1-9-2014

Past, Present, and Potential Future 100-year floods in the Lamprey River Watershed

Cameron P. Wake
University of New Hampshire, cameron.wake@unh.edu

Fay Rubin
University of New Hampshire

Steve Miller
Great Bay National Estuarine Research Reserve

Robert M. Roseen
University of New Hampshire

Ann Scholz
University of New Hampshire

See next page for additional authors

Authors
Cameron P. Wake, Fay Rubin, Steve Miller, Robert M. Roseen, Ann Scholz, Thomas P. Ballestero, Michael Simpson, Julia Peterson, Lisa Townson, John Echeverria, Katherine Garvey, and Peg Elmer

Past, Present, and Potential Future 100-year floods in the Lamprey River Watershed

Town of Lee 9 Jan 2014

Cameron Wake & Fay Rubin, EOS, University of New Hampshire

Steve Miller, Great Bay National Estuarine Research Reserve

Robert Roseen, Ann Scholz & Tom Ballestero, UNH Stormwater Center

Michael Simpson, Antioch University New England

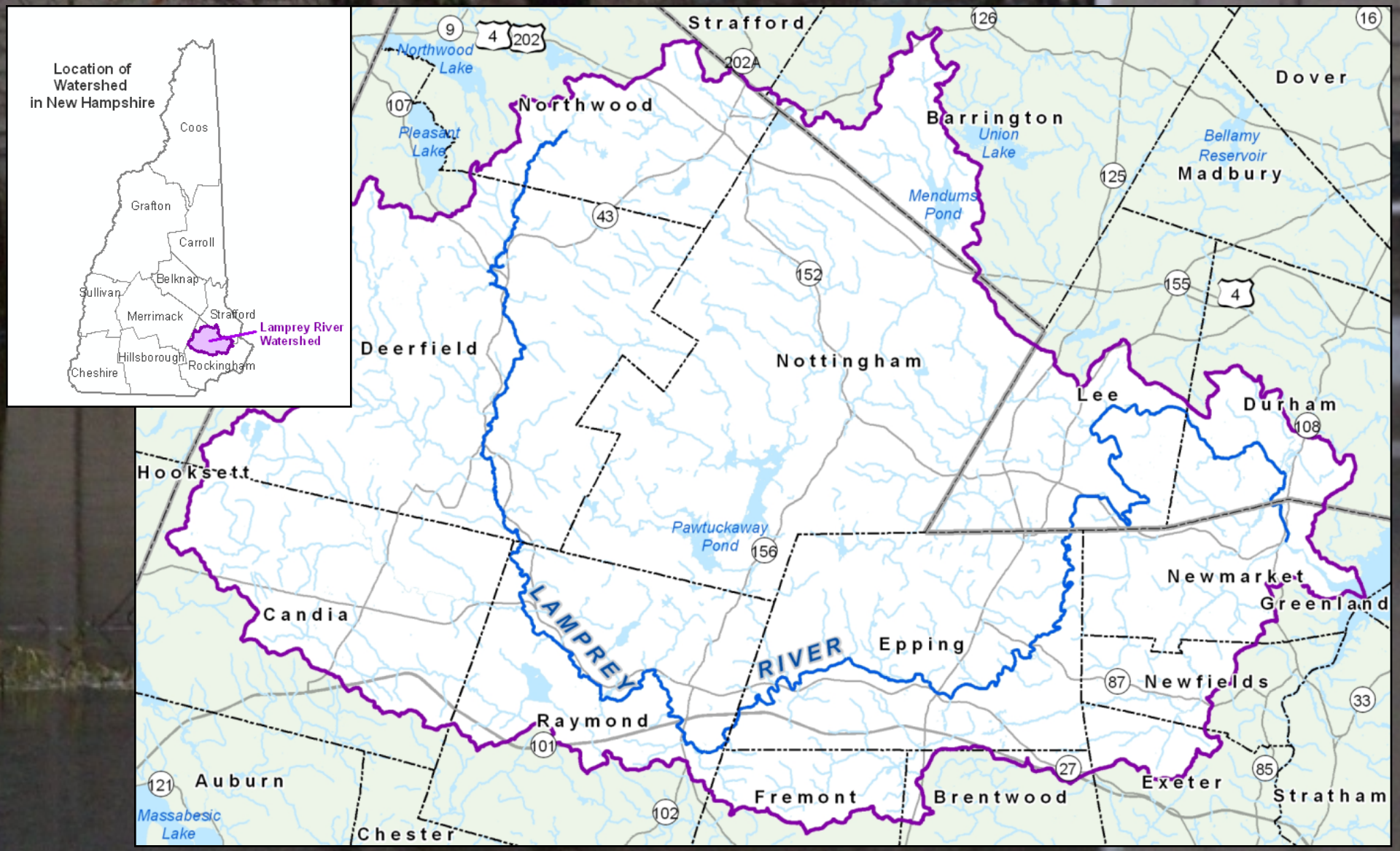
Julia Peterson & Lisa Townson, UNH Cooperative Extension

