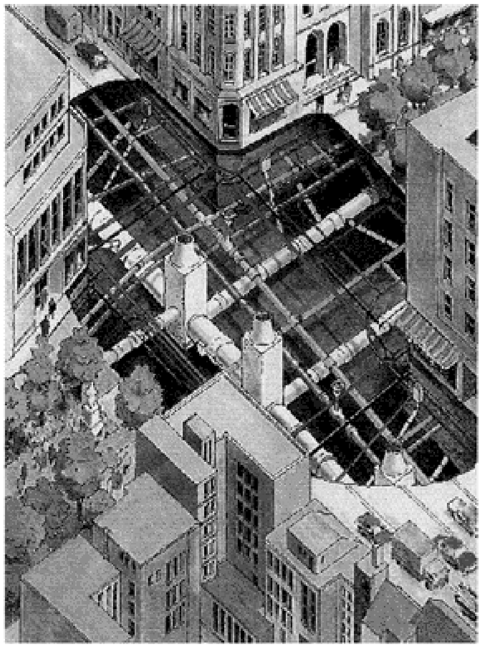

Underground Congestion.

Low Impact Development:

Sustainable Solutions for Watershed Development

1

The Low Impact Development Center, Inc.

Balancing Growth and Environmental Integrity

Who we are and what we do

- **501 c 3**
- **Innovative and sustainable solutions for development/ redevelopment**
- **Focus on pilot projects, institutional development, manuals of practice**
- **Small, but partner alot**

2

New Stuff!

- LID for NPDES Phase II
- WERF Decentralized Study
- NCHRP Stormwater Report
- EPA HQ
- Navy/EPA Region 3 Partnership
- LID for Big Box Retailers

3

Chip In

- ASCE Database
- EWRI LID Committee

4

Today's Goals

- Introduction to LID
- Background
- Importance for Watershed Planning
- Some Case Studies
- Where are we going?

5

<u>Low Impact Development (LID)</u>
Stormwater Management
Ecosystem Based Functional Design
"Uniformly Distributed Small-scale Controls"
"Integration of Controls with Sites, Streets and Architecture "

Hydrologic Cycle Based Approach
"Centralized versus Decentralized Controls"

Prince George's County, MD

Prince George's County Manual 1997

<u>LID National Design Manual 1999</u>

6

What is LID?

- A Storm Water Management Strategy Concerned With:
  - Maintaining or Restoring the Natural Hydrologic Functions of a Site
    - Helps Meet Construction (New & Retrofit) Storm Water Management Goals
  - Fulfilling Environmental Regulatory Requirements
    - Helps Reach NPDES Permit Limits & TMDL Goals
  - Meeting Natural Resource Protection Objectives
    - Using Low Maintenance & Native Vegetation
    - Protection of Watersheds
- LID Employs Natural & Built Features that:
  - Reduce Runoff
  - Filter Out Pollutants
  - Facilitate Water Infiltration

Thanks, Larry Coffman 7

SEE APPENDIX 11, UFC Page 1

What is LID? 1. A sustainable stormwater management technology that incorporates small -scale control devices across a site to maintain, restore or closely mimic pre-development development watershed hydrologic functions (volume, recharge, evapotranspiration and peak runoff). {Recharge and evapotranspiration considered indirectly.} These techniques are known as **Integrated Management Practices (IMPs).** New projects, redevelopment projects, and capital improvement projects can all be viewed as candidates for implementation of LID.

2. Opportunities to create a "customized" functional watershed to address specific regulatory or aquatic resource protection goals. Not a land use control, but a management and design strategy that is integrated into the proposed land use.

3. Watershed and Site Strategies integration

4. **BASIC LIST OF IMPs.** Here is a basic list of IMPs that are available. More detailed descriptions are presented in UFC Chapter 8. Appendix B contains a list of acronyms and abbreviations cited in the UFC.

Bioretention: Vegetated depressions that collect runoff and facilitate its infiltration into the ground.

Dry Wells: Gravel- or stone-filled pits that are located to catch water from roof downspouts or paved areas.

Filter Strips: Bands of dense vegetation planted immediately downstream of a runoff source designed to filter runoff before entering a receiving structure or water body.

Grassed Swales: Shallow channels lined with grass and used to convey and store runoff.

Infiltration Trenches: Trenches filled with porous media such as bioretention material, sand, or aggregate that collect runoff and infiltrate it into the ground.

Inlet Pollution Removal Devices: Small stormwater treatment systems that are installed below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain.

Permeable Pavement: Asphalt or concrete rendered porous by the aggregate structure.

Permeable Pavers: Manufactured paving stones containing spaces where water can penetrate into the porous media placed underneath.

Rain Barrels and Cisterns: Containers of various sizes that store the runoff delivered through building downspouts. Rain barrels are generally smaller structures, located above ground. Cisterns are larger, are often buried underground, and may be connected to the building's plumbing or irrigation system.

Soil amendments: Minerals and organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation.

Tree Box Filters: Curbside containers placed below grade, covered with a grate, filled with filter media and planted with a tree in the center.

Vegetated Buffers: Natural or man-made vegetated areas adjacent to a water body, providing erosion control, filtering capability, and habitat.

Vegetated Roofs: Impermeable roof membranes overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundation.

What is better?
Smart Growth or LID?

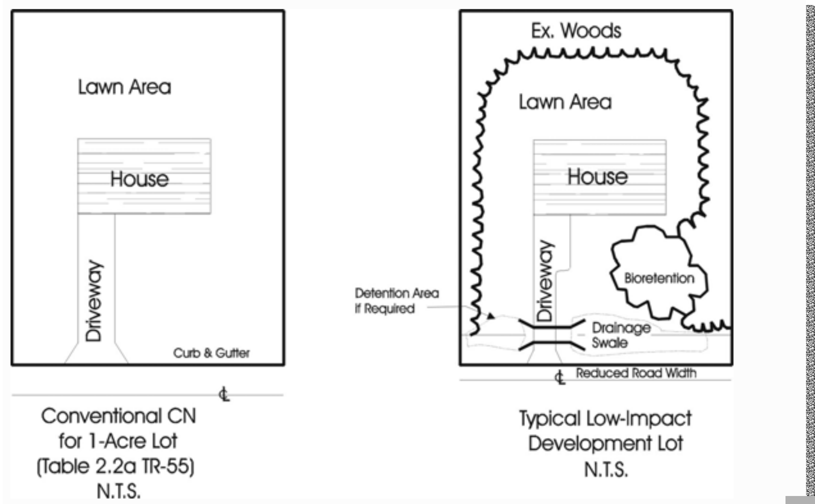
HUH?

LID is a site planning and design strategy that uses decentralized controls to manage stormwater!

NOT LAND USE it's Technology !!!!!!

8

Comparison of Conventional and LID Site Conditions



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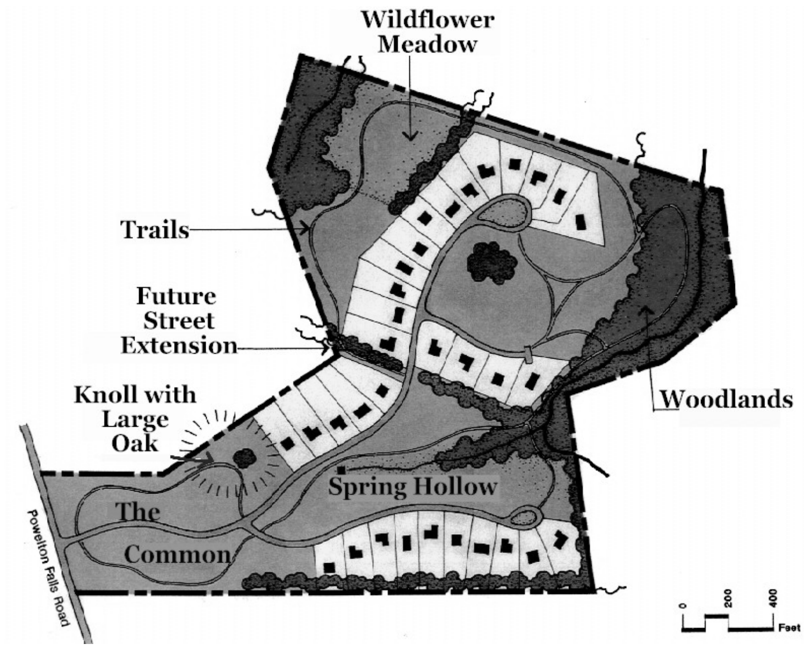


Courtesy Arendt

10

How this all started!

