5-18-2011

Changing Climate and Land Use: Consequences for 100-Year Flooding in the Lamprey River Watershed of New Hampshire

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ASFPM 18 May 2011 Louisville, KY

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Funded by NOAA Cooperative Institute for Coastal & Estuarine Environmental Technology

University of New Hampshire

Carbon Solutions New England™ CarbonSolutionsNE.org

SC

Antioch University New England

Great Bay National Estuarine Research Reserve

Fish and Game

NOAA

Engaged Scholarship at UNH

At UNH, engaged scholarship is defined as:

"*a mutually beneficial collaboration between UNH and community partners for the purpose of generating and applying relevant knowledge to directly benefit the public*"

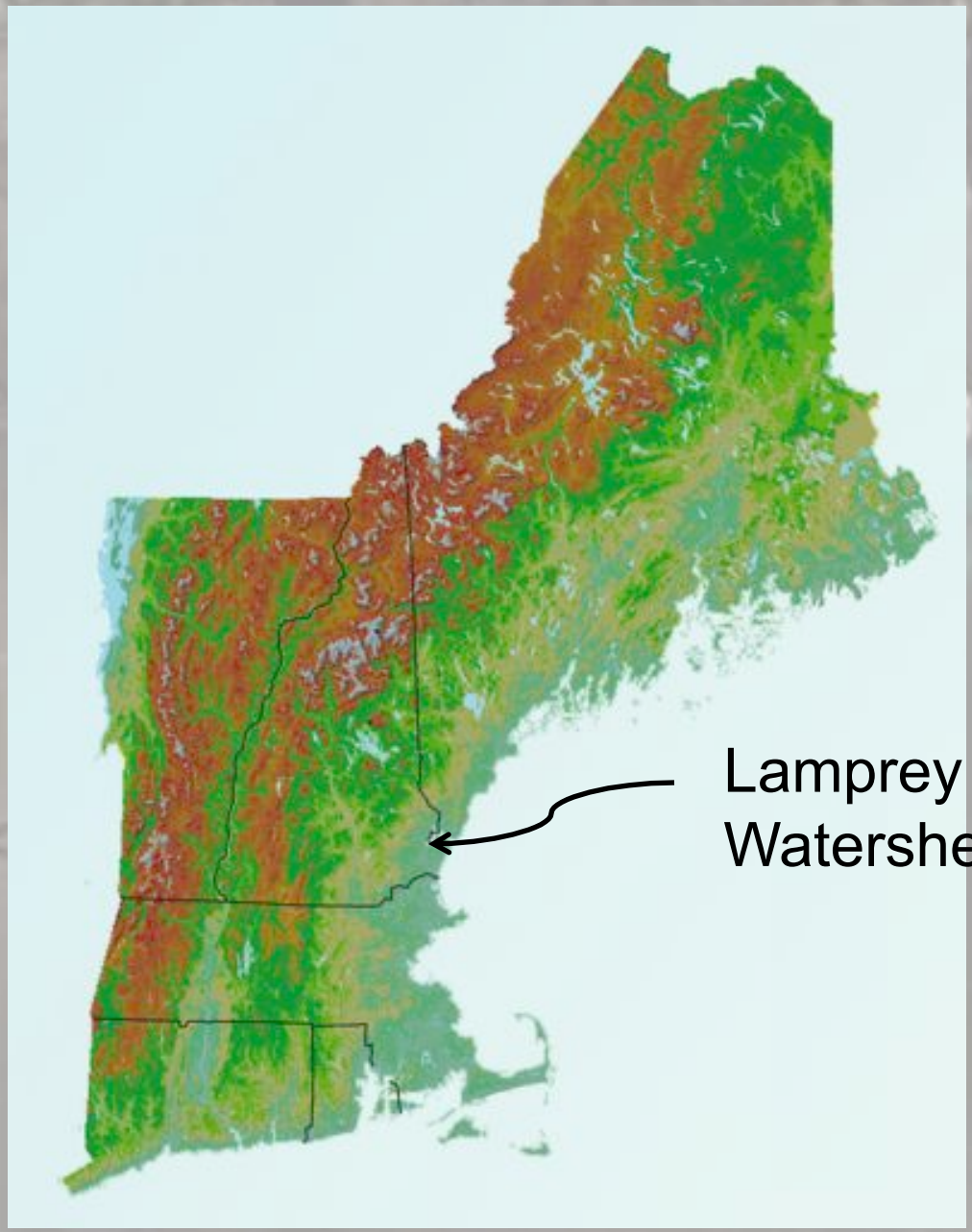
Carnegie Foundation for the Advancement of Teaching officially recognized the University of New Hampshire as a "Community Engaged" university (2008)

Assessing Flood Risk - Lamprey River Watershed

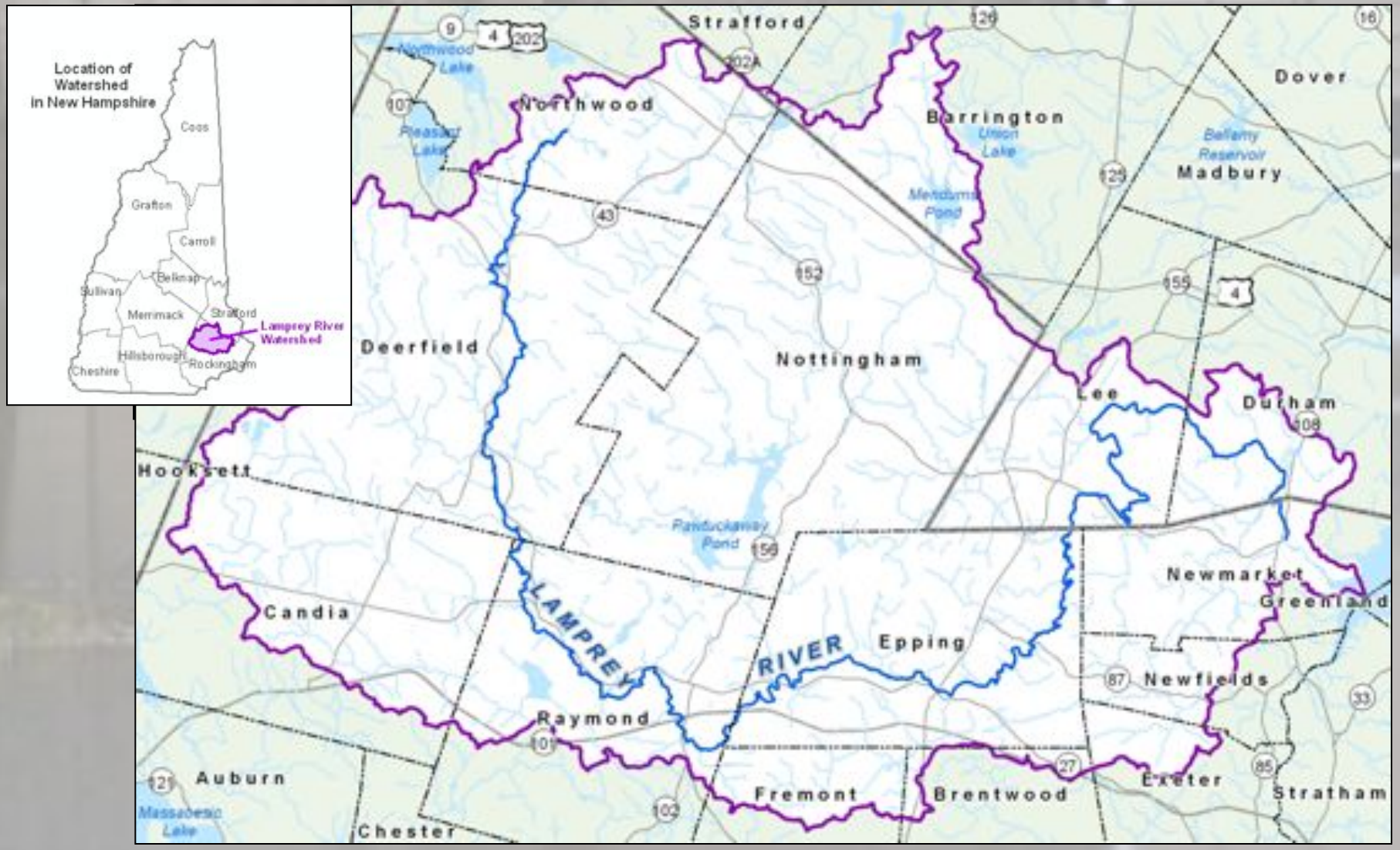
Project Objectives:

- Assess flood risk associated with combined land use and climate change scenarios out to 2100
- Produce maps of the 100-year flood risk boundaries and river discharge at specific locations
- Demonstrate the use of our products to support land use decision-making in coastal communities
- Serve as a model for other New England watersheds
- Address legal issues of using projected flood information

Assessing Flood Risk - Lamprey River Watershed



Lamprey River Watershed, New Hampshire



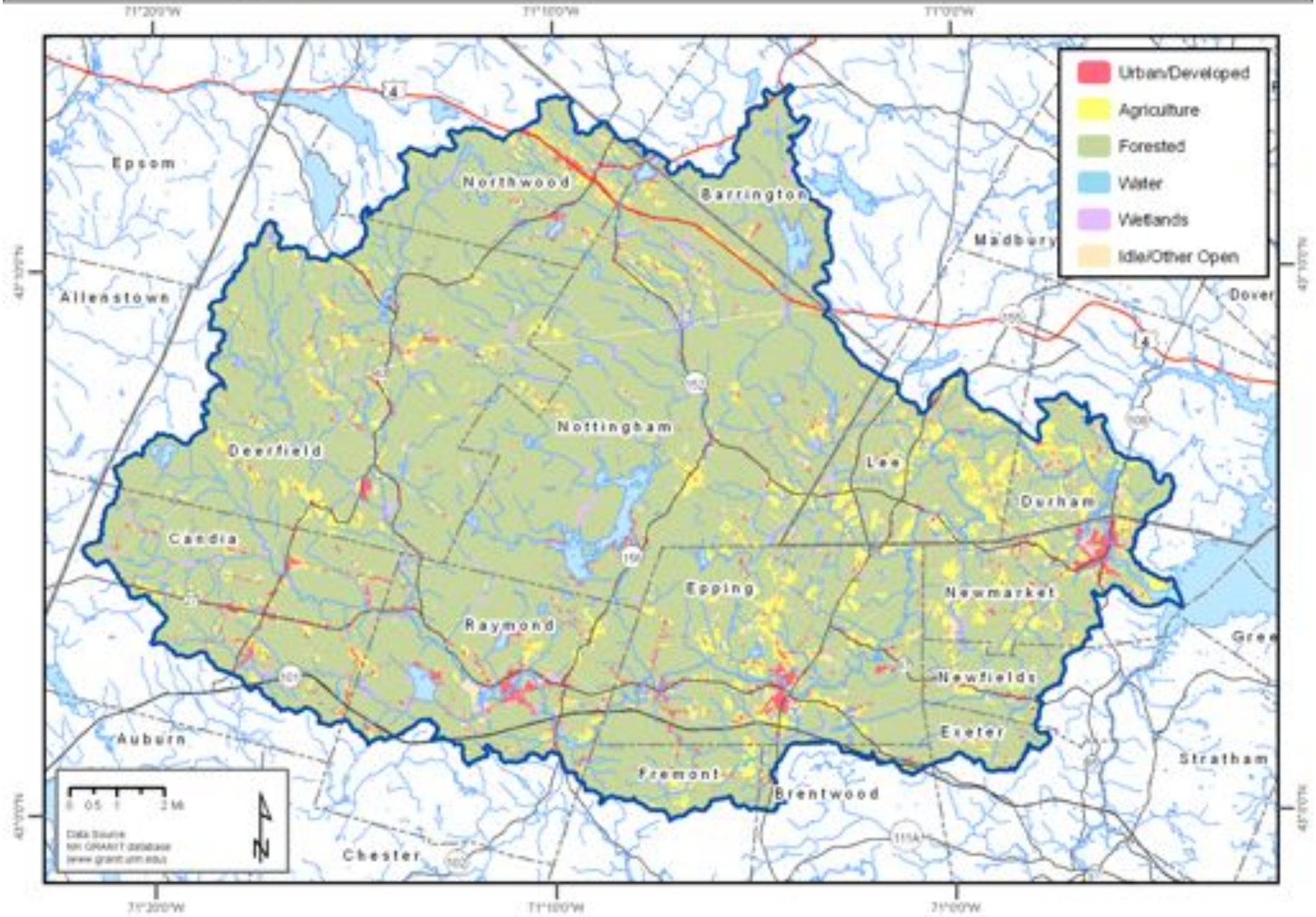
Assessing Flood Risk - Lamprey River Watershed

