LID, INFRASTRUCTURE & CLIMATE CHANGE

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NEMO U7
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Newmarket, NH April 2007

In recent years New Hampshire has experienced three major flood events in October 2005, May 2006, and April 2007 . . . .

Comprehensive Flood Management Study Commission 2008

The New Orleans Hurricane Protection System: What Went Wrong and Why-- 1**0 Lessons Learned from Katrina** by the ASCE Hurricane Katrina External Review Panel and the USACE Interagency Performance Evaluation Task Force

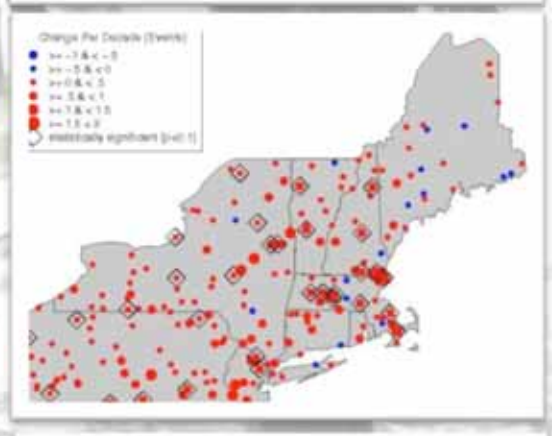
1. Failure to think globally and act locally-We must account for climate change
2. Failure to absorb new knowledge
3. Failure to understand, manage, and communicate risk-Need to take rigorous risk based approach,
4. Failure to build quality in
5. Failure to build in resilience
6. Failure to provide redundancy
7. Failure to see that the sum of many parts does not equal a system
8. The buck couldn't find a place to stop--Poor organization, lack of accountability
9. Beware of interfaces: materials and jurisdiction
10. Follow the money-People responsible for design and construction had no control of the monies.

Primary Causes of Runoff Increase

- Land Use Changes→Increase in impervious cover
- Changes in storm depth, duration, and frequency→Increased rainfall depth and runoff volume

SOLUTIONS

- Land use management strategies to mitigate runoff volumes



- Research examining impacts of climate change on rainfall depths (28-60% increase) demonstrated existing urban infrastructure (culverts) will be under-capacity by 35% (Guo, 2006)
- This in addition to stressed stormwater infrastructure from land use change

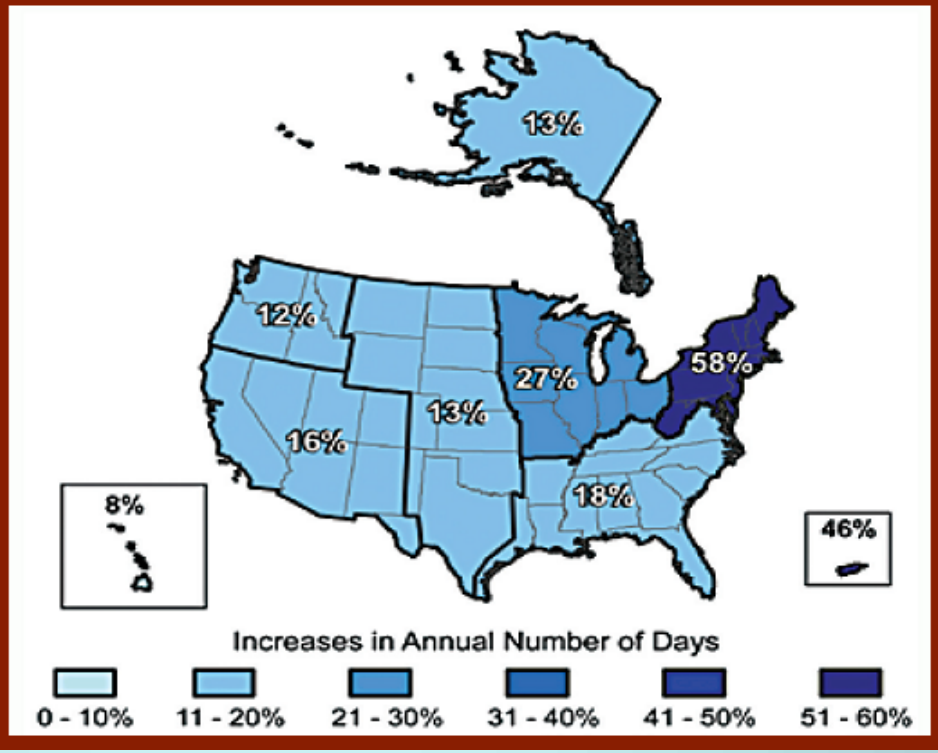
15 Highest Events –

Daily Discharges on Lamprey River near Newmarket

Rank	Date	Discharge (cfs)
1	16-May-06	8400
2		
3		
4		
5		
6		
7		
8		
9	19-Apr-07	4830
10	27-Feb-10	4640
11	15-Mar-77	4620
12	3-Apr-04	4550
13	16-Jun-98	4500
	15-Jun-98	*4400*
14	21-Mar-83	4310
15	6-Apr-60	4270

Increase in Heavy Rainfall Events 1958-2007

(Karl 2009)

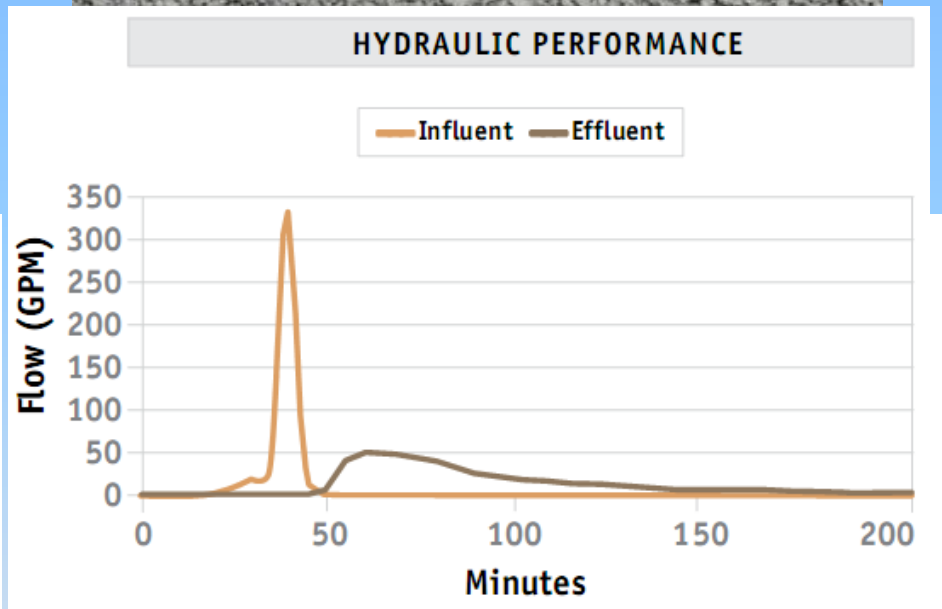


34:
years
years
ears

Presentation Overview

1. Monitoring of System Level Hydrology
2. Modeling of Site Level Hydrology for an LID Subdivision
3. Watershed Scale Evaluation of Culvert Vulnerability in the Oyster River Watershed
4. Watershed-Scale Assessment of Climate Change and Land Use Impacts upon 100-Yr Floodplain in the Lamprey River

