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The Cost of Green Infrastructure: Worth the Investment?

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THE COST OF GREEN INFRASTRUCTURE: WORTH THE INVESTMENT?

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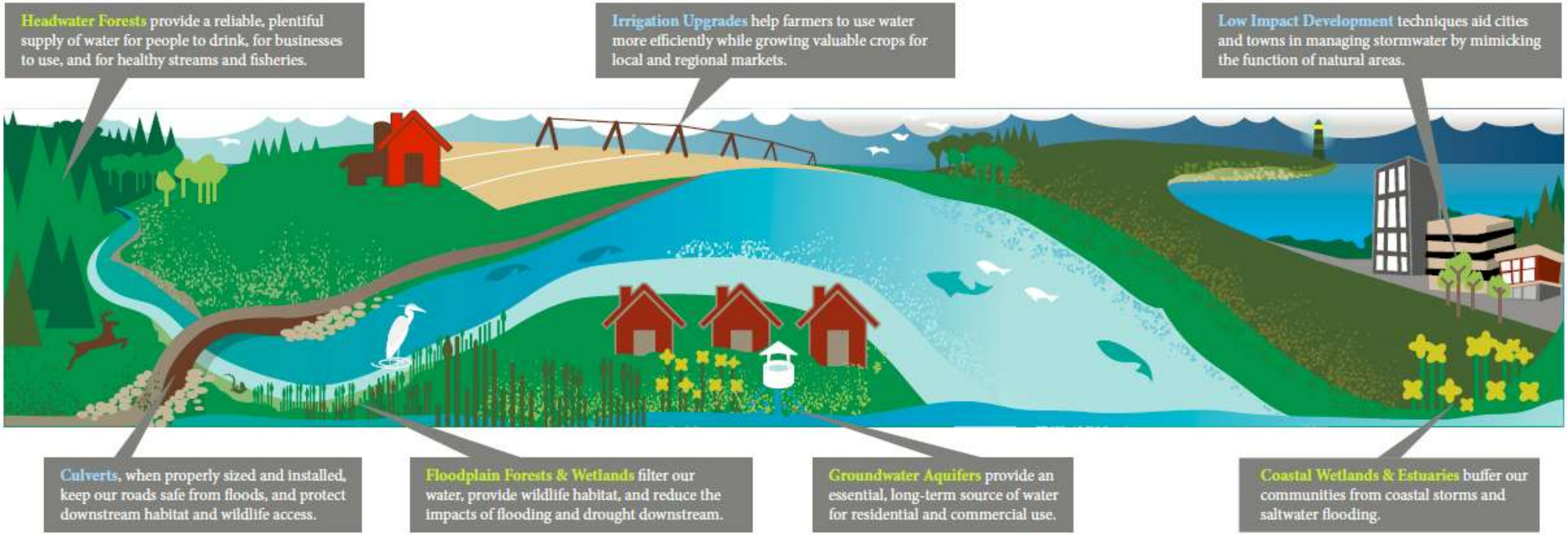
Infrastructure

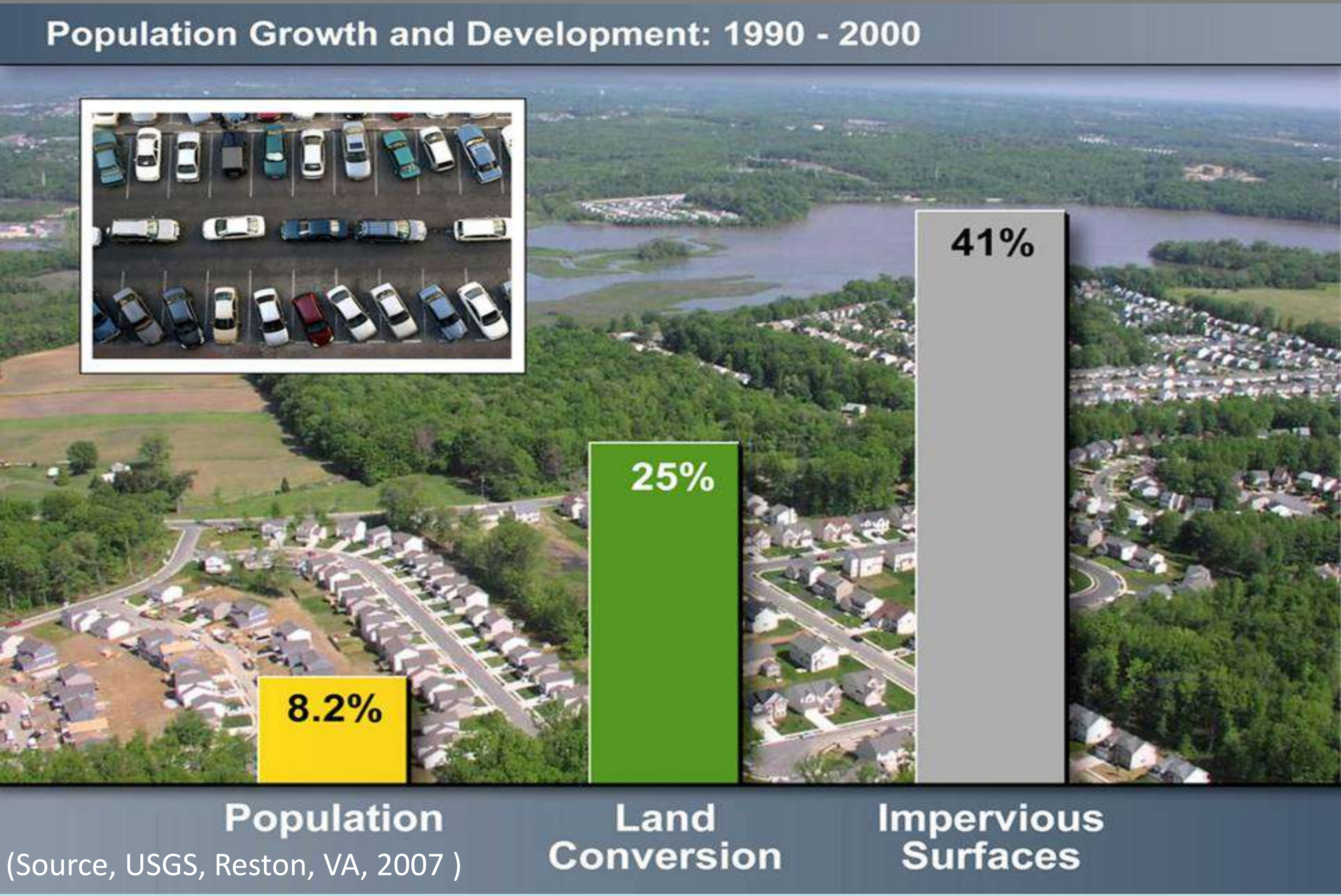
BUILT

Gray - pipes

Green – LID

NATURAL


Headwater Forests provide a reliable, plentiful supply of water for people to drink, for businesses to use, and for healthy streams and fisheries.
Irrigation Upgrades help farmers to use water more efficiently while growing valuable crops for local and regional markets.
Low Impact Development techniques aid cities and towns in managing stormwater by mimicking the function of natural areas.
Culverts, when properly sized and installed, keep our roads safe from floods, and protect downstream habitat and wildlife access.
Floodplain Forests & Wetlands filter our water, provide wildlife habitat, and reduce the impacts of flooding and drought downstream.
Groundwater Aquifers provide an essential, long-term source of water for residential and commercial use.
Coastal Wetlands & Estuaries buffer our communities from coastal storms and saltwater flooding.