Advisory Committee

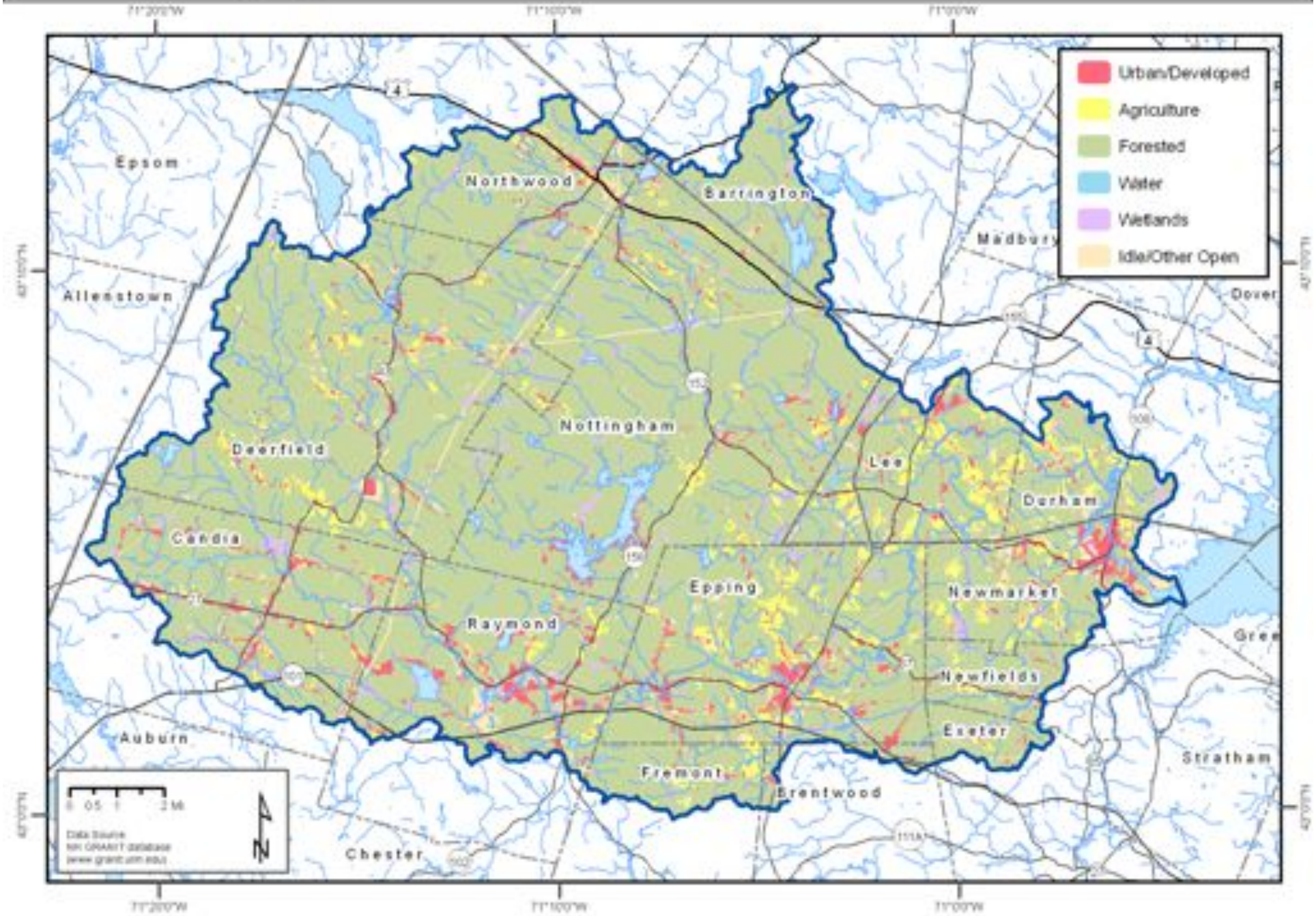
municipal, regional, state, federal and non-profit representation

Cliff Sinnott, Rockingham Planning Commission (Chair)
Joanne Cassulo, NH Office of Energy and Planning
David Cedarholm, Durham Public Works
Cynthia Copeland, Strafford Regional Planning Commission
Michael Goetz, FEMA Region 1
Diane Hardy, Newmarket Planning Department
Sharon Meeker, Lamprey River Advisory Committee
Jack Munn, Southern New Hampshire Planning Commission
Jennifer Perry, Exeter Public Works
Ron Poltak & Becky Weidman, NEIWPC
Keith Robinson, USGS
Carl Spang/Dawn Genes, Lamprey River Watershed Association
Eric Williams, NH Department of Environmental Services

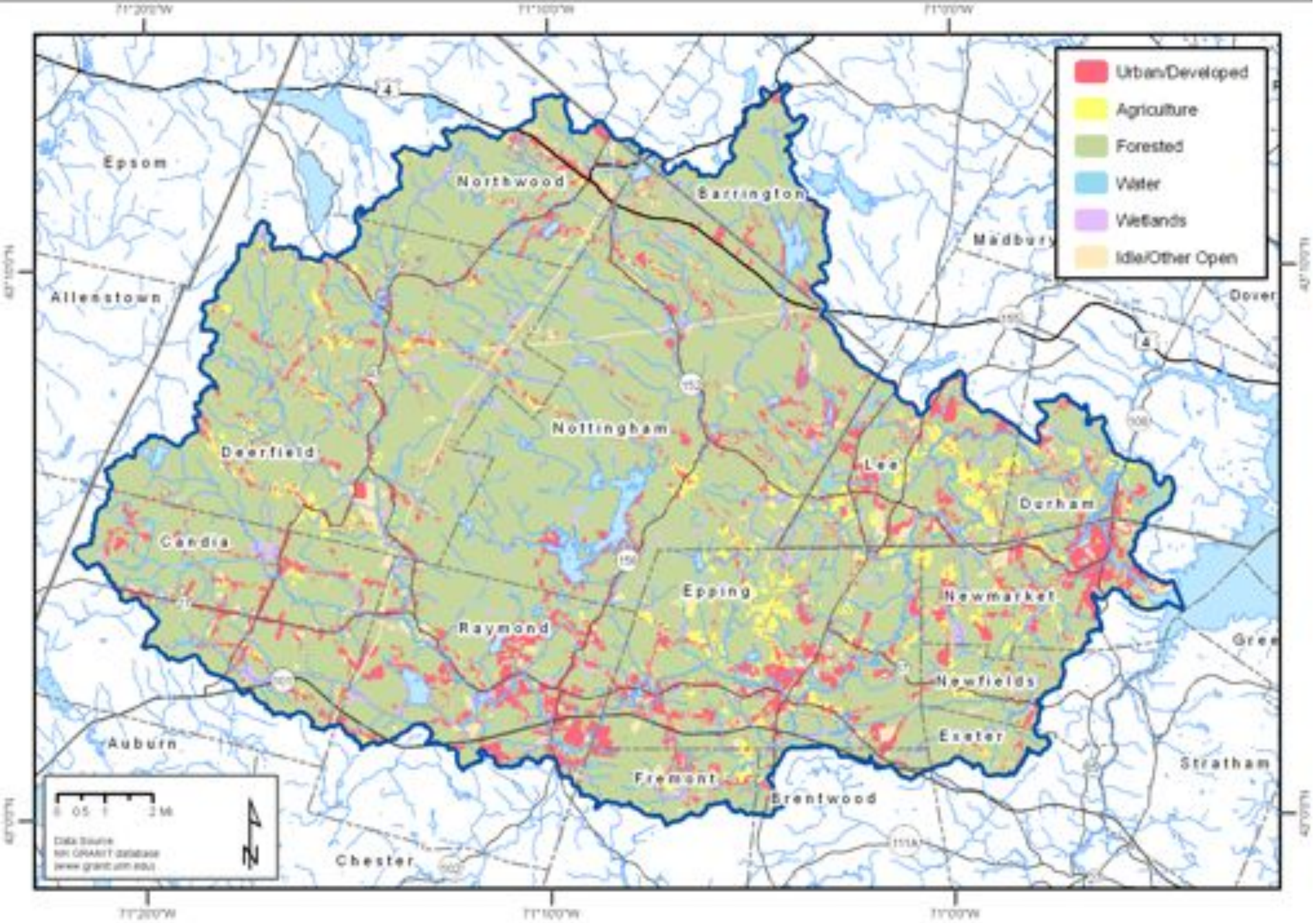
Lamprey River Watershed Generalized Land Use - 1962



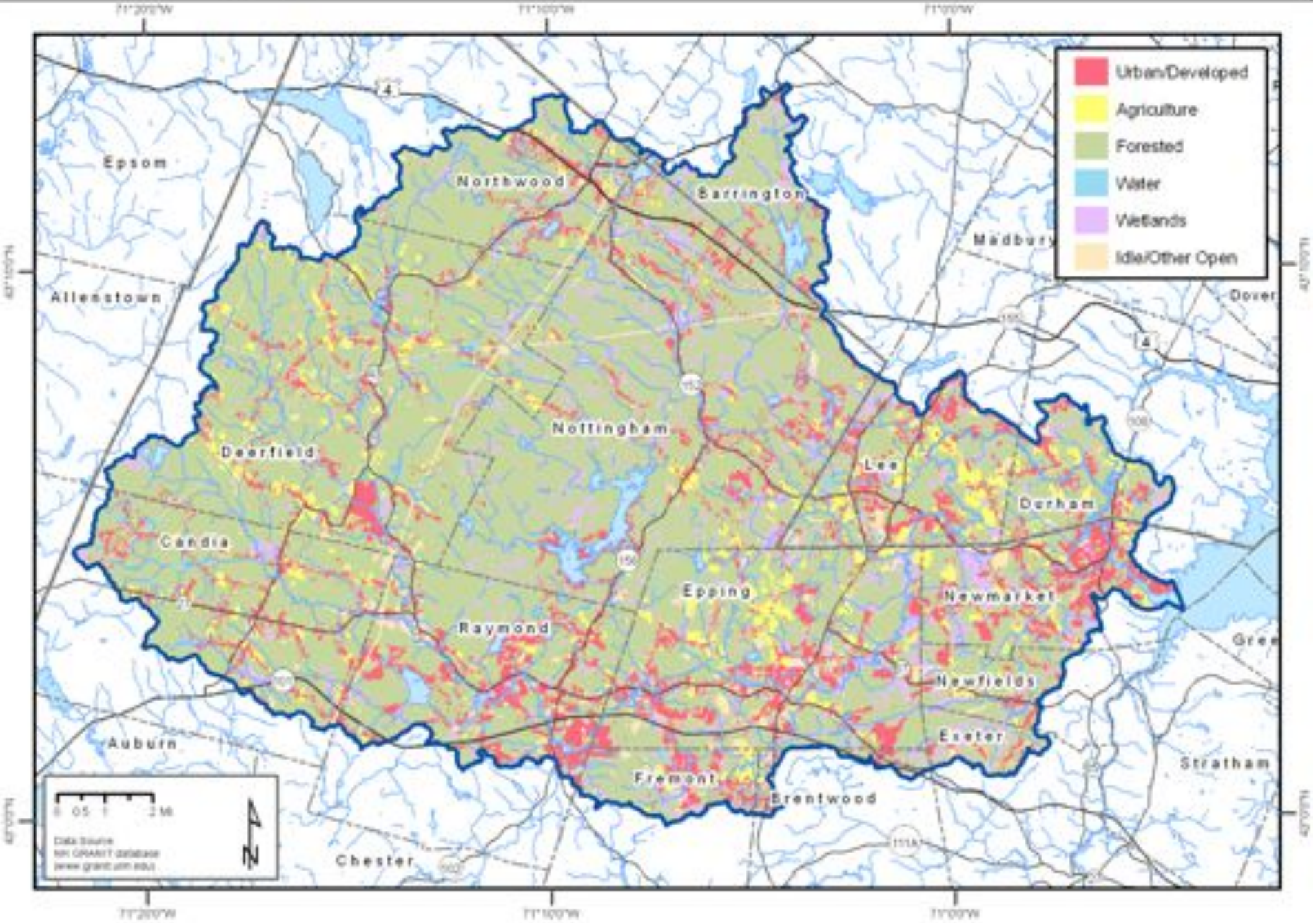
Lamprey River Watershed Generalized Land Use - 1974



