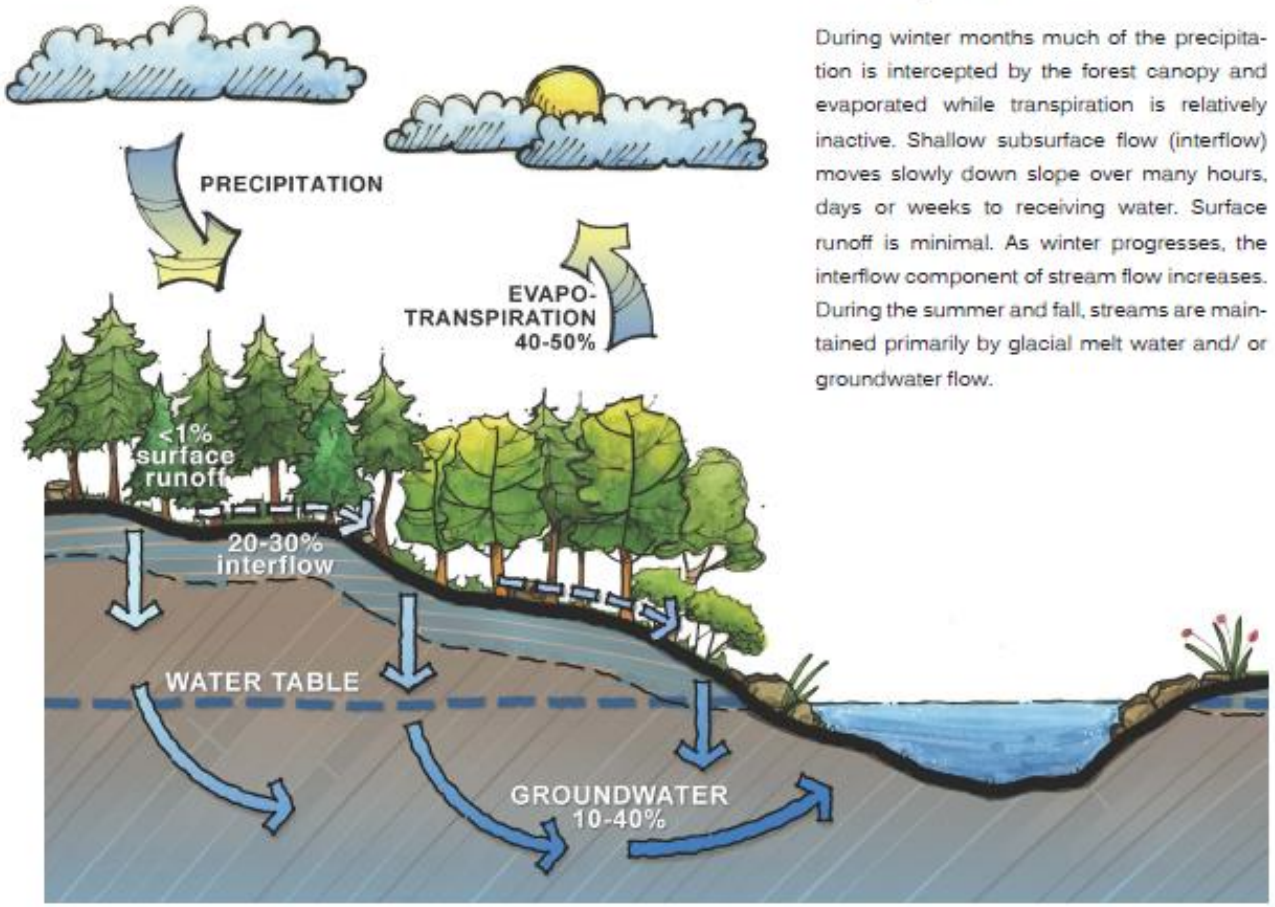
Changing Pollution Concerns

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

A sewage treatment plant on the Naugatuck River in Connecticut.