(Source, USGS, Reston, VA, 2007)

Measuring $$$ saved / spent

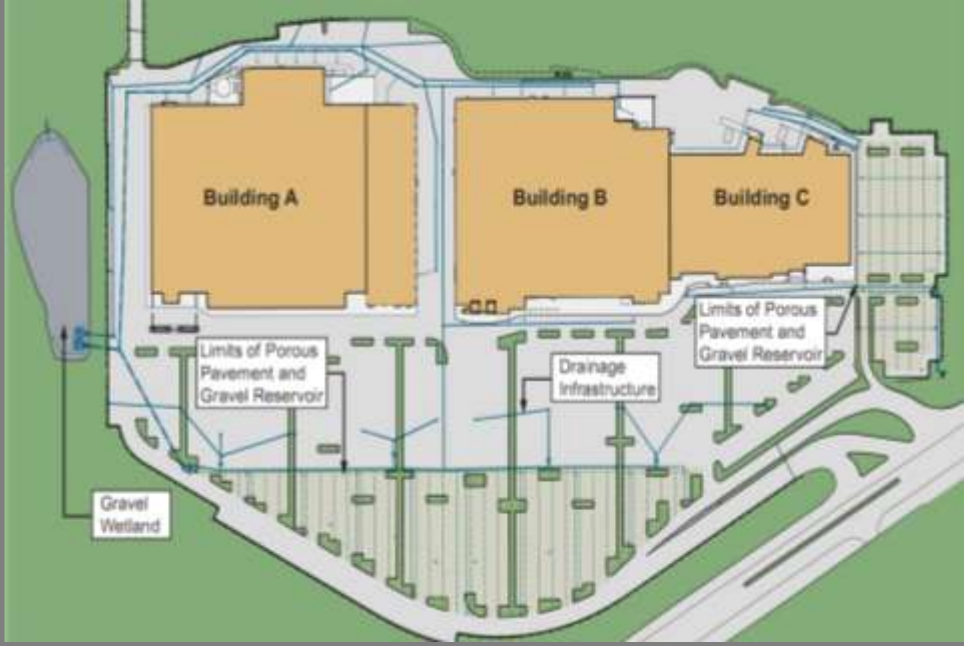
- Cost Savings: when a proposed action reduces costs
- Avoided Costs: When an action prevents a future (reasonably certain) cost.

Greenland Meadows Commercial Development, Greenland, NH

- Near Impaired Waters/303D (Pickering Brook)

- Brownfields site, ideal location

- LID Stormwater Design: attenuation, storage, conveyance and treatment



THE COST OF GREEN INFRASTRUCTURE:
WORTH THE INVESTMENT?

SC
STORMWATER CENTER

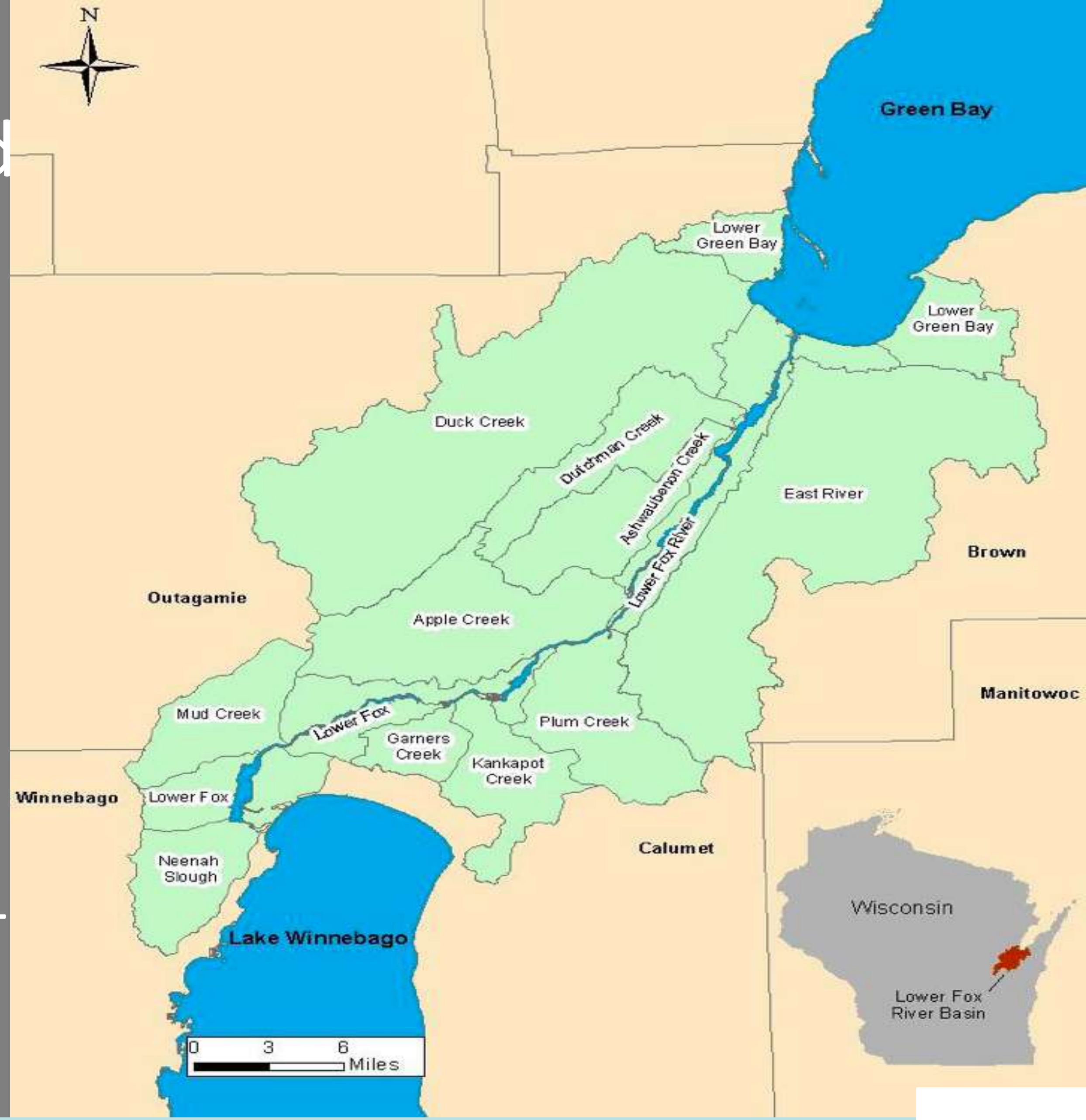
Item	Conventional Option	LID Option	Cost Difference
MOBILIZATION / DEMOLITION	$555,500	$555,500	$0
SITE PREPARATION	$167,000	$167,000	$0
SEDIMENT / EROSION CONTROL	$378,000	$378,000	$0
EARTHWORK	$2,174,500	$2,103,500	–$71,000
PAVING	$1,843,500	$2,727,500	$884,000
STORMWATER MANAGEMENT	$2,751,800	$1,008,800	–$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