1200 Years and Still Working !!!

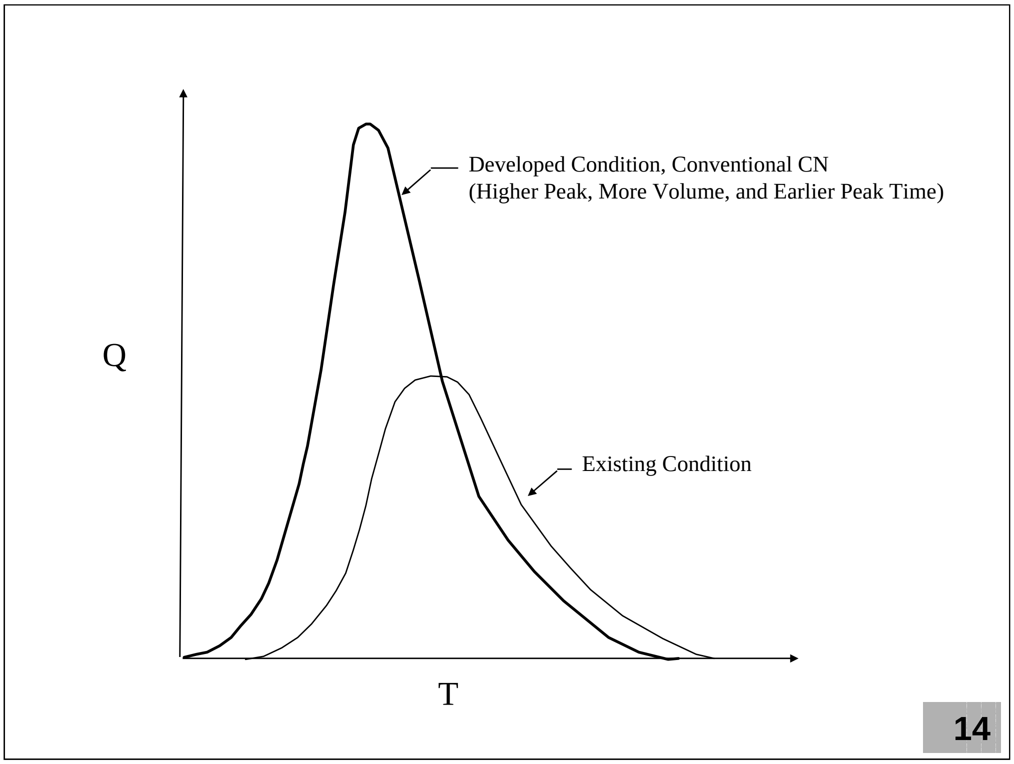
11

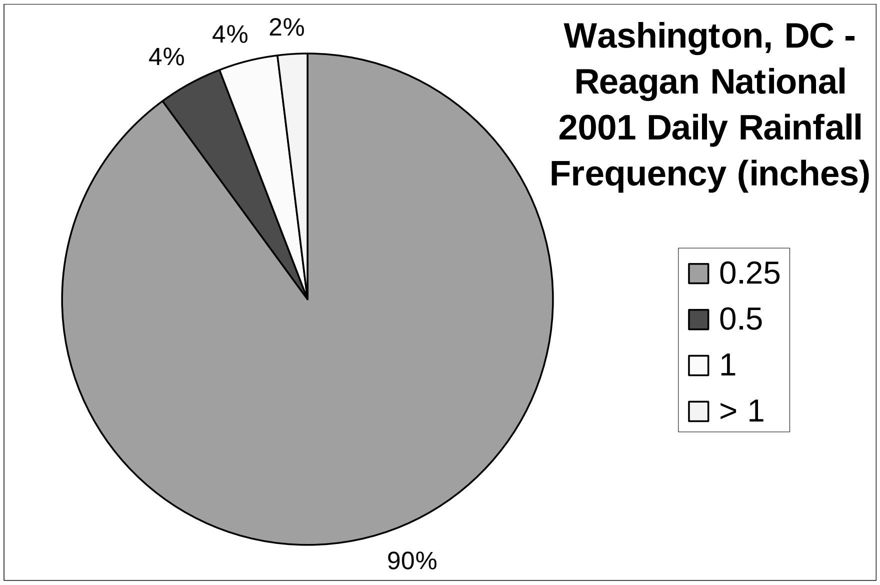
Guess the State?

12

Early Stormwater

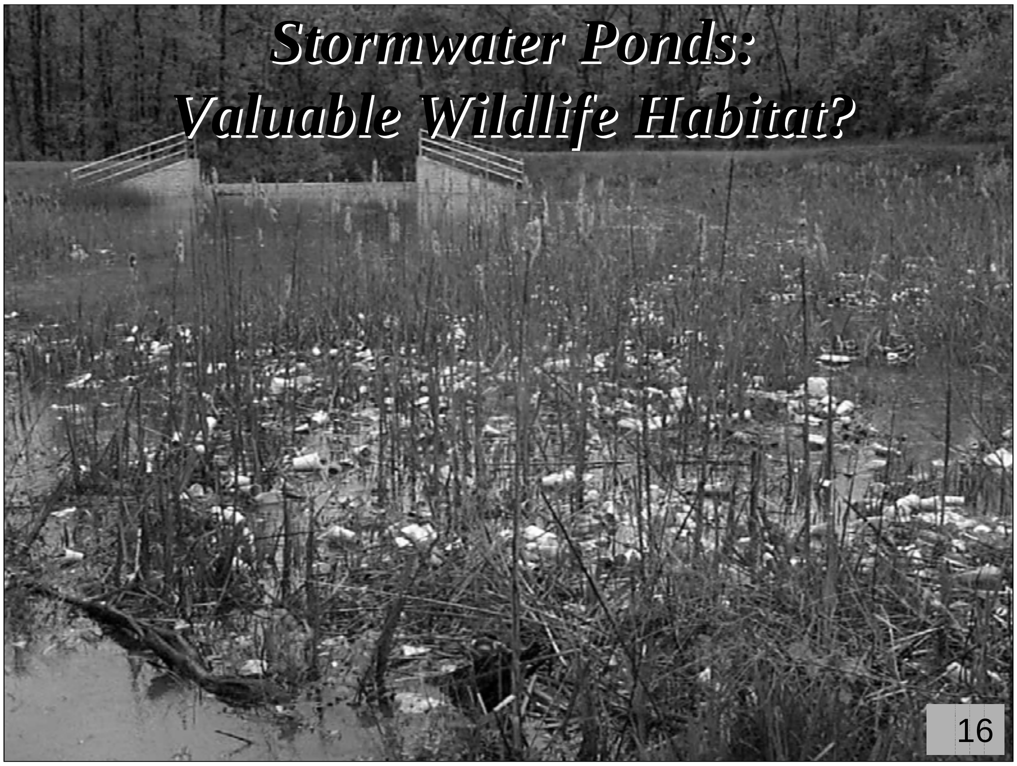
$$K = \frac{\beta}{n} A R^{2/3}$$

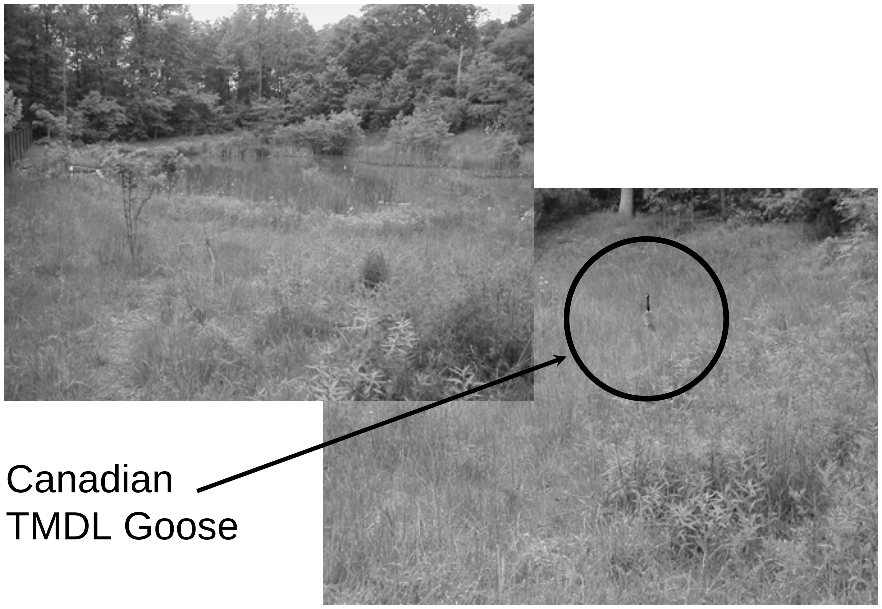

Developed Condition, Conventional CN
(Higher Peak, More Volume, and Earlier Peak Time)
Q
Existing Condition
T
14



Volume/Frequency

15


Stormwater Ponds:
Valuable Wildlife Habitat?
16



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19

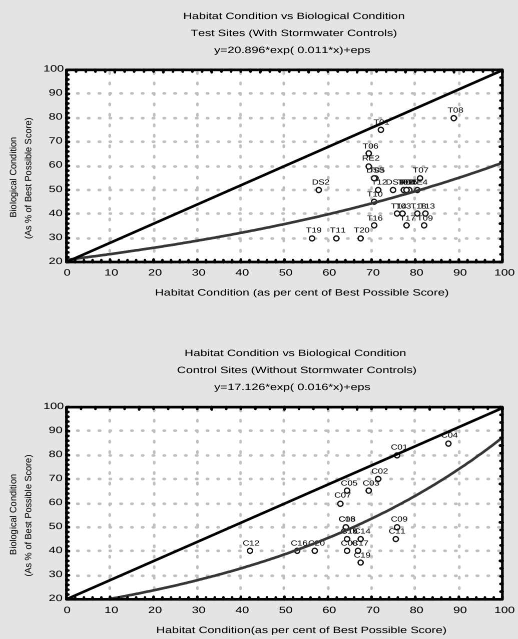
20

Buttermilk off North Shore

Buttermilk off Ring Road

21

Figure 1. Comparison of Habitat Condition and Biological Condition for Sites With and Without SWM



Montgomery County, MD

Both of the datasets plot mainly below the line (Figure 1). Almost all test sites do, and while 6-7 of the control sites plot along the line, the remainder plot below the line.

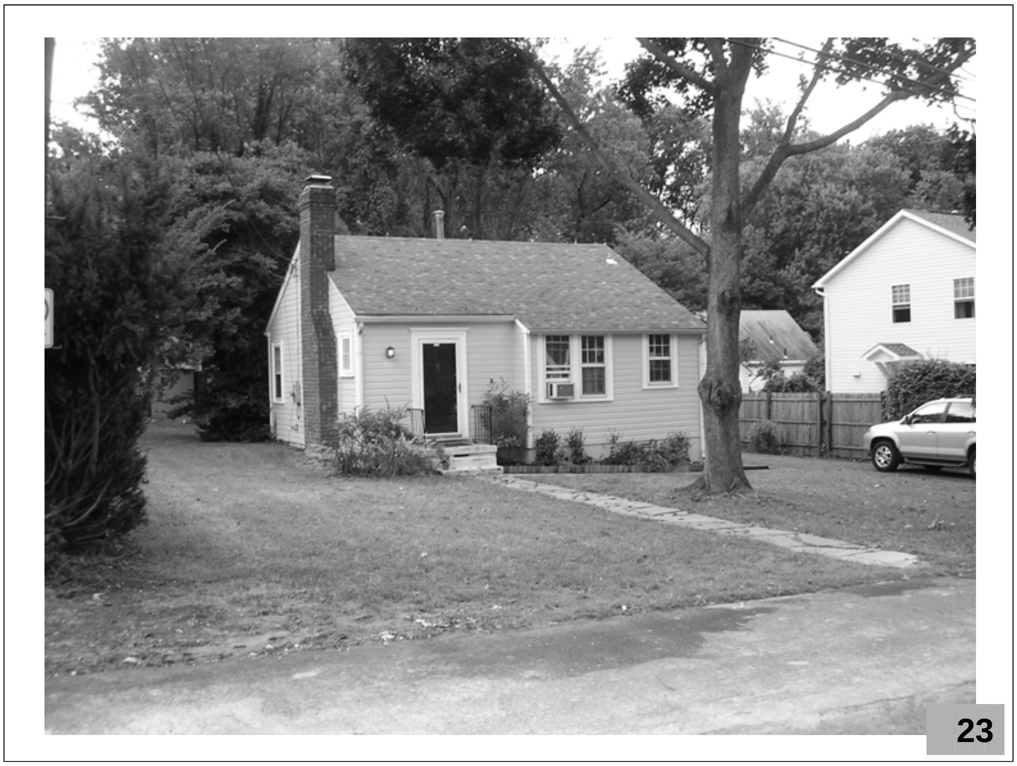
Stream embedding

Riffle areas

Flow regime

WMI

22


23

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The Future of the Urban America 25

26

Smart Growth/LID Hydrology

- Control Runoff at Microwatershed Level
- Consider Hydrologic Process in Microwatershed Layout
- Maintain First Order Receiving Streams
- Maintain Vegetated Buffer Zones
- Control Spatial Pattern of Hydrologic Storage
- Control Upland Flow Velocities
- Control Temporal Characteristics of Runoff

McQuen, 2004

27

What we know about codes and ordinances

- We're stuck!
- Site development BMPs don't protect watersheds (Energy Balance and Ranking and Prioritization of Projects is critical)
- Policies of Segregation don't work
- Land use planning/codes/and ordinances are the critical element to watershed based planning
- Requirements must be functional and not "accounting" based
- We really need adaptive management approach for regulations due to our lack of knowledge and training! The lag time is to long for responses to development
- The watershed concept is critical !