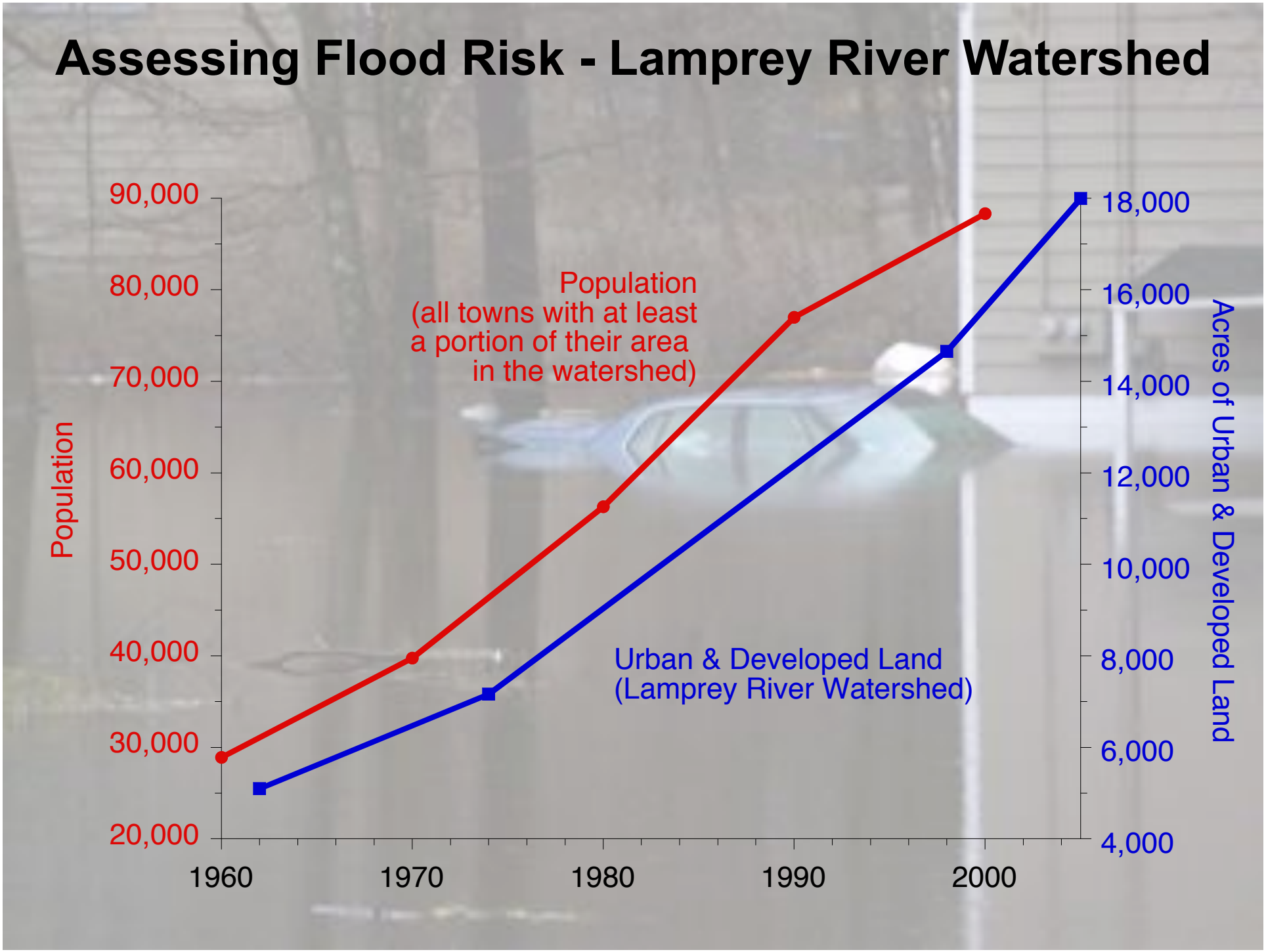
Lamprey River Watershed Generalized Land Use - 1998



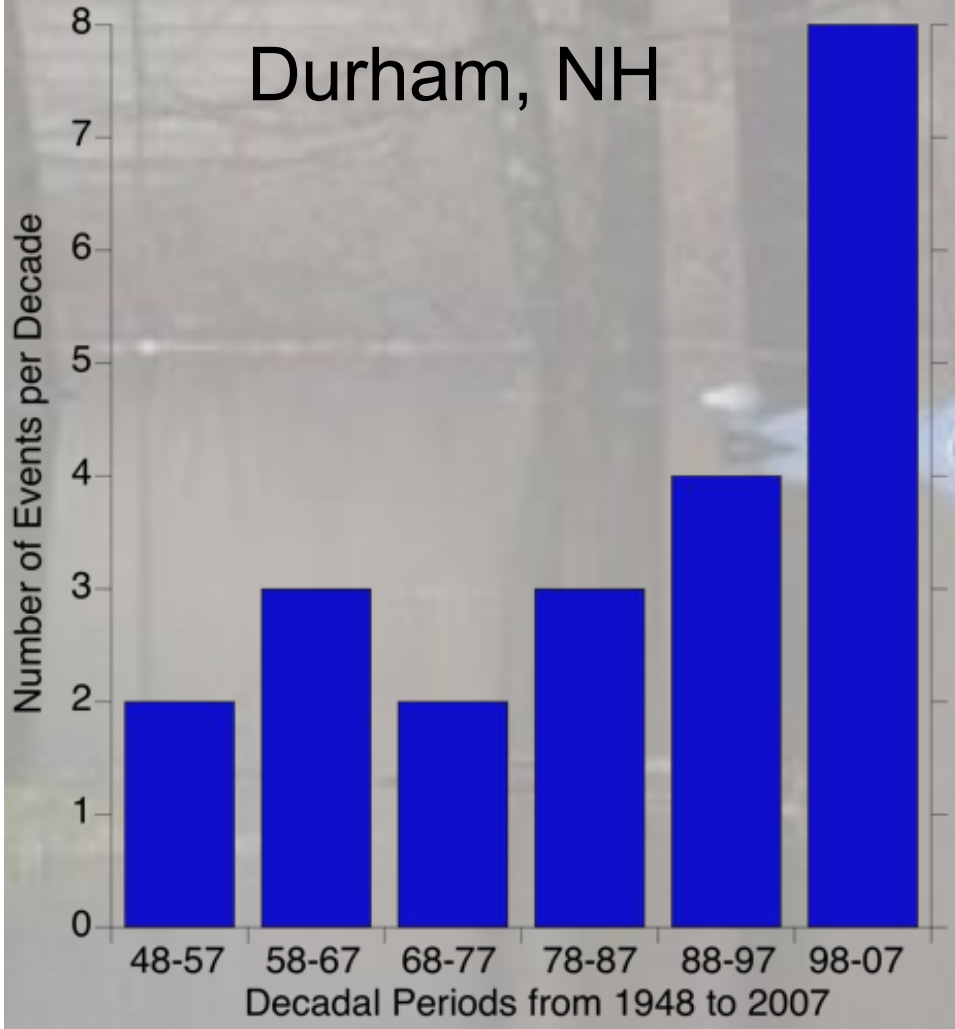
Lamprey River Watershed Generalized Land Use - 2005

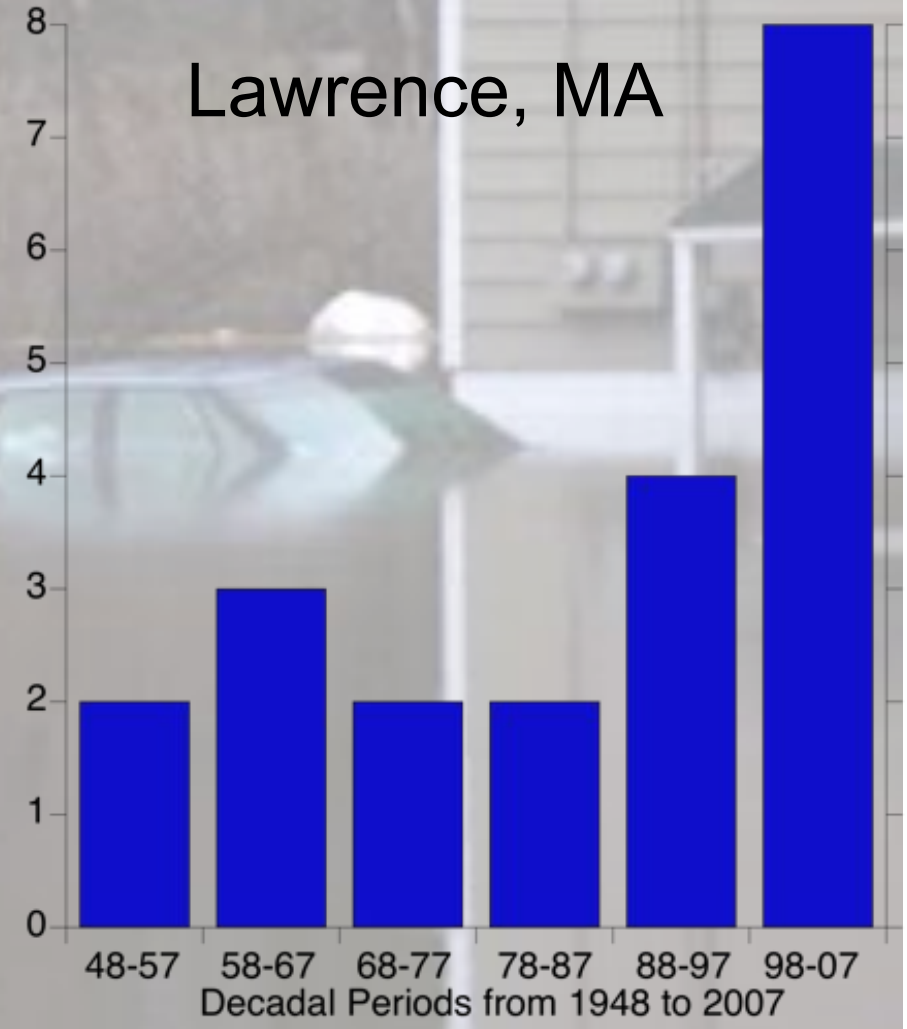


Assessing Flood Risk - Lamprey River Watershed



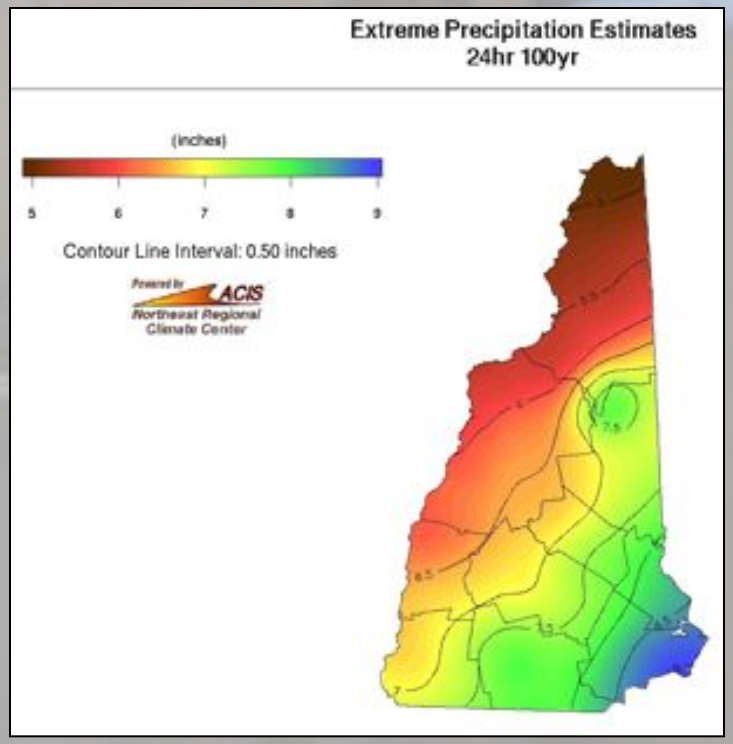
4 Inch Precipitation Events by Decade 1948 - 2007





