Mitigating Sewer Overflows and Flooding with Green Infrastructure

Green Infrastructure Summit

April 20, 2010

Presented by:

The Low Impact Development Center, Inc.

A non-profit water resources and sustainable design organization

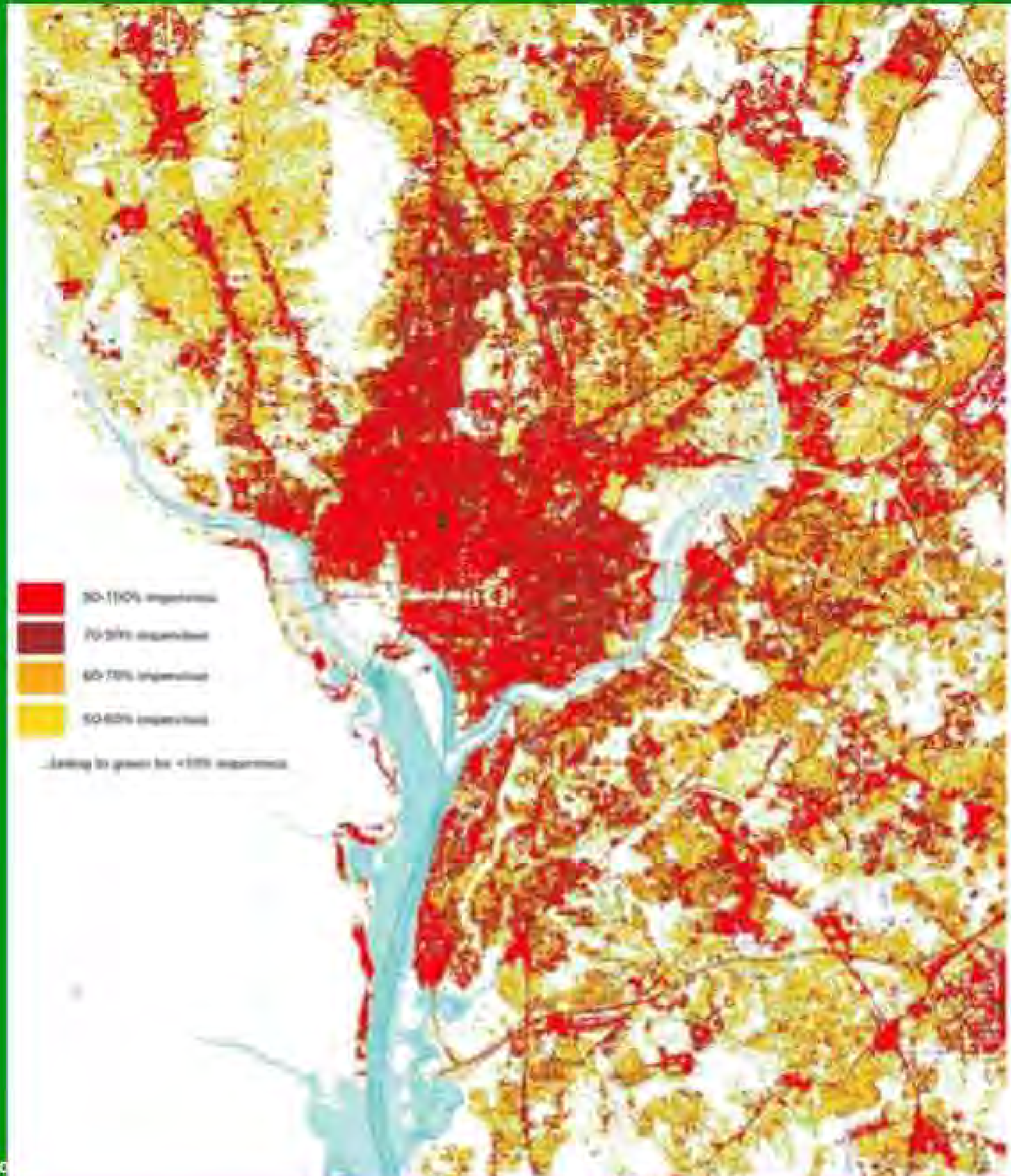
www.lowimpactdevelopment.org

Figure 2. How impervious cover affects the water cycle.