LID: Lower Cost Approaches to Managing the Largest Environmental Costs Problem for Municipalities

Municipality	Cost Savings of Integrating LID & Conventional	Reference
Kansas City, MO	$19 million	Odefey, 2012
Portland, OR	$61 million	Garrison & Hobbs, 2011
Philadelphia, PA	$1.9-4.5 million annual benefit over 40 years	Stratus Consulting, 2009
New York, NY	$1.5 billion	NYC DEP, 2011

The Role of Land Use in Adaptation to Increased Precipitation and Flooding:

A Case Study in Wisconsin's Lower Fox River Basin, 2011 (89,600 acres)



Evaluating a GI Investment

What if, instead of developing the area, it was retained in green space? what would be the floodplain protection costs and benefits?

COSTS

Purchase of land or purchase of conservation easement (≈ 60% of cost)

BENEFITS

Less development = reduced exposure to storm and flood damages = REDUCED ECONOMIC LOSSES

The Hazus Model

- GIS-based FEMA model that estimates damages from flood events

- Contains layers that can map the stream network, flood depth, and estimates $$$$$ damages to buildings in the watershed for various flood events (10, 50, 100, 500 year floods)

RFF

How Study Uses Hazus

- Estimate losses in future 2025 scenario WITH development as projected by county, for different flood events (10, 50, 100, and 500 years)

- Estimate losses in alternative 2025 scenario WITH NO development in floodplain, for different flood events (10, 50, 100, and 500 years)

- Compute average annualized losses (AAL) for each scenario

DIFFERENCE = an estimate of ANNUAL BENEFITS from preserving land from development

Estimated Benefits and Costs

Average Annualized Loss (AAL)		BENEFITS
Current Land Use (2010)	Future land Use (2025)	
$19.43 million	$22.06 million	**$2.63 million**
833 parcels; 7,403 acres		

Annualized Costs:

Fee simple purchase: $5.1 million
Easement purchase: $3.1 million

costs > benefits

RFF

Targeting

3 scenarios for targeting GI investments:

1. FLOOD DEPTH – only parcels > 1 ft mean flood depth in 100-yr flood

2. FLOOD DEPTH & PARCEL SIZE – only parcels that account for 90% of total acre-feet of flooding

3. FLOOD DEPTH, PARCEL SIZE, & COSTS – only parcels below median cost per acre-ft. of flooding (property value as measure of cost)

RFF

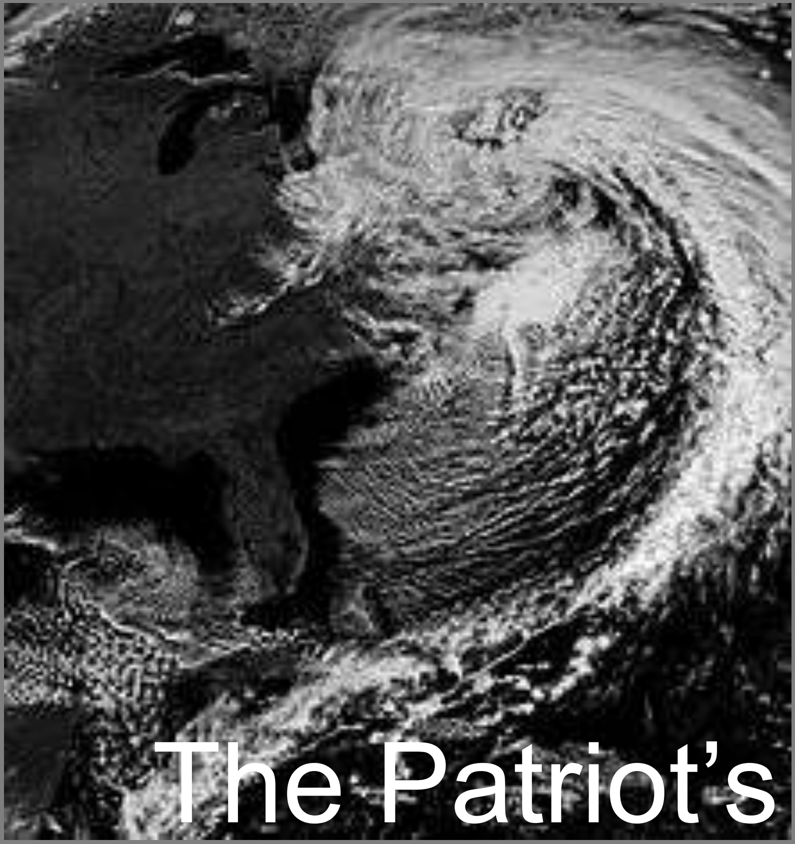
Comparing Targeting Scenarios to Baseline

Scenario 2:
86% of the acreage at only 23% of cost

Scenario 3:
86% of the acreage at 9.7% of cost

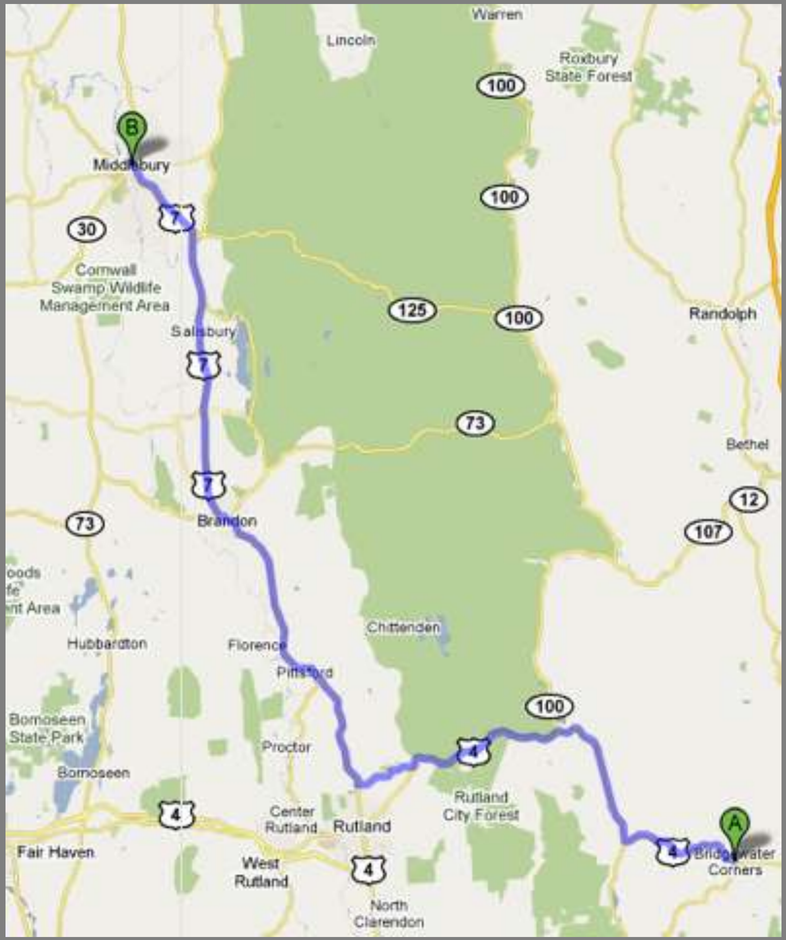
Note: Benefits were not re-calculated. However, these scenarios likely to pass benefit-cost test.