System Level Hydrology

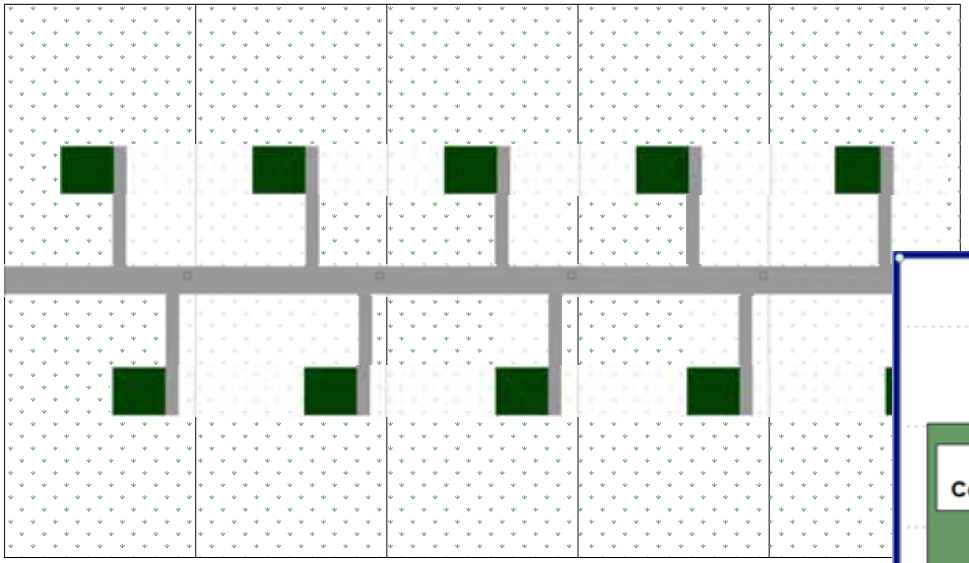


	Winter	Summer	Annual Average
Average Peak Flow Reduction	76%	82%	79%
Average Lag Time (minutes)	376	254	309

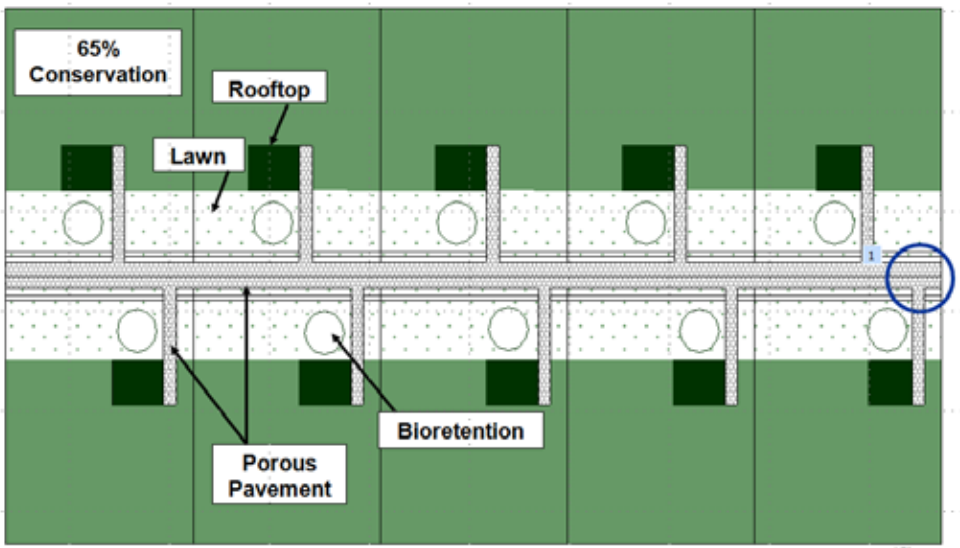
	Winter	Summer	Annual Average
Average Peak Flow Reduction	88%	97%	93%
Average Lag Time (minutes)	848	1,365	1,144
Average Volume Reduction	91%	98%	95%

