Low Impact Development Practices and Smart Growth

An Introduction for Town Officials

John Rockwell, Wetland Specialist
Buzzards Bay Project
National Estuary Program

November 6, 2004

Acknowledgements

This presentation is an overview of Low Impact Development (LID) and how it can be used to help protect and restore the water quality and biological resources of Massachusetts. LID is being used throughout the country. This presentation is largely taken from a presentation from the Puget Sound Action Team's 2001 conference "Low Impact Development in Puget Sound." Additional slides have been taken from presentations at the Council of Governments LID Conference "Putting the LID on SWM" held September 21-23, 2004. The conference proceedings are one of this workshop handouts. Additional Information and graphics have been downloaded from various websites. Links to those websites have been provided on the CD provided by the Buzzards Bay Project, www.buzzardsbay.org/lid.htm.

Low Impact Development

An innovative, ecosystem-based approach to land development and stormwater management

Presentation Highlights

- **Why We Need Low Impact Development**
- **Goals and Basic Principles**
- **Common Practices**
- **Projects and Studies**

Why We Need Low Impact Development

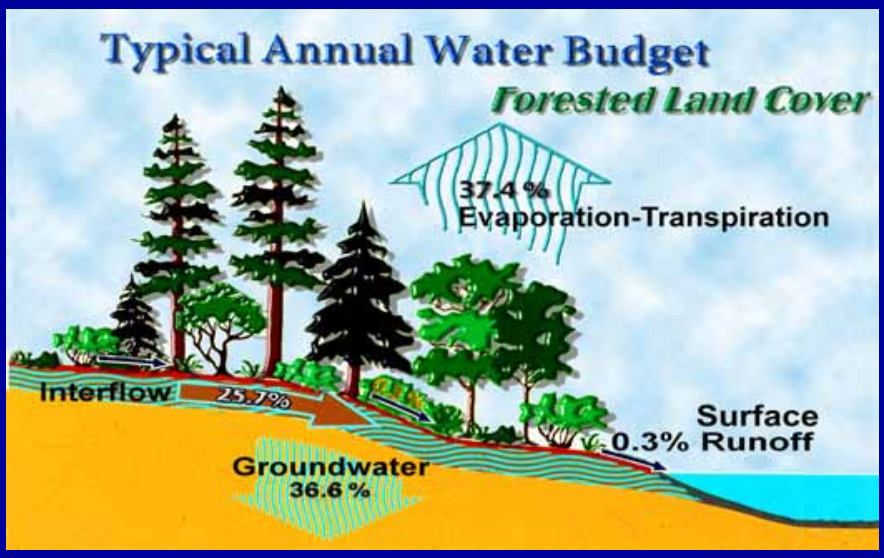
To better protect our:

- Streams
- Fish and shellfish habitat
- Watershed hydrology
- Drinking water
- Water quality

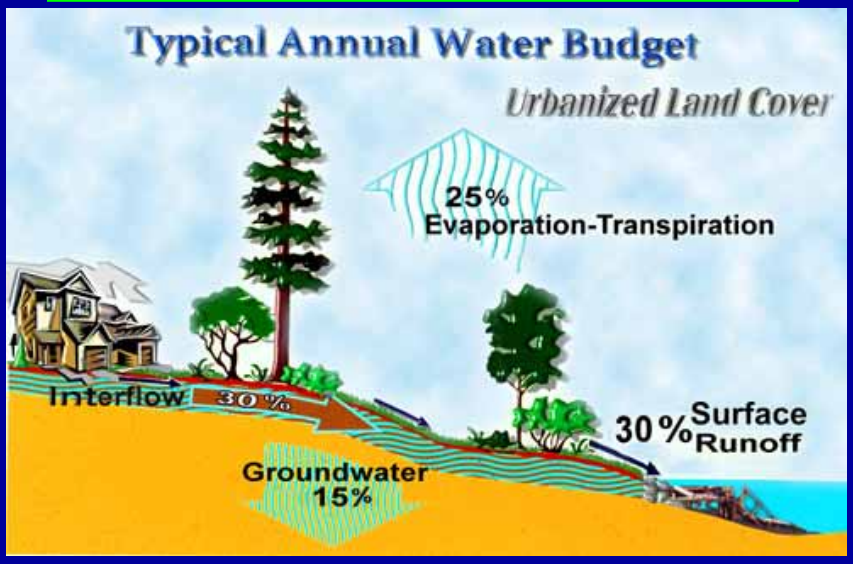
To reduce infrastructure costs

To make our communities more attractive

Natural Conditions



Developed Conditions



Excessive Street Width

Rapid catchment of runoff leads to….