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

Understanding Hydrology



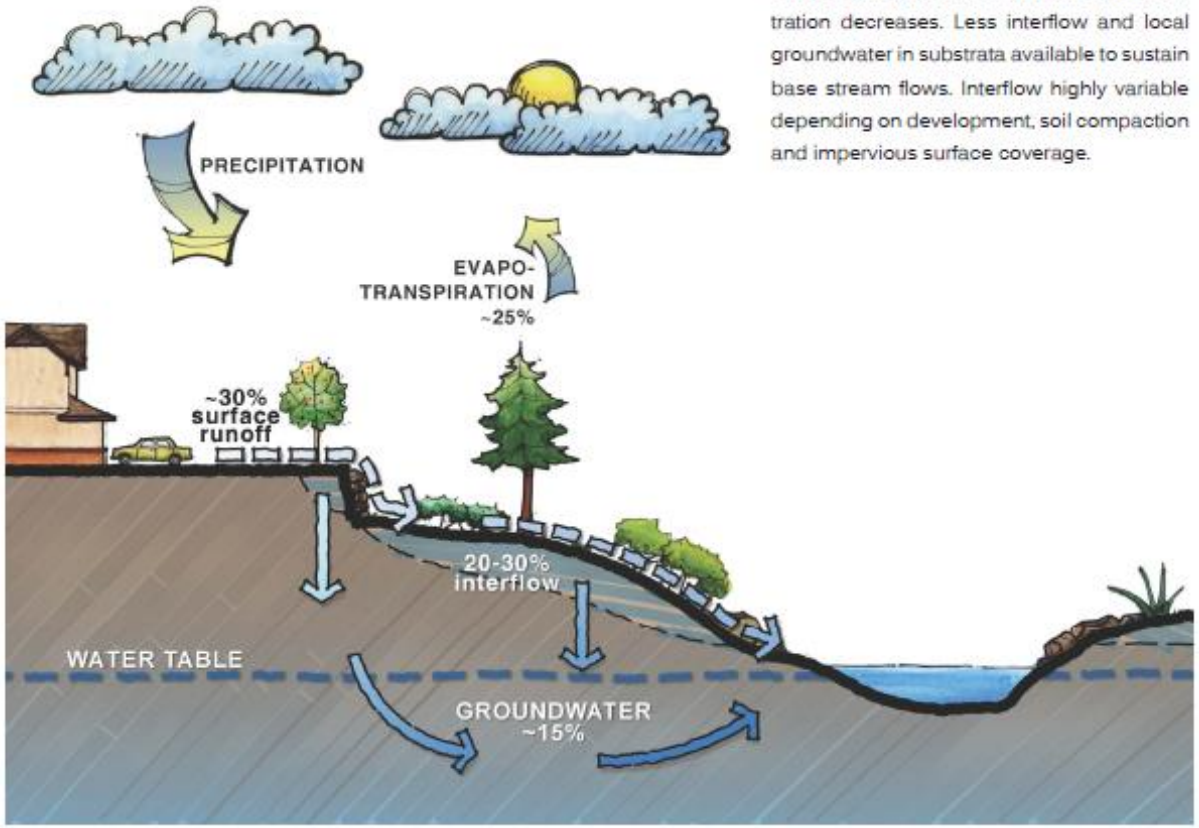
Pre-Development Forest

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.



Impacts of Development on Hydrology

PRE-Development

POST-Development

Evapotranspiration	40%	Evapotranspiration	30%
Runoff	10%	Runoff	55%
Shallow Infiltration	25%	Shallow Infiltration	10%
Deep Infiltration	25%	Deep Infiltration	5%

