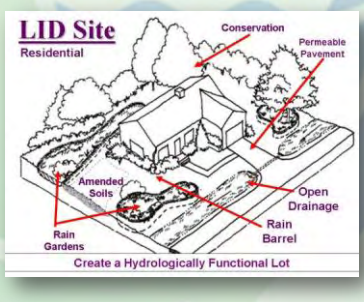
EPA Region 1 MS4 Stormwater General Permits and LID Training Clinic



Fundamentals of LID

NHDES
Concord, NH
May 12, 2011

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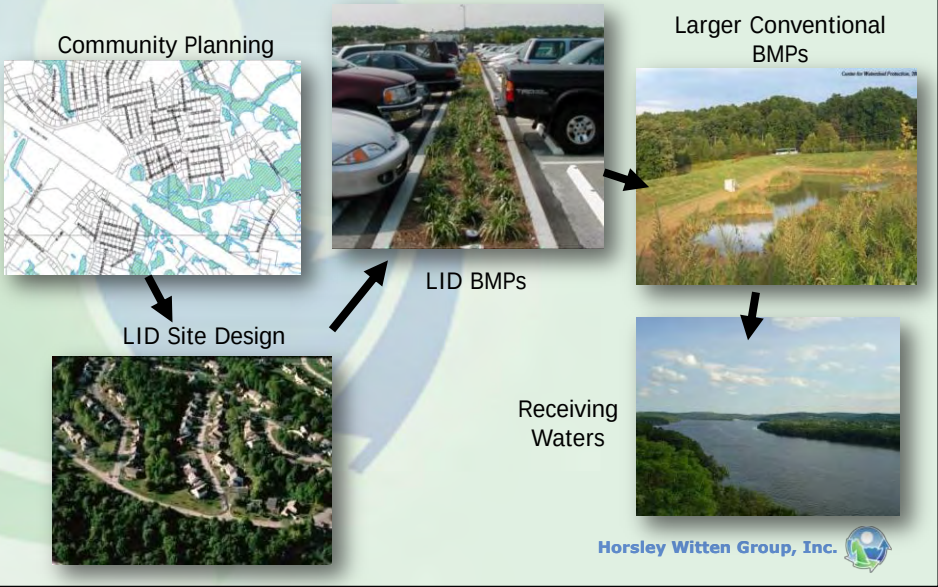
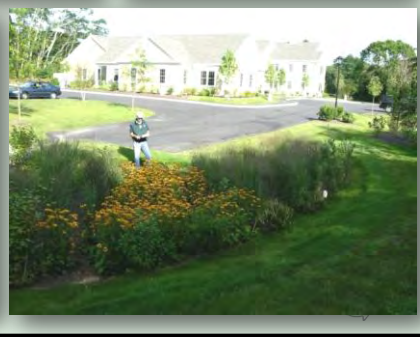
Low Impact Development (LID)



Low Impact Development (LID)

	Traditional	LID
Site Design		
BMPs		

LID Site Planning and Design Approach

Objective - to provide a process by which LID is considered at an early stage in the planning process to prevent stormwater impacts rather than mitigate them.

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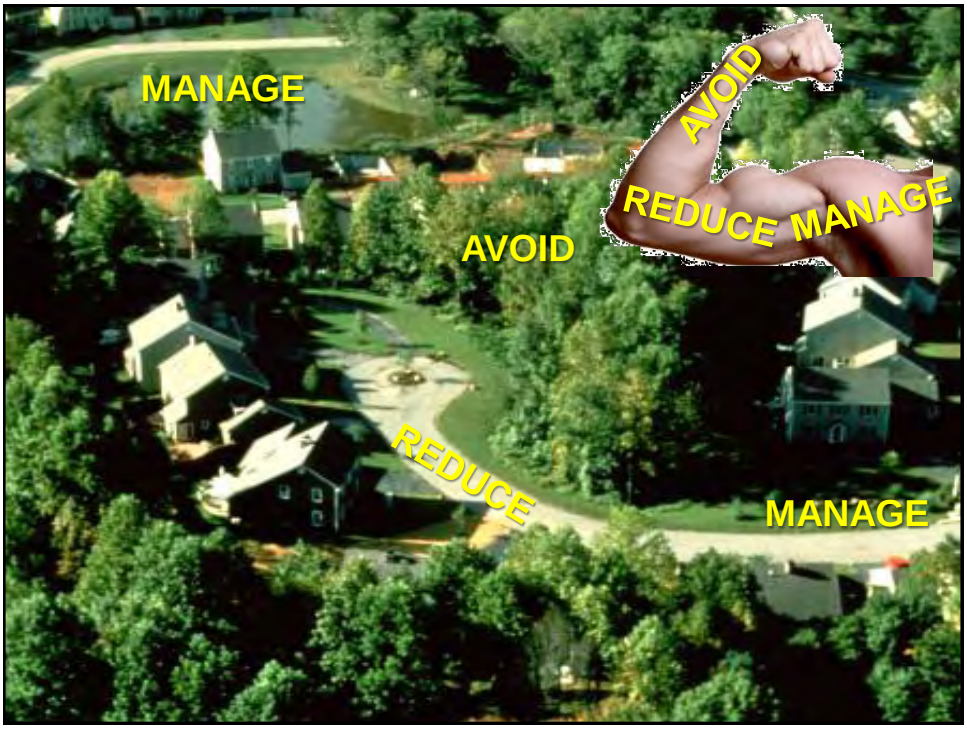