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Questions ????

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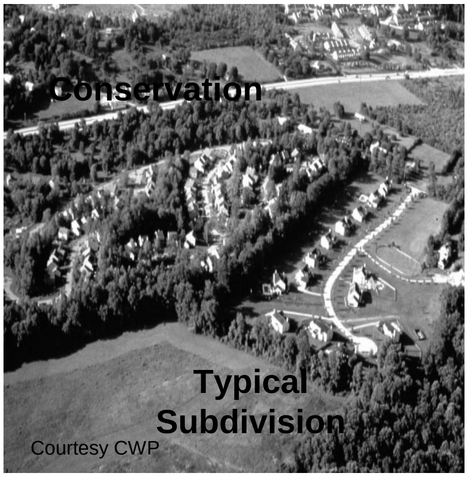
Defining LID Technology

Major Components

1. Conservation (Watershed and Site Level)
2. Minimization (Site Level)
3. Strategic Timing (Watershed and Site Level)
4. Integrated Management Practices (Site Level)
   Retain / Detain / Filter / Recharge / Use
5. Pollution Prevention
   Traditional Approaches

30

Conserve Natural Areas



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

31

Site Fingerprinting

32

33

LID Key Element

Direct Runoff - Maintain Time of Concentration

- Open Drainage
- Use green space
- Flatten slopes
- Disperse drainage
- Lengthen flow paths
- Save headwater areas
- Vegetative swales
- Maintain natural flow paths
- Increase distance from streams
- Maximize sheet flow

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See Appendix 11, UFC, Page 25 & 26

1. Methods to Direct Runoff include:

Open Drainage; Use green space; Flatten slopes; Disperse drainage; Lengthen flow paths; Save headwater areas; Vegetative swales; Maintain natural flow paths; Increase distance from streams; Maximize sheet flow

2. The use of Native vegetation in an open channel reduces cost and materials for maintenance, conserves water because native plants are more adaptable to the site conditions and need less irrigation, and helps slow runoff through infiltration so becomes an innovative solution to excessive runoff on a site.

3.**How does this LID Key Element Meets LEED Requirements?**

a. LEED Category: Stormwater Management: Rate and Quantity

Intent for LEED Credit: Limit disruption and pollution of natural water flows by managing stormwater runoff.

b. LEED Category: Stormwater Management: Treatment

Intent For LEED Credit: Limit disruption of natural water flows by eliminating stormwater runoff, increasing on-site infiltration and eliminating contaminants.

LID Practices (No Limit!)

"Creative Techniques to Treat,Use, Store, Retain, Detain and Recharge"

- Bioretention / Rain Gardens
- Strategic Grading
- Site Finger Printing
- Resource Conservation
- Flatter Wider Swales
- Flatter Slopes
- Long Flow Paths
- Tree / Shrub Depression
- Turf Depression
- Landscape Island Storage
- Rooftop Detention /Retention
- Roof Leader Disconnection
- Parking Lot / Street Storage
- Smaller Culverts, Pipes & Inlets
- Alternative Surfaces
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels / Cisterns / Water Use
- Catch Basins / Seepage Pits
- Sidewalk Storage
- Vegetative Swales, Buffers & Strips
- Infiltration Swales & Trenches
- Eliminate Curb and Gutter
- Shoulder Vegetation
- Maximize Sheet flow
- Maintain Drainage Patterns
- Reforestation………………..
- Pollution Prevention………….

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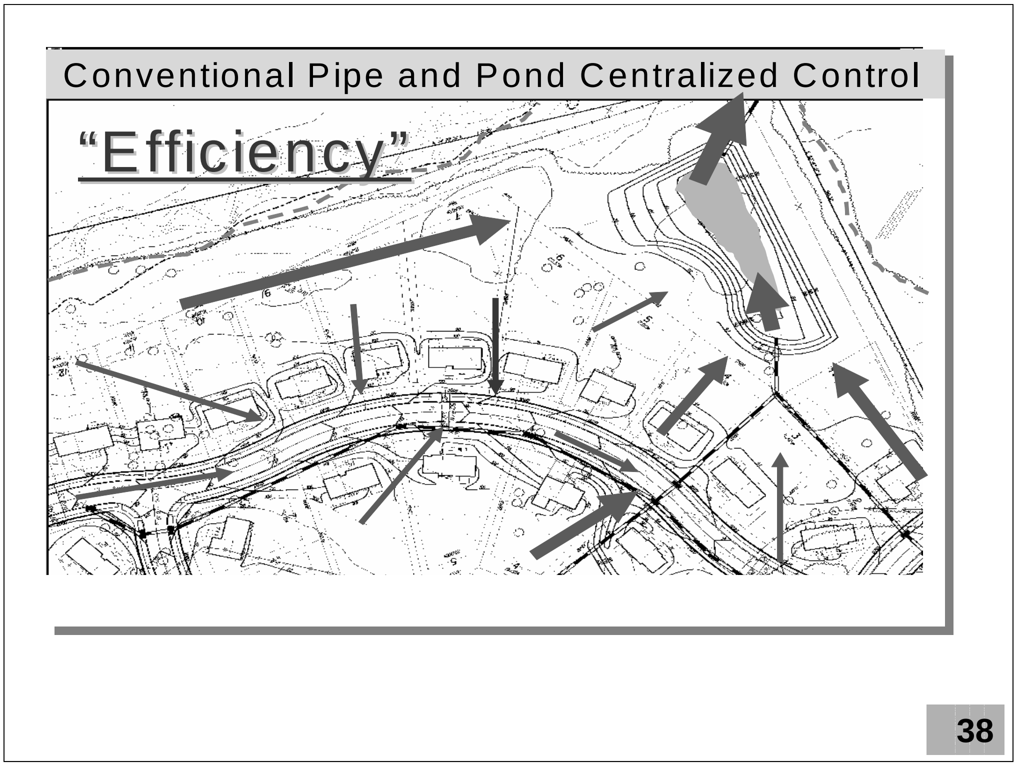
Chicago City Hall after 18 months
Roofscapes inc.
Green Technology for the Urban Environment
36


Wetlands Mitigation?
37



See Appendix 11, UFC, Page 17

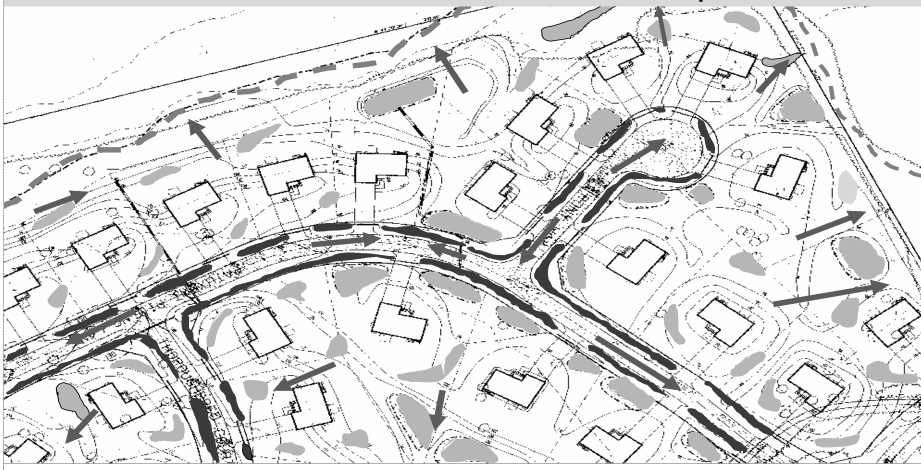
Conventional Storage Concepts. Conventional stormwater strategies often include the storage of water in large centralized end-of-pipe facilities. Site designs direct and convey most runoff as quickly as possible to these facilities and then discharge through an outlet structure at a limited release rate (e.g., 2-year 24-hour pre-development runoff rate). Conventional runoff management techniques can dramatically reduce the flow of runoff into natural storage areas such as wetlands, depriving a variety of organisms of the level of moisture they need.

Conventional approaches can have other negative impacts. By removing opportunities for storage onsite, rates of ground water recharge will be reduced. In addition, the concentrated flow conveyed to large-scale facilities accumulates pollutants and increases the erosive force of the water, which must be slowed down and treated to maintain the natural energy and chemical balance of the ecosystem. An increase in temperature as the water is pooled may also be detrimental to the ecological integrity of the receiving water.

UFC Page 19

Conventional Infiltration Concepts. Conventional approaches concentrate on the infiltration capacity of a single end-of-pipe management facility such as a pond. Infiltration potential elsewhere on the site is often discounted or only analyzed for its effect on the flow of runoff into the facility. The conventional infiltration objective is to concentrate flows in one area and then utilize the infiltration capacity of the natural soil or conduits such as gravel. Natural groundwater flow patterns and recharge are often not considered. Conventional approaches may result in the elimination of critical volumes of flows to sensitive areas such as wetlands. Additionally, in many urban areas, the high loads of fine sediments to centralized facilities and the impacts of construction compaction can severely limit the infiltration capacity of the facility.

LID Uniform Distribution of Micro Controls – Residential Example



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See Appendix 11, UFC, Page 16

LID Storage Concepts. LID employs site planning and grading techniques to direct or maintain the flow of runoff to naturally occurring storage areas such as wetlands. Keeping the storage area volume stable helps to maintain the existing hydrologic and biological function of the storage area.

An LID design may also include small-scale retention components (retention is defined as the volume of runoff that never reaches the drainage area outlet). Retention can be provided in a variety of ways that not only support the management of runoff, but also supply water for on-site use.

Capturing runoff in small volumes helps to prevent erosion, because the runoff is less likely to reach damaging flow rates. The distribution of storage components also tends to result in a more robust stormwater management system, because the failure of one component will not cause the entire system to fail.

UFC, Page 18

LID Infiltration Concepts. Maintaining natural infiltration rates is an important aspect of LID design. Accomplishing this requires an accurate understanding of the existing soils and groundcover conditions. The design should take care not to overload the hydraulic conductivity of existing soils. Dispersing flows, maintaining natural flow patterns, and directing flows towards soils with high capacities for infiltration will help maintain ground water levels. Amending soils by adding organic materials, reducing compaction by aeration, maintaining leaf or “duff” layers in natural areas, and reducing compaction requirements for non-load bearing areas will also enhance and maintain infiltration rates and patterns.