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


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

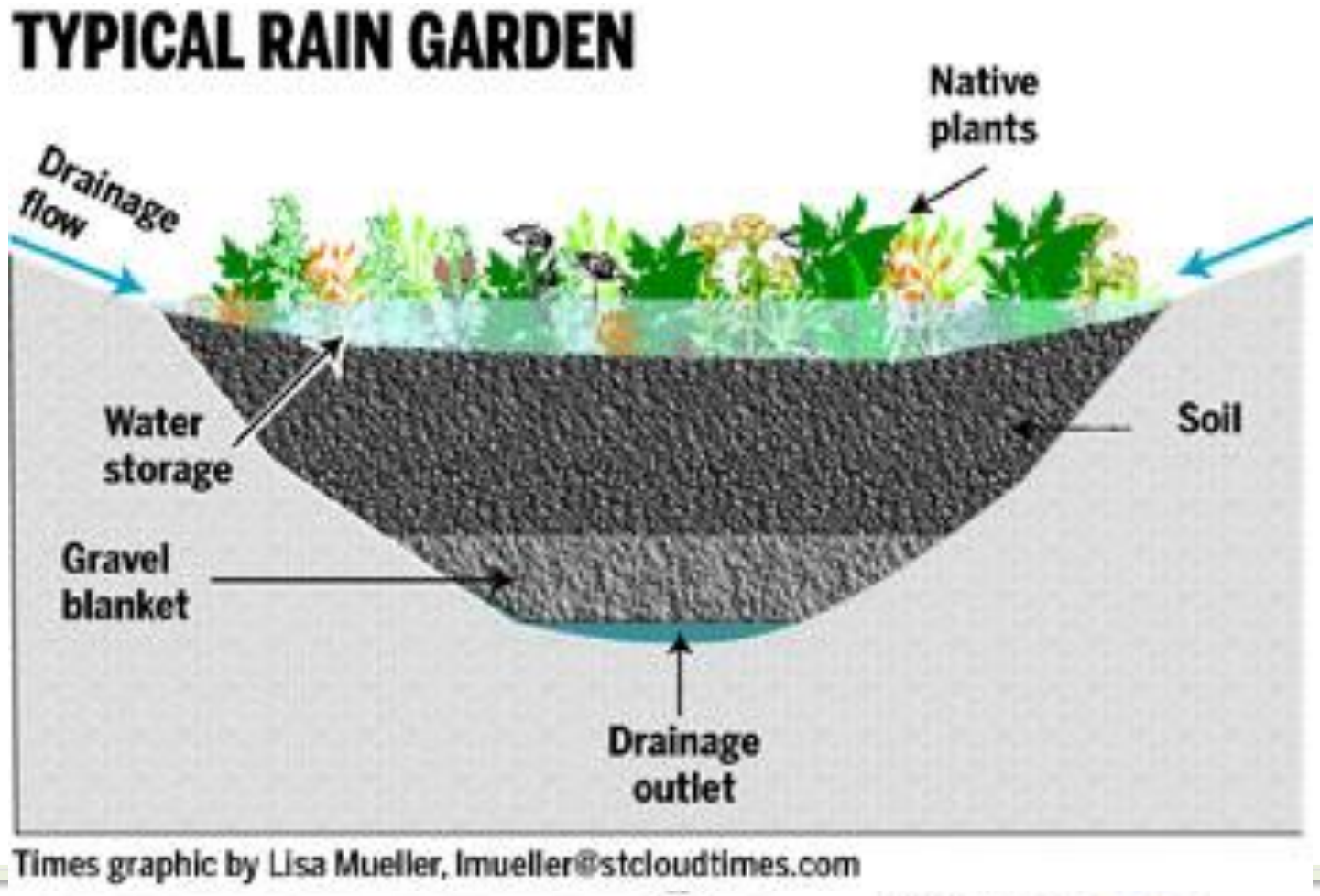
- Clustering

GSI in Practice – Infiltration/Treatment

- Bioretention

- Rain Gardens

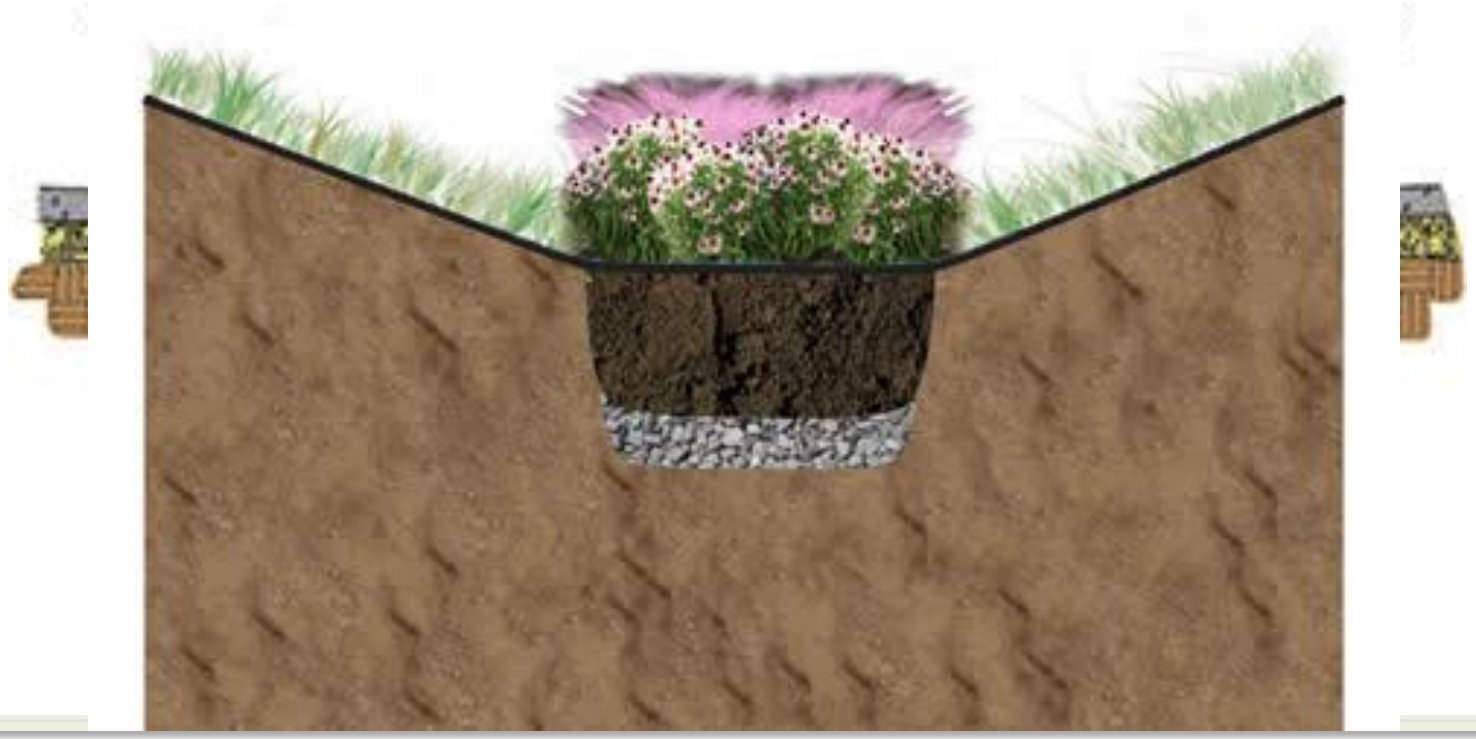
Bioinfiltration Cross Sections



GSI in Practice – Conveyance (infiltration)