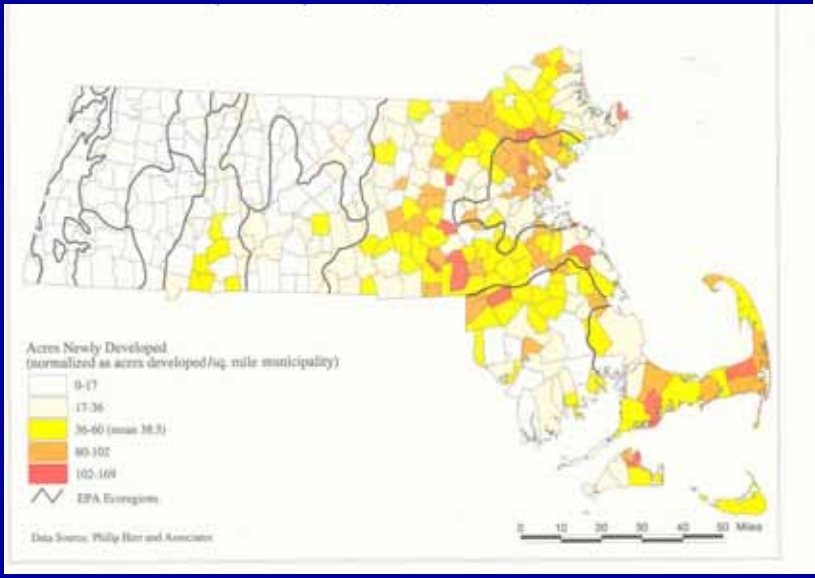
Flooding

Where is the Green?

Storm Water Runoff Pollutants

- **Bacteria**
- **Sediment**
- **Heavy Metals**
- **Pesticides**
- **Fertilizers**
- **Petroleum Products**

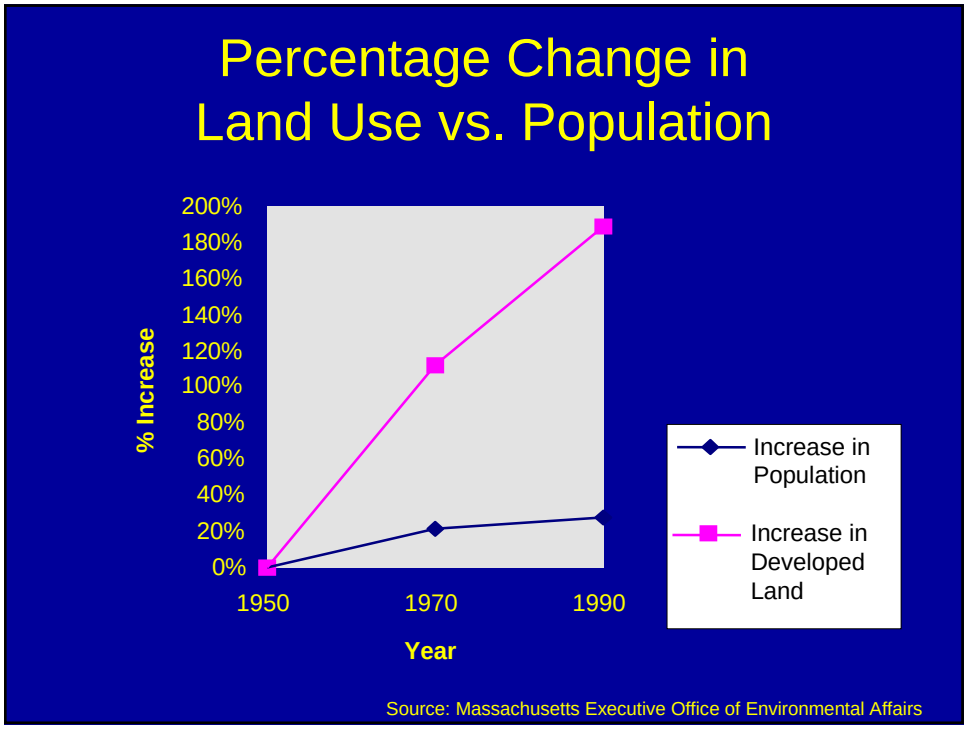
Newly developed land in Mass.