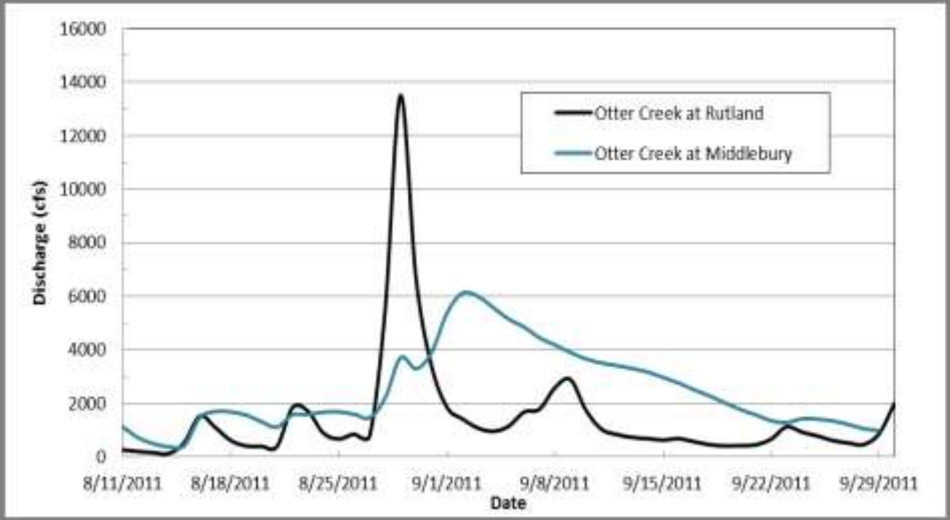
Flood Mitigation



The Patriot's Day Storm: 2007

The difference that open space makes: Hurricane Irene in Vermont





An Assessment of the Economics of Natural and Built Infrastructure for Water Resources in Maine