Site Level Hydrology

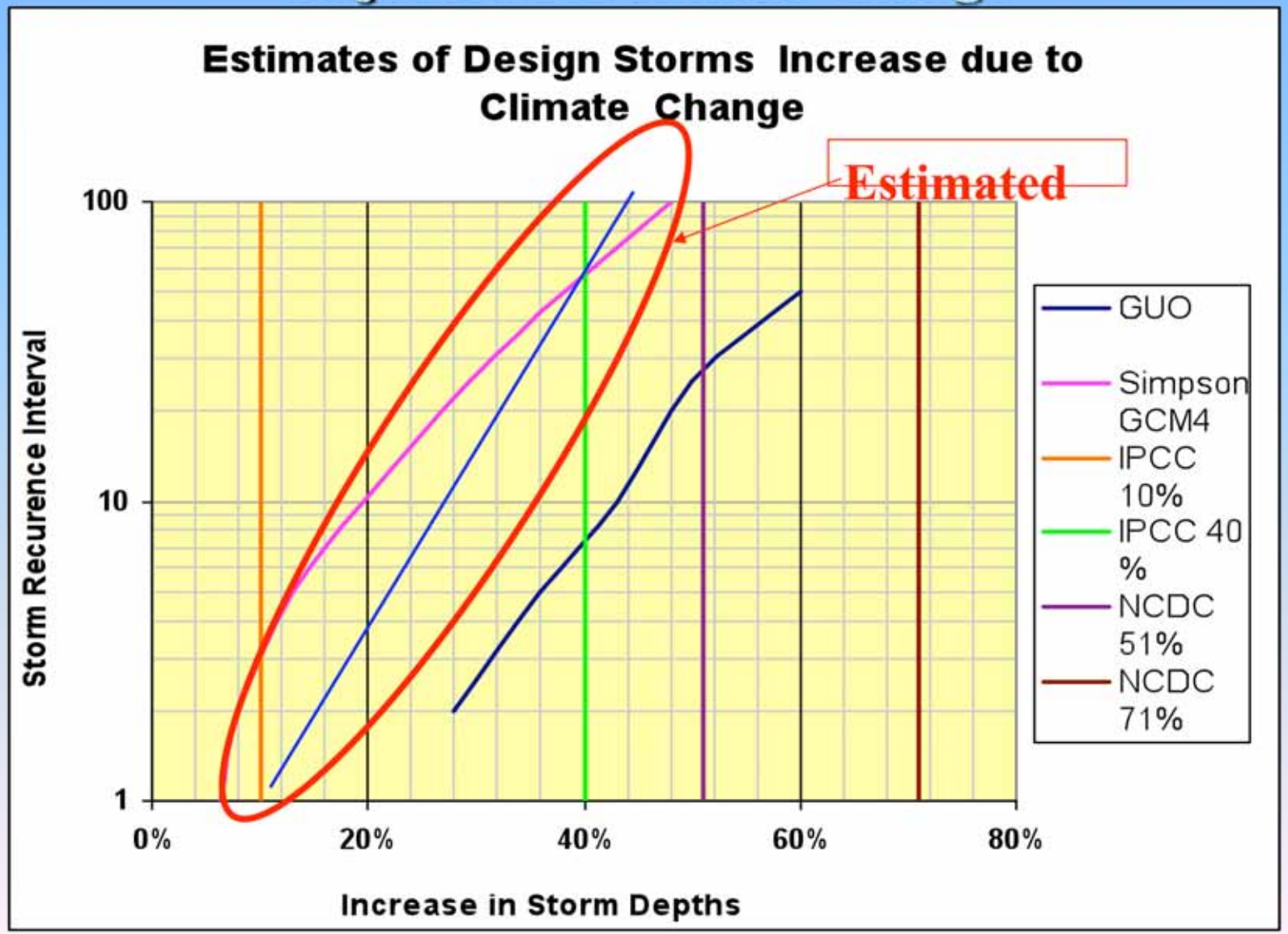
Conventional design



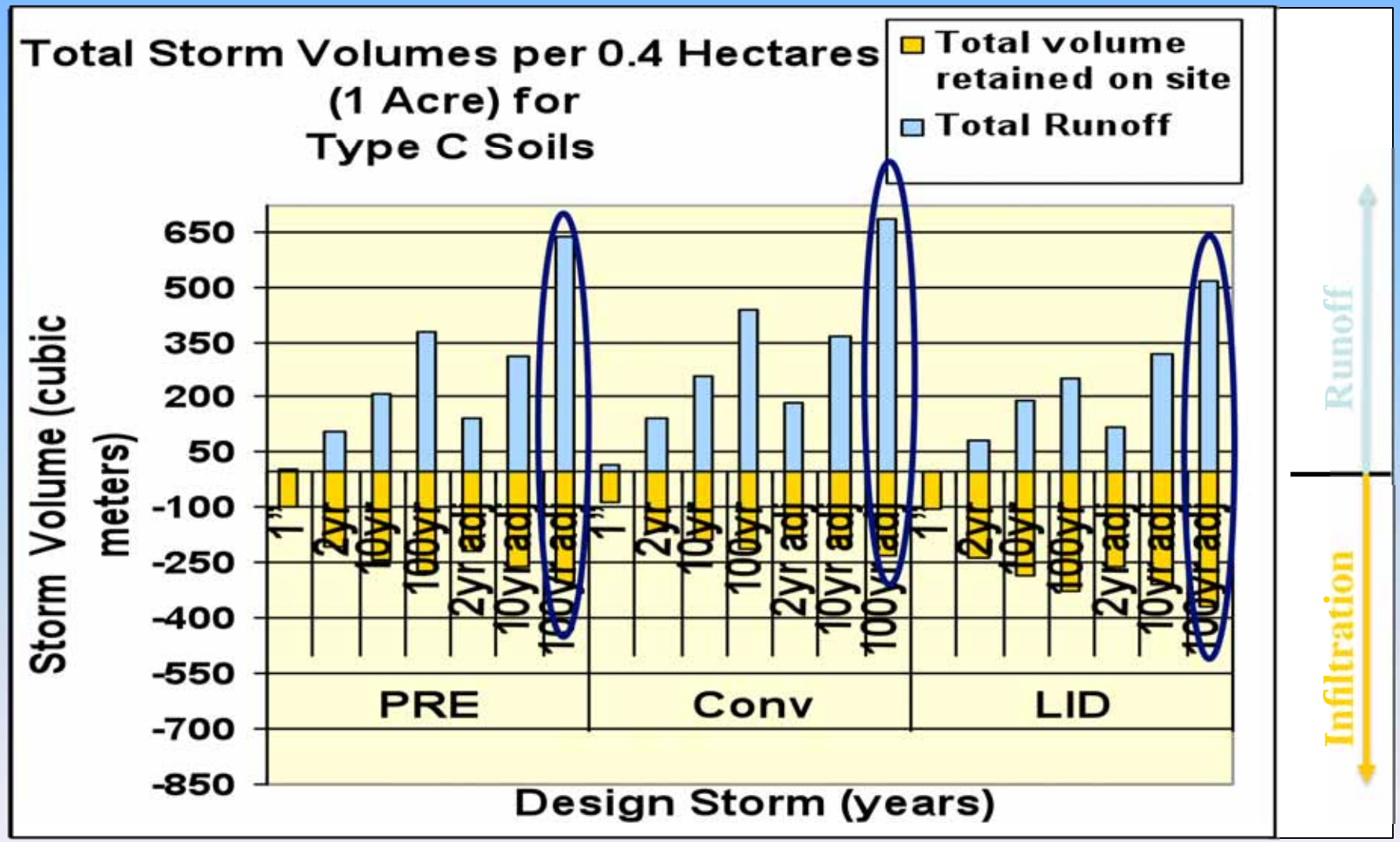
LID design



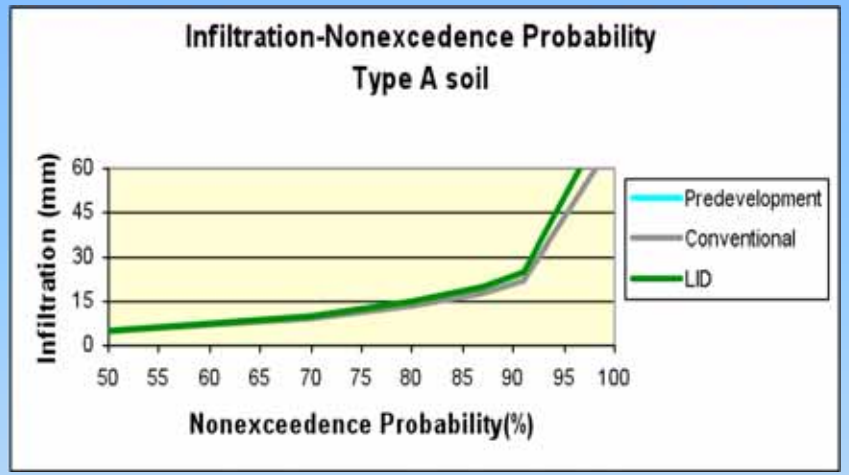
Analyses for 2-,10-, and 100-year design storms and 2-, 10-, and 100-year storms adjusted for climate change