- Vegetated Swale

Bioswale Cross Section



GSI in Practice – Storage/Reuse

- Rain barrels and cisterns

Rain Barrel & Cistern Examples

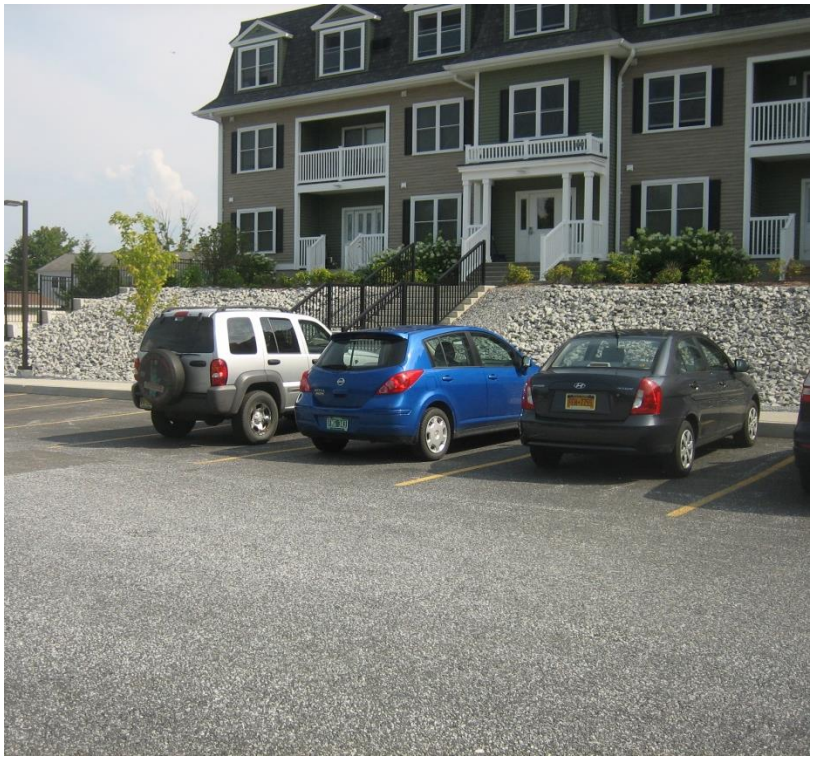
GSI in Practice – Volume Reduction/Evapotranspiration