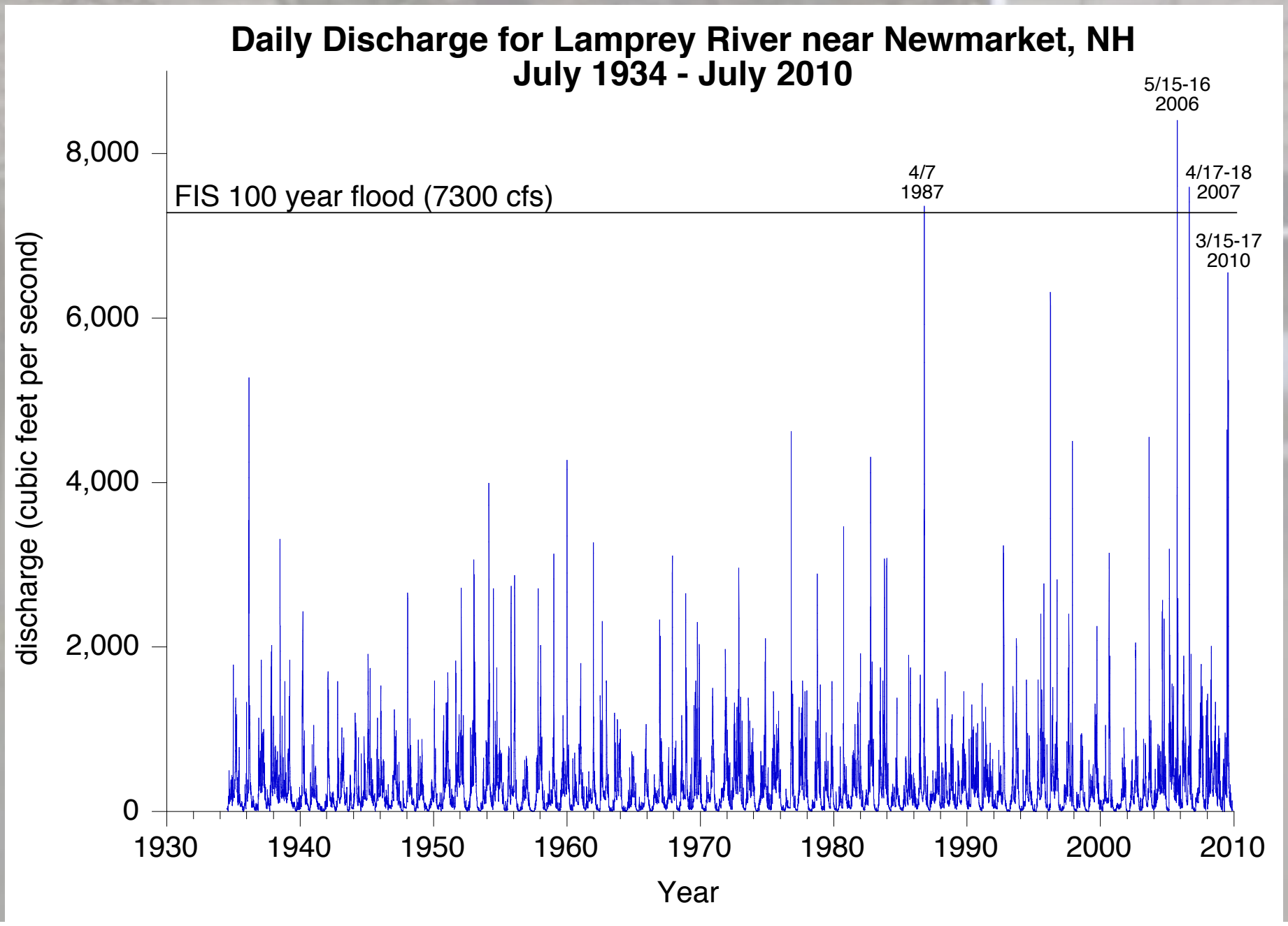
100-year Rainfall Estimates

TP-40 Rainfall Frequency Atlas used for effective conditions = 6.3”

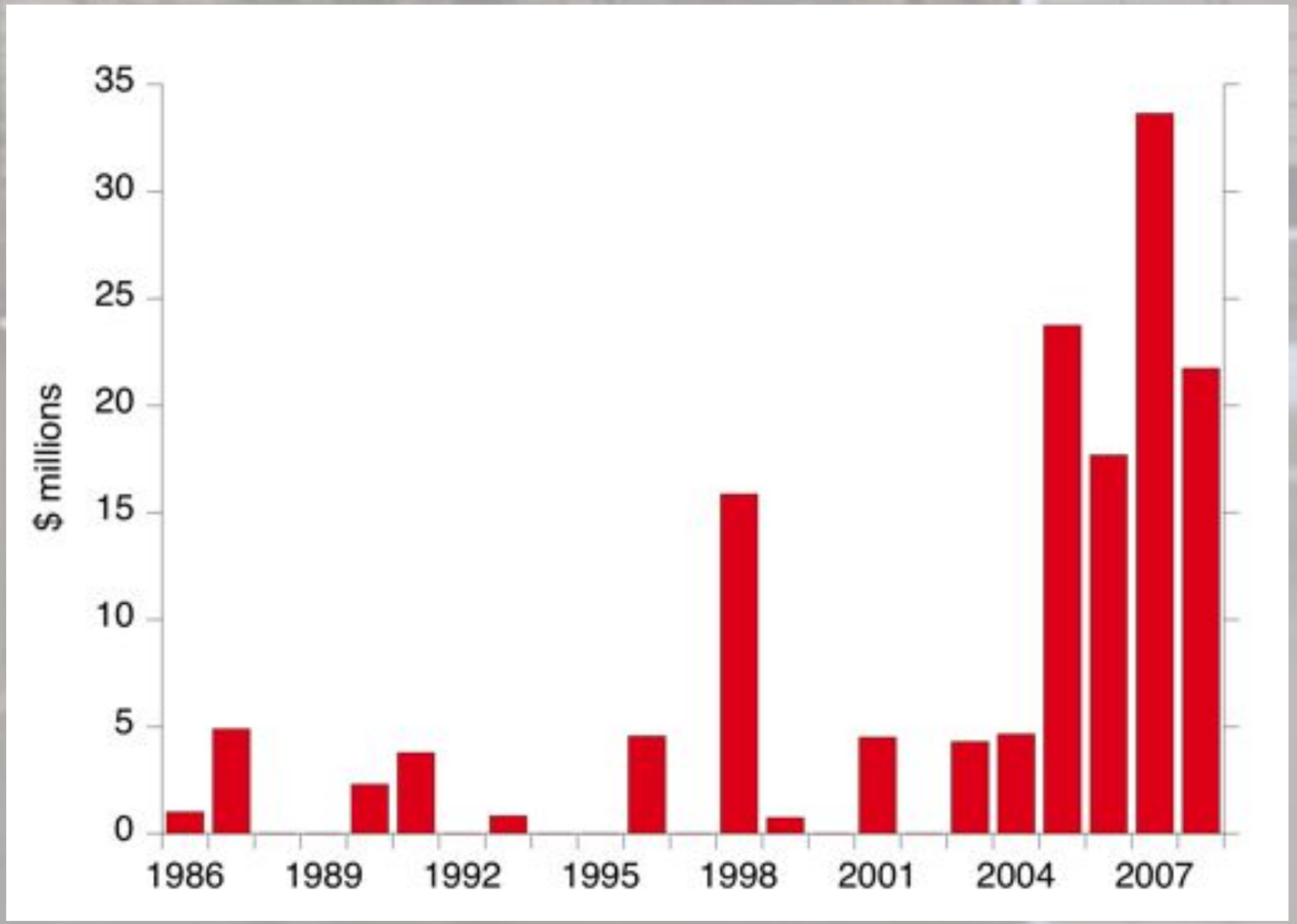


Northeast Regional Climate Center Atlas for Extreme Precipitation for current conditions = 8.5”

Assessing Flood Risk - Lamprey River Watershed



Costs from Presidentially Declared Disasters in NH



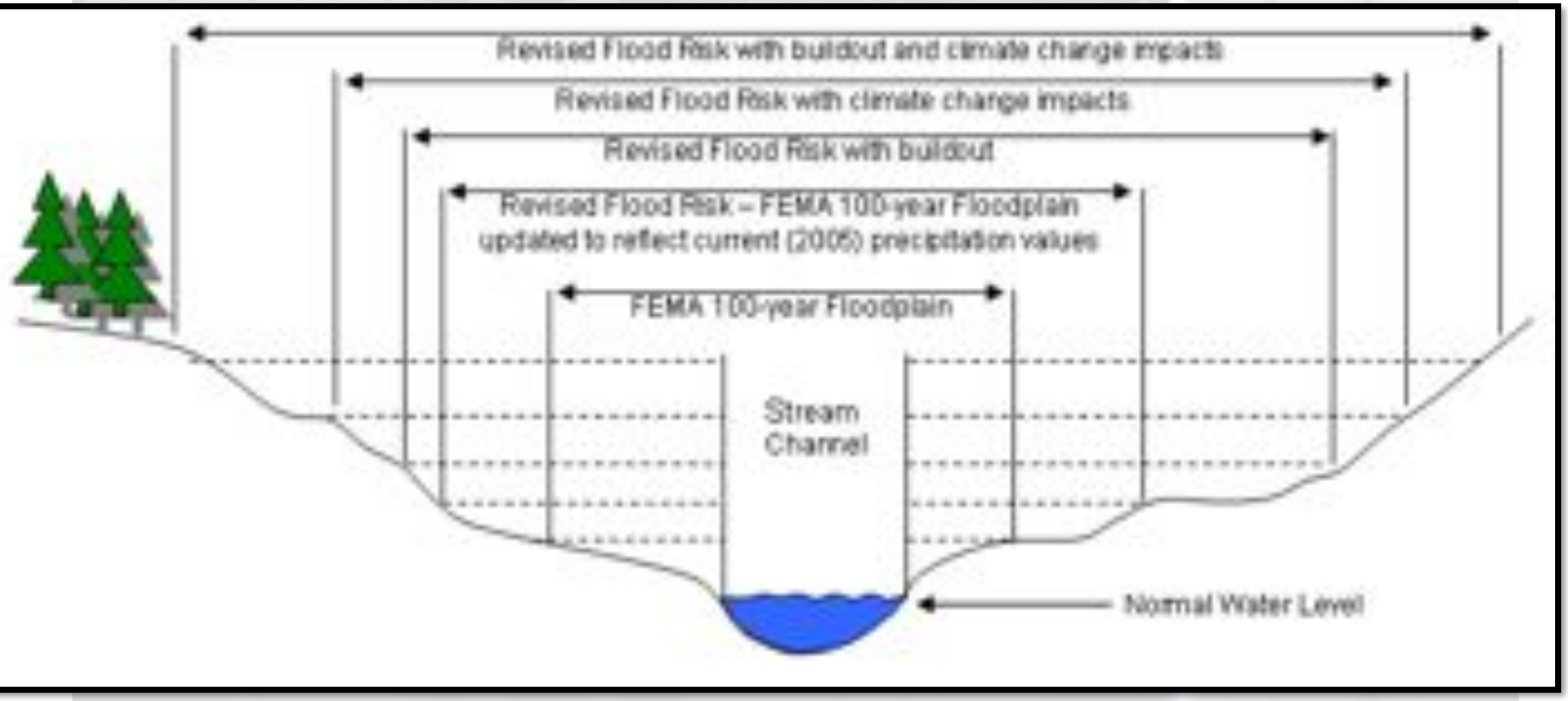
Assessing Flood Risk - Lamprey River Watershed