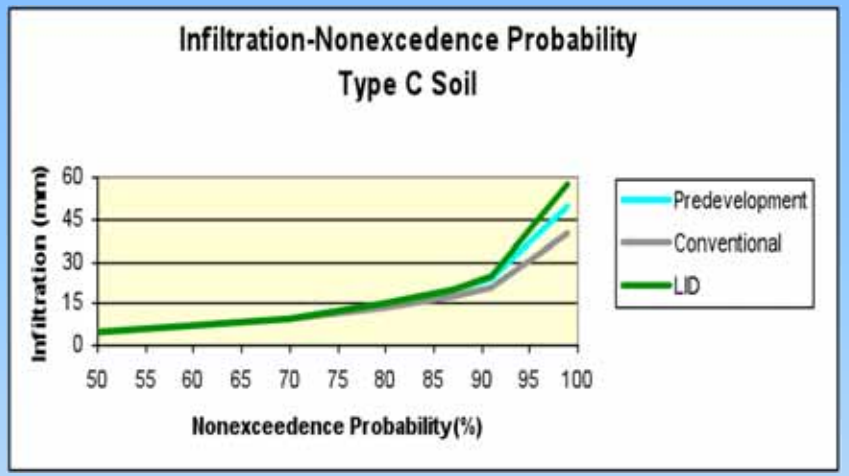


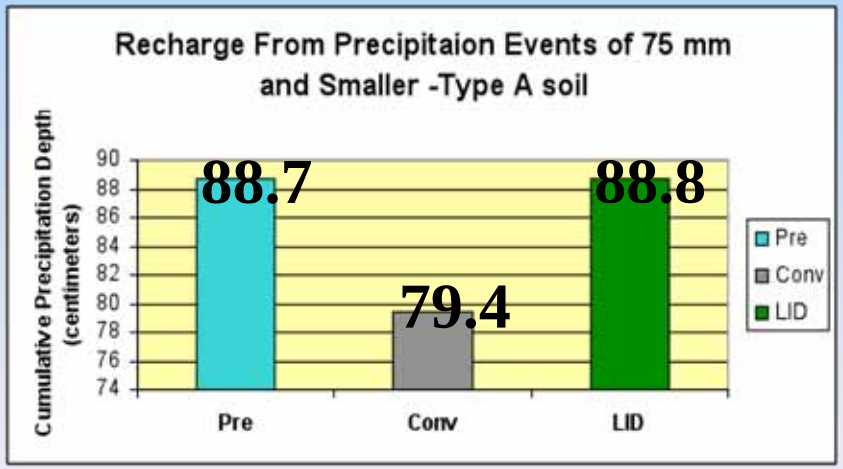
Distribution of Storm Volumes

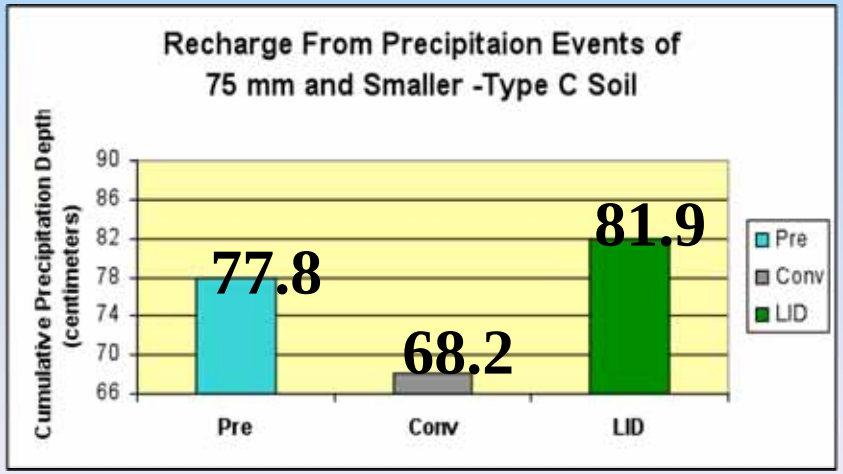


Annual groundwater recharge from storms of 7.5 cm or smaller





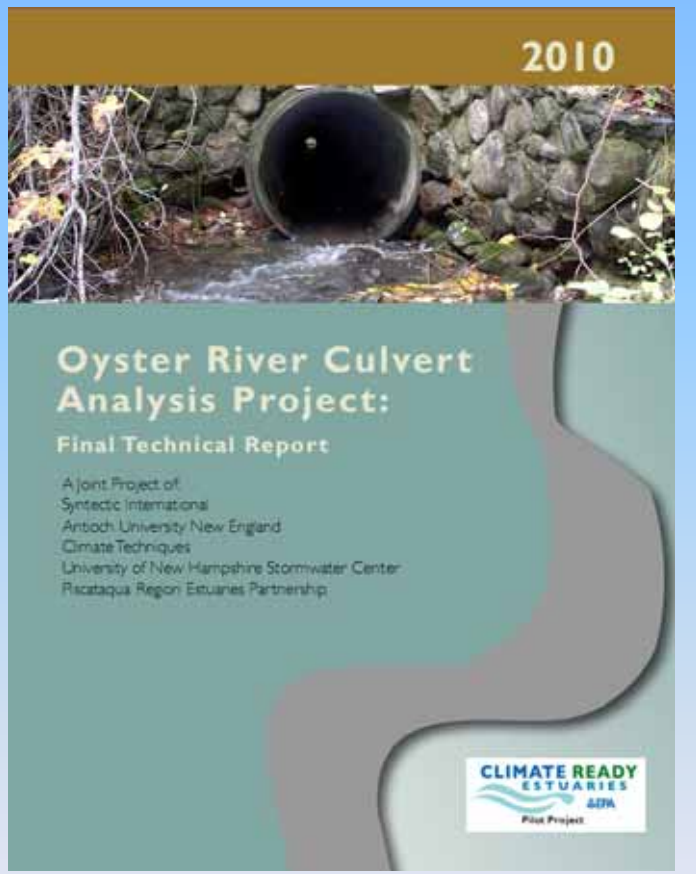




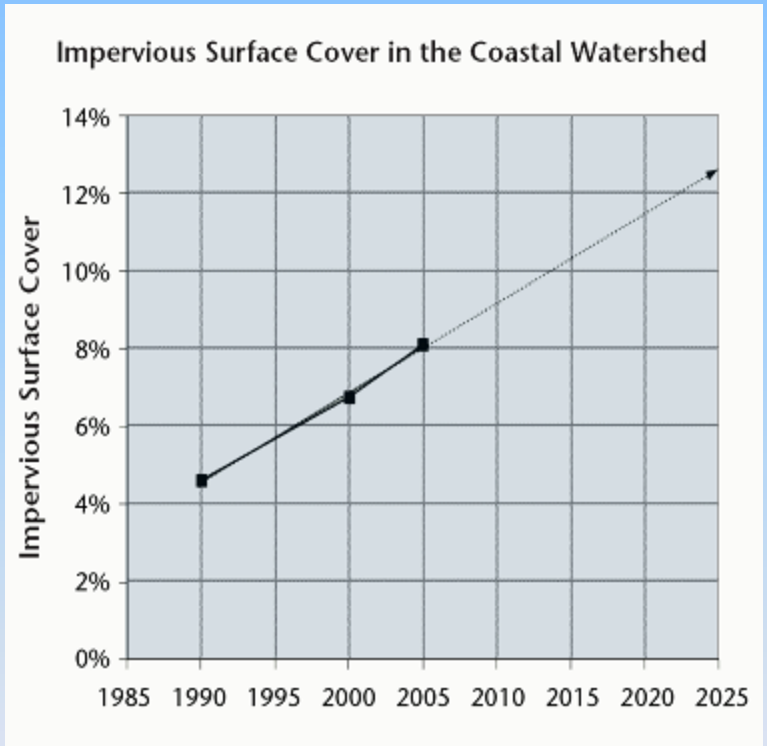
99% of storms < 75mm =3in

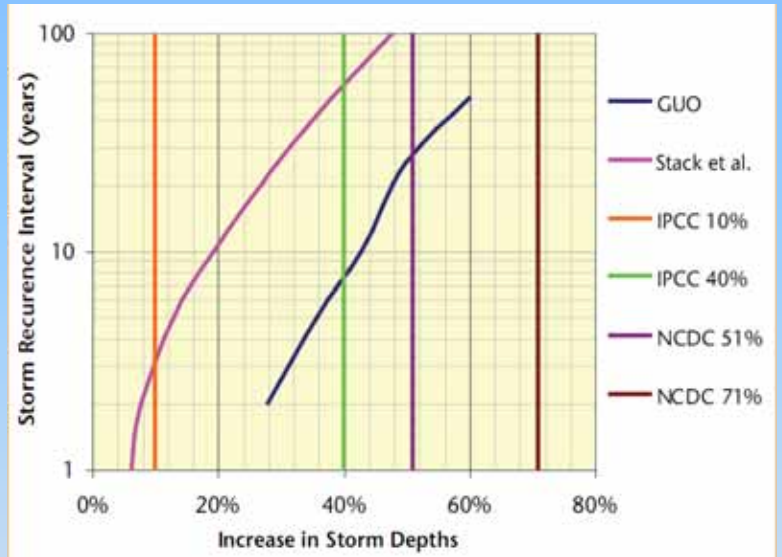
Watershed Scale Evaluation of Culvert Vulnerability in the Oyster River Watershed

- Study examined culvert vulnerability
- In context of Land-Use and Climate Change
- Evaluated Impacts of Current Zoning Vs LID