- Green roofs

Green Roofs in VT

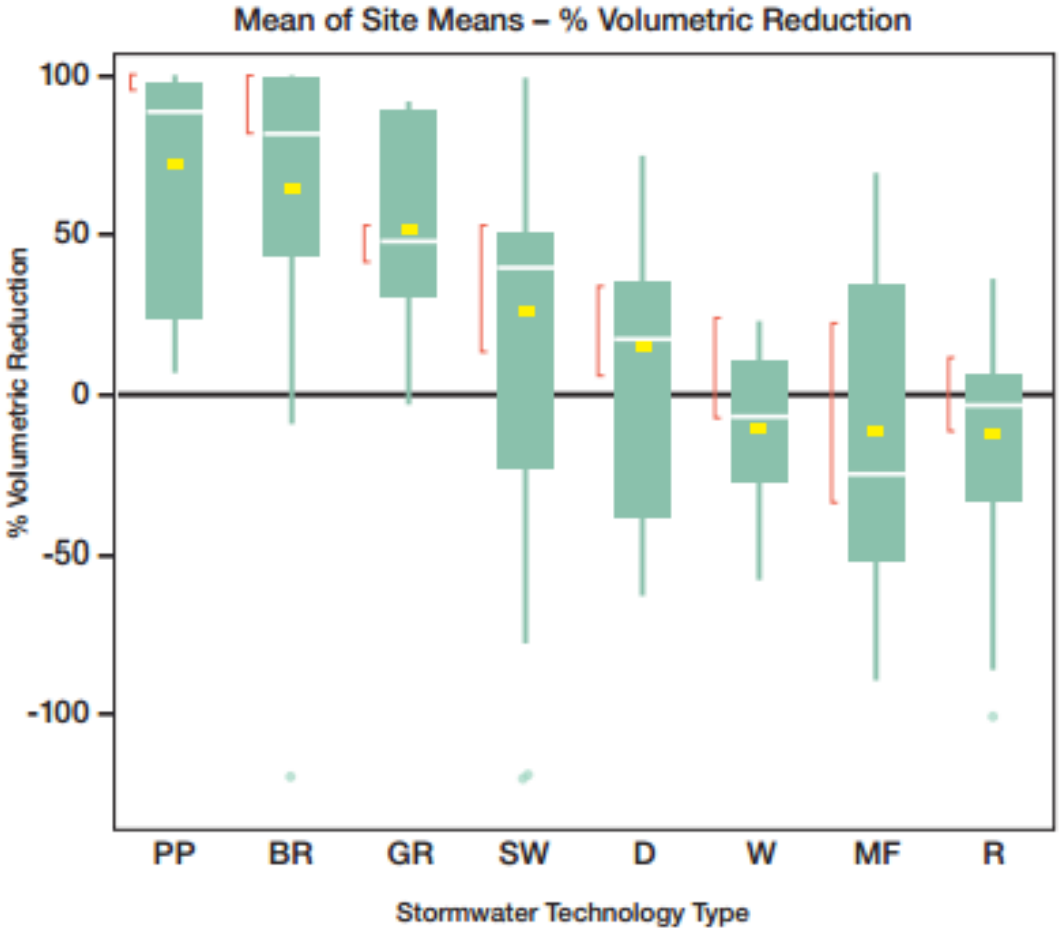
GSI in Practice - Infiltration

- Porous pavements



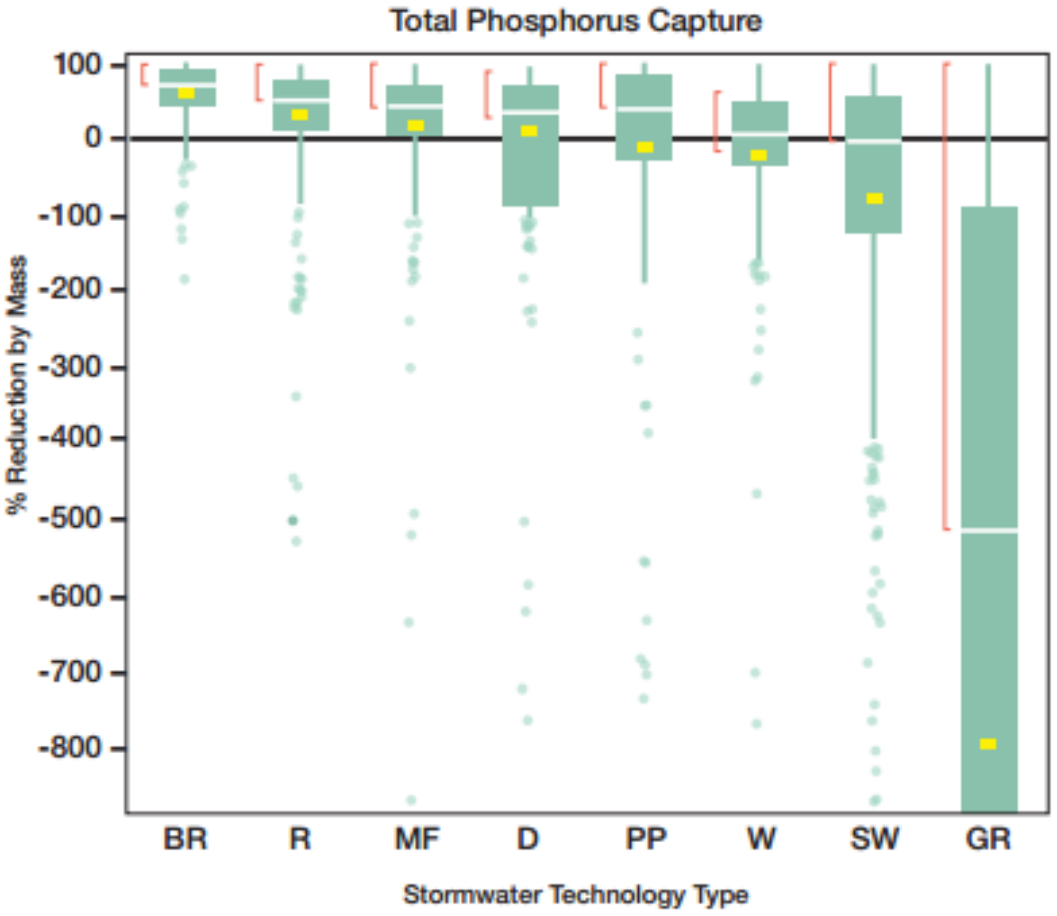
Technology Examples

Technology Performance
Quantity Retention



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



BR - Bioretention: 58.5%
R - Retention Pond: 32.0%
MF - Media Filter: 17.3%
D - Detention Pond: 12.7%
PP - Porous Pavement: -9.25%
W - Wetland: -19.9%
SW - Swale: -76.3%
GR - Green Roof: -791%

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)