LID Site Planning and Design Criteria

A	Protect undisturbed open space;
A	Maximize the protection of natural drainage areas, streams, surface waters, wetlands, and buffers;
A	Minimize land disturbance, locate disturbances in less sensitive areas;
A/R	Minimize the decrease in the "time of concentration" from pre-construction to post-construction;
A/R	Minimize soil compaction;
R	Minimize impervious surfaces;
M	Provide vegetated conveyance and treatment systems;
M	Provide low-maintenance landscaping;
M	Break up or disconnect runoff over impervious surfaces;
M	Provide source controls to prevent / minimize the release of pollutants into stormwater runoff.

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Avoid the Impacts

Preservation of Natural Features & Compact Development

- Preservation of undisturbed areas;
- Preservation of buffers, natural drainage systems;
- Reduction of clearing and grading;
- Locating sites in less sensitive areas;
- Compact development; and
- Working with natural conditions (landscape, hydrology, soils)

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Open Space Residential Design

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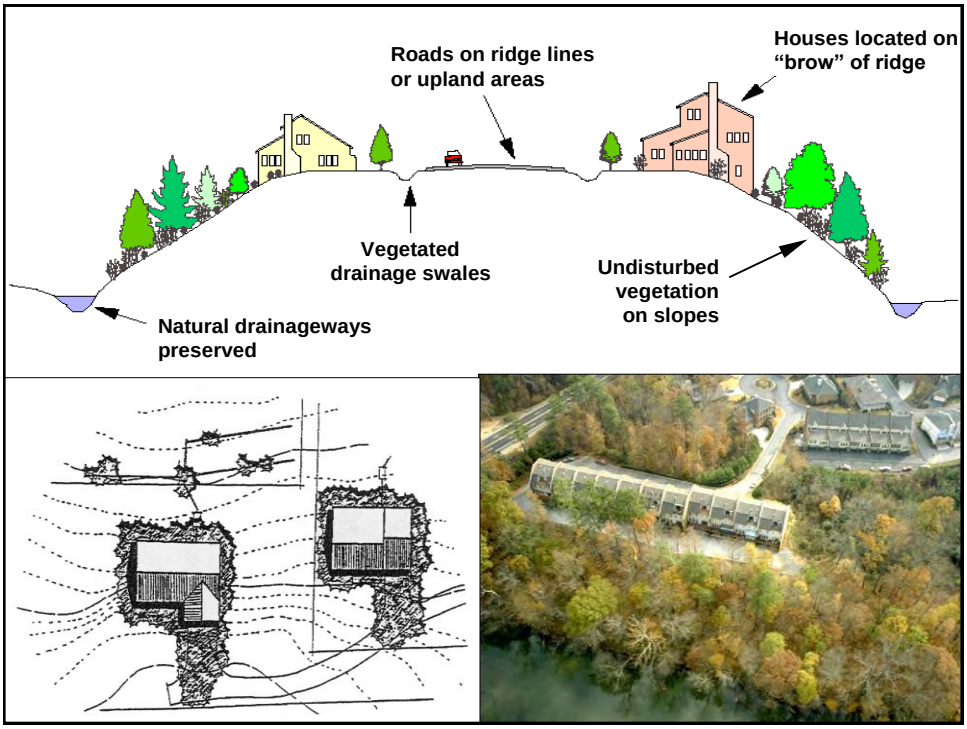
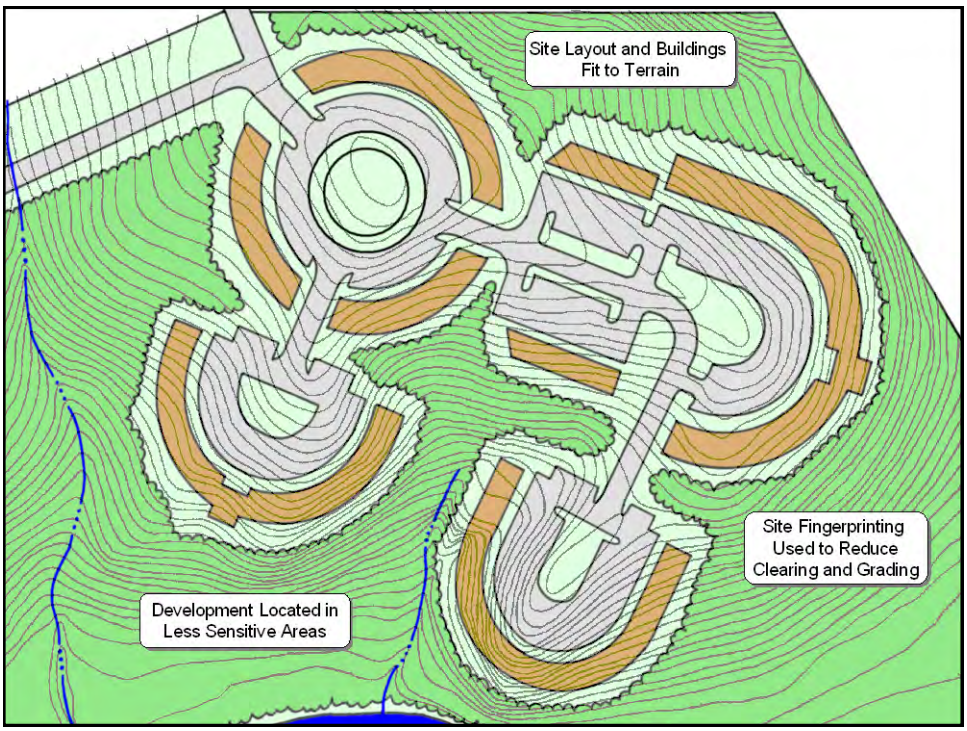