LID Center Examples

- Institutional
- Compliance
- CSO
- Green Highways
- Technology Demonstration

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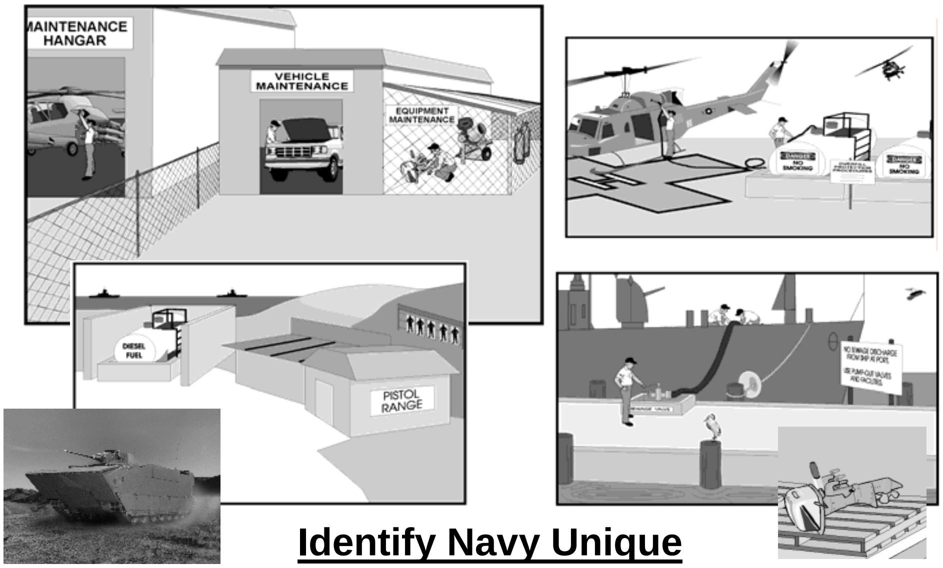
Partnership Approach



Identify Navy Unique Requirements/Solutions

41

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DRAFT UFC X-XXX-XX
11 July 2003

UNIFIED FACILITIES CRITERIA (UFC)

DRAFT
DESIGN: LOW IMPACT DEVELOPMENT MANUAL

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

NAVAC Low Impact Development Manual

Randy Jackson, P.E.
Engineering Innovation and Criteria Office
Naval Facilities Engineering Command

Neil Weinstein, P.E.,R.L.A.,AICP Executive Director

The Low Impact Development Center, Inc.

Emil Dzuray

Logistics Management Institute

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Sustainability Program Elements

EPA Region 3 / Naval District Washington Partnership

Estornell.paula@epa.gov **Parrish.Reginald@epa.gov** 44

The picture and areas below are based on the program developed by the Navy's NW Regional Office. **Document Available from: http://www.federalsustainability.org/showcase/NavyNWSustainProgGoalsDec2004.pdf See also Appendix 2**

Mission **–** The mission of the Navy is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas.

1. Military Assets:

a. Manage ranges and installations in a sustainable way to meet current and emerging needs

b. Adopt improved technologies and improve planning, design, maintenance, and operational practices.

2. Human Capital: Train personnel in sustainable technology use to enhance quality of service and improve operations, and conserve resources

Community **–** The people, places, organizations, and agencies that live or operate in the vicinity of the Command and have the potential to be affected by or to affect Navy activities.

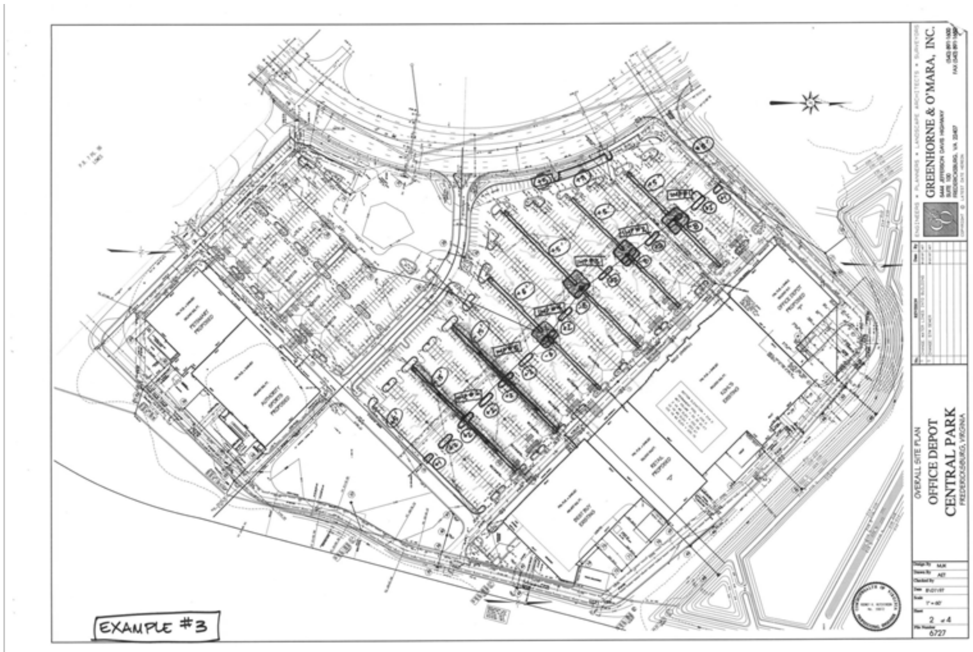
1. Smart Development: Reduce the Navy's burden on community infrastructure by planning, developing and maintaining sustainable Navy facilities.

2. Education: Train the community, military, civilian and contractors on sustainable economic development & stability of military operations.

Environment **–** The complex of physical, chemical, and biotic factors that have the potential to support or restrict Navy activities.

1. Resource Conservation: Reduce use and improve operation efficiency

2. Natural Resource Management: Improve management, promote conservation, reduce disposal/emissions/discharges



EXAMPLE #3
GREENHORNE & O'MARA, INC.
OVERALL SITE PLAN
OFFICE DEPOT
CENTRAL PARK
FREDERICKSBURG, VIRGINIA

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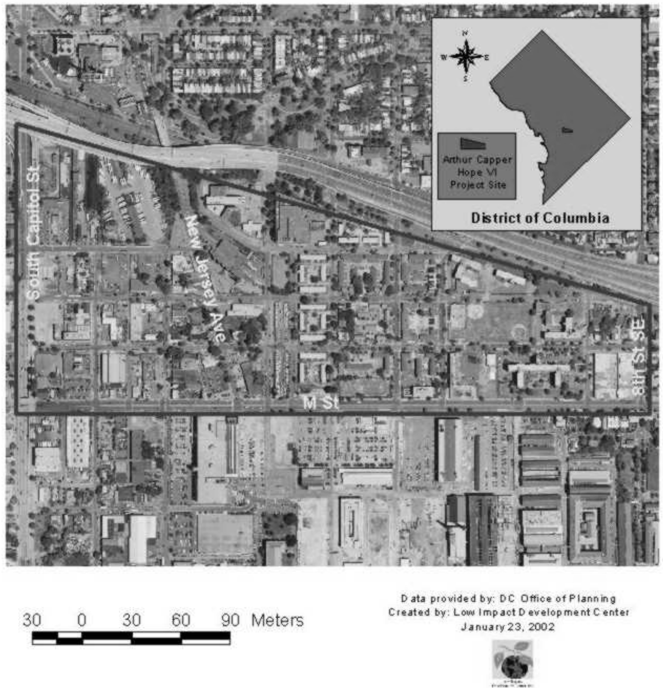
South Capitol St
New Jersey Ave
M St
8th St SE
Arthur Capper Hope VI Project Site
District of Columbia
30 0 30 60 90 Meters
Data provided by: DC Office of Planning
Created by: Low Impact Development Center
January 23, 2002

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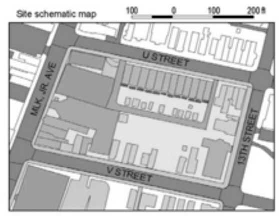
U Street Results

U Street block

Land uses	Land areas			Areas draining to BMPs			
	ft²	ac.	% of site	ft²	ac	% of site	% of LU
Entire site	137864.8	3.165					
Commercial Impervious	25597.6	0.588	18.6%	13653.1	0.313	9.9%	53.3%
High Density Res. Impervious	-	-	-	-	-	-	-
Med. Density Res. Impervious	25150.61	0.577	18.2%	11467.6	0.263	8.3%	45.6%
Paved roads or walks	38762.2	0.890	28.1%	19385.3	0.445	14.1%	50.0%
Open / permeable area	48354.4	1.110	35.1%	-	-	-	-

BMPs	BMP areas			Areas treated by BMPs			
	ft²	ac.	% of site	ft²	ac	% of site	% of IMPA
Green roofs	13653.1	0.313	9.9%	13653.1	0.313	9.9%	15.3%
Bioretention	891.4	0.020	0.6%	11467.6	0.263	8.3%	12.8%
Permeable pavement	19385.31	0.445	14.1%	19385.3	0.445	14.1%	21.7%
Total for BMPs	33929.7	0.8	24.6%	44506.0	1.022	32.3%	49.7%

Site schematic map



Yearly results

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/yr	77.6	66.3	15%
Sediment	Tons/yr	12.6	6.4	50%
BOD_5	lb/yr	138.4	114.2	18%
Total N	lb/yr	25.7	17.5	32%
Total P	lb/yr	3.1	2.2	29%
Total Zinc	lb/yr	2.3	1.4	41%

Week report 1 — Week of 7/19; Total rain 1.83"; i_{rain} max 0.83 in/hr

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/wk	3.3	3.1	8%
Sediment	tons/wk	0.4	0.2	48%
BOD_5	lb/week	1.8	1.1	40%
Total N	lb/week	0.7	0.4	37%
Total P	lb/week	0.1	0.05	36%
Total Zinc	lb/week	0.1	0.04	43%
Peak Q	cfs	1.6	1.3	23%

Week report 2 — Week of 1/18; Total rain 1.28"; i_{rain} max 0.73 in/hr

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/wk	3.1	2.8	10%
Sediment	tons/wk	0.3	0.2	40%
BOD_5	lb/week	10.9	10.4	5%
Total N	lb/week	1.1	0.9	17%
Total P	lb/week	0.1	0.13	14%
Total Zinc	lb/week	0.1	0.05	30%
Peak Q	cfs	1.8	1.4	23%

Week report 3 — Week of 5/20; Total rain 0.75"; i_{rain} max 0.57 in/hr

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/wk	1.4	1.2	10%
Sediment	tons/wk	0.3	0.1	49%
BOD_5	lb/week	1.3	0.8	38%
Total N	lb/week	0.4	0.3	38%
Total P	lb/week	0.0	0.03	37%
Total Zinc	lb/week	0.04	0.02	44%
Peak Q	cfs	0.9	0.6	34%

