Green Infrastructure Approaches for Stormwater & CSO Control

NACWA Clean Water Law Seminar
Washington, DC
November 13, 2008

Chris Kloss
Low Impact Development Center
www.lowimpactdevelopment.org

The Low Impact Development Center, Inc.

Stormwater's Effect on National Water Quality

- 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 2007, stormwater caused more than 10,000 beach closing and advisory days; sewage spills and overflows caused more than 4,000.

*Sources: U.S. EPA, *Report to Congress: Impacts and Control of CSOs and SSOs*, August 2004.
Natural Resources Defense Council, *Testing the Waters 2008*, August 2008.

The Low Impact Development Center, Inc.

Wet Weather Pollution Problems are Large and Growing

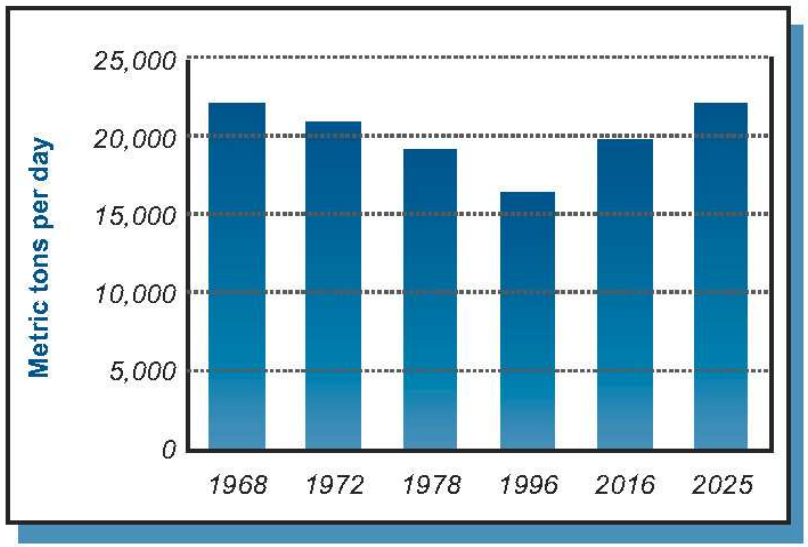


Figure 1–2: Projection of Increase in Biological Chemical Oxygen Demand (BOD)[8]

Source: EPA Report, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, EPA-816-R-02-020, Sept. 2002.

- 67% of wadeable streams are in fair or poor condition
- EPA predicts that sewage pollution will exceed 1968 levels by 2025
- Upward trend for
  - Beach closings
  - Red tides
  - Dead Zones
  - Coral reef damage
  - Water shortages

The Low Impact Development Center, Inc.

Estimated Cost of Mitigating Stormwater Runoff

- $60 billion in capital investment for CSO control.
- $10 billion for stormwater management programs.

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

The Low Impact Development Center, Inc.

Water Quality Issues

The Low Impact Development Center, Inc.

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.

The Low Impact Development Center, Inc.

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.

The Low Impact Development Center, Inc.

Green Infrastructure Economic Advantages

- Incremental approach stages funding – less debt service.
- Less capital intensive, lower cost.
- Effectively extends existing capacity.
- Captures asset value of clean water, soil capacity, open space amenities.

*Slide courtesy of the Center for Neighborhood Technology.

The Low Impact Development Center, Inc.

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.*

The Low Impact Development Center, Inc.

Where did it all start?

Portland, Oregon

- City code requires on-site stormwater management for new and re-development.
- Subsidized downspout disconnection program.
  - 45,000 participating households.
  - Infiltrates 1.5 billion gallons of rainwater annually.

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

The Low Impact Development Center, Inc.

Portland, Oregon (cont.)

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.*

The Low Impact Development Center, Inc.

Portland Street Side Infiltration Planters

Photos courtesy of Martina Frey.

The Low Impact Development Center, Inc.

Portland, Oregon (cont.)

Permeable Paver Blocks

- Used in a similar manner to curb extensions to manage street runoff.
- Allow hardscape function to be retained.
- Have virtually eliminated runoff from the street.

Permeable paver block installation.

The Low Impact Development Center, Inc.

Portland, Oregon (cont.)

Green Roofs

- Zoning bonus allows additional building square footage for buildings with a green roof.
- Two years of monitoring demonstrated that 58% of rainfall was retained.
- Nearly 100% retention of warm season rainfall.

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

The Low Impact Development Center, Inc.

Portland Infiltration Planter

The Low Impact Development Center, Inc.

Vancouver, British Columbia

- Uses naturalized streetscapes, infiltration bulges and Country Lanes to manage stormwater from roadways.
- More than 30 green roofs installed in the city.
- First SEA street design projected to reduce annual runoff 90%.

Country Lane. *Photo courtesy of City of Vancouver Greenways Program.*

The Low Impact Development Center, Inc.