Roads on ridge lines
or upland areas
Houses located on
"brow" of ridge
Vegetated
drainage swales
Undisturbed
vegetation
on slopes
Natural drainageways
preserved


Site Layout and Buildings
Fit to Terrain
Site Fingerprinting
Used to Reduce
Clearing and Grading
Development Located in
Less Sensitive Areas

Buffers and Stormwater

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Reduce the Impacts
Reduction of Impervious Cover

- Roadway Reduction;
- Sidewalk Reduction;
- Driveway Reduction;
- Cul-de-sac Reduction;
- Building Footprint Reduction; and
- Parking Reduction.

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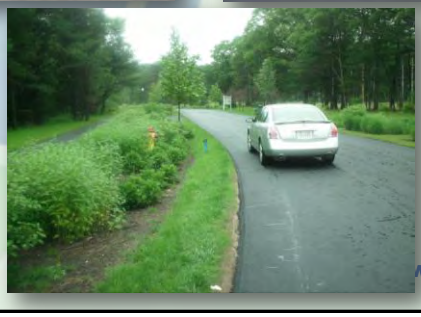
Street Widths and Lengths



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Shared driveways reduce total area


Wide cul-de-sac with excessive impervious cover
Photo Copyright 1999, Center for Watershed Protection


Hammerhead turn-around


Permeable pavers are an alternative


Oversized parking lot with excessive impervious cover


Parking demand ratios dictate parking lot size

Manage the Impacts
Source Controls/Structural Controls

- Disconnection of Impervious surfaces;
- Mitigation of runoff*;
- Stream restoration; and
- Reforestation.