Technical Analysis
- Construct hydrologic and hydraulic model
- Develop land use and climate change scenarios
- Run model; plot cross-sections; map results

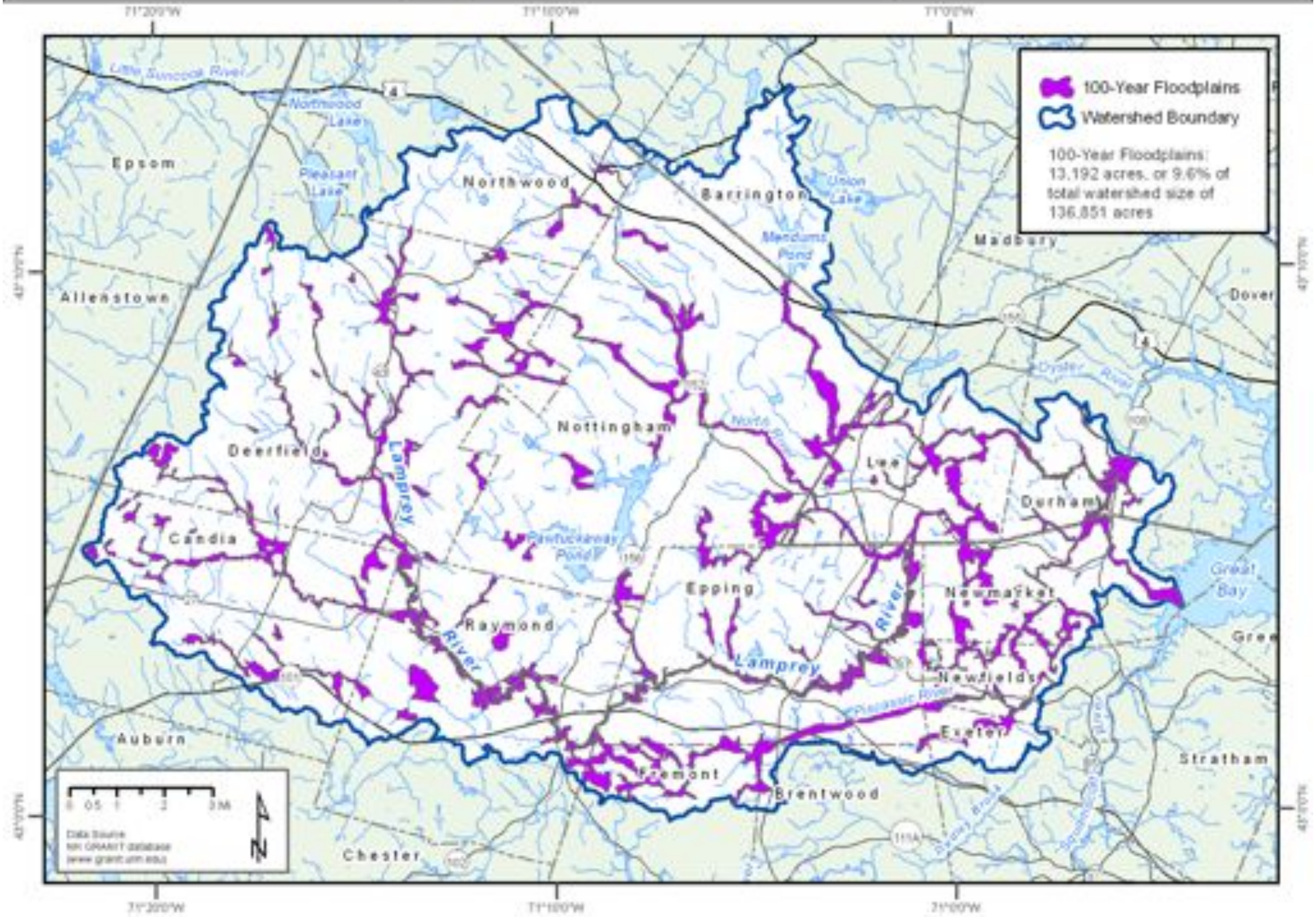
Dissemination
- Advisory Group & Focus Groups
- Community Workshops
- Municipal & Regional Planners
- NH GRANIT website

Evaluation and Feedback

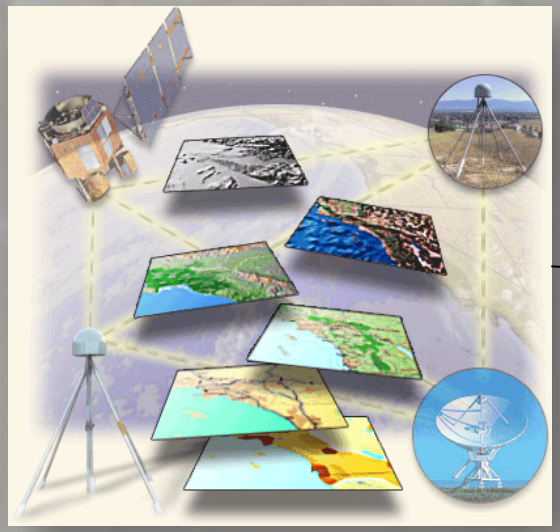
Lamprey River 100 Year Flood Risk Project