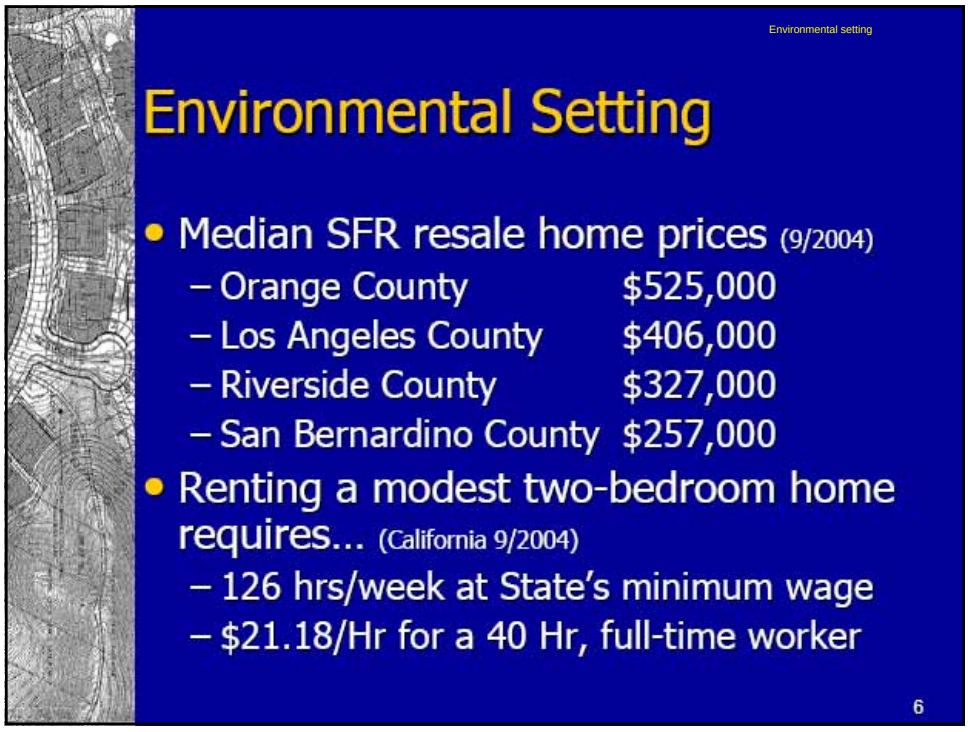


Facts About Land Use Change

- Developed land throughout Massachusetts now has less than half the population density (4.97 persons/acre) than it had in 1950 (11.19 persons/acre).
- 16,000 acres of land is developed each year in Massachusetts.
- More than twice as much land has been developed since 1950 than was developed in the previous 300 years.

Source: Executive Office of Environmental Affairs and Massachusetts Audubon Society


Percentage Change in
Land Use vs. Population
200%
180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
% Increase
1950
1970
1990
Year
Increase in Population
Increase in Developed Land
Source: Massachusetts Executive Office of Environmental Affairs


Environmental setting
Environmental Setting
• Median SFR resale home prices (9/2004)
– Orange County $525,000
– Los Angeles County $406,000
– Riverside County $327,000
– San Bernardino County $257,000
• Renting a modest two-bedroom home requires... (California 9/2004)
– 126 hrs/week at State's minimum wage
– $21.18/Hr for a 40 Hr, full-time worker
6

Even low imperviousness impacts stream quality (Chesapeake Bay Program 2003)

Imperviousness and Stream Quality in Montgomery Co., Maryland (Blaha et al., 2001)

- **Quality measured by fish and benthic IBI scores**
- **Influence of imperviousness mediated by forested buffer quality between 6% and 28%**
- **Detectable impacts commence around 6%**
- **All streams are in poor condition where imperviousness >28%**

Impacts of Impervious Area

- **Increased** Rate **of Runoff**
  - – Flash Flooding
- **Increased** Volume **of Runoff**
  - – Reduced Infiltration
  - – Increased Streambank Erosion
- **Increased** Pollutant **Loadings**
  - – Temperature Changes
  - – Loss of Aquatic diversity

Levels of Imperviousness

(NRCS Urban Hydrology for Small Watersheds, 1995)

- **- Low density residential = 20%**
- **- High density residential = 38-65%**
- **- Commercial and business = 85%**
- **- Industrial = 75%**

Old Practices

Conventional Storm Water Basins

Dry Detention Basin

Wet Pond

Mosquitoes?

Construction Impacts on Soils

Standard WQ Treatment For Storm Water

Treat the "Water Quality Storm" to eliminate the "first flush" pollutants.

Require a limited amount of Infiltration.