*Practices that rely on natural systems (e.g., bioretention, constructed wetlands, infiltration, filtering)

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Rain Gardens

Rain Barrels and Cisterns

Source: http://www.rdrop.com/users/krishna/rainwatr.htm

Green/blue Roofs

Green/blue Roofs

Stream Restoration

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Stream Daylighting

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Reforestation

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Center for Watershed Protection

Street Trees

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New England Examples

- LID Retrofit in Plymouth Harbor, MA;
- Pilot installations at Silver Lake in Wilmington, MA
- NH Examples from Greenland, Pelham & Rochester
- Costs and Benefits

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Water Street Retrofit
Plymouth, MA
Plymouth
Water Front Park
N Park Ave
S Park Ave
Memorial Dr
Hilton St
Howland St
Brewster St
Plymouth
Plymouth Rock


Existing Conditions and
Site Constraints
• 4.5 acre drainage area – 33% imperviousness
• Residential & commercial properties
• Heavily trafficked site
• Close proximity to Plymouth Harbor Coastal Bank
• Steep grades and poor soils (Urban Fill)

Stormwater Design Features

- Bioretention facility designed as primary treatment;
- 990 square-feet of treatment area;
- Sized to treat ½-inch of runoff;
- Low flows directed through diversion structure;
- High flows bypass bio to prevent scouring & erosion;
- Bio designed w/ underdrain system due to poor soils;
- Steep grades accommodated w/ boulder wall;
- Designed to fit in w/ surrounding landscape.

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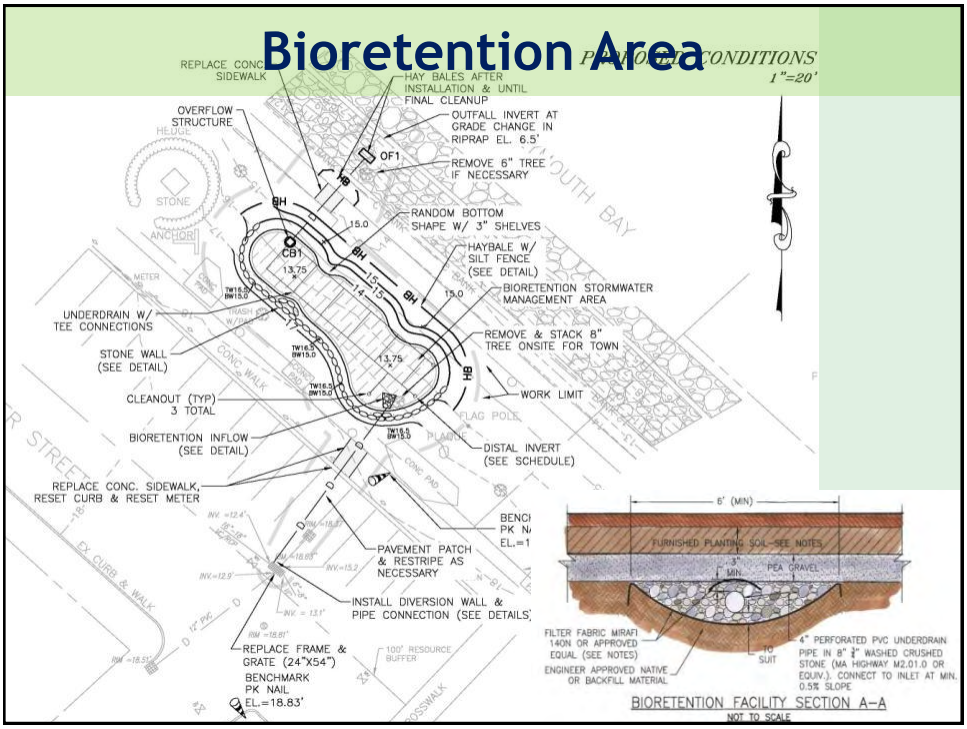
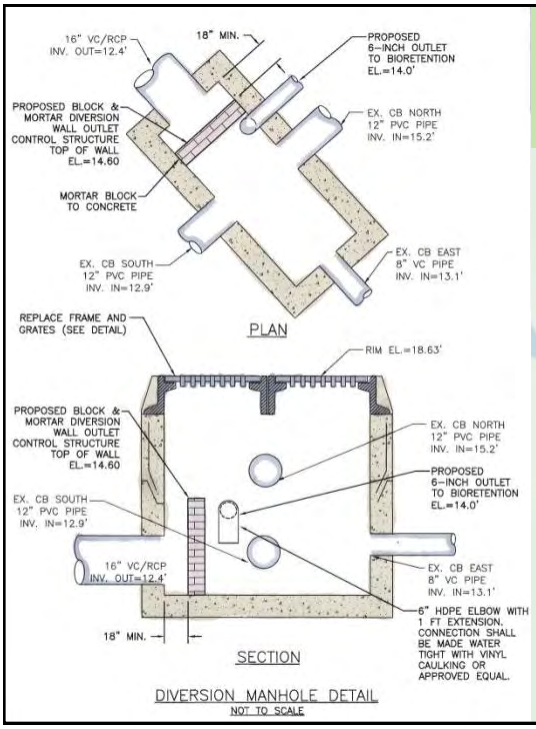
Bioretention Area