Week report 4 — Week of 3/4; Total rain 2.07"; i_{rain} max 0.34 in/hr

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/wk	4.6	4.0	12%
Sediment	tons/wk	0.4	0.2	45%
BOD_5	lb/week	12.1	11.5	6%
Total N	lb/week	1.3	1.1	18%
Total P	lb/week	0.2	0.15	15%
Total Zinc	lb/week	0.1	0.06	32%
Peak Q	cfs	0.8	0.6	27%

Week report 5 — Week of 9/14; Total rain 1.17"; i_{rain} max 0.18 in/hr

Indicator	Units	No LID	LID retrofit	% red.
Outflow	acre-in/wk	2.3	1.9	17%
Sediment	tons/wk	0.3	0.1	54%
BOD_5	lb/week	1.4	0.7	47%
Total N	lb/week	0.5	0.3	44%
Total P	lb/week	0.1	0.03	41%
Total Zinc	lb/week	0.1	0.03	46%
Peak Q	cfs	0.3	0.2	31%

Outflow includes both direct, untreated runoff, and discharges from BMPs. LU = land use IMPA = impervious area

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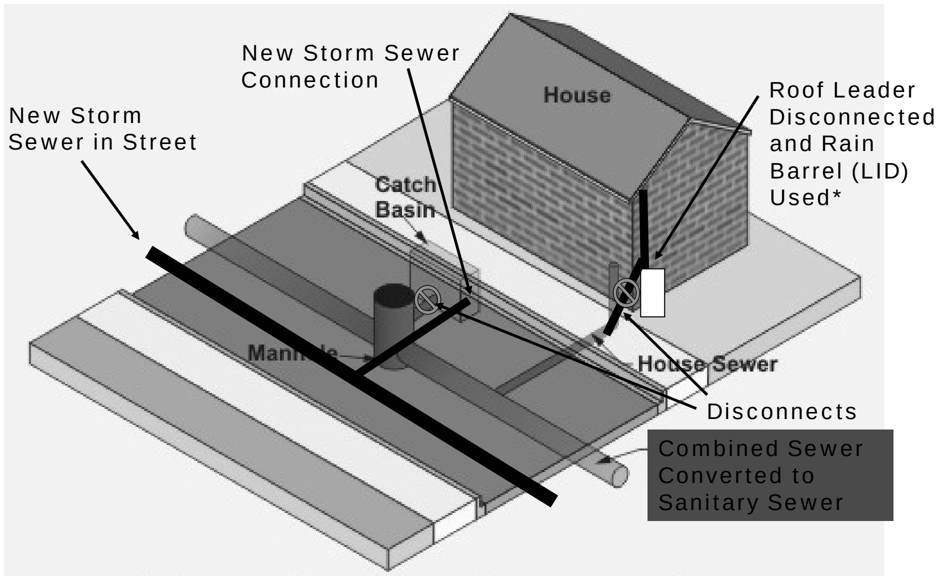
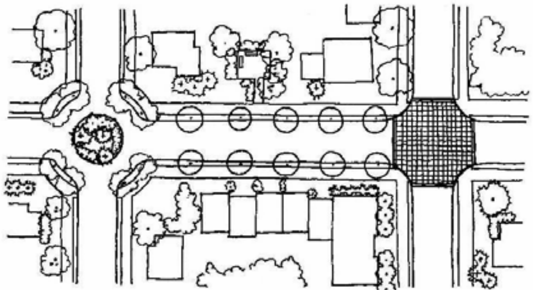
Separation Plan in CSO 006 Area (Est. Cost = $3,900/private property)

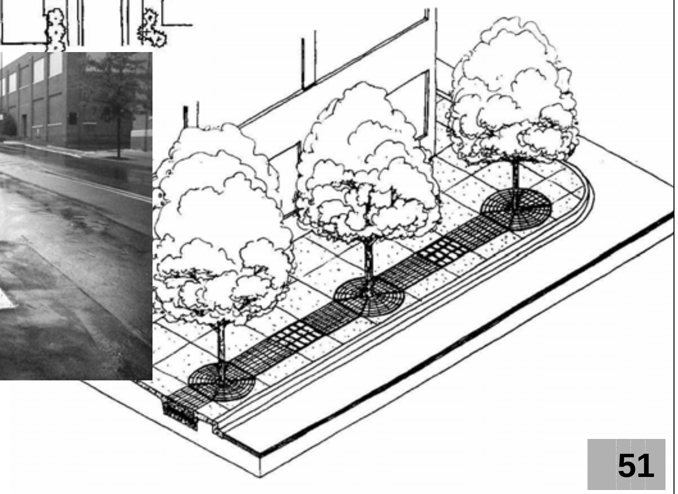


*No Extension on Private Property Required (May Result in 10-50% savings).

50



Sustainable Transportation



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Maryland State Highway Administration -

Mount Ranier Demonstration Project

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SHA Mt. Ranier Gutter Filters
Integrated into Streetscape

53

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Anacostia Waterfront

Transportation Architecture Design Standards

District of Columbia

District Department of Transportation

Infrastructure Project Management Administration

55

Construction and Temporary Uses

Maybe Construction Messed it up?

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Green Highways Initiative

- Region 3/FHWA/Private Public Partnership
- Sustainable Market Driven Goals
- Applied Research for Decision Makers
- Watershed Approach

http://www.greenhighways.org

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WERF Decentralized Controls

Research Objectives

The main focus of this project was to evaluate the practicability of incorporating decentralized stormwater controls into urban CSO control plans. Six specific research objectives were identified to guide the project.

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Research Objectives (cont.)

1. Research decentralized methods
2. Analyze technical issues and practicability
3. Evaluate implementation strategies, incentives, and disincentives
4. Evaluate implementation costs
5. Identify ancillary benefits
6. Develop guidance and protocols

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Overhead View of the Site

Cell A

Cell B

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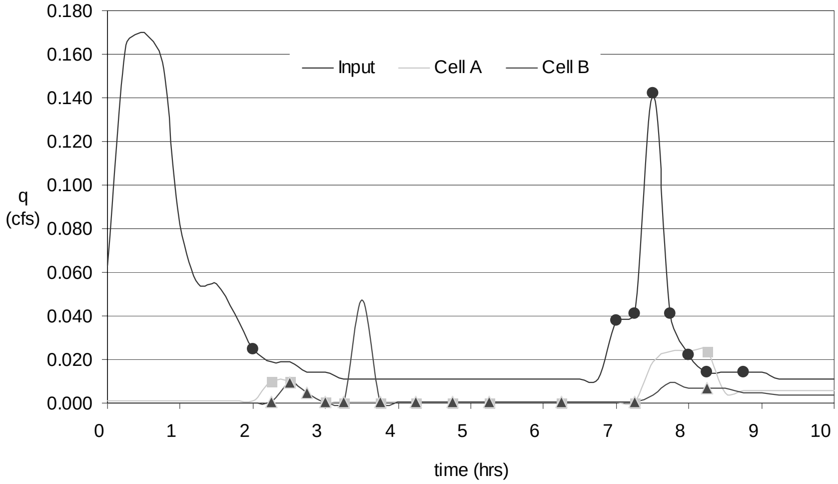
UMD Bioretention Hydrograph, July 28-29, 2003



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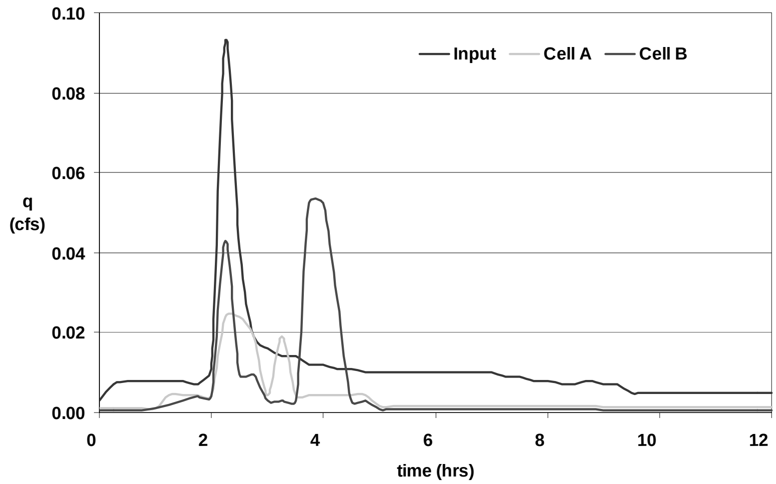
Hydrograph, August 1, 2003, UMD



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Questions ???

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Regional Applications

- Virginia (Haymount)
- California
- Puget Sound
- Seattle
- Massachusetts
- Alabama
- Minnesota

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Development Examples

W. Douglas Beisch, Jr., P.E
Sr. Water Resource Engineer

Williamsburg Environmental Group, Inc.

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Project Background
Haymount Development

- Located in Caroline County, VA just outside of Fredericksburg
- 1800+ acre development
- Located on 3 miles of Rappahannock River Shoreline
- 4000 Planned Housing Units
- Planning since 1990
- New Urbanism Style Development
- Responsible land use planning and Development

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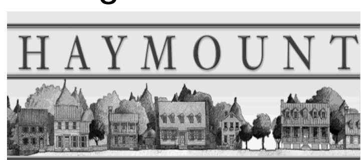

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Ecosystem Management

- Water Quality Management
- Nutrient Management
- Waste Water Reuse
- Wildlife Habitat Management
- Forestry Management

68

A Sustainable Ecosystem Approach

- Conservation of biological diversity
- Maintenance of productive capacity of forest ecosystems
- Maintenance of forest ecosystem health and vitality
- Conservation and maintenance of soil and water resources
- Maintenance and enhancement of long-term multiple socioeconomic benefits

HAYMOUNT

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Stormwater Management Objectives

- Treatment at all major outfalls
- Preserve/improve runoff quality
- Preserve, enhance or restore resources
- Incorporate innovative treatment approaches
- Use a “treatment train” including interior management practices, stormwater mgmt. facilities, and resource restoration
- Incorporate bioengineered techniques that act as community amenities

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HAYMOUNT

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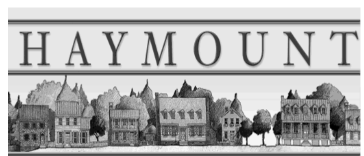
LID – Site Design Techniques

- Concentrated Development with Preserved Corridors
- Limited Impacts – Maintain Stream Corridors
- Biofiltration in Open Space Settings
- Enhanced Outfall Protection & Open Bottom Crossings
- Stream Restoration
- Restore Degraded Riparian Corridors
- Focus development on existing ag. fields to limit clearing.
- Preservation of about 2/3 of the site
- Use of IMPs to minimize impervious cover
- Reuse of on-site wastewater



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BIOENGINEERING – Wetland & Streams