Charles S Colgan PhD

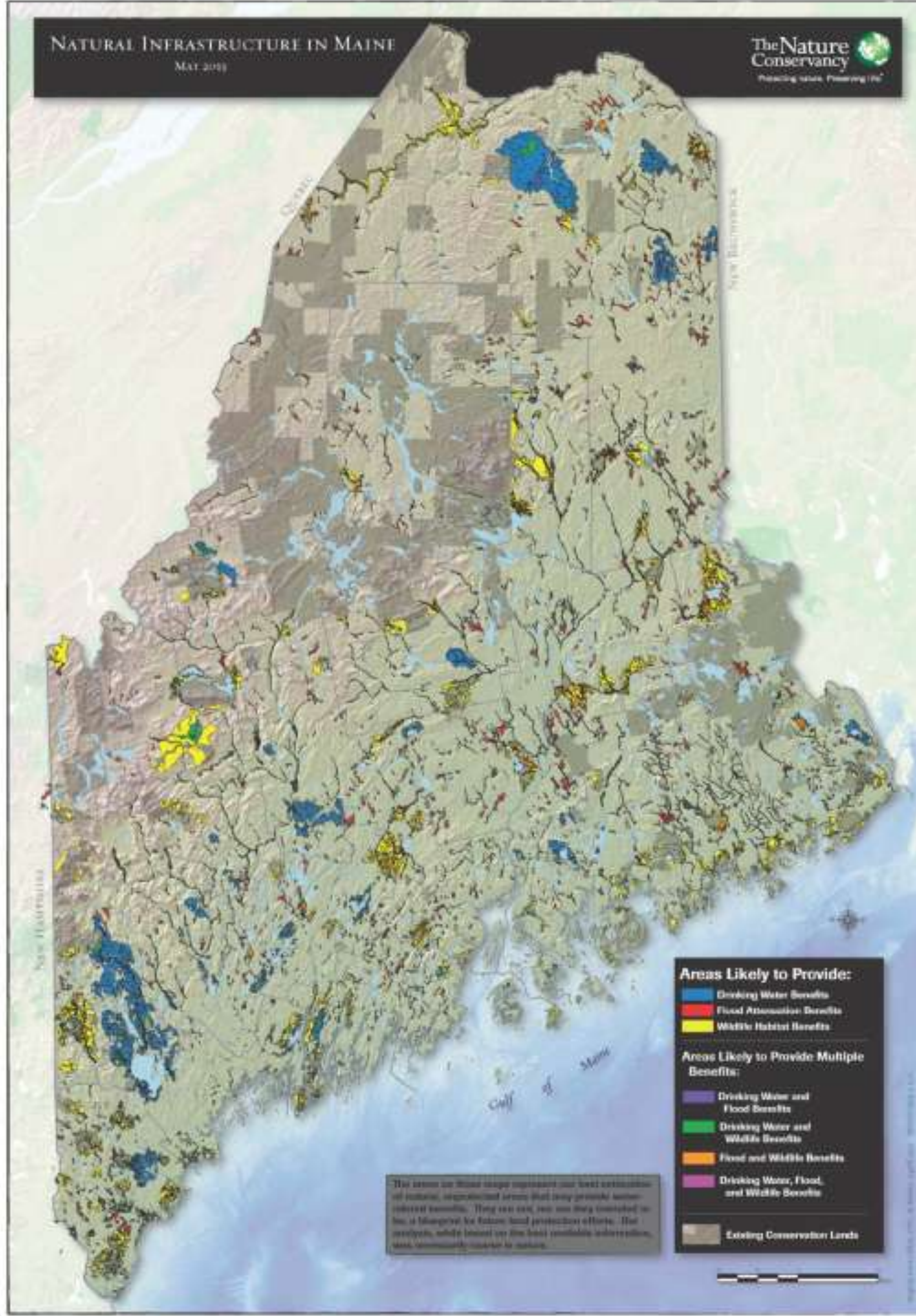
Damon Yakovleff MCPD

Samuel B. Merrill PhD

May 2013

UNIVERSITY OF SOUTHERN MAINE

New England Environmental Finance Center

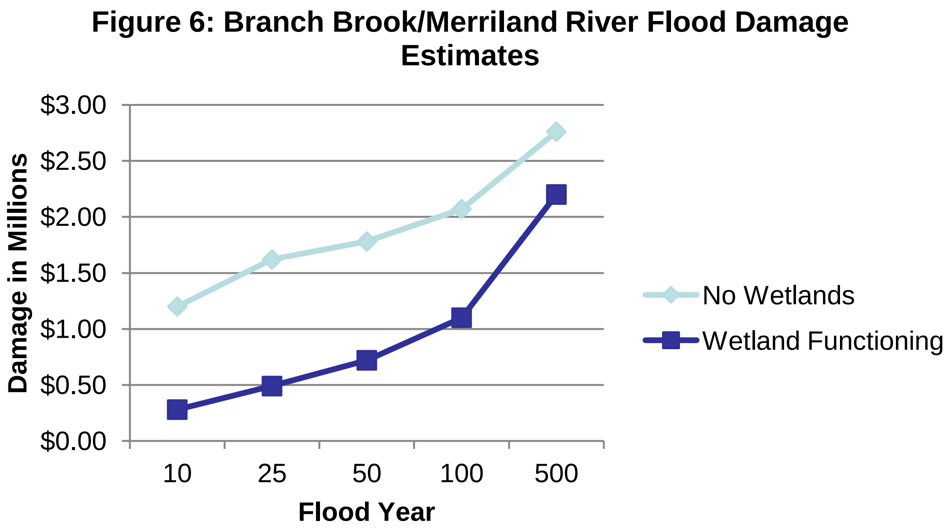

NATURAL INFRASTRUCTURE IN MAINE
The Nature Conservancy
Areas Likely to Provide:
Drinking Water Benefits
Flood Attenuation Benefits
Wildlife Habitat Benefits
Areas Likely to Provide Multiple Benefits:
Drinking Water and Flood Benefits
Drinking Water and Wildlife Benefits
Flood and Wildlife Benefits
Drinking Water, Flood, and Wildlife Benefits
Existing Conservation Lands
Gulf of Maine

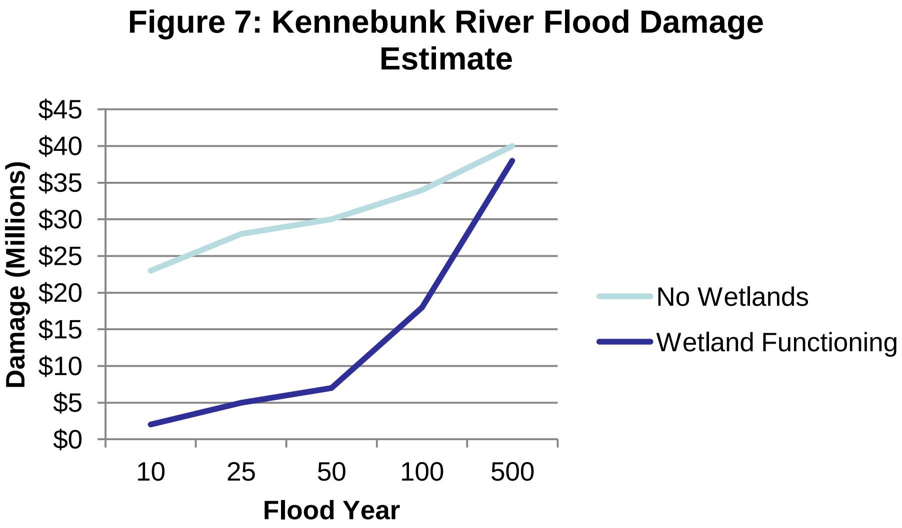
Avoided Costs of Riverine Flooding in York County with Natural Infrastructure (wetlands)

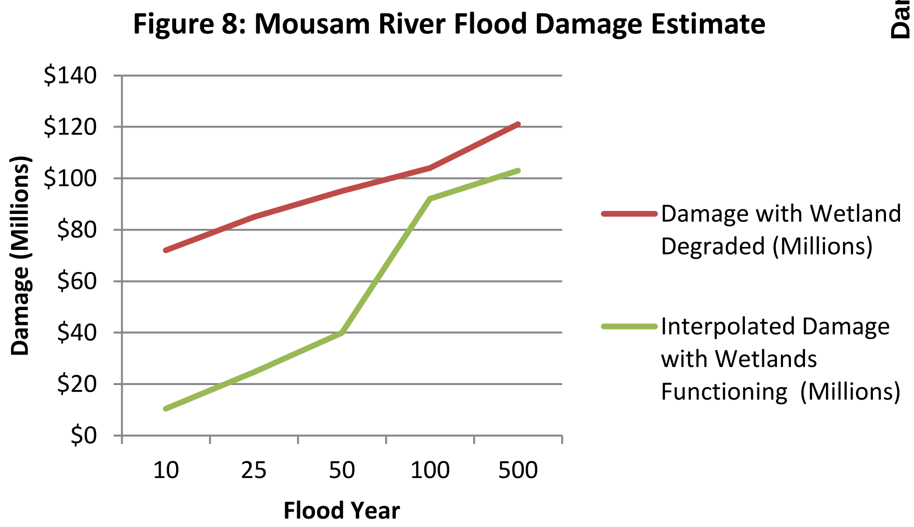
Three watersheds in York County:

1) Kennebunk River
2) Mousam River
3) Branch Brook

Modeling Flood Damages with HAZUS







Estimating the Costs of Conserved Land in Maine

County	Total Acres	Overall Cost / Acre	Standard Deviation	Project Count
Androscoggin	38,533	**$1,028**	$849	5
Aroostook	6,244	**$831**	$865	8
Cumberland	8,813	**$5,947**	$8,345	51
Franklin	28,143	**$818**	$646	10
Hancock	46,582	**$976**	$1,052	11
Kennebec	6,864	**$1,388**	$737	6
Knox	912	**$3,710**	$1,653	8
Lincoln	1,326	**$2,456**	$1,595	9
Oxford	9,651	**$1,255**	$761	10
Penobscot	6,156	**$1,619**	$1,440	12
Piscataquis	243,548	**$755**	$578	8
Sagadahoc	2,991	**$3,142**	$2,275	19
Somerset	64,396	**$1,742**	$1,870	7
Waldo	2,313	**$2,394**	$2,716	10
Washington	83,499	**$2,128**	$2,171	37
York	15,381	**$3,027**	$2,367	25
Total	**565,351**	**$2,076**	**$1,870**	**236**