Diversion Structure

- Retrofit of existing structure
- ½-inch water quality event directed to bio
- High flows bypass to existing outlet

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Bioretention Planting Plan

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Underdrain and Stone Placement

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Filter Media Placement and Bio Plantings

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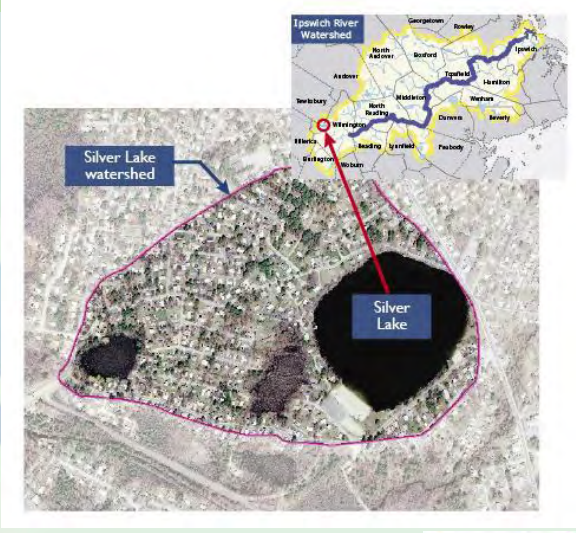
Silver Lake Wilmington, MA

- Silver Lake
  - Watershed Area: 132 acres
  - Pond Area: 28.5 acres
  - Watershed/Lake Ratio = 4.6:1
- Ipswich River Watershed



Horsley Witten Gr

Geosyntec consultants

LID Technologies Demonstrated

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Geosyntec consultants

Pre-Construction Conditions

Geosyntec consultants

Parking Lot Improvements

Monitoring Results

Infiltration Test Results

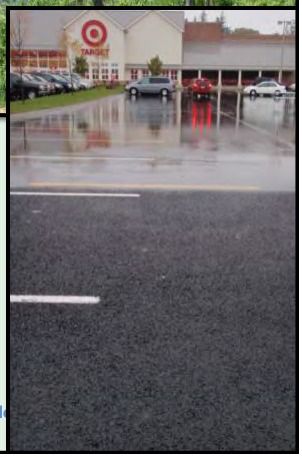
Location	Infiltration Rate (in/hr)
Bioretention Cell 1	22.73
Bioretention Cell 2	21.94
Raingarden	12.38

Note: ASTM D3385-94 provides accurate results for soils with infiltration rates between 0.0014 and 14.17 in/hr.

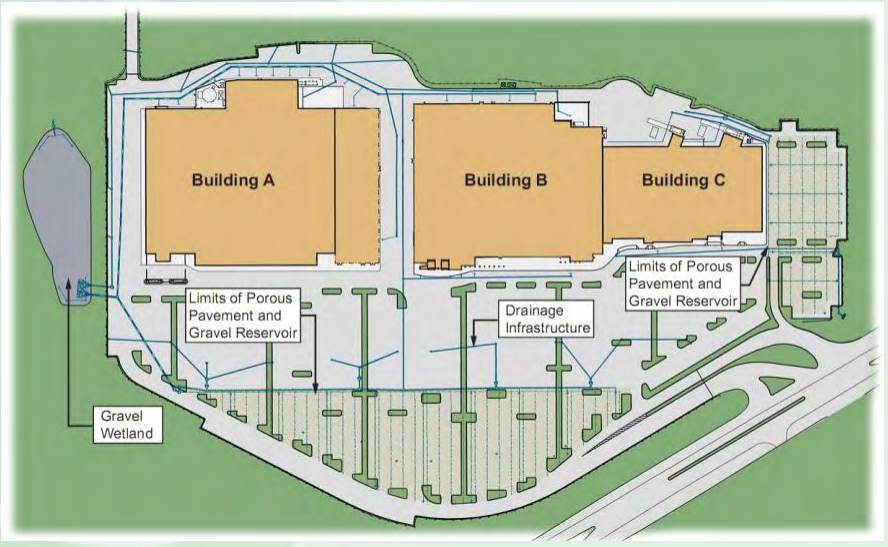
Geosyntec consultants

Greenland Meadows Commercial, Greenland, NH

- "Gold-Star" Commercial Development
- Cost of doing business near Impaired Waters/303D
- Saved $900k in SWM on costly piping and advanced SWM proprietary
- Brownfields site, ideal location, 15yrs
- Proposed site >10,000 Average Daily Traffic count on >30 acres