Theory of the *80% TSS Removal Requirements

- **Nationwide Standard**
- **First Focused predominantly on Agricultural Runoff, (now everywhere)**
- **90% of Storms, 90% of TSS**
- **Many other pollutants "cling" to the soil particles**

Problems with Focus on the Water Quality Storm

- **20% of Pollutants "pass through" during the generation of the WQV**
- **Developed sites now generate runoff in the smaller storms**

Runoff Generation in Predevelopment Conditions

- **A soils – no runoff until 7.5 inches**
- **B soils – no runoff until 3.0 inches**
- **C Soils - no runoff until 1.8 inches**
- **D Soils – no runoff until 1.3 inches**

Overview - Development and Storm Water

- **Conventional development trends and storm water**
  - dispersed development has translated into more impervious surface per project
  - collection of storm water from impervious surfaces creates faster flow, higher temperatures and more pollutants
  - as older areas abandoned, watershed must handle effects of old & new development footprint - plus effects of crumbling infrastructure

How can we make residential developments function hydrologically like natural systems

Primary Goal of LID

- **Hydrologically functional landscaping**
  - Increase foliage interception
  - Increase infiltration
  - Increase soil moisture storage capacity
  - Slow down runoff flow
  - Moderate temperature
  - Encourage plant uptake of contaminants

Basic LID Principles

1. Conserve natural areas
2. Minimize development impacts
3. Maintain site runoff rate
4. Use integrated management practices
5. Implement pollution prevention, proper maintenance and public education programs

1. Conserve Natural Areas

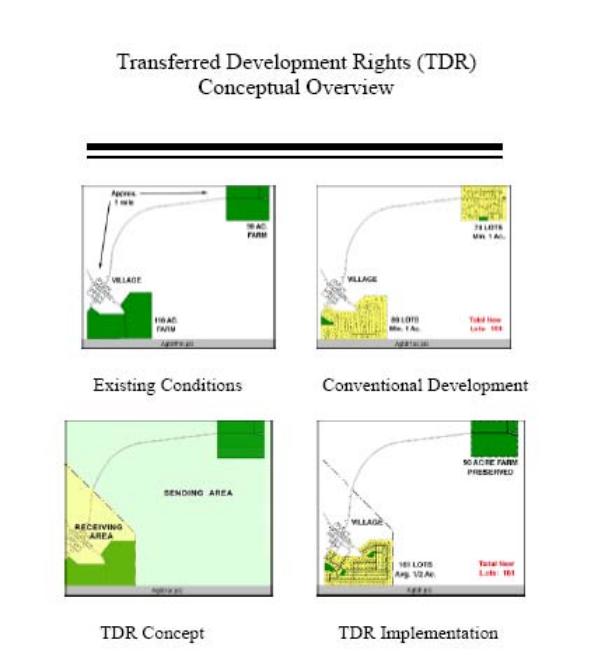
- Conservation of drainages, trees & vegetation
- Land use planning
- Watershed planning
- Habitat conservation plans
- Stream & wetland buffers

Impervious Reduction by Clustering on an 80 Acre Site

2 acre lot size has 12% impervious cover.

A 80 Acre site of 40 - 2 acres has 7.2 acres of impervious cover.

A 80 acre site of 40 – ¼ acre sites has 3.8 acres of impervious cover. Overall imperviousness has been reduced to 3.8 acres.



TDR's

Cluster development on a larger scale.

2. Minimize Development Impacts

- Reduce storm pipes, curbs and gutters
- Preserve sensitive soils
- Cluster buildings and reduce building footprints
- Reduce road widths
- Minimize grading
- Limit lot disturbance
- Reduce impervious surfaces

3. Maintain Site Runoff Rate

- Maintain natural flow paths
- Use open drainage
- Flatten slopes
- Disperse drainage
- Lengthen flow paths
- Save headwater areas
- Maximize sheet flow

4. Integrated Management Practices

- Small-scale stormwater controls
- Distributed throughout site
- Maintain flow patterns, filter pollutants and re-create or maintain hydrology

5. Pollution Prevention Maintenance & Education

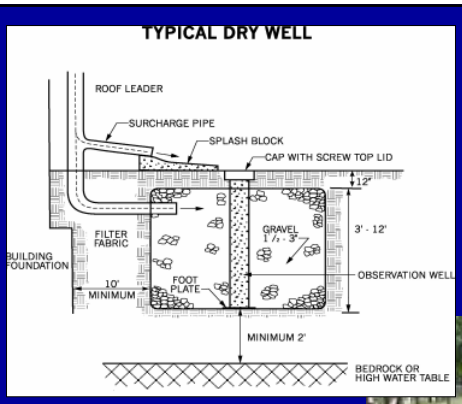
- Homeowners, Industry and Businesses
- Proper use & disposal of hazardous chemicals
- Use of non-toxic alternatives
- Preventive, routine maintenance
- Educational brochures, manuals & workshops