Land for Maine's Future

LMF

Land for Maine's Future

Maine Natural Resources Conservation Program

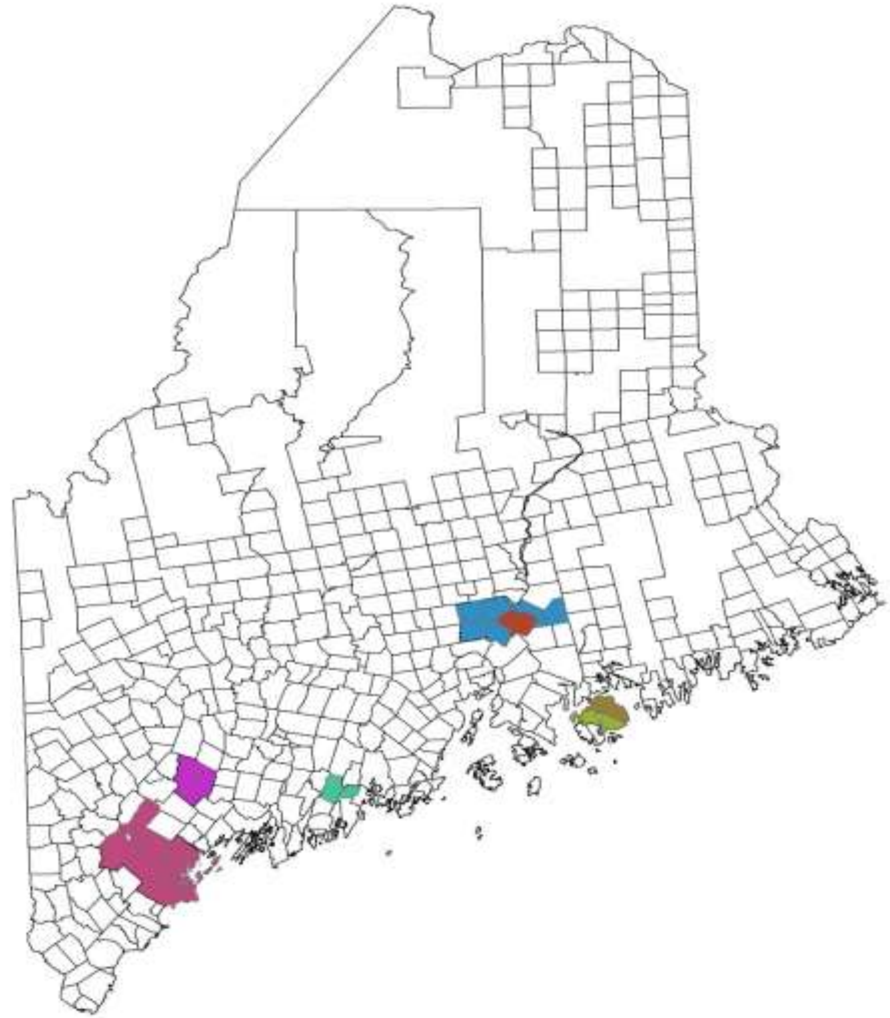
A collaboration of The Nature Conservancy, the Maine Department of Environmental Protection and U.S. Army Corps of Engineers.

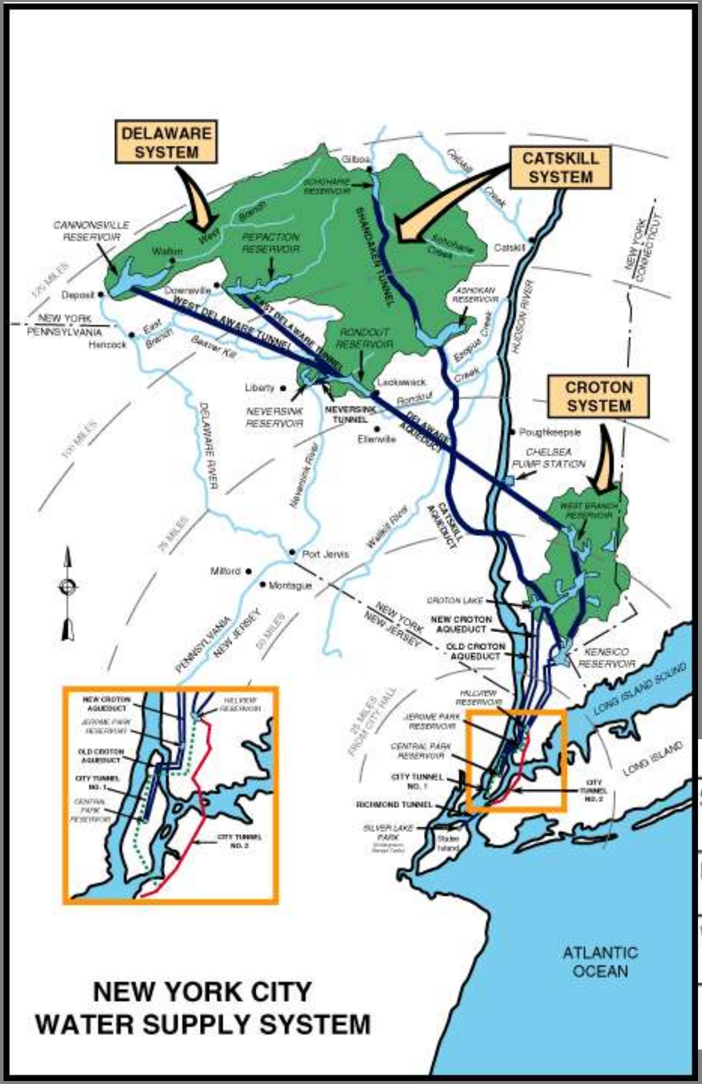
York County Flood Mitigation HAZUS Analysis

Watershed name	Estimated Present Value of flood losses **W/O wetlands (mil $)**	Estimated Present Value of flood losses **WITH wetlands (mil $)**	Avoided flood damages **(mil $)**	Conservation cost of wetland **(mil $)**	Net benefits **(mil $)**	B/C Ratio
Kennebunk River	$87.15	$15.70	$71.45	$1.49	$69.96	47.95
Mousam River	$270.50	$77.53	$192.97	$8.67	$184.30	22.26
Branch Brook	$4.84	$1.51	$3.33	$4.92	($1.59)	0.68
TOTAL	**$362.49**	**$94.74**	**$267.75**	**$15.08**	**$252.67**	**17.76**