Site Design using LID and MTD



28 ac site, initially >95% impervious, now <10%EIC, with all drainage through filtration, expected to have minimal WQ impact except thermal and chloride

47

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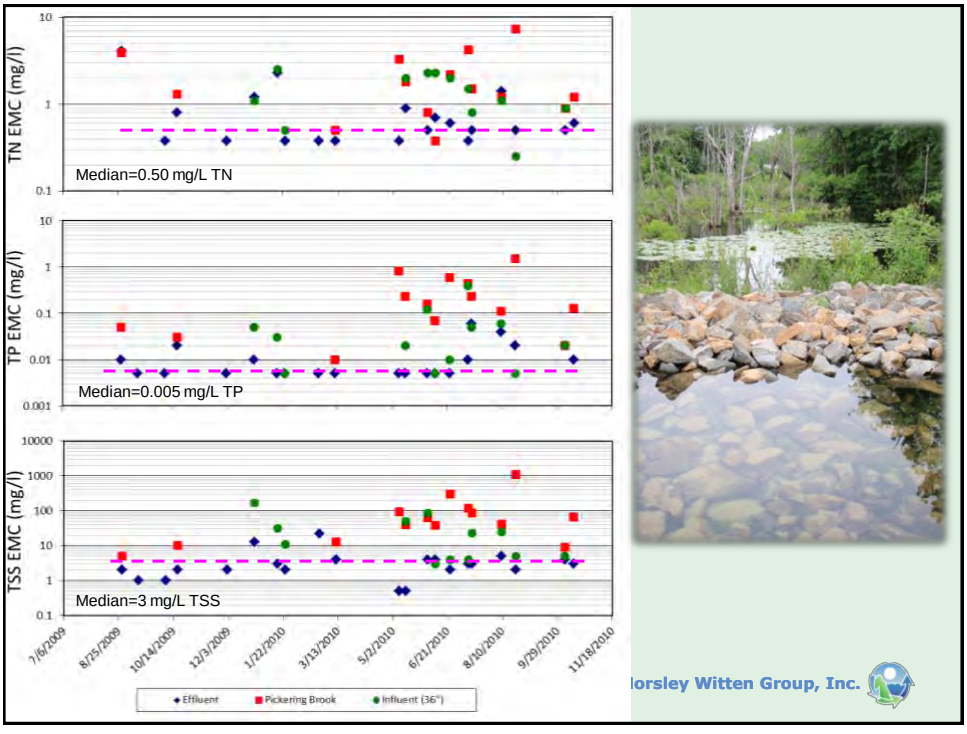
TN EMC (mg/l)
Median=0.50 mg/L TN
TP EMC (mg/l)
Median=0.005 mg/L TP
TSS EMC (mg/l)
Median=3 mg/L TSS
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010
3/13/2010
5/2/2010
6/21/2010
8/10/2010
9/29/2010
11/18/2010
Effluent
Pickering Brook
Influent (36")
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Comparison of Unit Costs

Item	Conventional Option	LID Option	Cost Difference
MOBILIZATION / DEMOLITION	$555,500	$555,500	$0
SITE PREPARATION	$167,000	$167,000	$0
SEDIMENT / EROSION CONTROL	$378,000	$378,000	$0
EARTHWORK	$2,174,500	$2,103,500	–$71,000
PAVING	$1,843,500	$2,727,500	$884,000
STORMWATER MANAGEMENT	$2,751,800	$1,008,800	–$1,743,000
ADDITIONAL WORK-RELATED ACTIVITY (utilities, lighting, water & sanitary sewer service, fencing, landscaping, etc.)	$2,720,000	$2,720,000	$0
PROJECT TOTAL	$10,590,300	$9,660,300	–$930,000

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Boulder Hills, Pelham, NH

- 2009 Installation of 900’ of first Porous Asphalt (PA) private residential road in New England (that we know of);
- Site nearly Zero Discharge;
- LID subdivision 55+ Active Adult Community;
- Large sand deposit (great geology/soils);
- Cost of PA 25% greater per ton installed

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Infrastructure Savings

- Built on 9% grade;
- Avoided use of 1616’ of curbing, 785’ pipe, 8 catch-basins, 2 detention basins, 2 outlet control structures;
- 1.3 acres less of land clearing
- Conventional SWM=$789,500 vs LID SWM=$740,300;
- $49,000 savings (6.2% of total SWM cost).