Common Integrated Management Principals

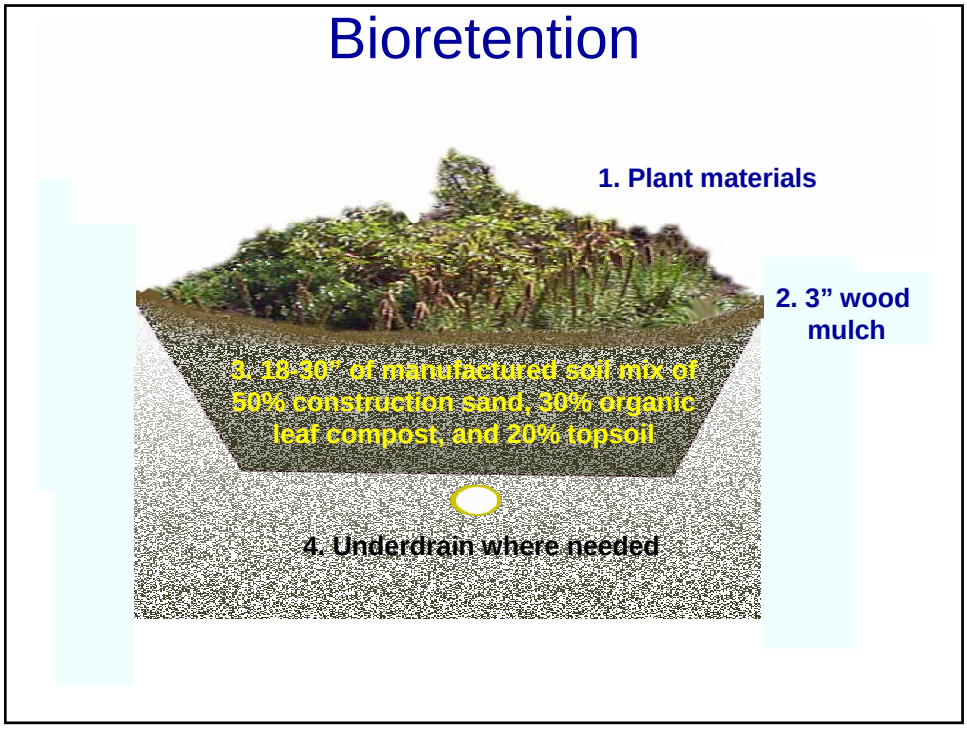
- **Control volume at the source**
  - Increase interception
  - Increase on-site retention
  - Encourage infiltration
- **Simple is safe**
  - Use natural soil and vegetation
  - Avoid labor-intensive mechanical devices
  - Distribute maintenance among site users