Chicago Green Alleys

- 13,000 alleys – more than 1,900 miles.
- 3,500 acres of impervious surface.
- 20% unimproved; 20% need repair.
- Alleys not connected to storm sewers, cause of flooding.

High albedo permeable pavers in Chicago Alley.
Photo courtesy of Abby Hall, U.S. EPA.

The Low Impact Development Center, Inc.

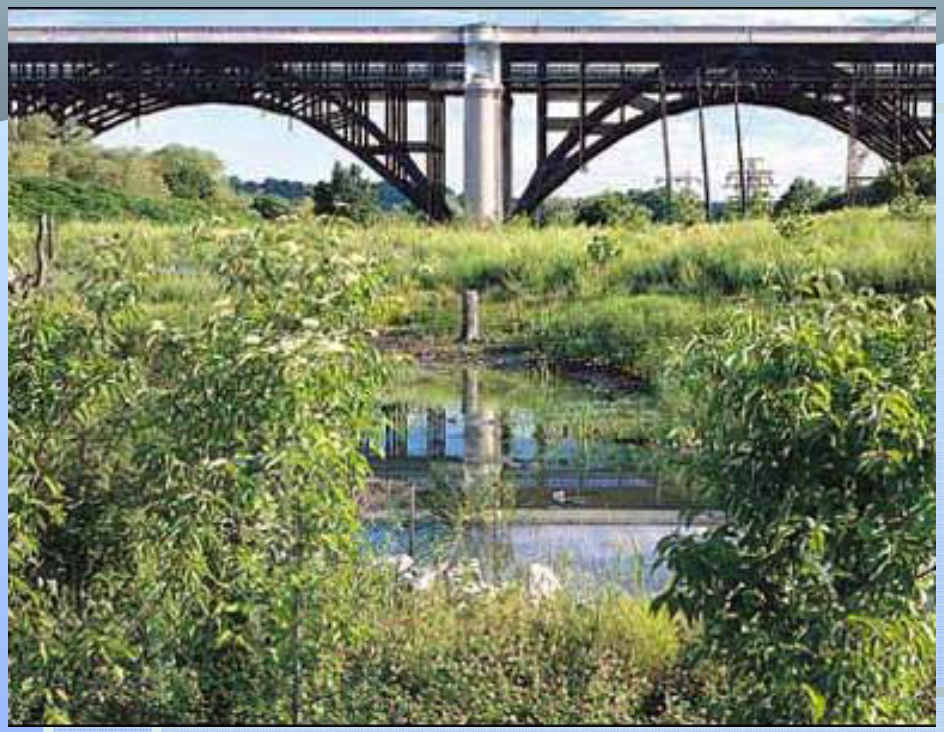
Chicago Green Alleys (cont.)

- Pilot projects address stormwater, urban heat island, recycled materials, energy efficiency and light pollution.
- Transformed from a source to a sink.
- Early pilot alley retains the volume of a 3-inch, 1-hour event.
- Created a market for permeable concrete - $145/yd to $45/yd one year later (regular concrete $50/yd).

High albedo concrete and permeable concrete trench in Chicago Alley. *Photo courtesy of Abby Hall, U.S. EPA.*

The Low Impact Development Center, Inc.

Toronto Policy Approach



Chester Springs Marsh. *Source: City of Toronto, www.toronto.ca.*

- Urban stormwater identified as a leading cause of degradation – polluted runoff and CSOs.
- In 2003, the City Council adopted a 25-year stormwater plan.
- Plan augments conventional infrastructure with green infrastructure.