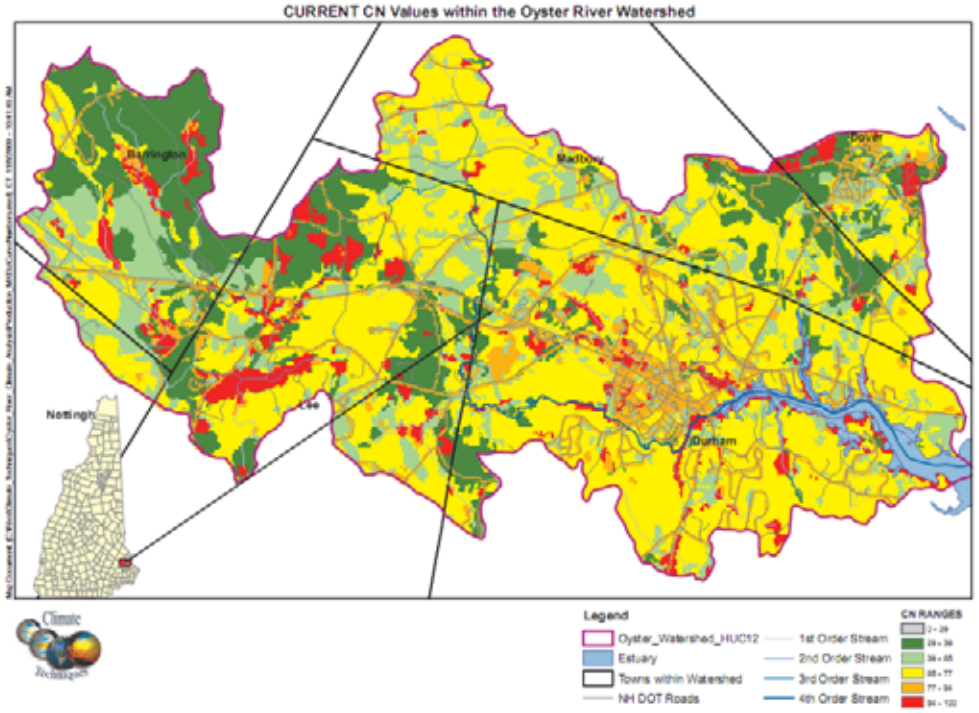


Scenarios Considered



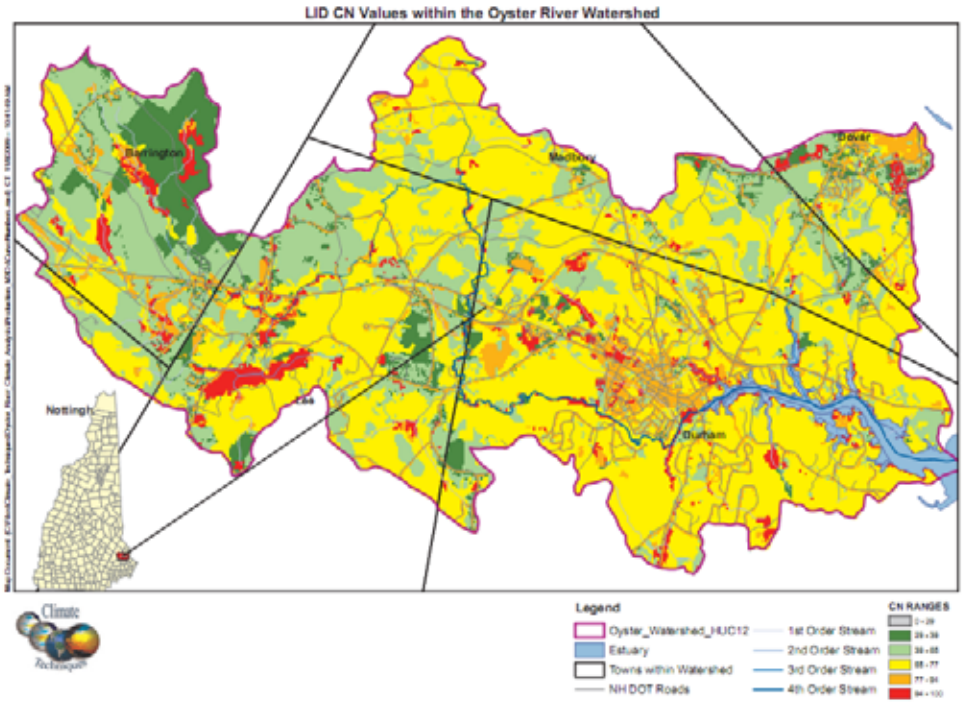


Design storm (year)	2	10	100
Climate Change Depth Increase (%)	17	28	45
Current depth in cm (in)	7.53 (3.01)	10.86 (4.35)	15.75 (6.3)
Increased depth in cm (in)	8.8 (3.52)	13.93 (5.57)	22.85 (9.14)



Current Zoning Build-Out

LID Build-Out



Culvert Capacity under different Land-use Scenarios without Climate Change

Number of Undersized Culverts in a Buildout Scenario During Flooding Season			
	Conventional (No LID)	LID Scenario	Difference % / (Actual number)