- Constructed Stormwater Wetlands
- Multiple Teirs/Stages of Vegetation
- Hydraulic Connection to Existing Riparian Corridor
- Natural Channel Design
  - Channel Shaping
  - Instream Structures
  - Floodplain Connection
  - Stabilization with native species

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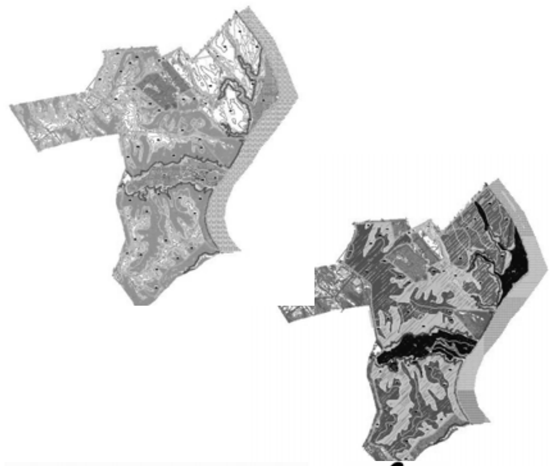
INTEGRATED PRACTICES – Suitability Screening

- Natural Resource Mapping & Analysis
  - Soils (Infiltration)
  - Slopes (Stability)
  - Floodplains (Limits)
- Pre-Development Hydrology
  - Maintain Flow Patterns
- LID Feasibility Analysis
  - Yields Suitable Areas



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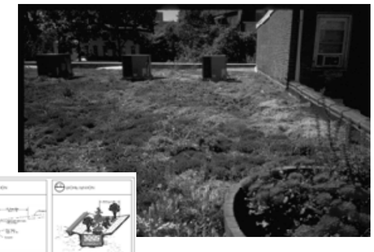
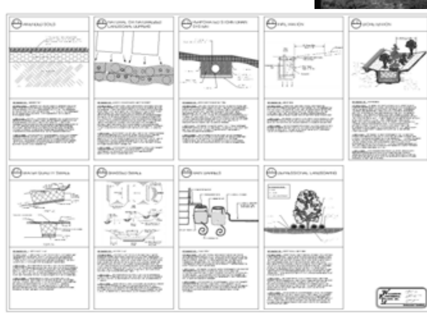
INTEGRATED PRACTICES – Menu of IMPS

- Bioretention / Biofiltration
- Soil Amendments
- Permeable Pavements
- Green Roof Applications





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LID Education Program

- Haymount has begun an LID Education Program with Friends of the Rappahannock
- The project is being funded through grant money awarded by Virginia Environmental Endowment
- The focus of the project is to educate high school students on the benefits and how to implement LID

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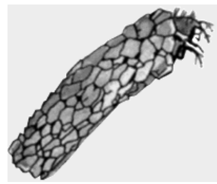
Water Quality Monitoring Program

- Chemical and Biological Water Quality Monitoring to assess water quality



- Real time data collection posted on Haymount's environmental website

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Photo http://www.sosva.com/macromonitoring.htm

Wastewater Treatment Plant

- SBR Technology
- Aerobic and Anerobic process for nutrient reduction
- Energy efficient pumps and design

Earth Tech's LEED™ accredited architects, engineers and environmental scientists are working with Haymount to create an energy-efficient and environmentally sound Waste Water Treatment Plant

EarthTech
A tyco International Ltd. Company

Clean water is the lifeblood of a community,
AND WE'RE THE LIFELINE.

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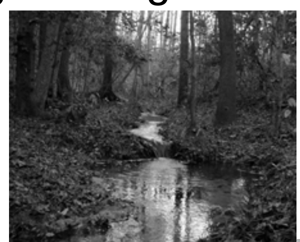
Water Reuse

- Street Tree Irrigation
- Stream Augmentation
- Wetland Enhancement
- Commercial Building Heating/Cooling
- Car Wash



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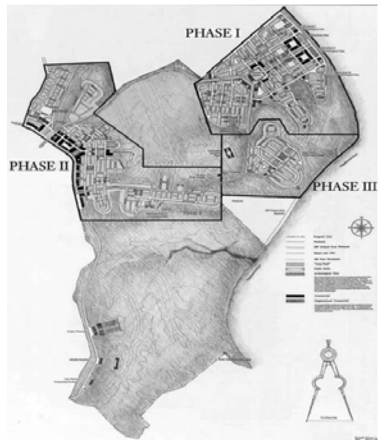
The Reason and the Vision for Sustainability at Haymount

- Design with humility & acknowledge the complexity of nature
- Accept environmental responsibility
- Nurture the connection between nature and the human spirit
- Design with sustainability to allow for environmental technology and advancements



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Questions ???

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Puget Sound Action Team Efforts to Promote LID

- **Library of educational, technical publications & web site.**
- **All on the web at: http://www.psat.wa.gov/Programs/LID.htm**
- **Convened conference, workshops, provides ongoing assistance**

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•The Puget Sound Action Team has been actively promoting LID since 2000.

•The Action Team is in the Governor of Washington’s Office, and coordinates the interagency partnership to conserve and recover Puget Sound’s water quality and biological resources.

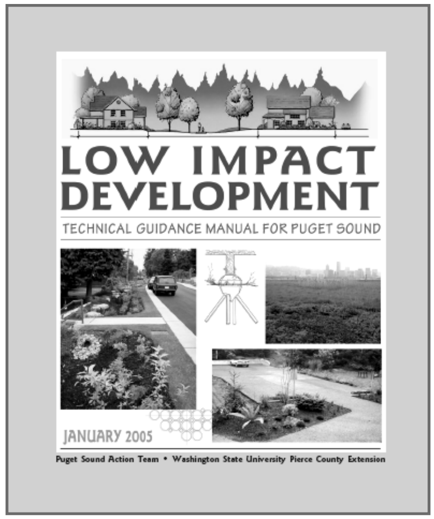
•The Action Team has produced numerous educational and technical publications, brochures, fact sheets, & newsletters on LID.

•All of these can be found on their web site

•The Action Team has also convened the first national conference on LID in 2001, numerous training workshops, and offers ongoing presentations and assistance.

Action Team/WSU LID Technical Manual

- Region's 1st LID manual
- Partnership – Action Team, WSU, Ecology, regional experts
- Guidance only
- Complements state stormwater manual
- Objectives, process, specifications, research



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•One of the Action Team's most important LID tools is the recently completed *LID Technical Guidance Manual for Puget Sound.*

•The manual is the region's first technical guidance manual on LID, and one of the most comprehensive in the nation.

•It represents a partnership among Washington State University Extension, a broad advisory group of experts, and the Washington Department of Ecology.

•The manual is guidance only and has no regulatory authority.

•It complements the state's stormwater manual, the Department of Ecology's *Stormwater Management Manual for Western Washington.*

•The manual provides a common understanding of the principles, goals and objectives for LID, the process to apply the LID approach, detailed specifications for integrated management practices, and research findings and monitoring data.

Action Team Local Regulation Assistance

- **Helping 5 cities and 6 counties revise regulations to allow for, encourage or require LID**
- **Draft products due 12/05**
- **Action Team will help local staff present to electeds**
- **State & federally funded**
- **Another round of assistance in '06**

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•Although the Action Team provides ongoing assistance to local governments, the Action Team ramped up this assistance in 2005 through the LID Local Regulation Assistance Project.

•This project is helping 5 cities and 6 counties around Puget Sound revise their regulations to better allow for, encourage, or require LID. These include

-Cities of Bellingham, Issaquah, Marysville, Redmond, and Poulsbo

-Clallam, Jefferson, Kitsap, Snohomish, Thurston and Whatcom counties

-All products will be developed by December of this year and will be added to the Action Team's web site.

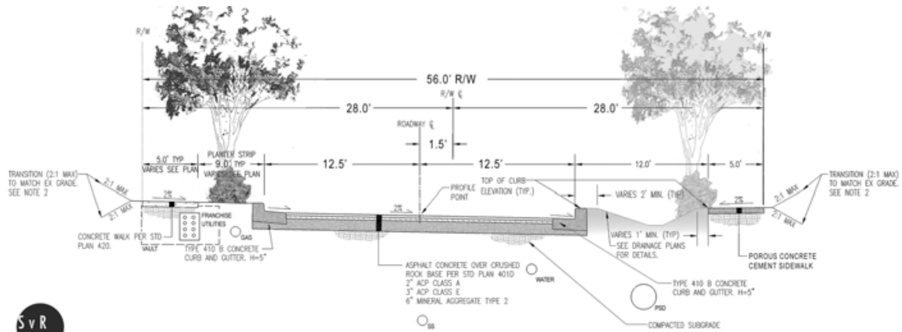
•Action Team and local government staff will present the draft regulatory changes to elected officials for their consideration for adoption.

•The project is funded by the Action Team, Washington Department of Ecology and EPA Region 10.

•The Action Team will work with another group of local jurisdictions in 2006.

•Action Team staff also work with local governments to integrate LID into local land use and watershed planning efforts.

Developing Cross Section & Swale Length



SvR

- The cross sections for the NDS swales were developed through discussions with various City of Seattle departments (decisions by inches)
- Street widths: 25 feet/56 right of way; 28 feet/56 ft rw; 32 feet/60 ft rw
- Curb height, swale width, street tree locations, berm locations, side slopes, bottom width, etc. were established
- Porous sidewalks on the swale side

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32nd Avenue - Porous Pavement Street

Courtesy SVR

85

32nd Avenue - Porous Pavement Street & Sidewalks

Courtesy SVR

86

Porous Pavement Sidewalks and Swales

Courtesy SVR

87

Splash Blocks by Myersculpture

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Fat Street

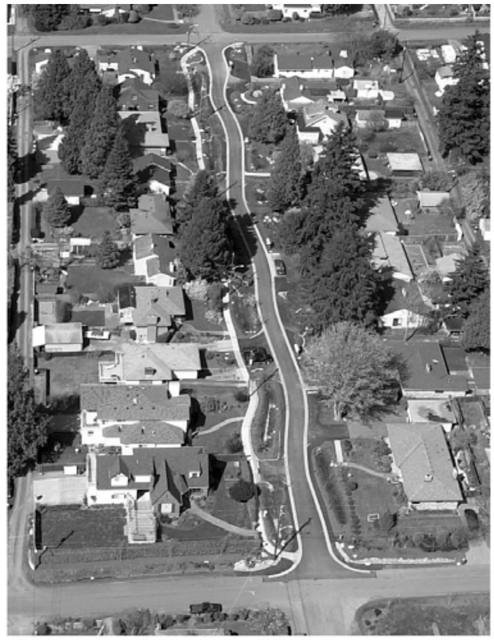
89

Skinny Street with Horizontally Challenged Person

90

Reduced Impervious Area

- 11% less impervious area than standard street improvement
- 98% Reduction in Volume