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Comparison of Unit Costs

Item	Conventional	LID	Difference
SITE PREPARATION	$23,200.00	$18,000.00	–$5,200.00
TEMP. EROSION CONTROL	$5,800.00	$3,800.00	–$2,000.00
DRAINAGE	$92,400.00	$20,100.00	–$72,300.00
ROADWAY	$82,000.00	$128,000.00	$46,000.00
DRIVEWAYS	$19,700.00	$30,100.00	$10,400.00
CURBING	$6,500.00	$0.00	–$6,500.00
PERM. EROSION CONTROL	$70,000.00	$50,600.00	–$19,400.00
ADDITIONAL ITEMS	$489,700.00	$489,700.00	$0.00
BUILDINGS	$3,600,000.00	$3,600,000.00	$0.00
PROJECT TOTAL	$4,389,300.00	$4,340,300.00	–$49,000.00

6% savings on total cost of SW infrastructure for a ~zero discharge site

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School Street School LID Retrofit

Background:

- Partnership between City of Rochester, Cocheco River Watershed Coalition, and the UNHSC on 319 Grant;
- School Street School is 0.6 acres of impervious surface with no stormwater management, and 64% IC;
- No existing drainage structures resulting in sheet flow runoff from all impervious areas during storms
  - Localized flooding
  - Reduced use of playground facilities
  - Damage to adjacent road and sidewalk
  - Water quality impacts to Willow Brook

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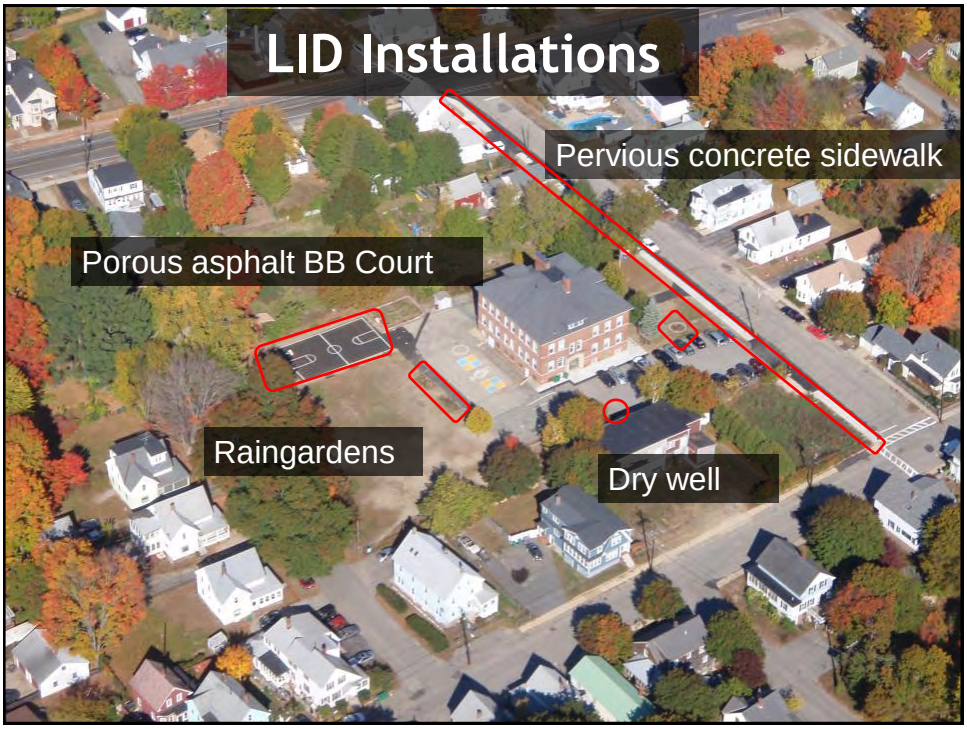

Retrofit Accomplishments

- Improved drainage and usability;
- Intercept runoff, divert from principle use areas (playground and parking lot);
- Store, treat, infiltrate, convey;
- Increased pedestrian safety (reduced ponding, snow and ice);
- Retrofits treated % 80 of IC;
- $IC_{initial}$= 64% → EIC 13%.