Baseline	4	0	100% (4)
Climate Change Projections	4 to 7	2 to 5	50-29% / (2)

Climate Change Scenario:

Number of undersized culverts for current conditions, build-out, and build-out with LID

Antecedent Moisture Condition	Precipitation Scenario	Land-use Scenario	Precip. (in.)	Number of under-sized Culverts
AMC II	Baseline	Current	5.4	4
		Build-out	5.4	8
		LID	5.4	6
	A1b	Current	6.9	9
		Build-out	6.9	16
		LID	6.9	12

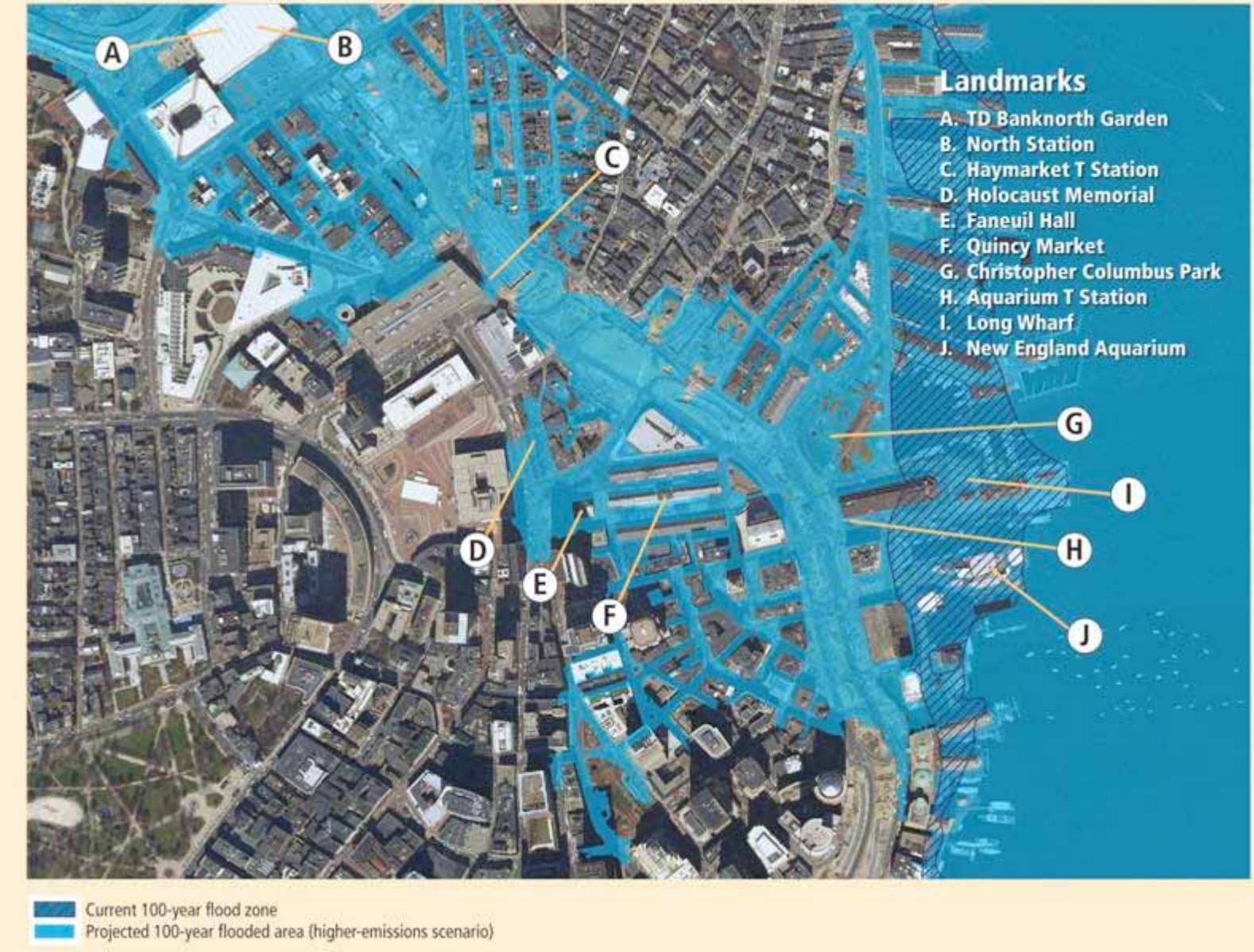
Watershed-Scale Assessment of Climate Change and Land Use Impacts upon 100-Yr Floodplain in the Lamprey River