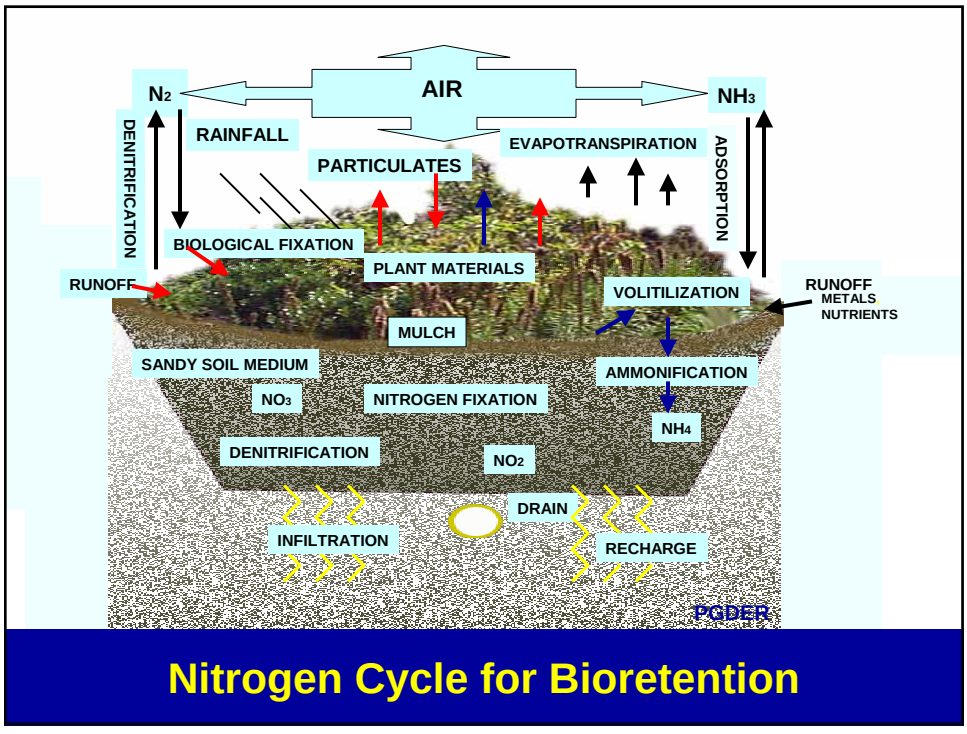
Disconnectivity

Dry Wells



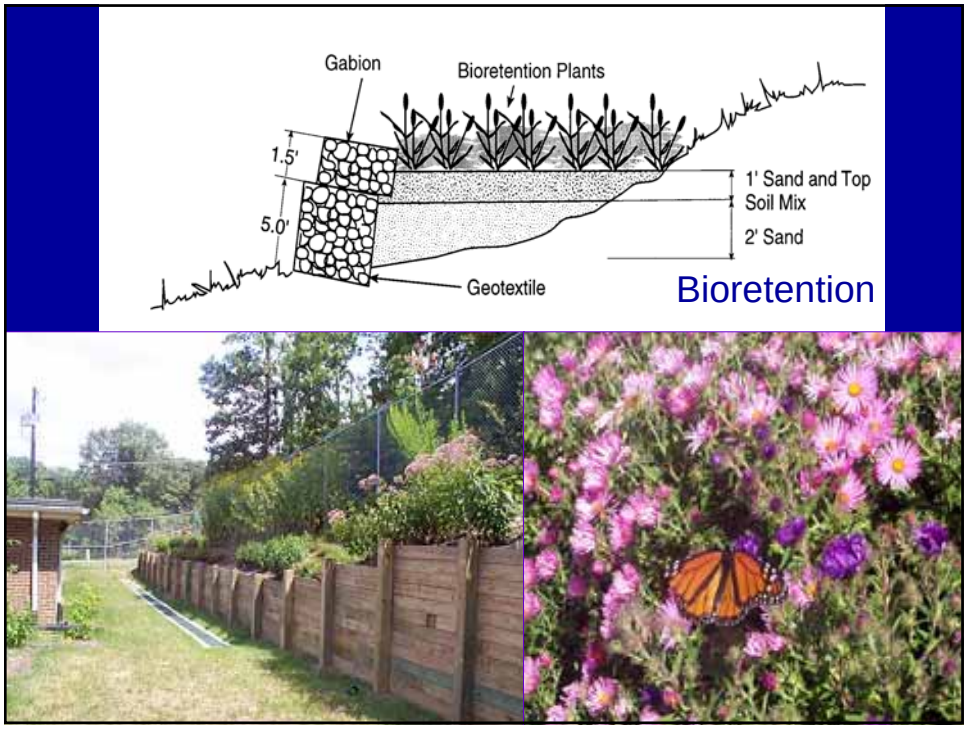
Scupper Garden


Bioretention
1. Plant materials
2. 3" wood mulch
3. 18-30" of manufactured soil mix of 50% construction sand, 30% organic leaf compost, and 20% topsoil
4. Underdrain where needed


AIR
N2
NH3
RAINFALL
DENITRIFICATION
EVAPOTRANSPIRATION
ADSORPTION
PARTICULATES
BIOLOGICAL FIXATION
PLANT MATERIALS
RUNOFF
VOLITILIZATION
RUNOFF
METALS
NUTRIENTS
MULCH
SANDY SOIL MEDIUM
AMMONIFICATION
NO3
NITROGEN FIXATION
NH4
DENITRIFICATION
NO2
DRAIN
INFILTRATION
RECHARGE
PGDER
Nitrogen Cycle for Bioretention


Rain Gardens


Rain Garden
•Sandy loam
•Design Size
•Mulched


Gabion
Bioretention Plants
1.5'
5.0'
1' Sand and Top Soil Mix
2' Sand
Geotextile
Bioretention