Lamprey River Watershed Floodplains



Hydrology Overview



GIS Preprocessed Spatial Hydrology Data Base

Standard Hydrologic Grid Hydrologic Rainfall Analysis Project

HEC-GeoHMS (ArcHydro Tools) to process DEM

Delineate Watershed and Sub-watershed

DEM Reconditioning

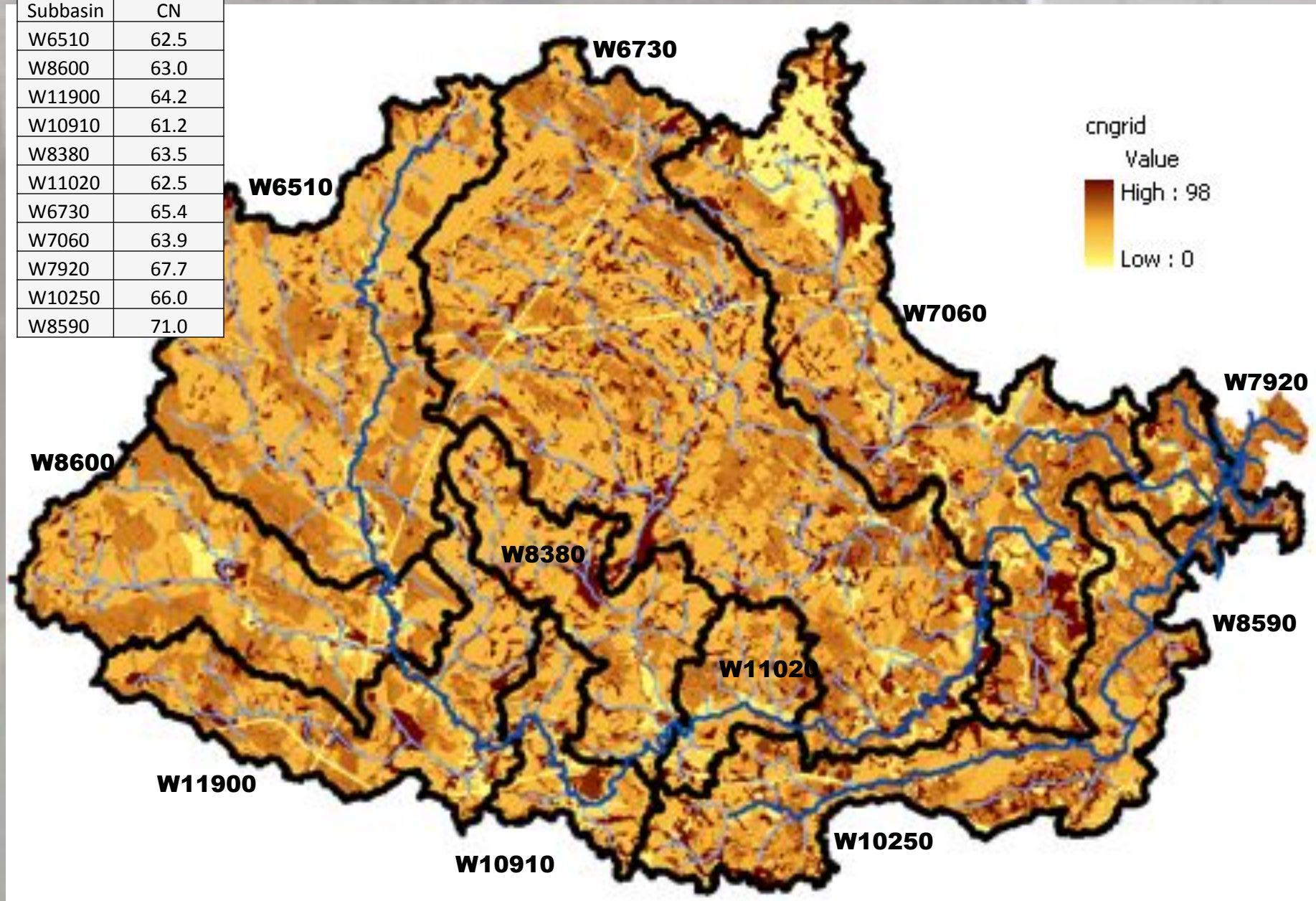
Runoff Parameters

Stream Network

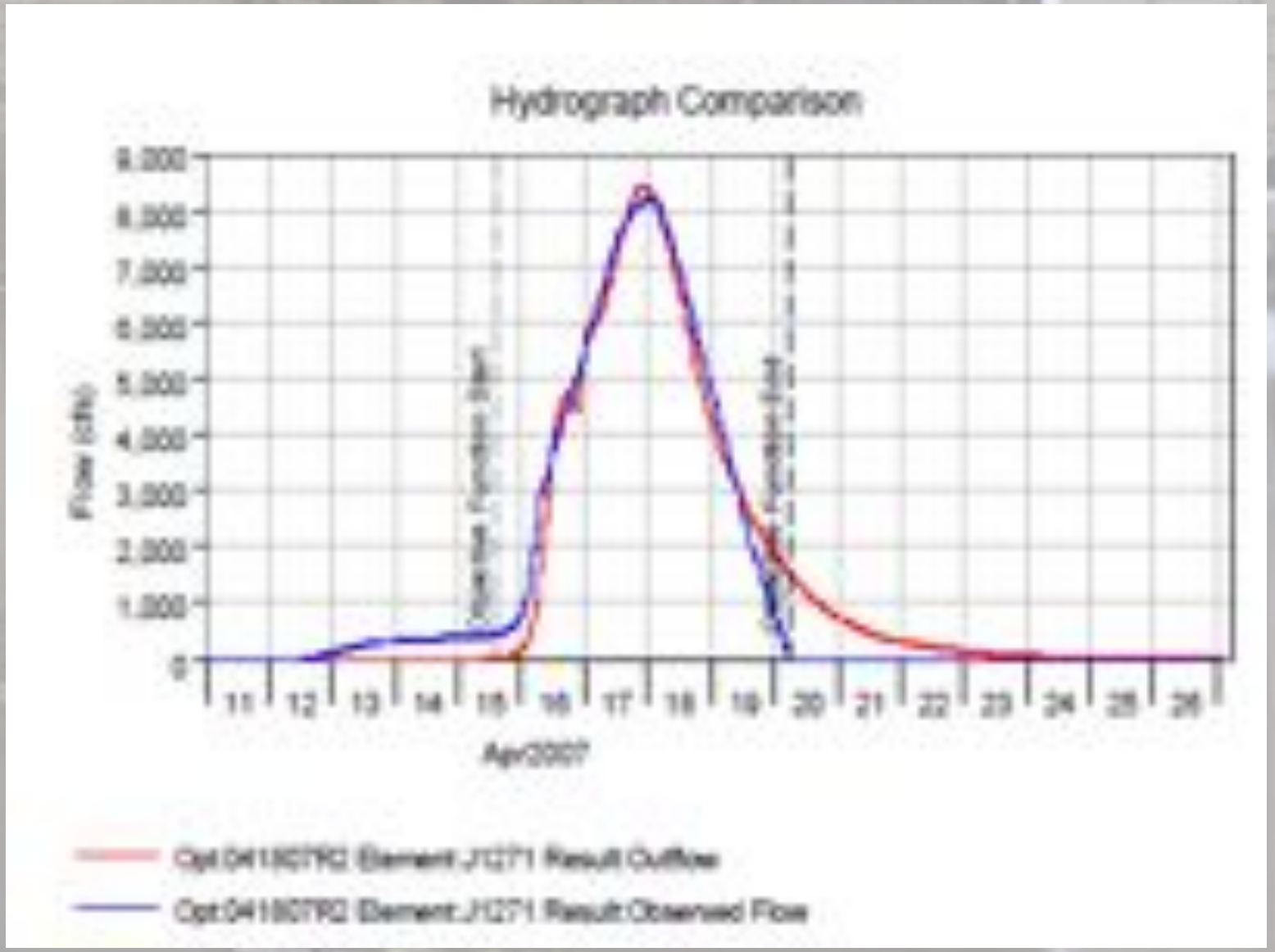
HEC-HMS Input File

Land Use Within the Watershed

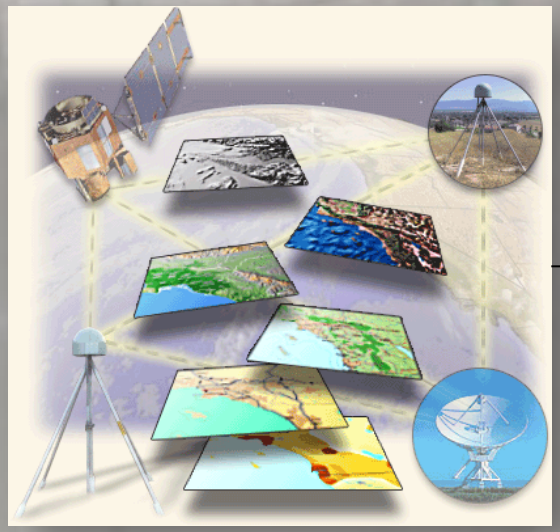
Subbasin	CN
W6510	62.5
W8600	63.0
W11900	64.2
W10910	61.2
W8380	63.5
W11020	62.5
W6730	65.4
W7060	63.9
W7920	67.7
W10250	66.0
W8590	71.0



Calibrating the Watershed



Hydraulic Overview



GIS Preprocessed Spatial Hydrology Data Base

HEC-GeoRAS (ArcView)