Project Objectives:

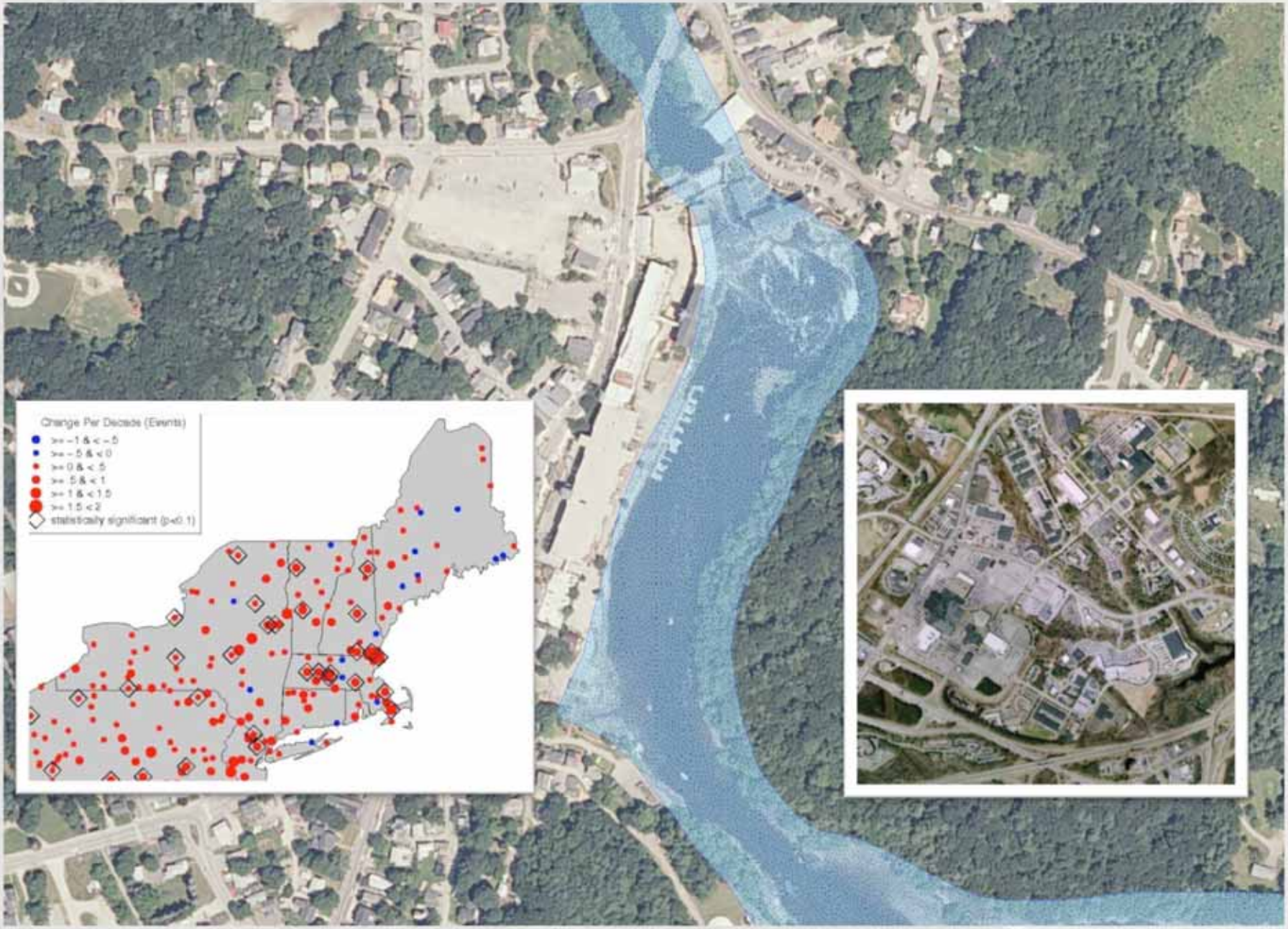
- Assess flood risk associated with combined land use and climate change scenarios in the Lamprey River watershed.
- Produce maps at the municipal scale of the 100-year flood risk boundaries and river discharge at specific locations.
- Develop associated products to support land use decision-making in communities.
- Serve as a model for other watersheds across New England.

Why focus on the 100 year flood?

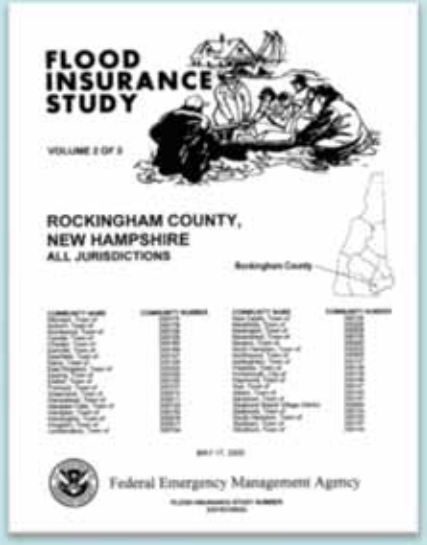
Boston: The 100-Year Coastal Flood in 2100 (Higher-Emissions Scenario; 16 inches of SLR)