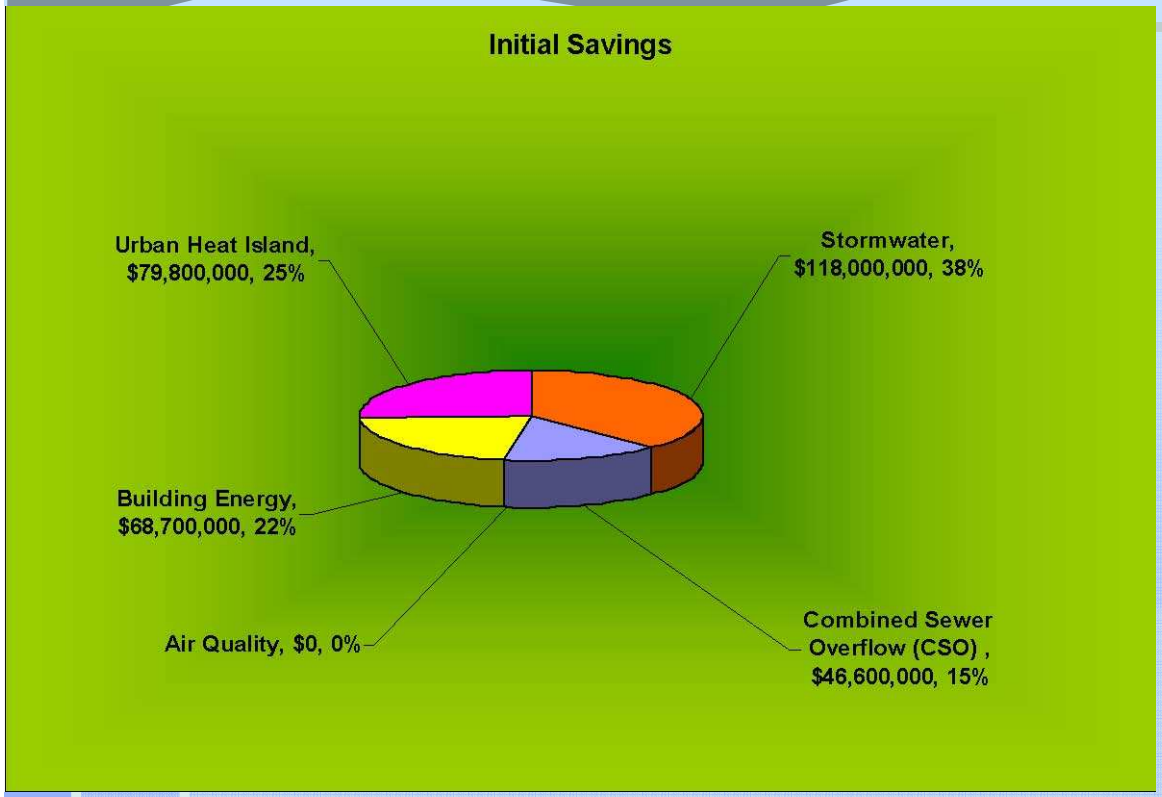
The Low Impact Development Center, Inc.

Toronto Policy Approach

- Wet Weather Plan is based on four principles.
  1. Recognizing rainwater and snowmelt as a valuable resource.
  2. Managing wet weather flows on a watershed basis.
  3. Establishing a hierarchy of management practices.
     a. Source
     b. Conveyance
     c. End-of-Pipe
  4. Educating communities and involving the public.
- More than 100 green roofs have been installed in the city, which reduce roof runoff by more than 50%.
- City provides free downspout disconnection.

The Low Impact Development Center, Inc.

Toronto Policy Approach



- 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*

The Low Impact Development Center, Inc.

Green Roofs: Air Quality

Quantity of Air Pollutants Removed by a 1.4 Acre Green Roof (Currie and Bass, 2005)

Pollutant	Mass Removed Annually (lbs)
O_3	2,800
PM_{10}	1,940
NO_2	1,430
CO	310
SO_2	550

Note: Annual pollutant removals based upon UFORE model results for Toronto.

The Low Impact Development Center, 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℉ or greater during the summer.

Energy savings of $3,600 per year.

Slide courtesy of the Center for Neighborhood Technology.

The Low Impact Development Center, Inc.

Urban Heat Island (cont.)

- Portland Central Eastside Industrial District green roof study.
- Full implementation for 670 acres.
- Cooling of 0.5 – 0.9°F in District
- Downwind cooling of 0.4°F up to one mile.

Photo courtesy of the Portland Bureau of Environmental Services.

The Low Impact Development Center, Inc.

Green Roof Energy Savings (cont.)

- Can reduce heating & cooling costs 10-15%.
- 10% energy savings for 50,000 SF office building = 49,000 kWh
- 2.095 lbs of CO_2 emissions per kWh for coal-fired power.
- CO_2 reduction of 50 tons.

Vancouver Public Library Green Roof

Sources: Energy Information Administration, Department of Energy, and Environmental Protection Agency.

The Low Impact Development Center, Inc.

Rainwater Harvesting
King Street Center – Seattle, WA

- Over 16,000 gallons of storage at 327,000 ft^2 King Street Center used for toilets and irrigation. Provides 60% (1.4 million gallons) of toilet flushing water annually.
- Water supply, conveyance, treatment & distribution = 1,450 kWh/MG
- CO_2 reduction of 2 tons.

King Street Center.

Sources: California Energy Commission, Department of Energy, and Environmental Protection Agency.

The Low Impact Development Center, Inc.

Summary

- Green infrastructure is an effective stormwater and CSO control that is currently underutilized.
- A philosophical change is needed in stormwater/CSO management.
  - A move away from collect and detain to source control and prevention.
  - Focus on hydrology and ecology as well as water chemistry.
- 2007 – A.A. Ben Grumbles memo endorses green infrastructure for CSO, SSO, and stormwater control and Administrator Johnson announces Green Infrastructure Partnership
- EPA Green Infrastructure Action Strategy
  - http://cfpub.epa.gov/npdes/home.cfm?program_id=298
  - http://cfpub.epa.gov/npdes/greeninfrastructure/information.cfm#greenpolicy

The Low Impact Development Center, Inc.