Providing Drinking Water

Maine Water Districts with Filtration Avoidance Determinations





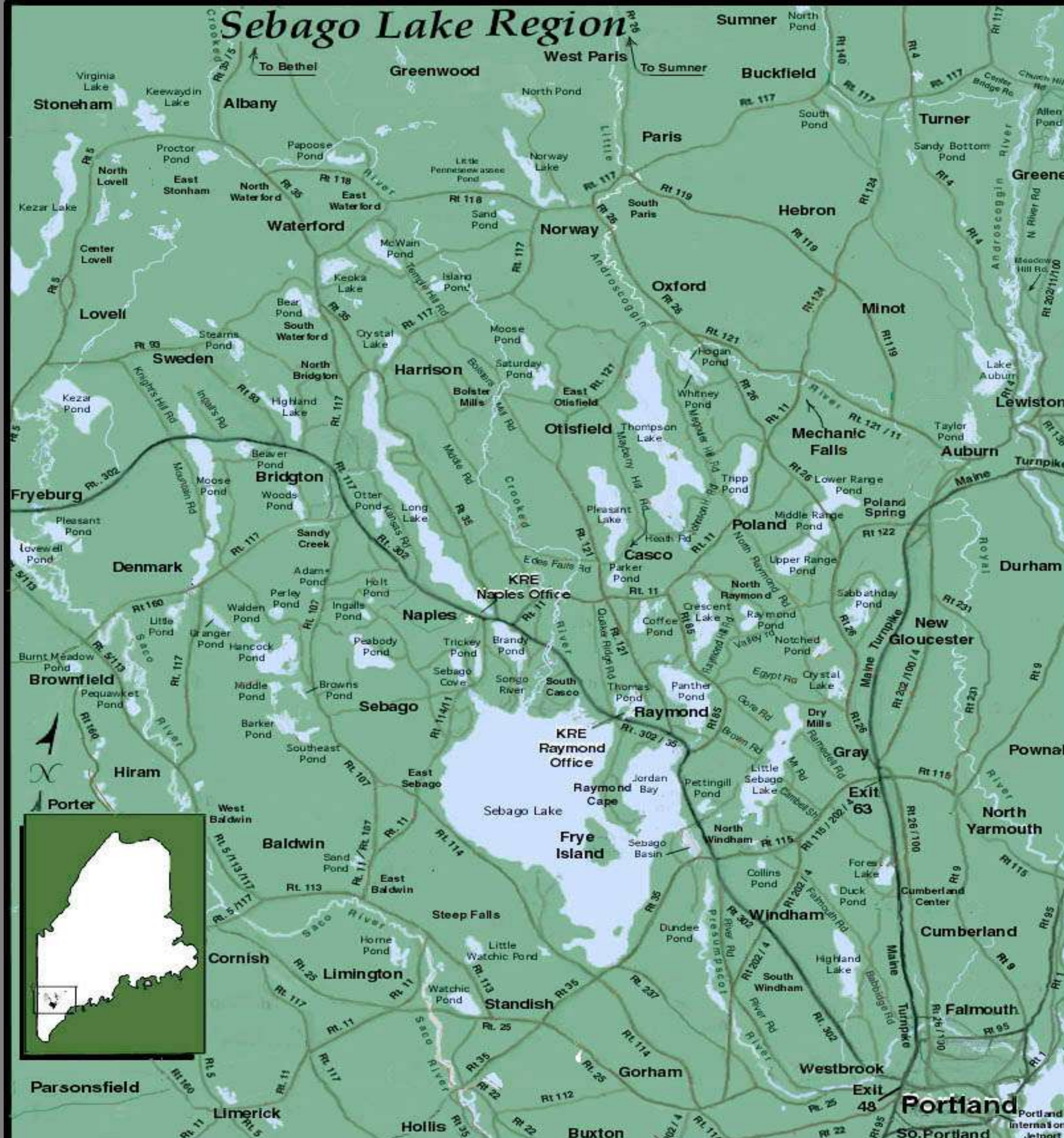
System	Percent of Water Supply	Natural Infrastructure Costs	Conventional Infrastructure Costs
East Side: Croton	~10%	Environment Degraded	$2.8 billion (2013)
West Side: Delaware / Catskills	~90%	$1.4 billion (1997-2007)	$3-$6 billion + $250 - $300 million Annually (2007)

Maintaining Drinking Water Quality

Catskill Delaware Watershed – water source for NYC

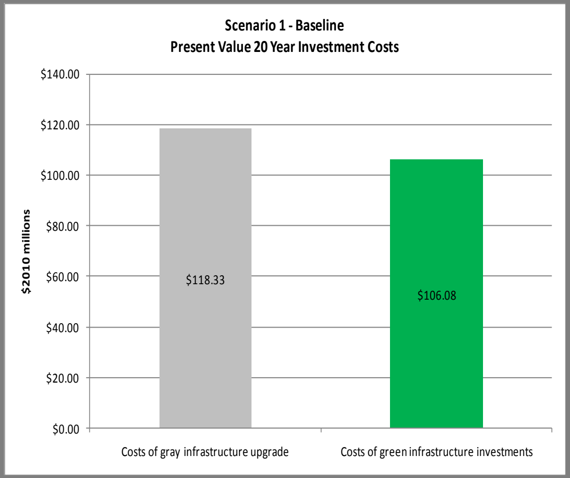
SPENT: $1.4 billion to preserve land & protect drinking water supplies in the Catskill Mountains

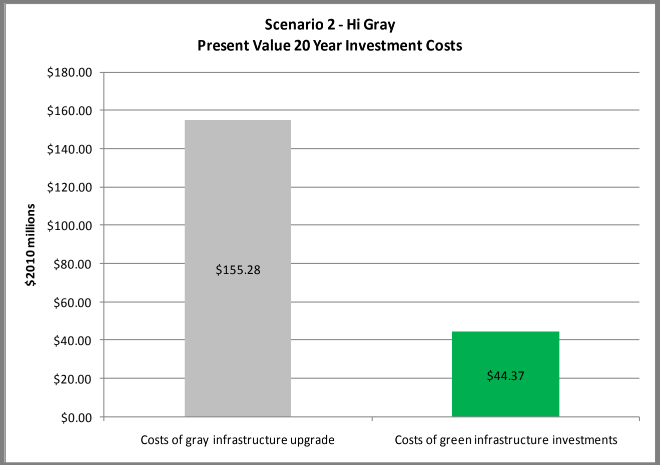
SAVED: $3 to 6 billion in capital construction costs (PLUS $250 million every year in operating costs) that it did NOT spend on filtration plants

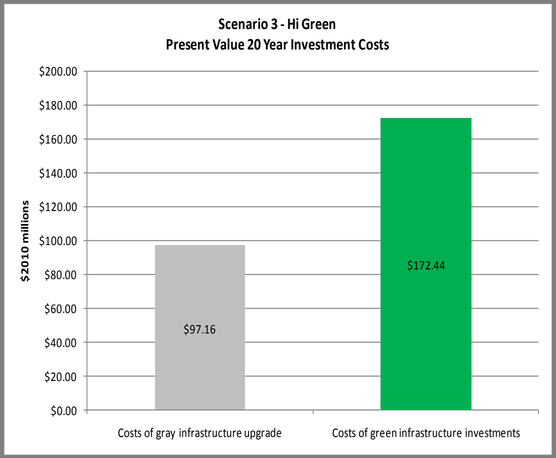


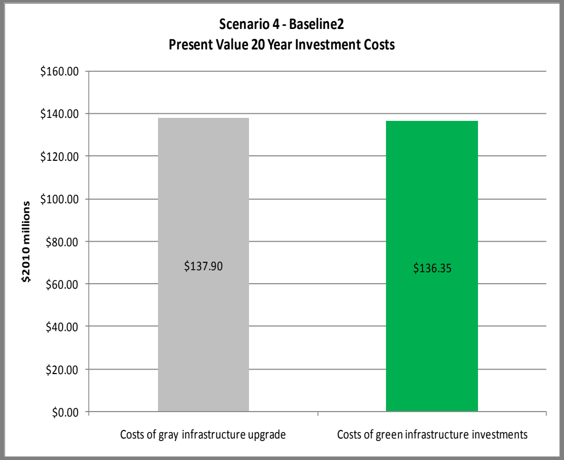
Region Map designed by Jeff Perron © 2004 Krainin Real Estate Inc Scale : 1" = 5 miles. (approx./ printed)