Create Stream Stationing and Reaches

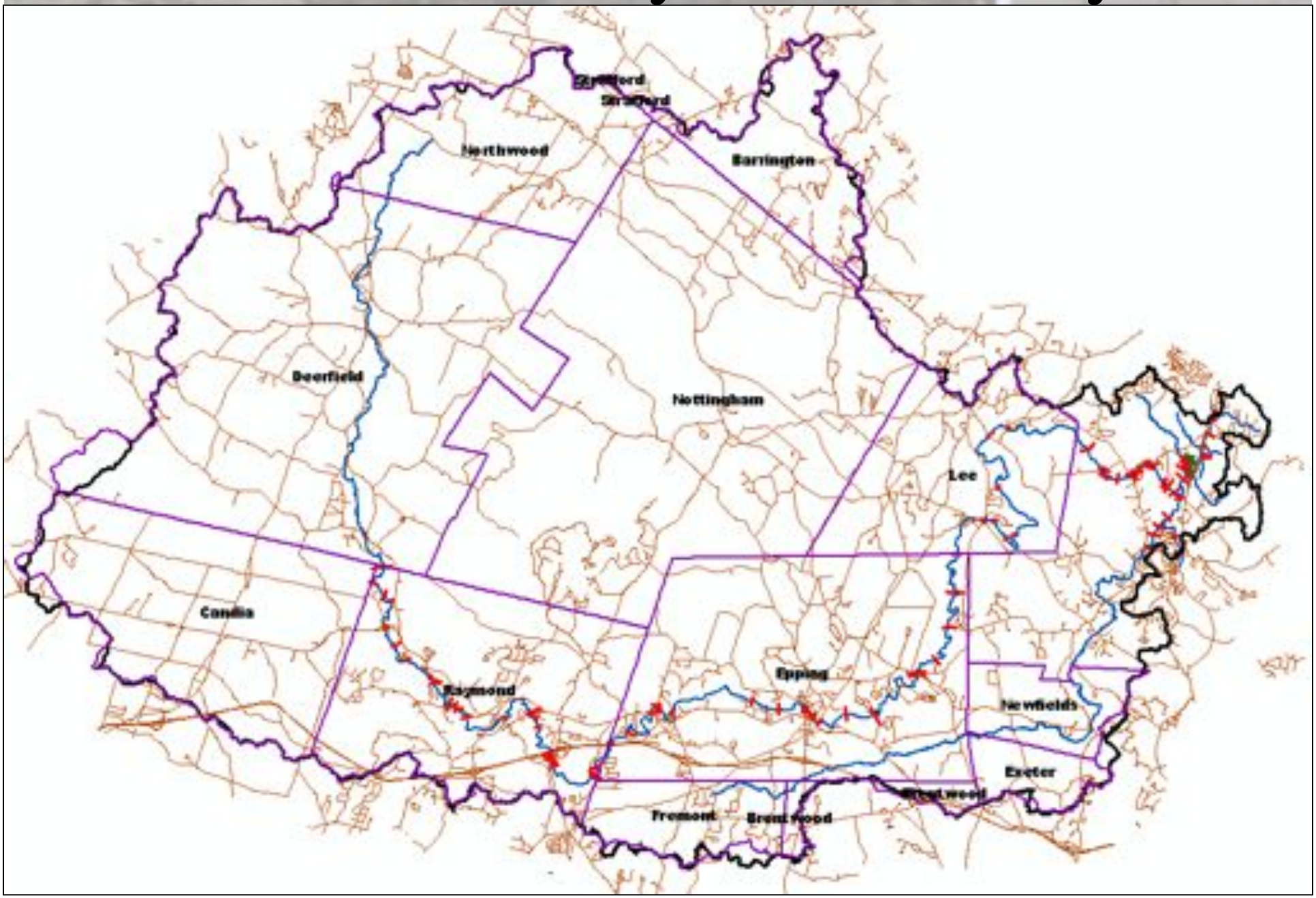
Create Stream Cross Sections

Extract Elevation Data

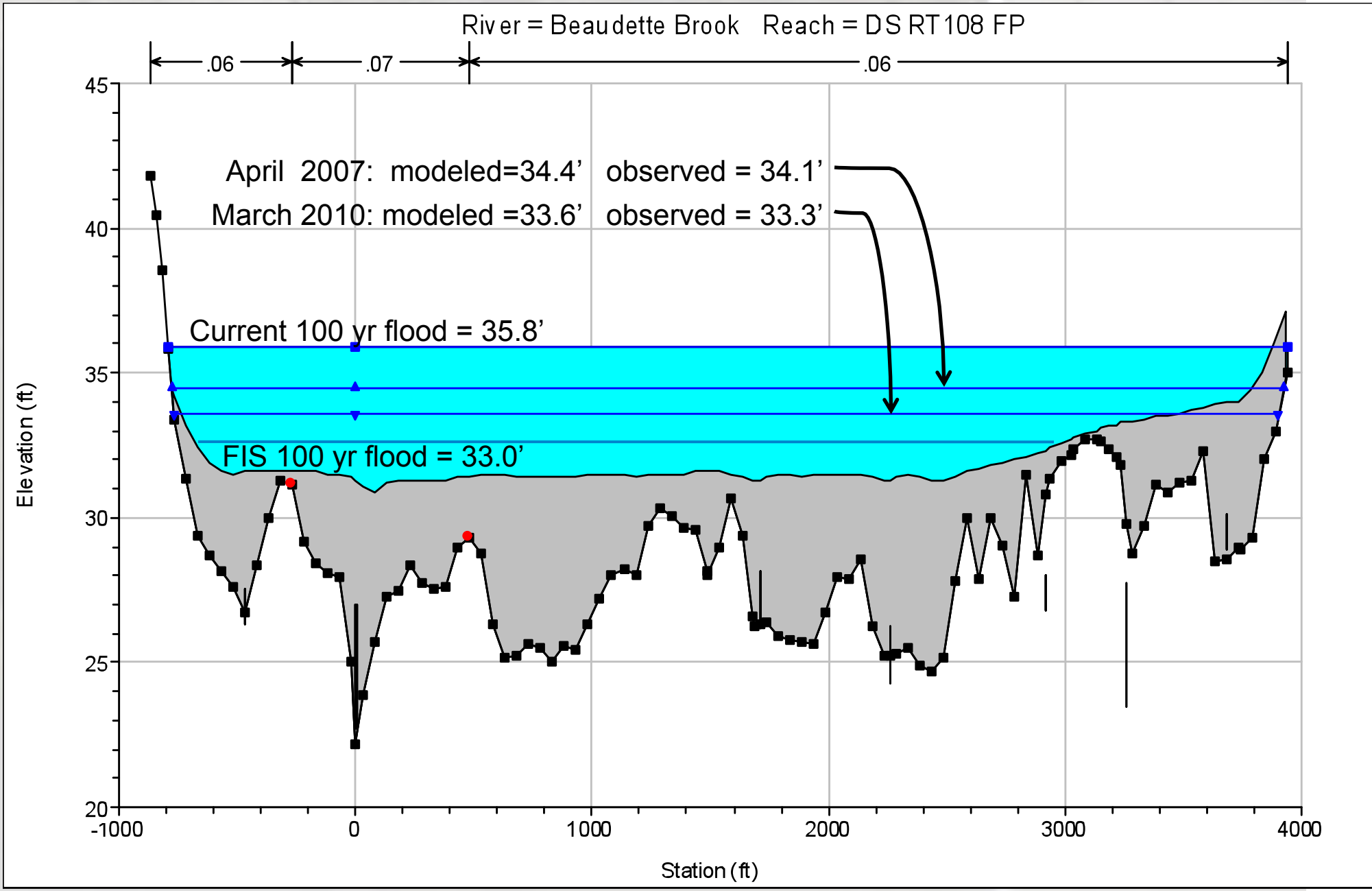
HEC-RAS Input File

RAS Mapping

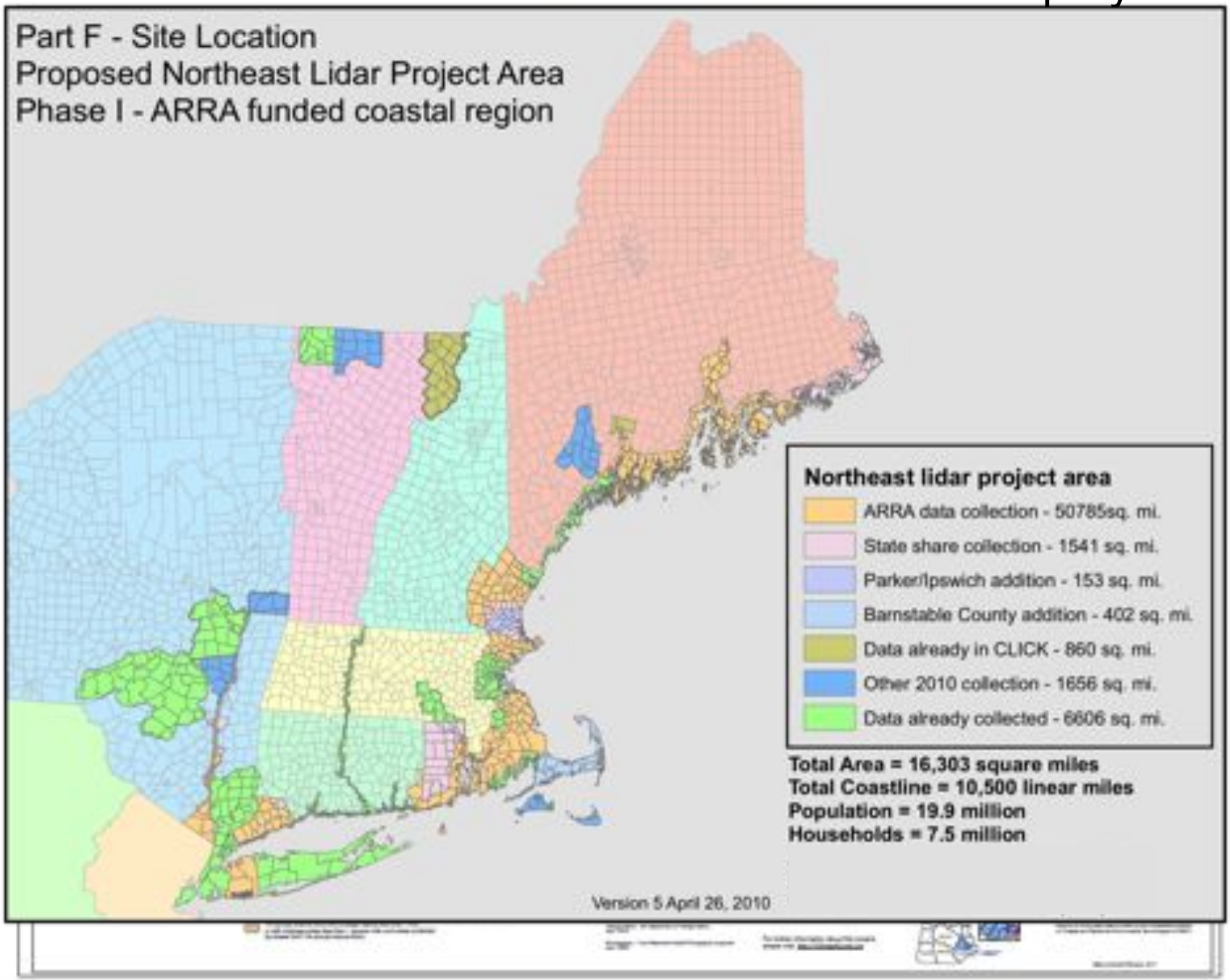
HEC-GeoRAS Hydraulic Analysis



UNH Hydraulics Model – Results for RT108



Effective and Current Conditions – Lower Lamprey

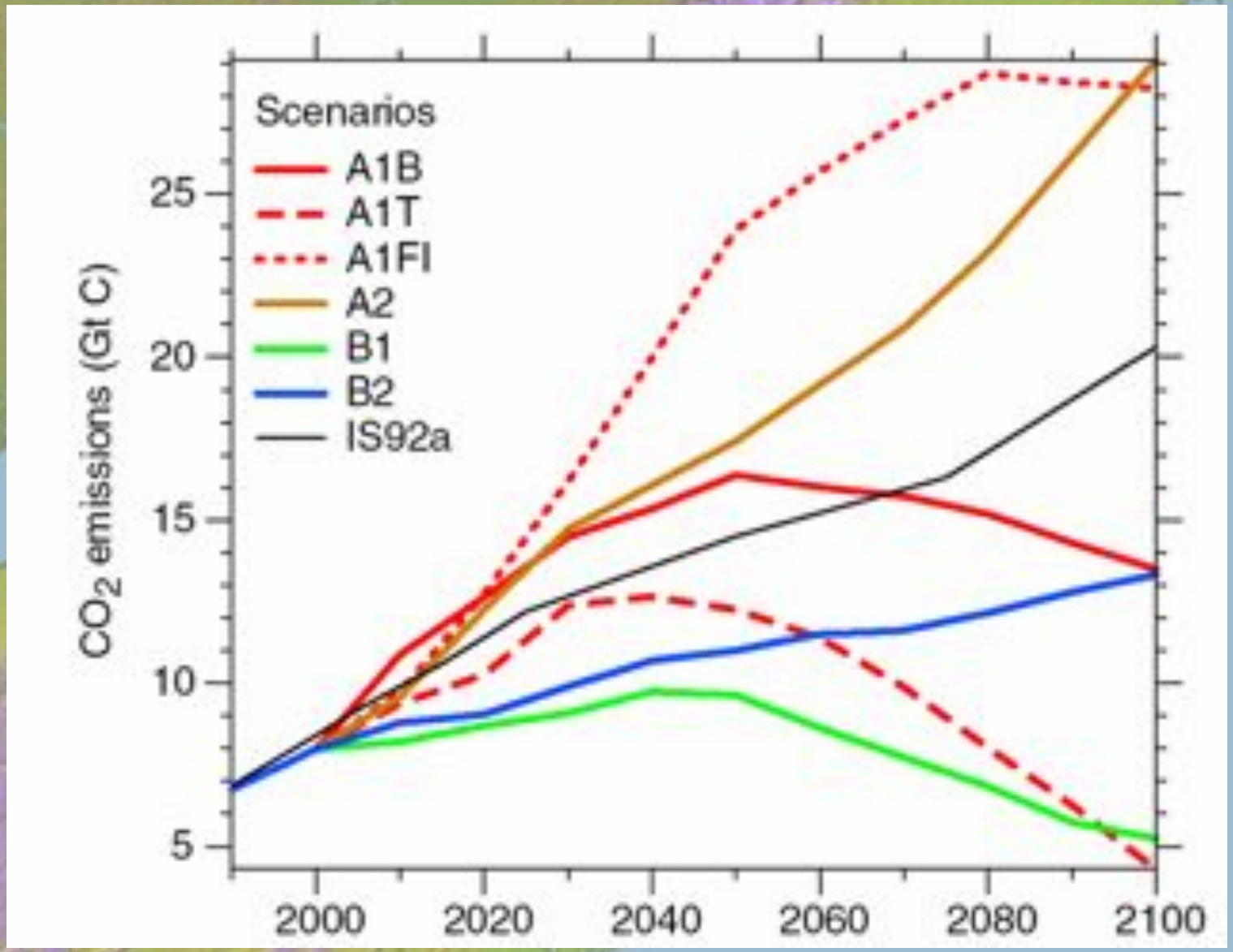


Assessing Flood Risk - Lamprey River Watershed

Land Use & Climate Scenarios to be Evaluated (6 total)

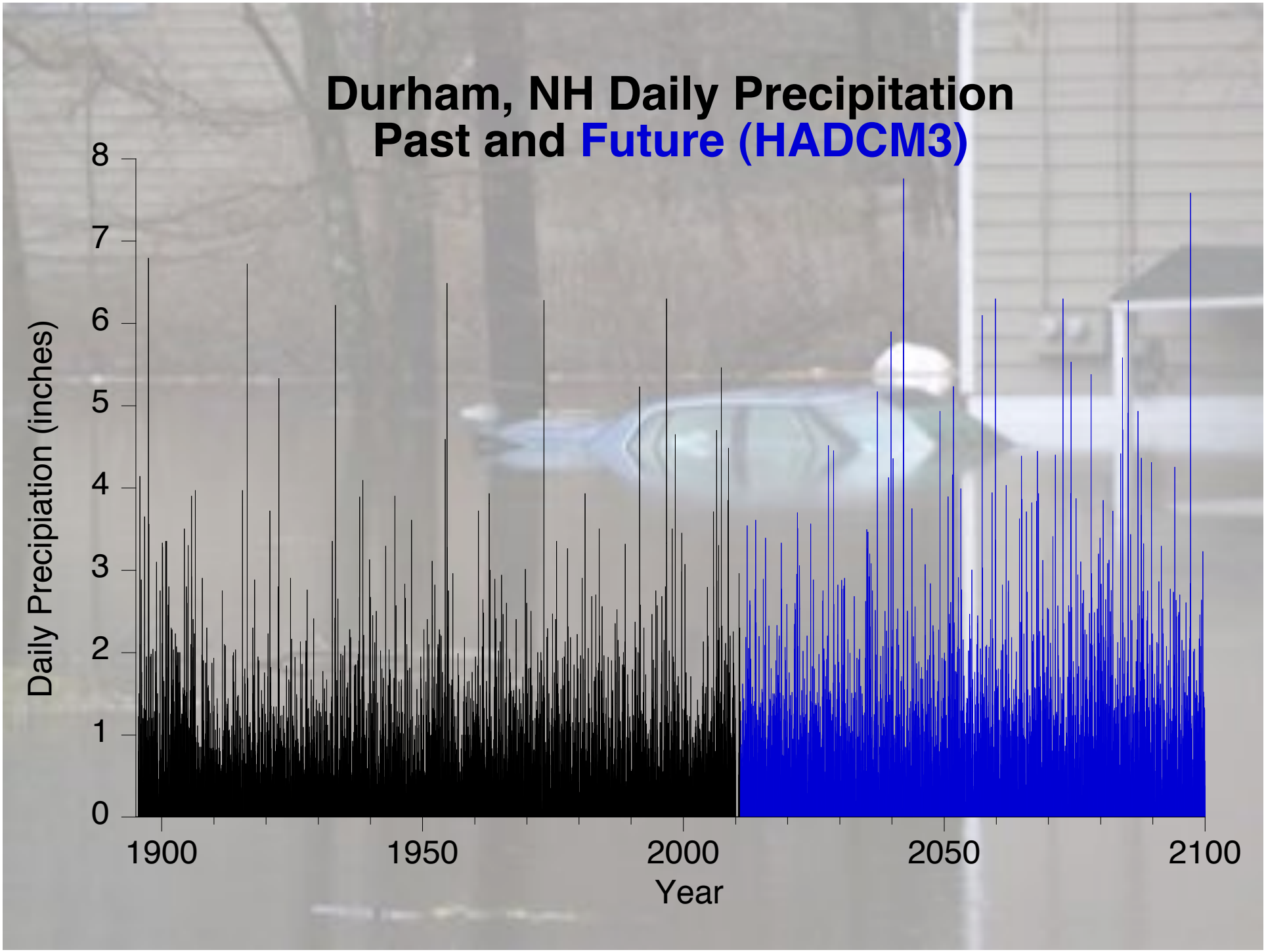
Land Use Condition	Climate Condition			
	FIS Conditions	Current Climate	2050 (2035 - 2064)	2085 (2070-2099)
FIS Conditions 1981	6.3"			
Current Conditions (2005)		8.5"		
Build-out conditions			X	X
Build-out with LID			X	X

Projecting Future Climate Change for the Northeast: Greenhouse Gas Emission Scenarios



Projecting Future Climate Change for the Northeast: Downscale Global Projections to Regional Level

GCM	Max Daily Precip - A1Fi	
	Durham, NH	Lawrence MA
CCSM	6.3"	11.4"
GFDL	6.5"	6.7"
HADCM3	7.8"	9.0"
PCM	7.5"	10.0"


Durham, NH Daily Precipitation
Past and Future (HADCM3)
Daily Precipiation (inches)
0
1
2
3
4
5
6
7
8
1900
1950
2000
2050
2100
Year