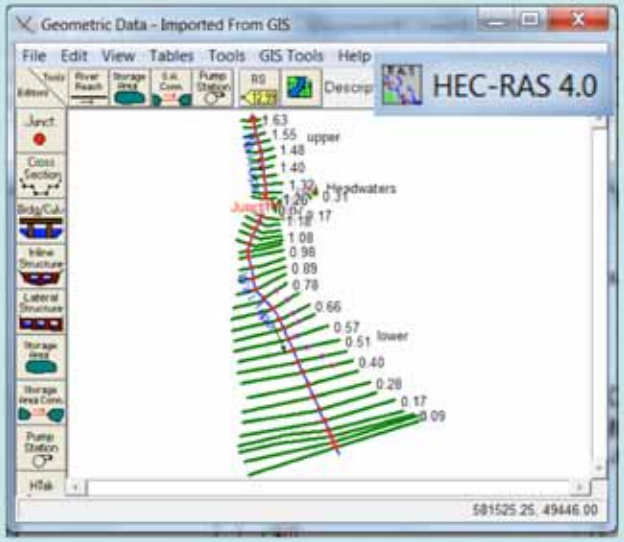


Current Newmarket 100 Year Floodplain



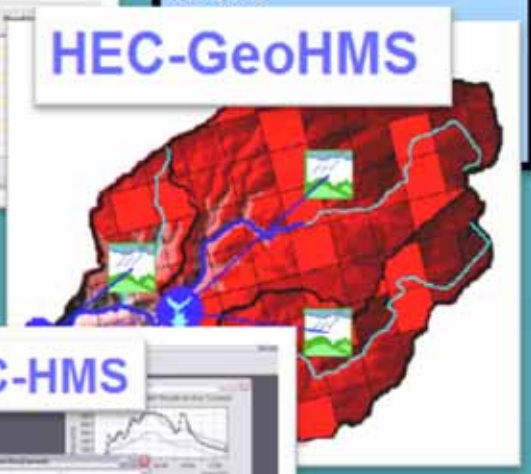
Historic Data and Development of Hydrologic and Floodplain Model

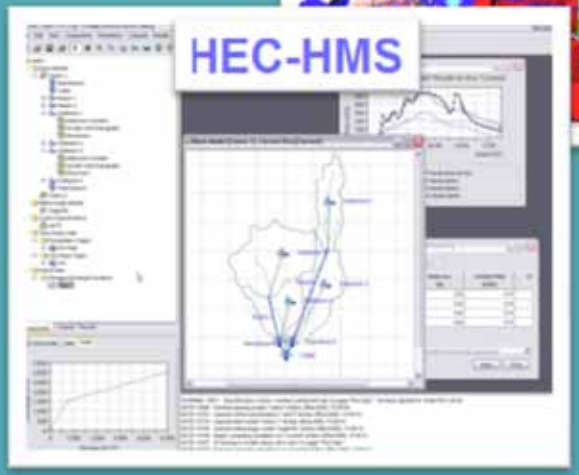


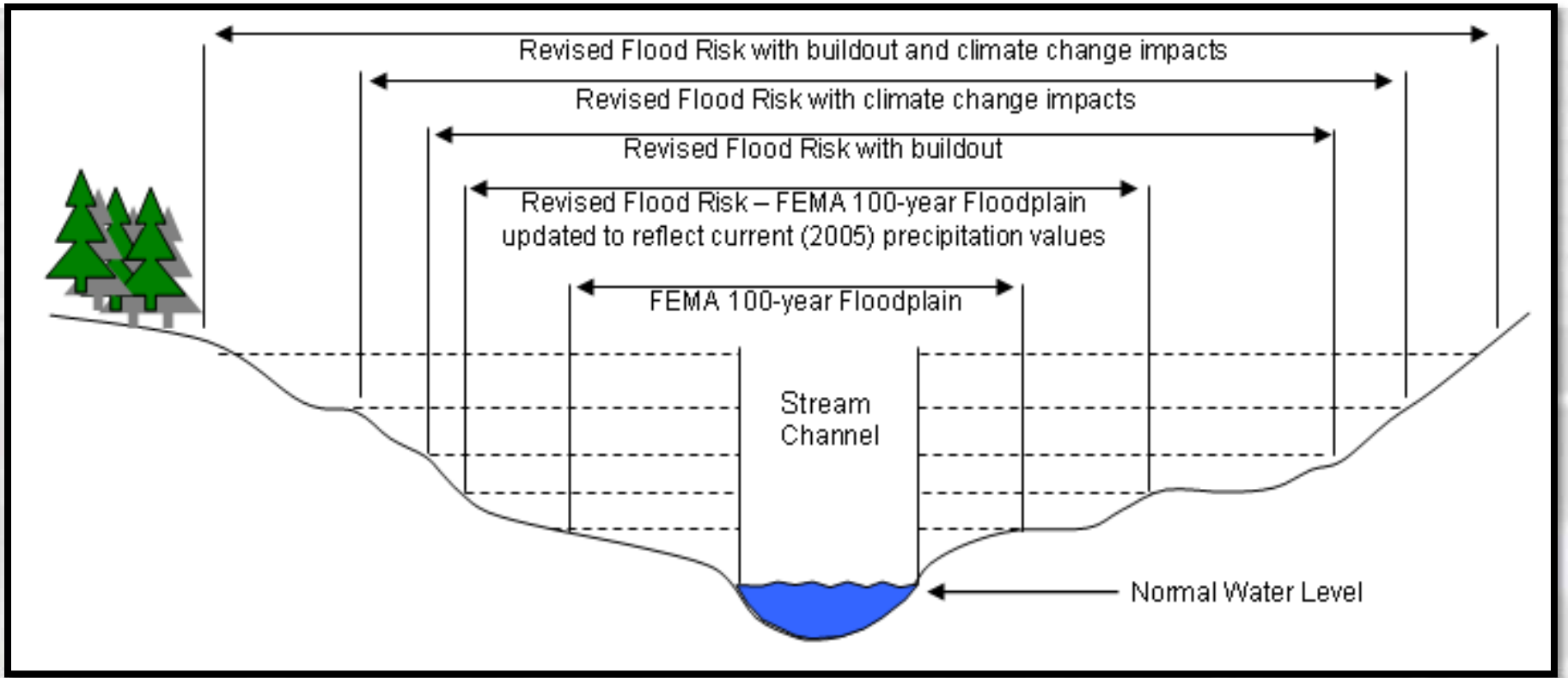


Land Use and Watershed Characterization and Development of Runoff Model

Urban districts
Commercial and business
Industrial
1/8 acre
1/4 acre
1/3 acre







Land Use Condition	Climate Period and GCM Scenario					
	FIS Conditions 1981	1988-2007	2041-2070		2071-2100	
			A1F1 (HI)	B1 (LO)	A1F1 (HI)	B1 (LO)
FIS Conditions 1981	X	X				
Current Conditions(2005)		X	X	X	X	X
Build-out conditions		X	X	X	X	X
LID/build-out		X	X	X	X	X

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Questions?