SEA Streets - After Construction
2nd Ave NW - NW 117th St to NW 120th St

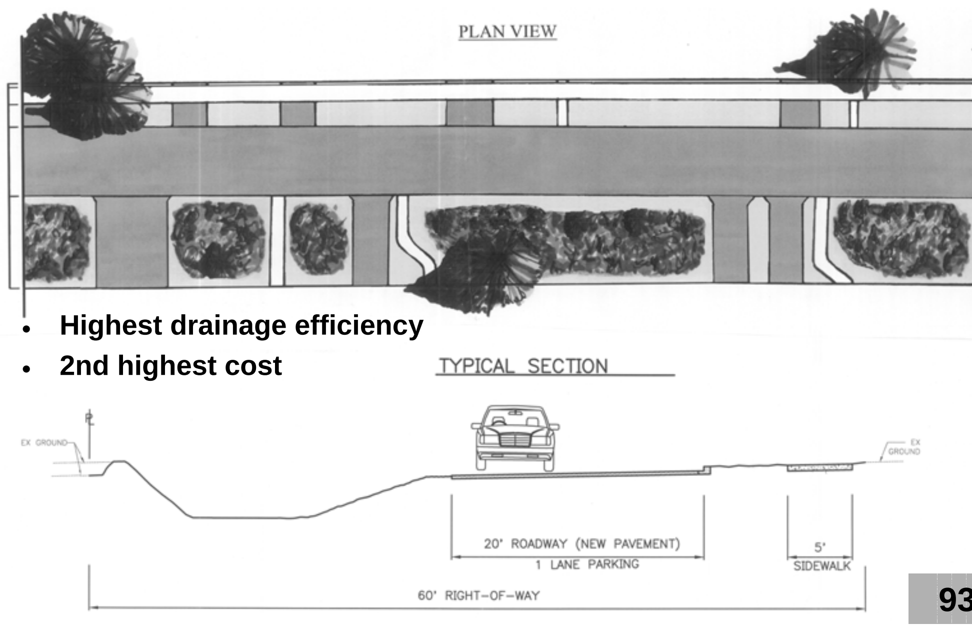
91

After Completion - January 2001

SEA Program, City of Seattle 92

This is a residential street reconstruction by the City of Seattle. This is part of a Street Edge program where the streets are narrowed and the curb and gutter are removed so that runoff can be directed to swales and bioretention areas. This not only reduces the amount of runoff but lets pollutants be filtered through the bioretention areas

Offset Template



- **Highest drainage efficiency**
- **2nd highest cost**

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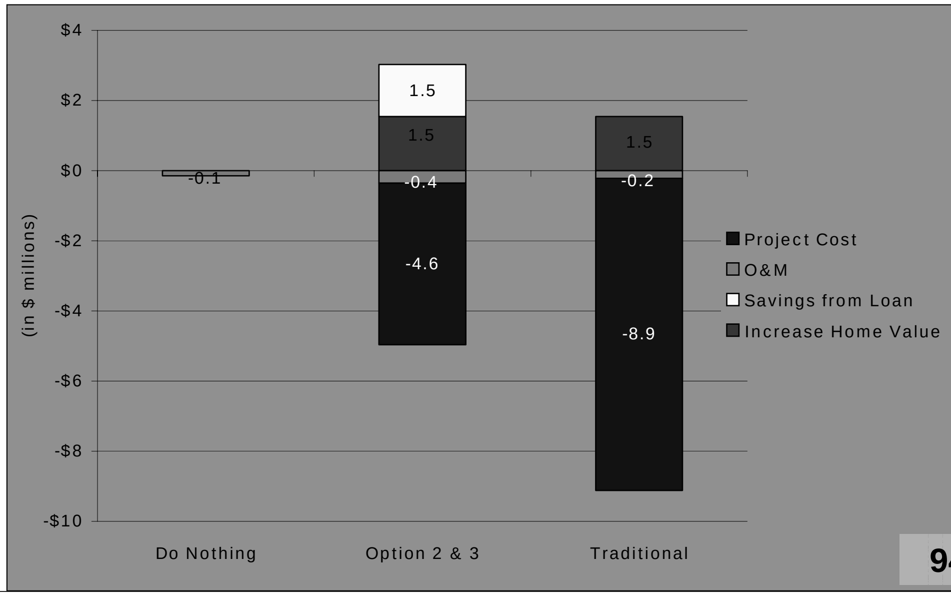
Quantifiable Costs and Benefits



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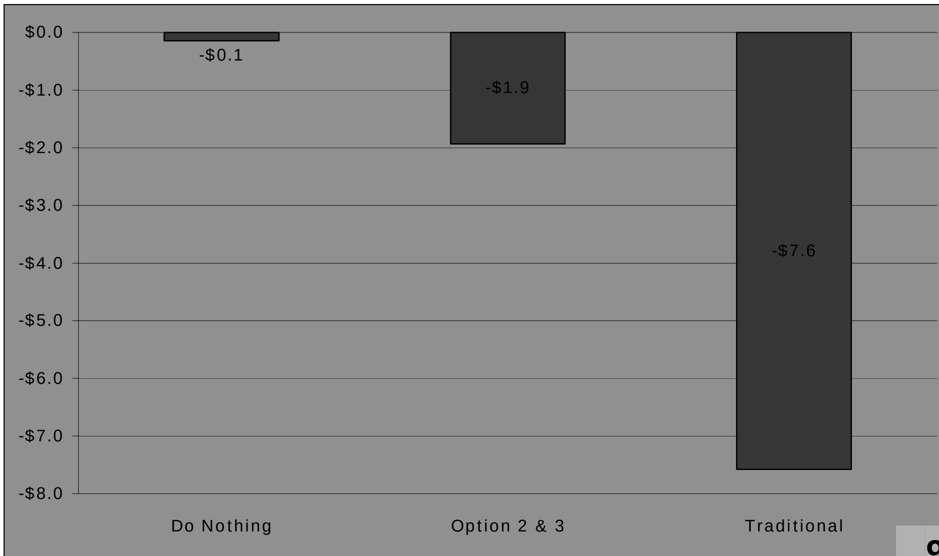
Net Present Value
(in millions)



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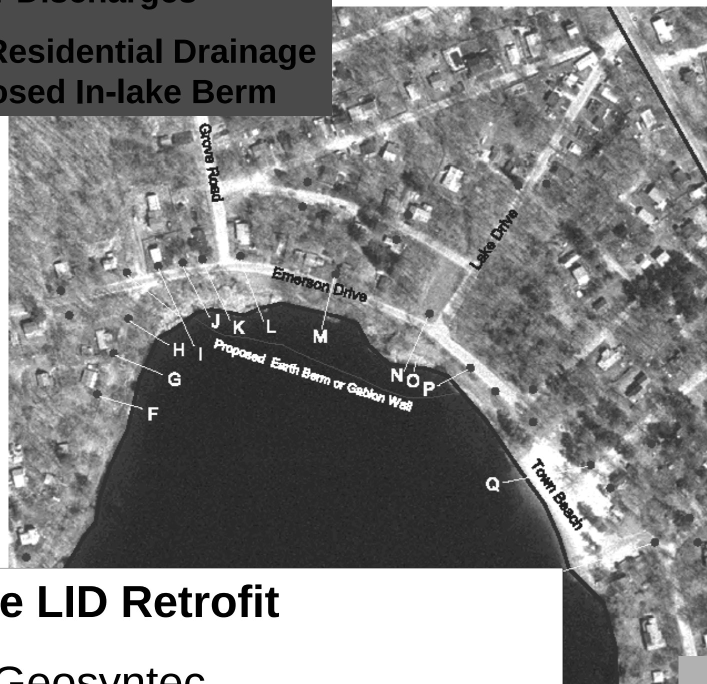
18 Stormwater Discharges

175 Acres of Residential Drainage
Original Proposed In-lake Berm



Long Lake LID Retrofit

Courtesy Geosyntec

96


Littleton Massachusetts
GEOSYNTEC, Inc.
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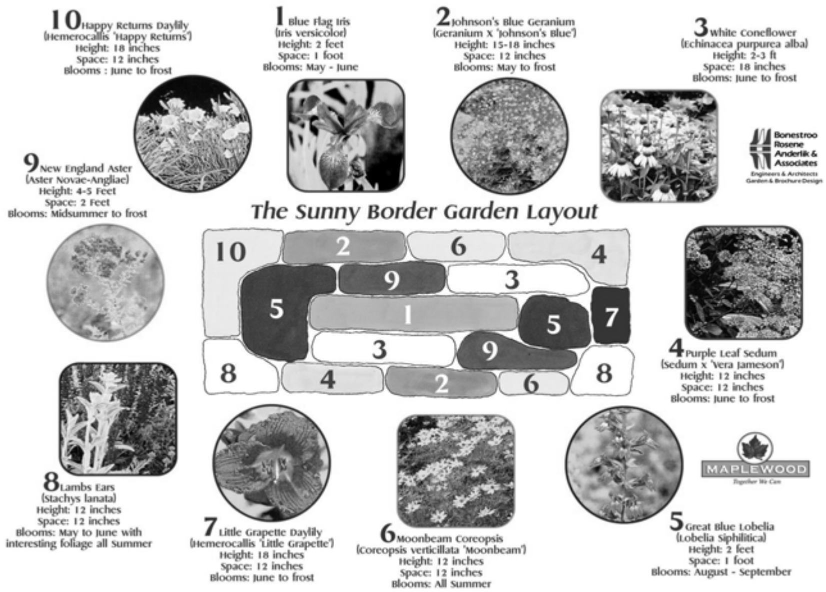
98