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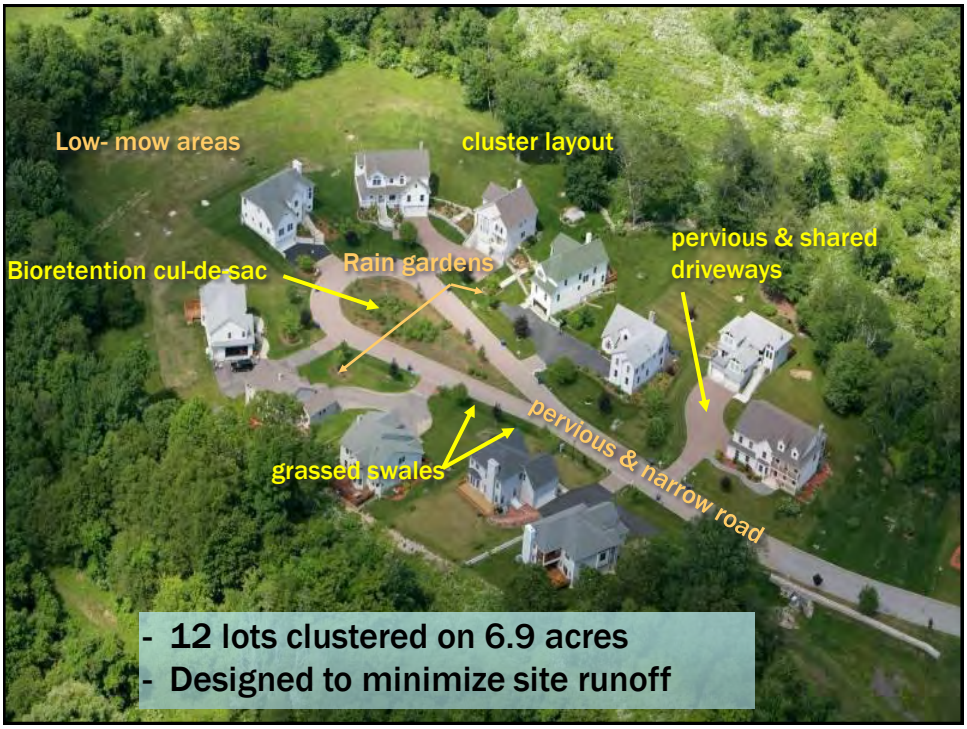
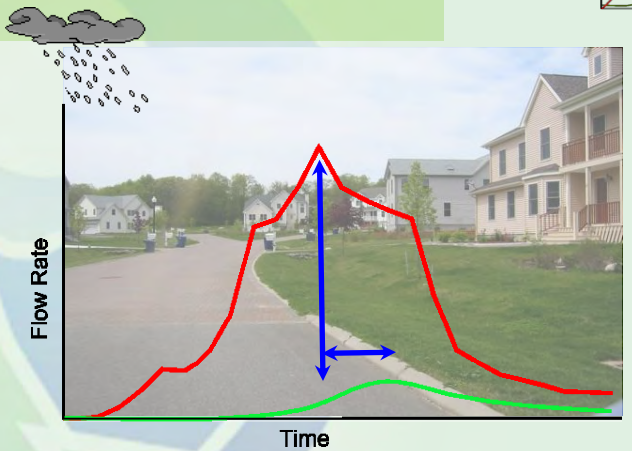
Low Impact Development

Does it really work?



But Does It Work?



Adapted from J. Clausen, UConn

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Some LID Cost Comparisons

(as recently reported in Stormwater Magazine)

Conventional Design Savings

- Mobilization
- Professional services (design and construction observation)
- Detention ponds
- Landscaping
- Paving?
- Maintenance?

LID Design Savings

- Site clearing and grading (earthwork)
- Temporary E&SC
- Drainage infrastructure (pipes and inlets)
- Curbing
- Site stabilization
- Paving?
- Maintenance?

But it really Depends

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LID Cost Savings a Function of Design and Expertise

- Is the project a Conservation Development (OSRD) with reduced disturbance?
- How much LID is incorporated (pervious pavers, swales, natural area preservation, etc?
- How complicated are the designs? Is multiple staging required?
- Are there unusual site constraints (slopes, soils, shallow groundwater, etc)?
- Is density going to be affected?
- How much expertise exists in your region?
- How much maintenance is required?
- Are the local codes compatible with LID?

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