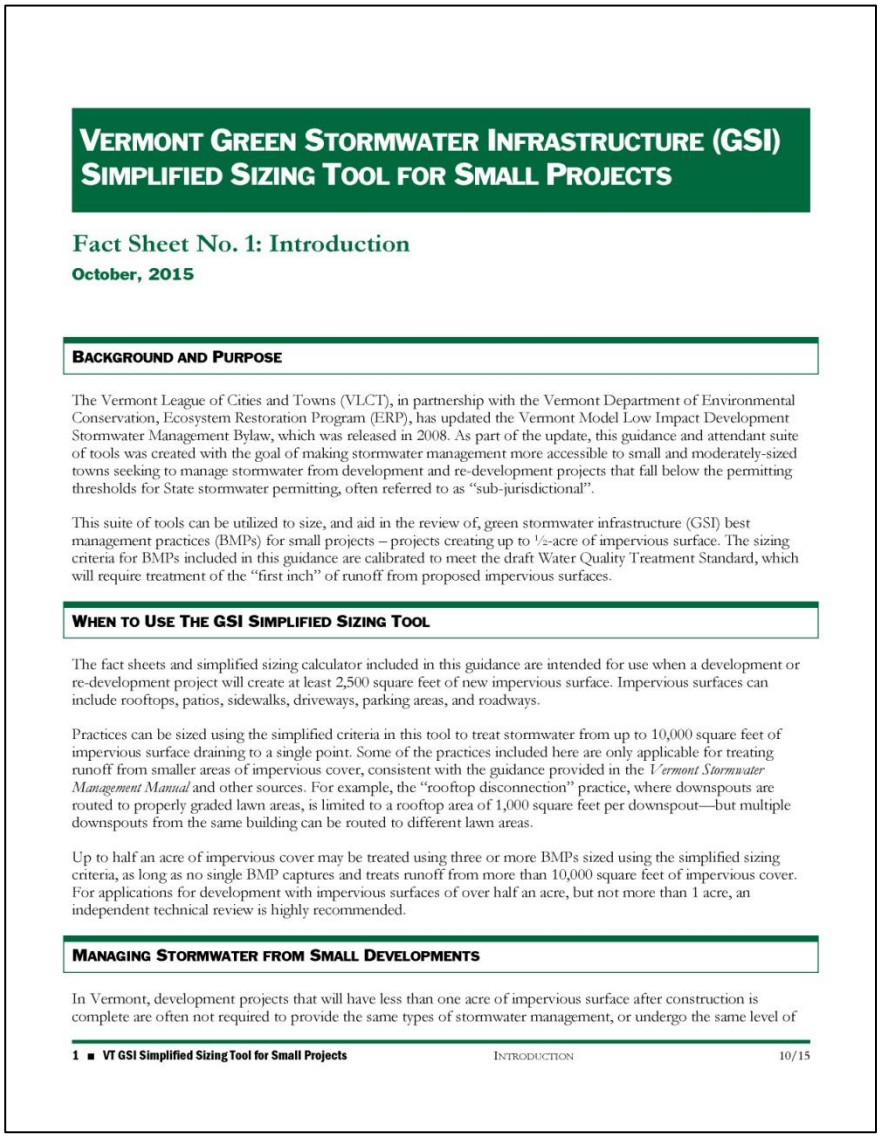
- Model bylaw
  - focuses on site design and GSI practices on small sites where the proposed change or increase in impervious cover is below the thresholds for State stormwater permitting.
- Guidance and sizing tools
  - help applicants and review boards understand what GSI practices are, and how they 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



VERMONT GREEN STORMWATER INFRASTRUCTURE (GSI) SIMPLIFIED SIZING TOOL FOR SMALL PROJECTS

Fact Sheet No. 1: Introduction

October, 2015

BACKGROUND AND PURPOSE

The Vermont League of Cities and Towns (VLCT), in partnership with the Vermont Department of Environmental Conservation, Ecosystem Restoration Program (ERP), has updated the Vermont Model Low Impact Development Stormwater Management Bylaw, which was released in 2008. As part of the update, this guidance and attendant suite of tools was created with the goal of making stormwater management more accessible to small and moderately-sized towns seeking to manage stormwater from development and re-development projects that fall below the permitting thresholds for State stormwater permitting, often referred to as "sub-jurisdictional".

This suite of tools can be utilized to size, and aid in the review of, green stormwater infrastructure (GSI) best management practices (BMPs) for small projects – projects creating up to ½-acre of impervious surface. The sizing criteria for BMPs included in this guidance are calibrated to meet the draft Water Quality Treatment Standard, which will require treatment of the "first inch" of runoff from proposed impervious surfaces.

WHEN TO USE THE GSI SIMPLIFIED SIZING TOOL

The fact sheets and simplified sizing calculator included in this guidance are intended for use when a development or re-development project will create at least 2,500 square feet of new impervious surface. Impervious surfaces can include rooftops, patios, sidewalks, driveways, parking areas, and roadways.

Practices can be sized using the simplified criteria in this tool to treat stormwater from up to 10,000 square feet of impervious surface draining to a single point. Some of the practices included here are only applicable for treating runoff from smaller areas of impervious cover, consistent with the guidance provided in the *Vermont Stormwater Management Manual* and other sources. For example, the "rooftop disconnection" practice, where downspouts are routed to properly graded lawn areas, is limited to a rooftop area of 1,000 square feet per downspout—but multiple downspouts from the same building can be routed to different lawn areas.

Up to half an acre of impervious cover may be treated using three or more BMPs sized using the simplified sizing criteria, as long as no single BMP captures and treats runoff from more than 10,000 square feet of impervious cover. For applications for development with impervious surfaces of over half an acre, but not more than 1 acre, an independent technical review is highly recommended.

MANAGING STORMWATER FROM SMALL DEVELOPMENTS

In Vermont, development projects that will have less than one acre of impervious surface after construction is complete are often not required to provide the same types of stormwater management, or undergo the same level of

1 ■ VT GSI Simplified Sizing Tool for Small Projects INTRODUCTION 10/15

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

Green Stormwater Infrastructure - Best Management Practices (BMPs)