With natural groundcover, 25% of rain infiltrates into the aquifer and only 10% ends up as runoff. As imperviousness increases, less water infiltrates and more and more runs off. In highly urbanized areas, over one-half of all rain becomes surface runoff, and deep infiltration is only a fraction of what it was naturally[8]

The increased surface runoff requires more infrastructure to minimize flooding. Natural waterways end up being used as drainage channels, and are frequently lined with rocks or concrete to move water more quickly and prevent erosion.

In addition, as deep infiltration decreases, the water table drops, reducing groundwater for wetlands, riparian vegetation, wells, and other uses.



Impacts of Stormwater

- Combined sewer systems in 746 municipalities in 31 states and the District of Columbia.
- An estimated 850 billion gallons of CSO discharges each year.
- In 2008, stormwater caused more than 7,300 beach closing and advisory days; sewage spills and overflows caused more than 1,700.

Sources:

U.S. EPA, *Report to Congress: Impacts and Control of CSOs and SSOs, Office of Water*, EPA-833-R-04-001, August 2004.

Natural Resources Defense Council, *Testing the Waters 2008*, August 2009.

Impacts of Urbanization

- Total phosphorus concentrations in urban streams exceed EPA's goal for nuisance growth in 70% of streams.
- Insecticides are usually at a higher concentration than in agricultural areas.
- Fecal coliform bacteria commonly exceed recommended standards for water recreation.

Source: USGS

Trash on the Anacostia River.

Stormwater's Effect on Regional Water Quality (cont.)

"The two-year drought has improved water quality and clarity in the Chesapeake Bay by reducing muddy runoff from city streets, lawns, and development sites.

The clear water has allowed sea grasses to flourish. Scientists report that the grasses, which breathe oxygen into the bay and provide shelter for fish and blue crabs, increased by 16,000 acres last year, the biggest growth spurt since 1978, when such trends first were measured…"

U.S. Water News Online, *Drought Improves Water Quality in Chesapeake Bay*, November 2002. http://www.uswaternews.com/archives/arcquality/2droimp11.html

Economic Impacts

- $220 billion in publicly owned treatment works needs.
- $60 billion in capital investment for CSO control and $10 billion needed for stormwater management programs.

Sources:
U.S. EPA, *Clean Watersheds Needs Survey 2004 Report to Congress, January 2008.*

The Results

- 40% of assessed waters do not meet water quality standards.
- Spend an estimated $35 to $40 billion each year on CWA programs.
- Percentage of assessed waters failing to meet water quality standards virtually unchanged since 1972 and the passage of the CWA.

Energy Analogy
Concept of Demand Management

- In the 1970s, Seattle city planners anticipated electricity capacity shortage.
- Seattle City Light and Mayor proposed investing in two new nuclear power plants to add capacity.
- In 1976, the City Council voted against the plan and instead passed conservation resolutions.
- Prevented new power plant construction for 20 years, at 20% of the cost of new generation capacity.

Demand Management for Stormwater

- Creating peak and baseload capacity with green infrastructure and conservation.
- Adapting, (re)naturalizing built landscape to absorb, clean, and hold water.
- Introducing trees, vegetation, open space and buffers into urban areas to manage and treat precipitation naturally rather than collecting it in a sewer system.
- Using engineered systems such as green roofs, bioretention cells, vegetated swales and infiltration practices to mimic nature and "green" urban areas.

Slide courtesy of the Center for Neighborhood Technology.

Additional Benefits of Green Infrastructure

- Reduces heat island effect
- Improves air quality
- Provides wildlife habitat and recreational space
- Improves energy efficiency
- Improves urban aesthetics
- Increases property values
- Often less expensive than conventional approaches

Lincoln Mercury Headquarters Green Roof, Irvine, CA. *Photo courtesy of Roofscapes, Inc.*

Downspout Disconnection Programs

- Portland's subsidized downspout disconnection program disconnects downspouts for free or pays homeowners $26/downspout.
  - 60,000 downspouts disconnected = 1.5 billion gallons eliminated out of CSS each year.
- Toronto disconnects downspouts for free.