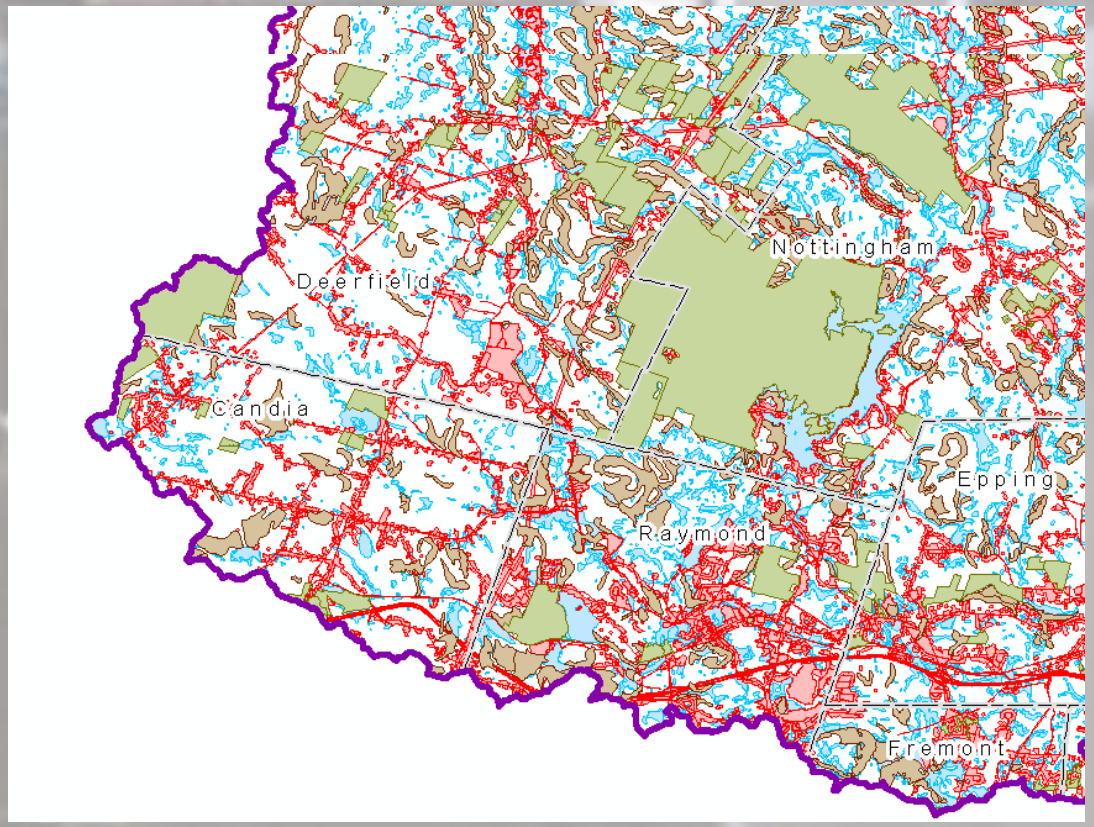
Mapping Buildout

Starting with total watershed acreage, eliminate:

- Developed land
- Hydric soils/wetlands/surface water
- Steep slopes (> 15%, based on soils)
- Conservation lands; public water supply protection areas

Build out flat terrains first, moving incrementally to steeper slopes

Within a slope category, build out areas closest to roads first

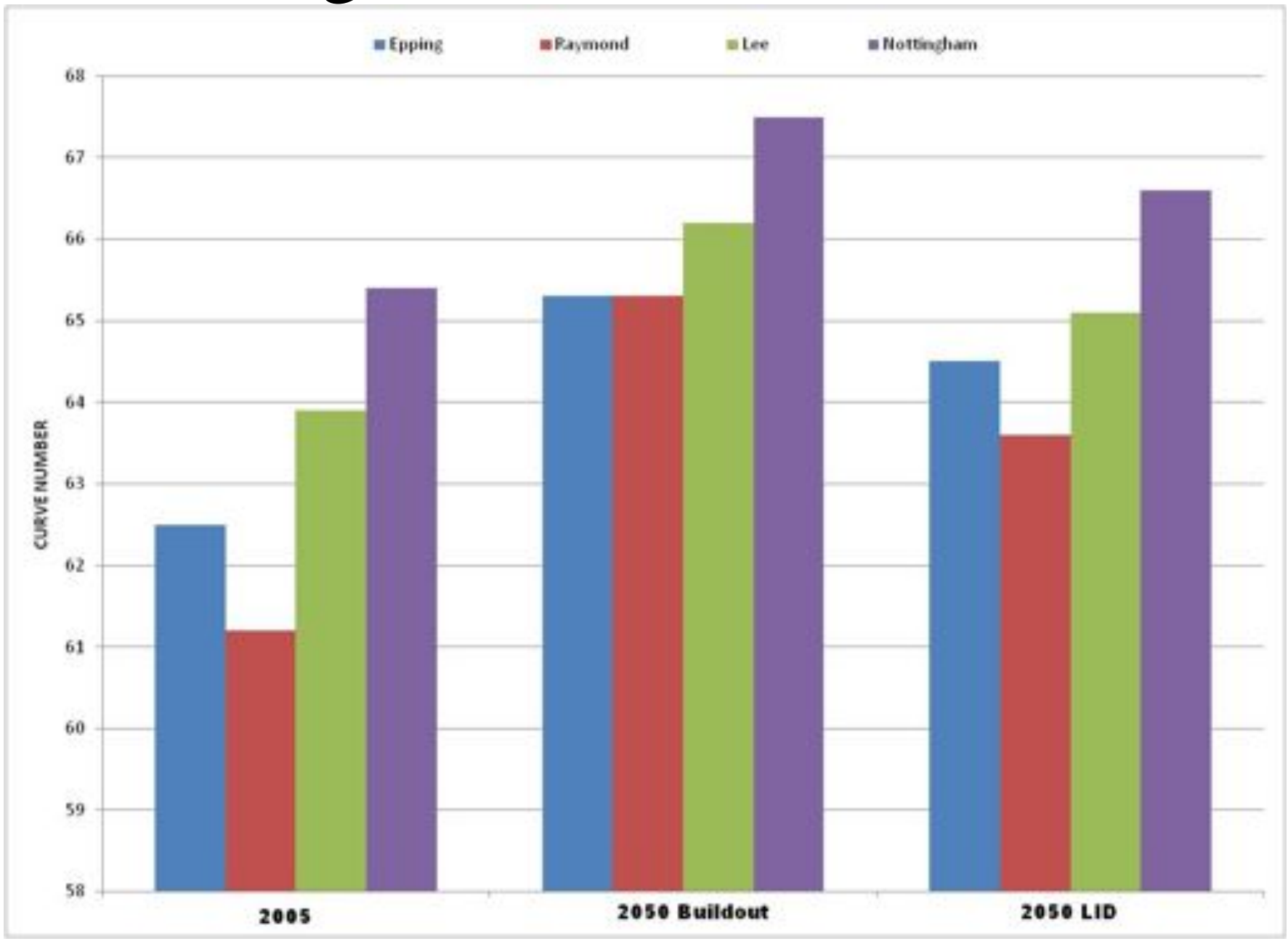


Buildout Acreage

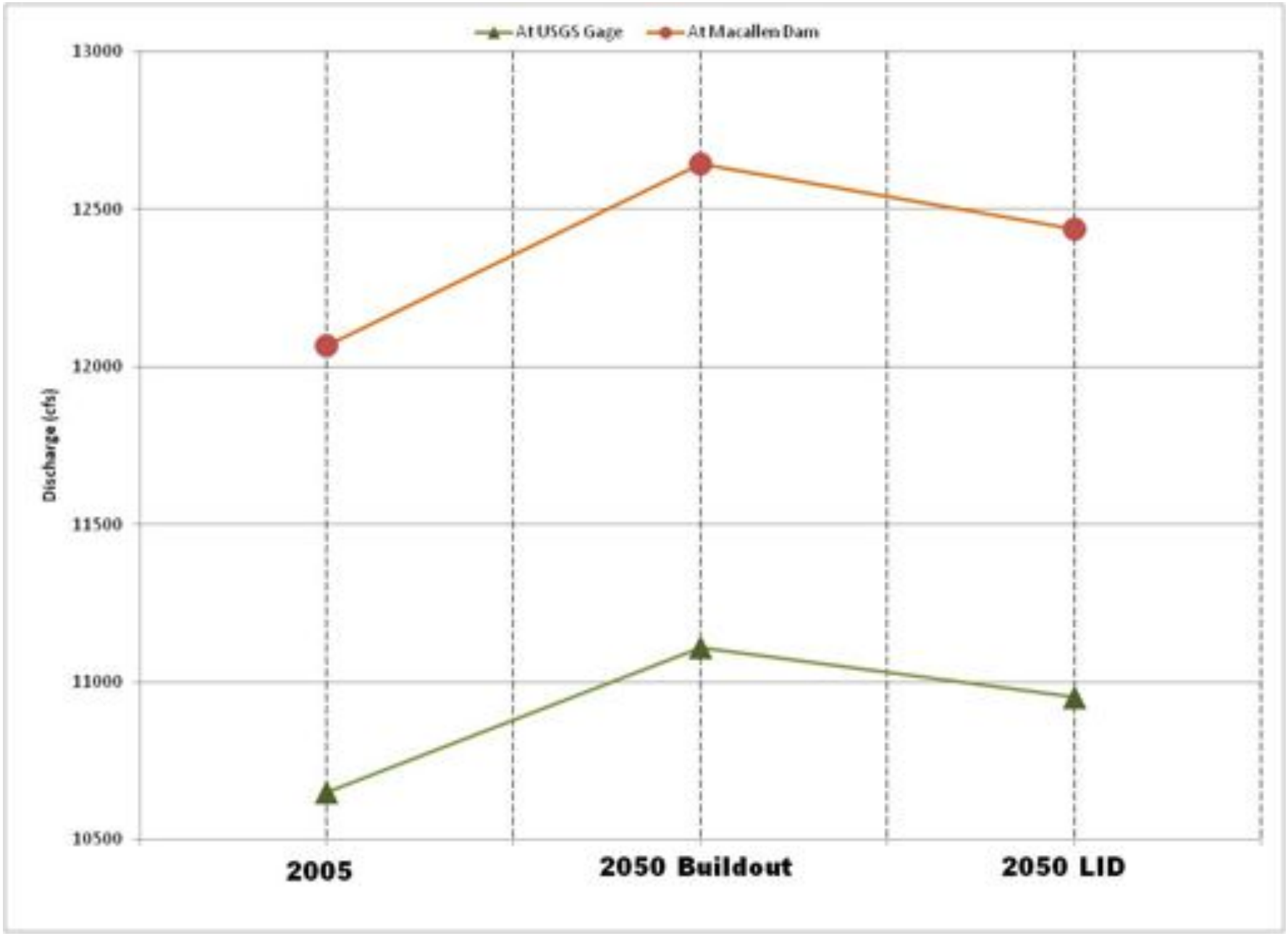
Time Period	Annual Growth Rate	
	Residential	Non-Residential*
2006-2030	1.2%	1.7%
2031-2085	0.6%	1.1%
*includes redevelopment		

Annual Growth Rate from Chapter 2, Regional Transportation Vision, Rockingham Planning Commission, 2009-2035 Long Range Plan

Regional Curve Number



Flood Flows


At USGS Gage
At Macallen Dam
13000
12500
12000
11500
11000
10500
Discharge (cfs)
2005
2050 Buildout
2050 LID

New Flood Plain Maps and Questions of Legal Authority, Measures and Consequences

In Collaboration with Vermont Law School

1. What is the potential liability of government if they fail to reduce vulnerability to the risk of flood based on UNH's information?
2. What legal and policy approaches may communities adopt to reduce flood risks in the expanded flood hazard?
3. Do New Hampshire communities have the legal authority to design and implement regulatory controls based on projected conditions (e.g., flooding levels)?
4. What legal standard of scientific and technical reliability must be met in order to support regulatory measures based on current/ future environmental conditions?
5. What is the potential regulatory takings exposure if communities impose regulatory controls that are designed to address anticipated future environmental conditions?

Newmarket Effective 100 Year Floodplain