Burnsville Minnesota Courtesy
JRiggs Dakota SWCD

99



Courtesy Maplewood MN

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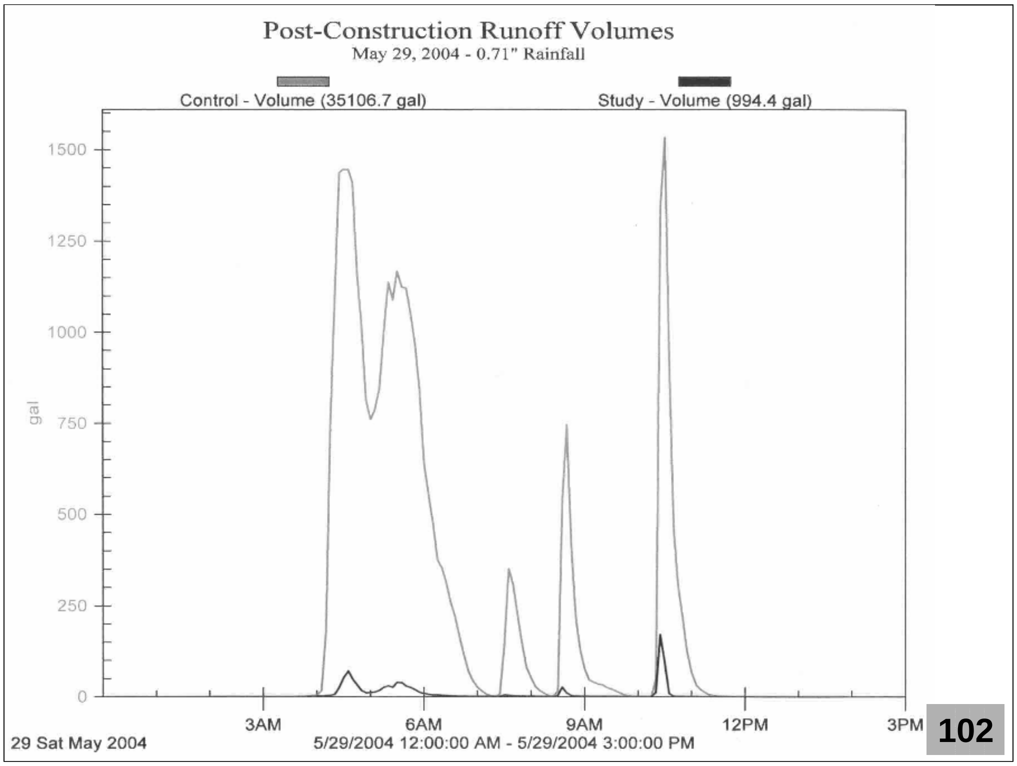
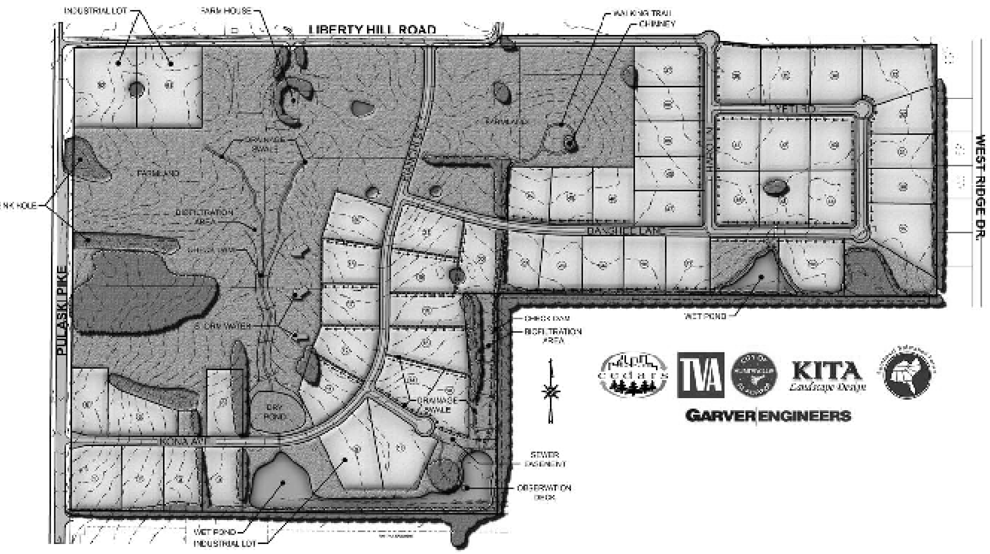
101


Post-Construction Runoff Volumes
May 29, 2004 - 0.71" Rainfall
Control - Volume (35106.7 gal)
Study - Volume (994.4 gal)
gal
1500
1250
1000
750
500
250
0
3AM
6AM
9AM
12PM
3PM
29 Sat May 2004
5/29/2004 12:00:00 AM - 5/29/2004 3:00:00 PM
102



NORTH HUNTSVILLE CONSERVATION DESIGN INDUSTRIAL PARK

Courtesy Pitt 2005

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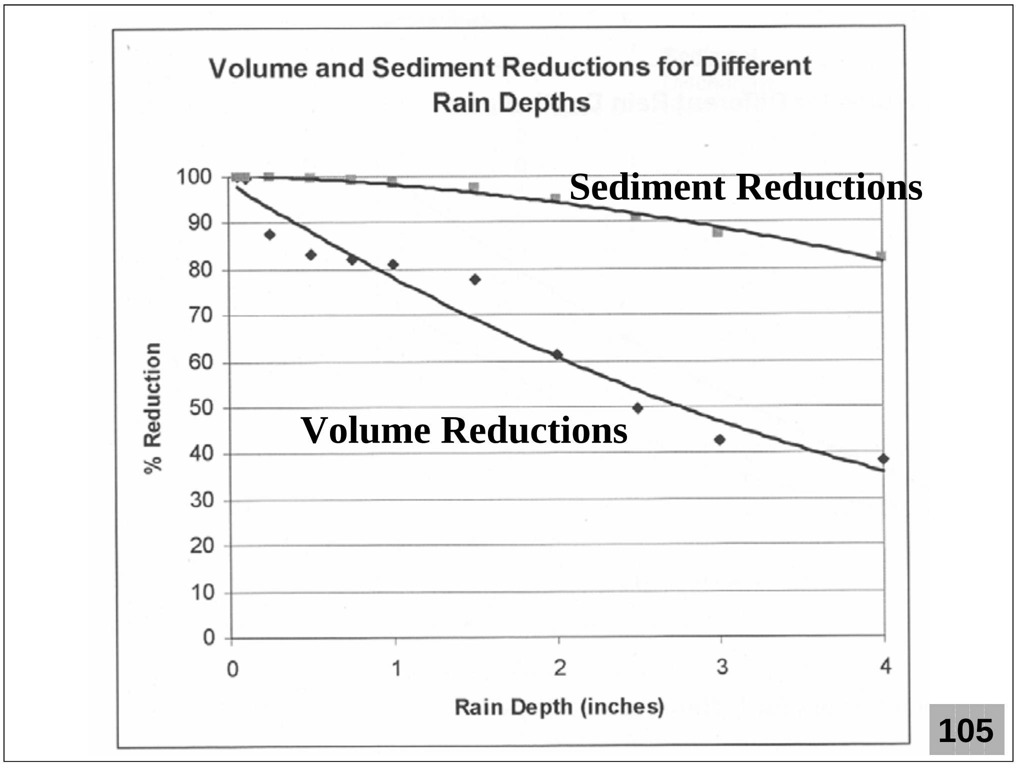
Conservation Design Elements for North Huntsville, AL, Industrial Park

- Grass filtering and swale drainages
- Modified soils to protect groundwater
- Wet detention ponds
- Bioretention and site infiltration devices
- Critical source area controls at loading docks, etc.
- Pollution prevention through material selection (no exposed galvanized metal, for example) and no exposure of materials and products.


Volume and Sediment Reductions for Different Rain Depths
Sediment Reductions
Volume Reductions
% Reduction
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
Rain Depth (inches)
105

“Start at the Source” (BASMAA, 1999)

Site Planning and Design Guidance for the San Francisco Bay Area

- Provides guidance for residential, commercial, and industrial project design for water quality protection
- Communicates basic stormwater management concepts and illustrates simple, practical techniques to preserve the natural hydrologic cycle
- Includes detailed technical information on design concept applications and criteria, maintenance, and costs

Obtain from:
www.basmaa.org

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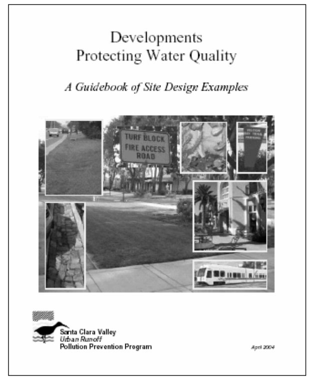
Santa Clara Valley Urban Runoff Program

Site Design Resources

- *Developments Protecting Water Quality - Site Design Examples Guidebook* (April 2004)
- BASMAA "Start at the Source" (1999)
- BASMAA "Using Site Design Techniques to Meet Development Standards" (2003)
- Site Design Dialogues Results



www.scvurppp.org

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Low Impact Development (LID)

A sensible approach to land development and stormwater management

NEMO

An educational program for land use decision makers that addresses the relationship between land use and natural resource protection.

What is Low Impact Development (LID)?

Low impact development is an ecological alternative to land development and stormwater management aimed at minimizing the impact of urbanization on natural habitats and hydrology. LID emphasizes designing with nature in mind; working with the natural landscape and hydrology to avoid unnecessary water pollution, environmental degradation, and flooding. LID accomplishes this through source control, retaining more water on the site where it falls, rather than releasing it directly into local water ways. The LID tool kit includes green roofs, porous pavements, grass swales, and bioretention cells. These techniques reduce the need for costly stormwater management practices, such as unsightly drainage systems, retention ponds, and flood control projects. In the past few years, LID has been applied to government, residential, and commercial development, and, in many cases, has proven to be a cost-efficient and effective method for managing runoff and protecting the environment.

Glossary

Green roofs: rooftops planted with vegetation that can absorb rainwater and heat, reducing runoff and energy costs.
Porous pavement: type of asphalt or concrete that allows rain and snow to infiltrate, reducing runoff and processing some pollutants (generally used for parking lots)
Grassy swale: vegetated channel that treats and slows storm runoff, reducing erosion and floods
Bioretention cell (rain garden): depression that contains a variety of absorbent materials that retain and filter runoff

GOAL of LID: Implement practical technology that mimics the pre-development balance of water runoff, infiltration, groundwater recharge, and evapo-transpiration in order to manage stormwater, protect drinking water and the environment, and minimize flooding.

INCORPORATING LID INTO RESIDENTIAL DEVELOPMENT

Natural Drainage Flow
Reduce need for grading and constructed drainage systems by using the natural hydrological landscape to direct stormwater flow

Bioretention Cells
Provide a physical filtering and adsorption media for stormwater

Amended Soil
Enrichment of soil with sand and organic materials increases the capacity of soil to retain nutrients

Grass Swale
Promotes infiltration, provides a barrier to trap particles, and helps treat pollutants

Green Roofs
Helps conserve energy by reducing roof temperatures, and reduces runoff volume and velocity from impervious rooftops

Preserved Native Vegetation
Enhances the aesthetic quality of community and improves the evaporation-transpiration rate

Porous Pavement
Improves infiltration and allows for groundwater recharge

Diagram adapted from Prince George's County Maryland Low-Impact Development Design Strategies

California State Water Control Board Partnerships

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Moving Environmental Regulations (Restrictions) to an Economic and Asset and Adaptable Management Approach

- Regulations should even the playing field for economic/environmental development instead of being a minimum standard!
- Do those minimum standards really protect the watershed?
- Sustainability/ LEED may not be a good example, Economics are!
- What are the true costs/value to the community for stormwater?

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Challenges and Unknowns

- Level of Performance
- Operations or Maintenance (who pays)
- Inspection
- Long Term Fate and Transport
- Policy and Code Development

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Finally!!

The Watershed Approach

- End-or-Pipe (ended)
- Wetlands Restoration
- Stream Restoration (not stabilization)
- Uplands (LID)

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Thank You

After viewing the links to additional resources, please complete our online feedback form.

Links to Additional Resources

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