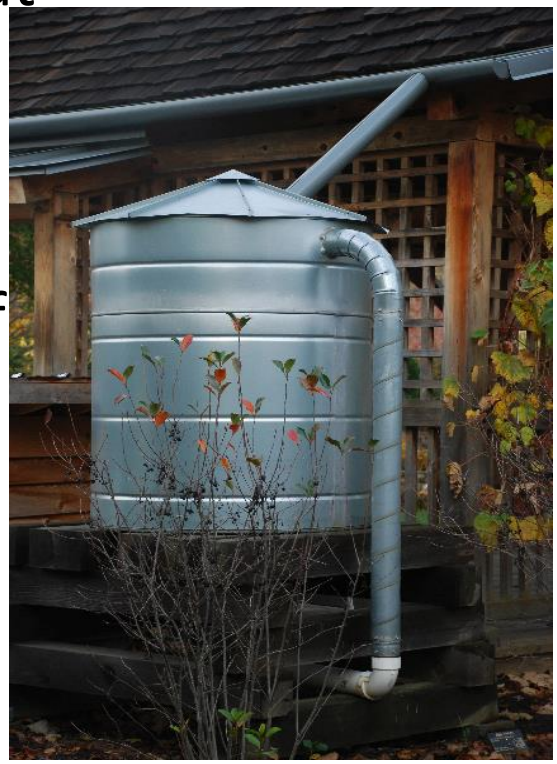
2. Retaining and / or Planting Trees

- 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)

Green Stormwater Infrastructure - Best Management Practices (BMPs)

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 exceed1,000 square feet

Green Stormwater Infrastructure - Best Management Practices (BMPs)

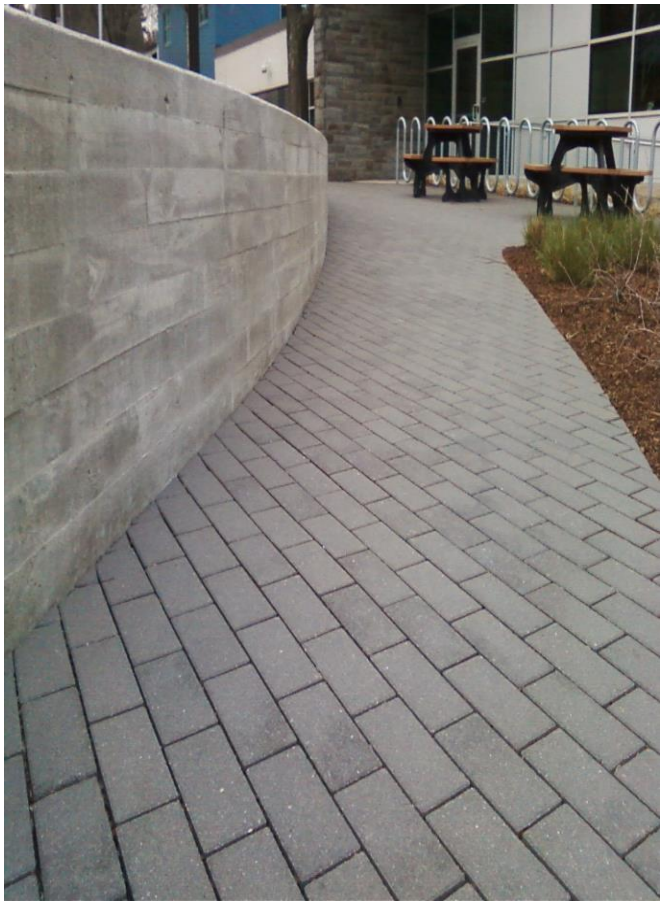
6. Bioretention / Rain Gardens

- 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

GREEN STORMWATER INFRASTRUCTURE SIMPLIFIED SIZING TOOL FOR SMALL PROJECTS
PROJECT INFORMATION SUMMARY

Project Name/Number		BETA-001
Application Submittal Date		10/1/2015
Name of Owner or Developer		
Name of Applicant (if different from Owner)		
Primary Contact Phone Number		
Primary Contact E-mail Address		
Project Location [e911 Address, or intersection or parcel ID No.]		
Project Description [Examples: "Single Family Residence," "Parking Lot Addition," "Retail and Parking"]		
Total Project Site Area (acres)		
Total Earth Disturbance (square feet) [Sum of currently pervious areas that will be cleared, graded, or otherwise disturbed during construction]		
Total New Impervious Surface Area (square feet) [Sum of currently pervious areas that will be covered with new impervious surfaces]		
Total Redeveloped or Replaced Impervious Surface Area (square feet) [Sum of currently impervious areas that will be covered with new impervious surfaces.]		
Total Pre-Project Impervious Surface Area (square ft.)		
Total Post-Project Impervious Surface Area (square ft.)		
Green Stormwater Infrastructure Practices Selected [Check one or more, include sizing detail sheets for each practice selected]		**Total Area Treated Using Selected Practices (sq. ft.)** [Enter the total surface area treated using each selected practice on the lines below]
Post-Construction Soil Depth and Quality (required)	X	0
Tree retention and planting		0
Cisterns and rain barrels		0
Rooftop disconnection		0
Non-rooftop disconnection		0
Drywell		0
Rain garden / bioretention		0
Vegetated swale		0
Infiltration trench		0
Permeable pavers		0
Site Plan Attached?		