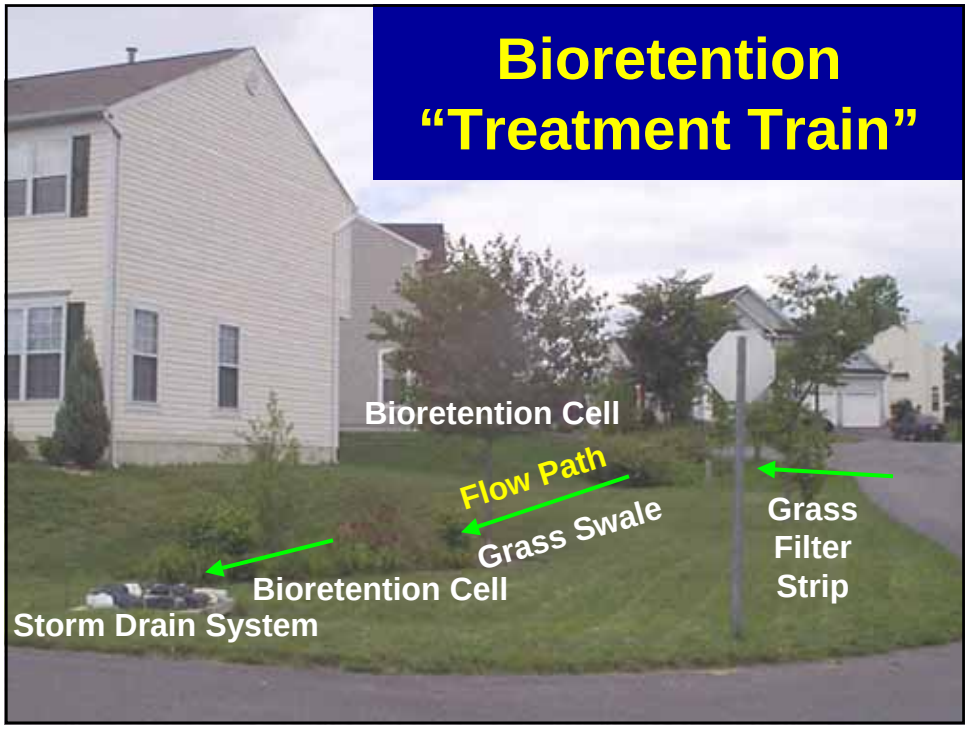

Urban Revitalization
Retrofit of 1-acre parking lot using bioretention

Parking Lot Retrofit

Parking Lot Retrofit


Parking Lots


Grassed Swale
•Homeowner maintained
•Integrated with the Lawn
•Specific Lawn Seed Mix



Green Street

Seattle's Street Edge Alternatives Program

After Completion - January 2001

SEA Street Today

Permeable Pavement

"Permeable Pavement"

A failed application caused by compaction and lack of maintenance.