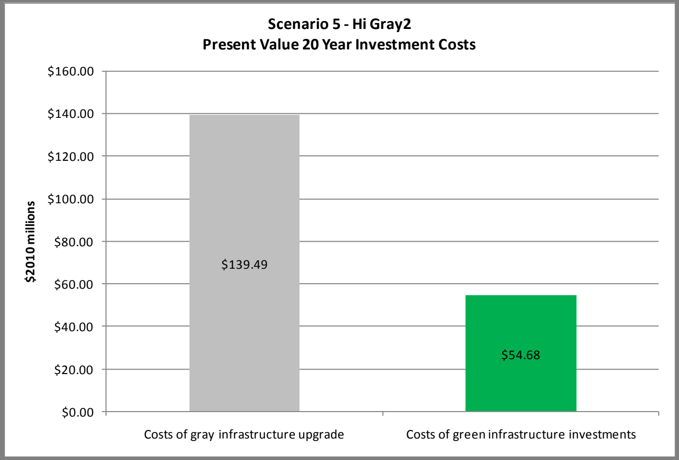
Comparison of “Grey” and “Green” costs for Portland Water District under different assumptions

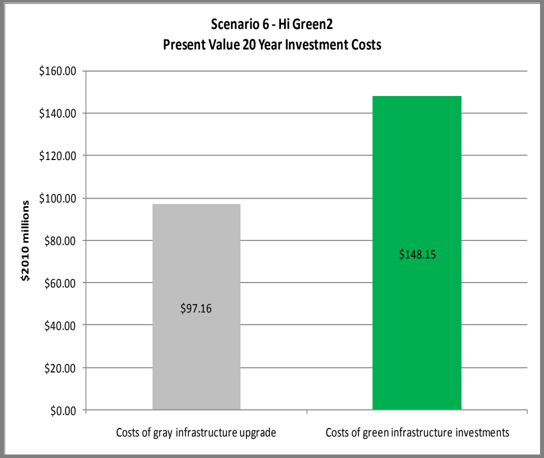








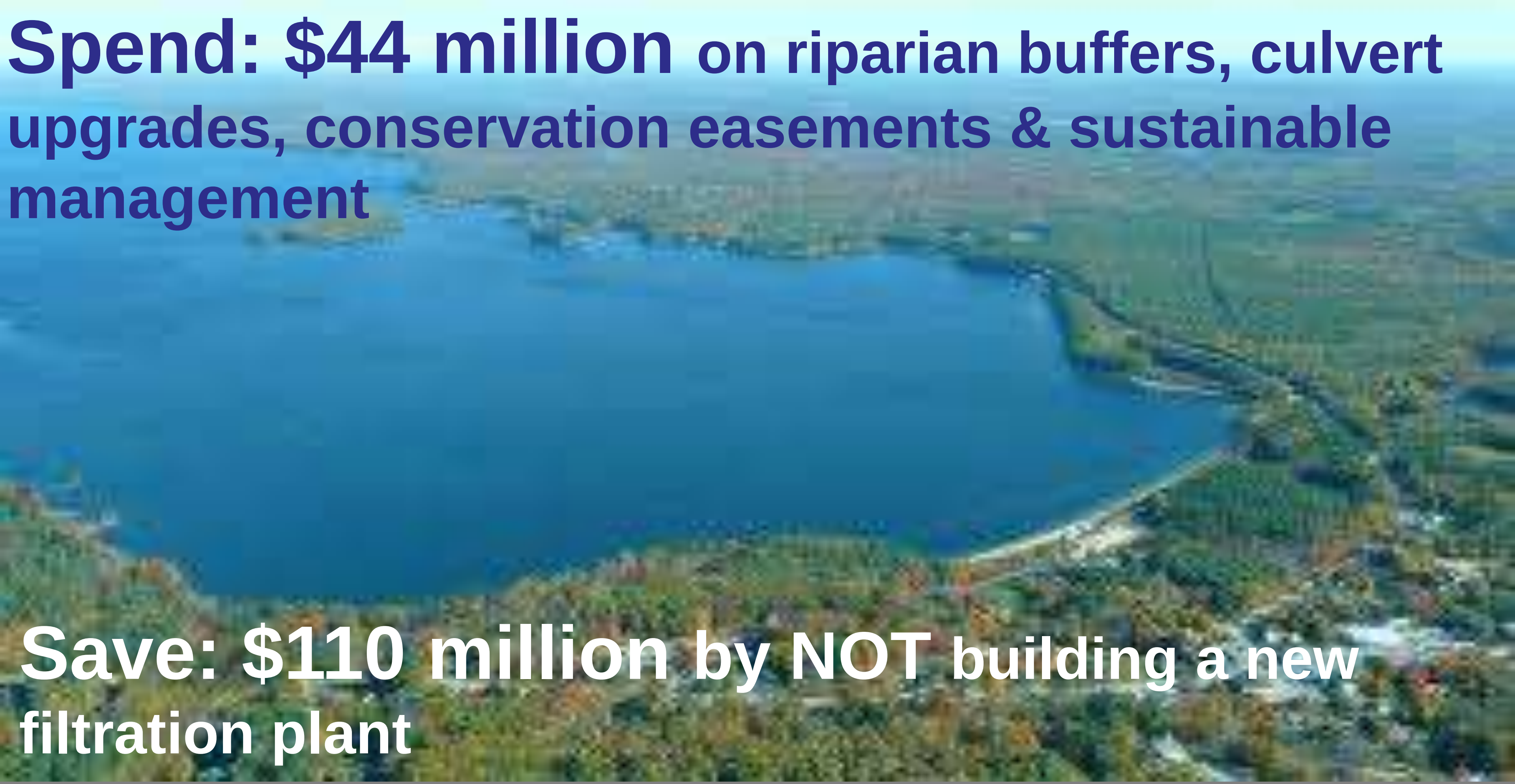




Green / Gray Infrastructure Analysis: Portland Water District Case Study

Infrastructure Options	Quantity	Present Value Costs (millions)
Riparian buffers (acres)	367	$16.33
Culvert upgrades and replacements (units)	44	$1.38
Conservation certification (acres)	4,699	$0.14
Afforestation/ reforestation (acres)	9,395	$14.67
Conservation easements - 80% forest cover (acres)	13,215	$11.85
Green infrastructure total		$44.37
Gray infrastructure (membrane filtration) total		$155.28
Avoided-cost benefits (gray minus green):		**$110.91**

Sebago Lake – water source for Portland Water District



Is GI worth the investment?

- LID techniques often lead to cost savings when we look at WHOLE PROJECT COSTS

- Natural Infrastructure investments for flood control, drinking water protection and wildlife habitat can yield SIGNIFICANT AVOIDED COSTS and additional co-benefits to communitites

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THANK YOU!

ANY QUESTIONS / COMMENTS TO:

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New England Environmental Finance Center's
Green Infrastructure Resource Directory
is available upon request