Vegetated Planter and disconnected downspouts at Portland State University. *Photo courtesy of Martina Frey.*

Portland, Oregon

Vegetated Curb Extensions

- Flow testing demonstrated 88% reduction in peak flow and 85% reduction in CSS inflow for 25-year storm event.
- Sufficient to protect local basements from flooding.
- Project cost $15,000 and required two weeks to install.

Vegetated Curb Extensions. *Photo courtesy of the Portland Bureau of Environmental Services.*

Green Streets Cost-Effectiveness

- Citywide priority – included in all development, redevelopment
- 40% cost savings compared to conventional design
- 80-85% CSO peak flow reduction
- Establishes 1% fee on street construction projects to establish Green Streets fund

Slide courtesy of the Center for Neighborhood Technology.

Vancouver Green Streets

Infiltration bulge. *Photo courtesy of City of Vancouver Greenways Program.*

Seattle Natural Drainage Systems

Bioretention Swales

- Stormwater source control.
- Monitoring has demonstrated 99% reduction in stormwater runoff.
- No measured runoff in 2nd Avenue pilot since December 2002.

Photos courtesy of Seattle Public Utilities.

Street Edge Alternatives (SEA) Streets

- Vegetated strips, no curbs = 11% reduction in impermeable surface
- 25% cost savings compared to conventional design

Chicago Green Roofs

- More than 2 million square feet of green roofs with another 2 million square feet planned.
- A 2003 study found green roof runoff volume was less than half that of conventional roofs.
- Estimated annual particulate capture equivalent to 74,000 cars.

Chicago City Hall Green Roof. *Photo courtesy of Roofscapes, Inc.*

Urban Heat Island

The temperature above Chicago's City Hall green roof averages 10 -15°F lower than the black tar roof. Difference can be 50°F or greater during the summer.

Energy savings of $3,600 per year.

Slide courtesy of the Center for Neighborhood Technology.

Portland Green Roofs

Green Roofs

- Zoning bonus allows additional building square footage for buildings with a green roof.
- Two years of monitoring demonstrated that 58% of annual and nearly 100% of warm season rainfall was retained.
- Modeling of 300 block downtown area with ecoroofs showed 32% stormwater reduction, 6.5% energy reduction, and 1% heat island effect reduction (0.5 – 0.9°F and 0.4°F downwind) .

Hamilton Apartments Ecoroof. *Photo courtesy of the Portland Bureau of Environmental Services.*

Real Estate Value: *A Philadelphia Story*

- Vacant land improvements increased surrounding housing values by as much as 30%.
- New tree plantings increased surrounding housing values by approximately 10%.

(University of PA data)

Before and after conditions of a lot in Philadelphia treated under the Vacant Land Stabilization program.

Photo: Cooperative Conservation America.

Slide courtesy of the Center for Neighborhood Technology.

Toronto Modeled Benefits

- Ryerson University study modeled impacts of installing green roofs on all city roofs >3,750 ft^2.
  - Would result in 12,000 acres of green roofs – 8% of total city land area.
  - Estimated nearly $270 million in municipal capital cost savings and more than $30 million of annual savings.

Source: Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto

EPA GI Cost-effectiveness Study

Table 2. Summary of Cost Comparisons Between Conventional and LID Approaches[a]

Project	Conventional Development Cost	LID Cost	Cost Difference[b]	Percent Difference[b]
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	-$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c]	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

[a] The Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs study results do not lend themselves to display in the format of this table.

[b] Negative values denote increased cost for the LID design over conventional development costs.

[c] Mill Creek costs are reported on a per-lot basis.

U.S. EPA, *Reducing Stormwater Costs through LID Strategies and Practices, 2007.*

Philadelphia Benefits Analysis

- PWD study compared managing 50% of the city's runoff with GI versus managing all runoff with a 30' diameter tunnel.
- Whole city present value of the GI approach was $2.8 billion in benefits in comparison to $120 million in benefits for the deep tunnel option (Stratus Consulting, 2009).

Projection of a greened Philadelphia neighborhood. *Photo courtesy of the City of Philadelphia.*