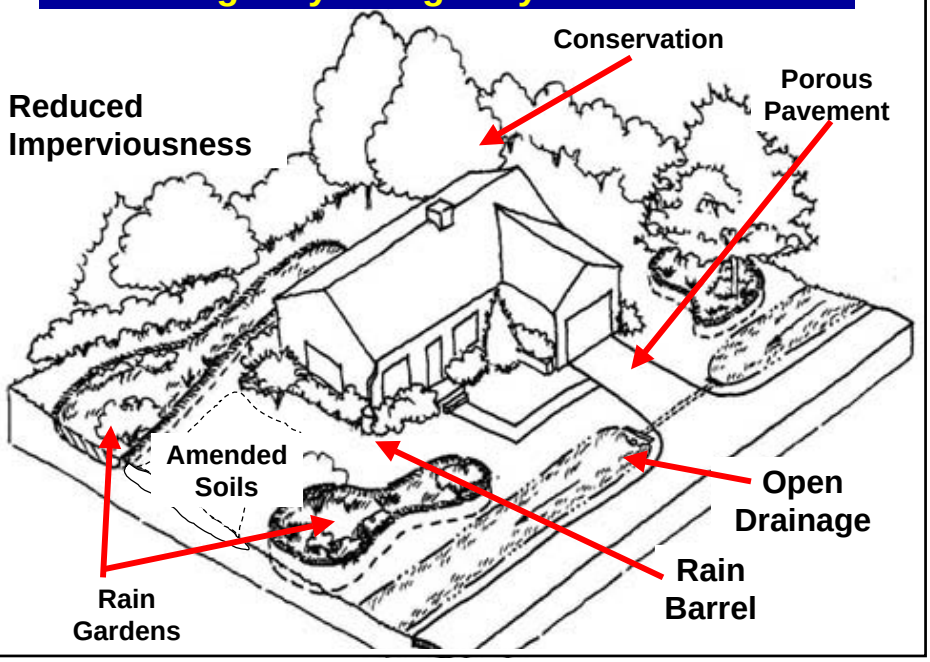
Green Roofs

Planter Boxes

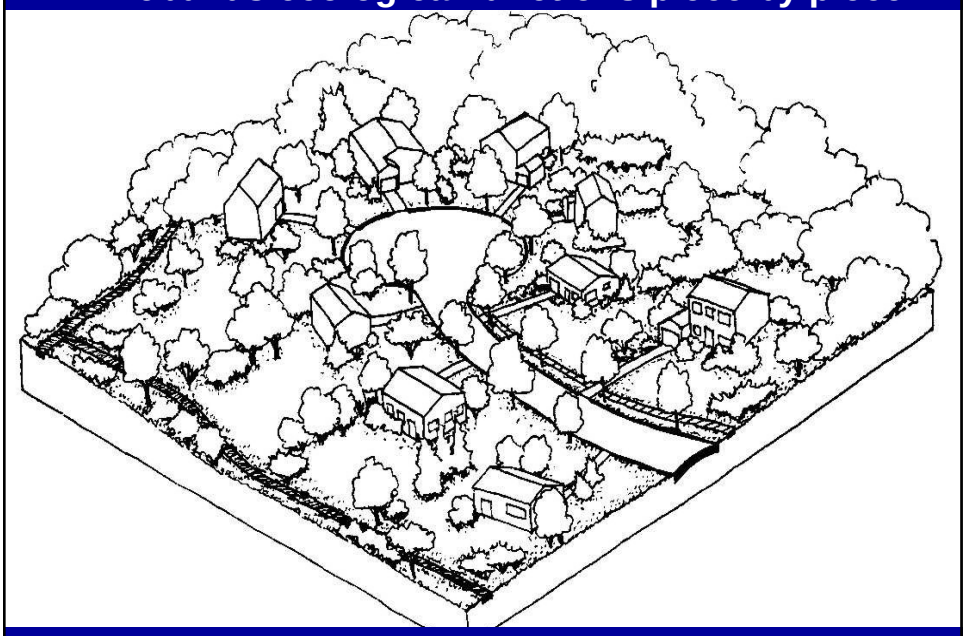
Soil Amendment

Rain Barrels, Cisterns and Storage Tanks

Creating a Hydrologically Functional Lot



LID rebuilds ecological functions piece by piece.



Cumulative Beneficial Impacts of LID Techniques

Owner Considerations

- **Maintenance**
- **Character of the Development**
  - – Aesthetics of stormwater treatment
  - – Planned land uses allow opportunity to incorporate LID practices
- **Cost Comparison**
- **Time Value of Money**

Tree conservation • Rain gardens
Narrower streets • Open drainage
On-lot detention storage and infiltration

Comparing LID and Conventional Development

Conventional Development

LID Subdivision

LID Development Scenario

- **Residential**

LID Development Scenario

- **Office**

LID Development Scenario

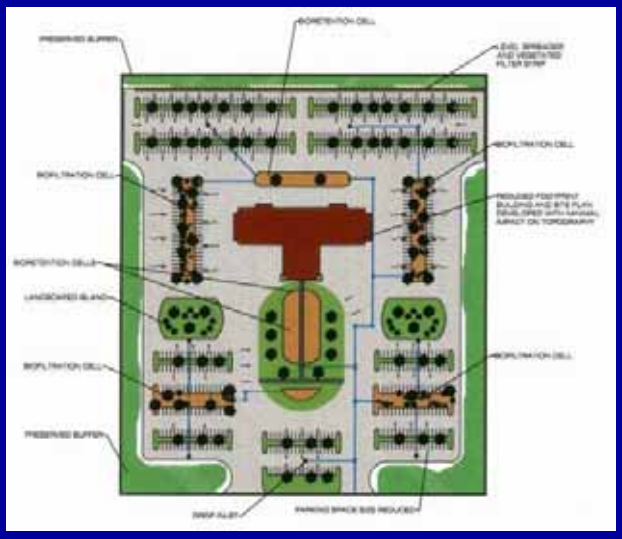
- **Small Commercial**

LID Development Scenario

- **Large Commercial**

LID Development Scenario

- **Hotel**



Some Not-So-Successful Installations

- **“Let it Rain”**
- **Day 1 – No Problem**
- **Day 4 – Problem?**
- **Day 10 – PROBLEM!**


12 11:59AM

Clogged, Water
Stands Too Long

Design problems:

Water Can't Get In

Water Gets Out

Infiltration Problems

LID Implementation

- Identify and develop applicable regulations and requirements
- Use drainage/hydrology as a design foundation
- Allow designs that reflect conservation plans
- Reduce site imperviousness and minimize directly connected impervious areas
- Use sustainable integrated management practices
- Develop pollution prevention, maintenance, public outreach and education programs

Summary

- Development and stormwater runoff have degraded streams, fish habitat and water quality for your Town.
- LID is a new approach to land development and stormwater management that helps protect water resources and watershed hydrology.
- We're gaining a better understanding of how LID can be used to protect the environment, reduce costs and make our communities more attractive.

For More Information

- **The Low Impact Development Center**
  http://www.lowimpactdevelopment.org
- **Center for Watershed Protection's Stormwater Center**
  http://www.stormwatercenter.net/
- **U.S. Environmental Protection Agency**
  http://www.epa.gov/owow/nps/urban.html
- **UW Center for Urban Water Resources**
  http://depts.washington.edu/cuwrm/
- **Puget Sound Action Team**
  http://www.psat.wa.gov/Programs/LID.htm