GREEN STORMWATER INFRASTRUCTURE SIMPLIFIED SIZING TOOL FOR SMALL PROJECTS
ROOFTOP DISCONNECTION SIZING DETAILS

Project Name/Number	BETA-001
Application Submittal Date	10/1/2015

DESIGN TABLE:		
	Disconnection Area Slope	
HSG of soil in disconnection area	**Less than 8%**	**8-15%**
A/B or infiltration rate >=0.5 in./hr	35 feet	50 feet
C/D or infiltration rate < 0.5 in./hr	65 feet	85 feet

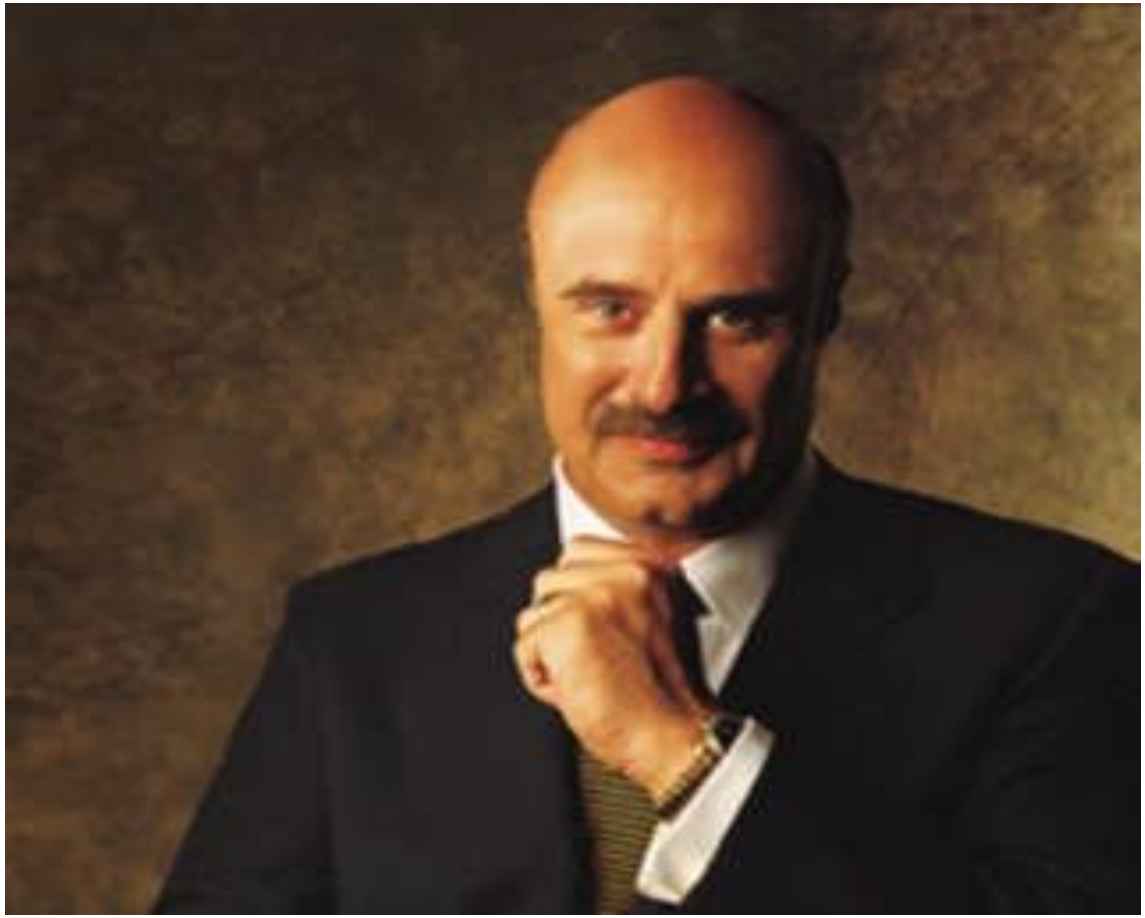
AREA NO.		(rooftop areas only)
Square footage of rooftop area:	0	square feet (maximum 1,000 square feet per downspout)
Slope of the disconnection area:	0	% (whole number slope %)
Infiltration rate:	0.5	inches / hour
SIZING CALCULATION RESULTS:		
Required Disconnection Area Width (across slope, on contour):	12	feet
Required Disconnection Area Length (down-slope):	35	feet
Grade controls every 20 feet are:	NOT REQUIRED	

AREA NO.		(rooftop areas only)
Square footage of rooftop area:	0	square feet (maximum 1,000 square feet per downspout)
Slope of the disconnection area:	0	% (whole number slope %)
Infiltration rate:	0.5	inches / hour
SIZING CALCULATION RESULTS:		
Required Disconnection Area Width (across slope, on contour):	12	feet
Required Disconnection Area Length (down-slope):	35	feet
Grade controls every 20 feet are:	NOT REQUIRED	

AREA NO.		(rooftop areas only)
Square footage of rooftop area:	0	square feet (maximum 1,000 square feet per downspout)
Slope of the disconnection area:	0	% (whole number slope %)
Infiltration rate:	0.5	inches / hour
SIZING CALCULATION RESULTS:		
Required Disconnection Area Width (across slope, on contour):	12	feet
Required Disconnection Area Length (down-slope):	35	feet
Grade controls every 20 feet are:	NOT REQUIRED	

Total Impervious Area Treated Using Rooftop Disconnection - Transfer this number to Sheet #1, Project Information:	**0 square feet**

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

- http://www.watershedmanagement.vt.gov/stormwater/htm/sw_manualrevision.htm

Questions?

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