John Echeverria, Katherine Garvey & Peg Elmer, Vermont Law School

http://100yearfloods.org **http://www.granit.unh.edu/**

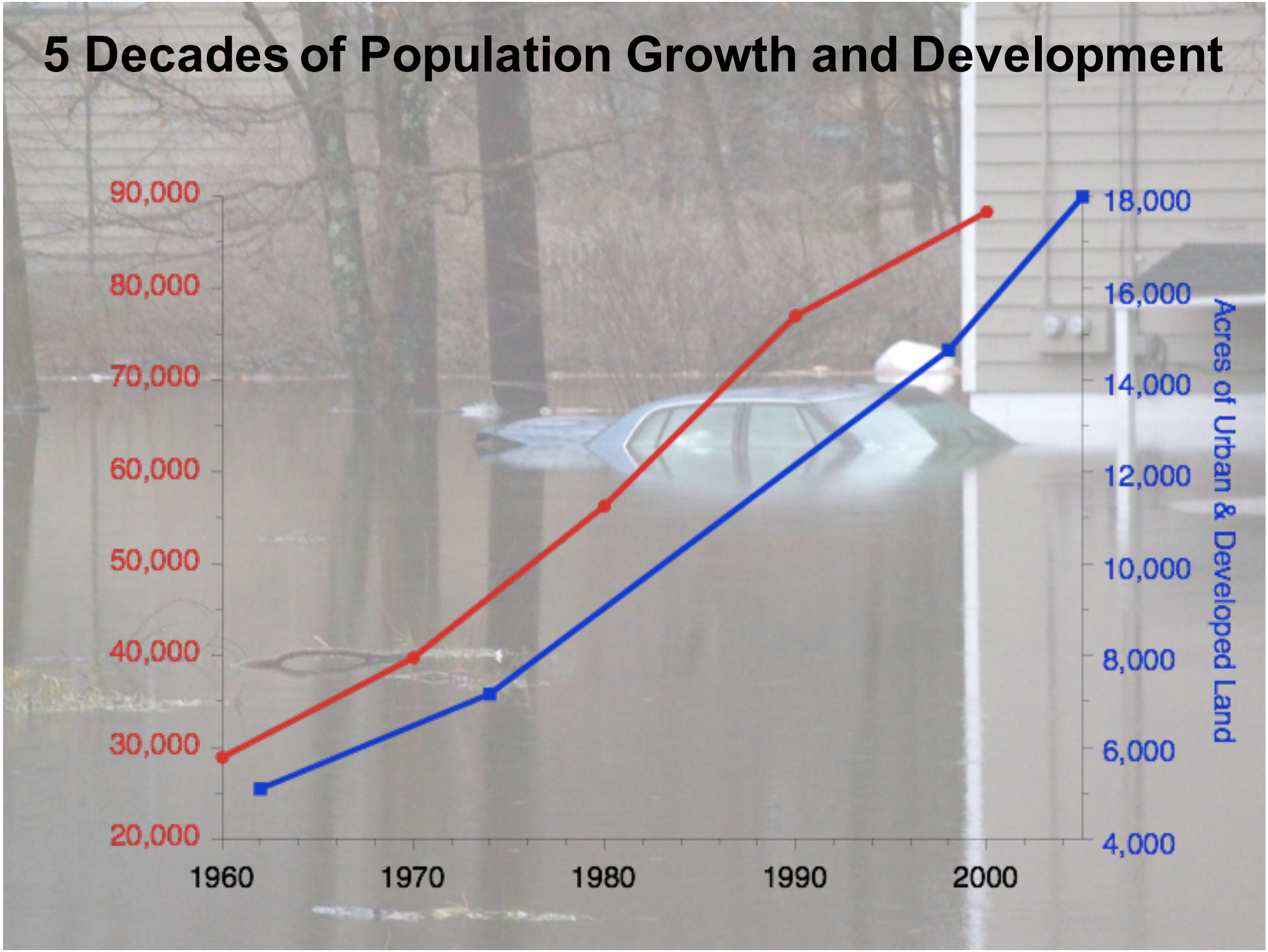
Funded by NOAA Cooperative Institute for Coastal & Estuarine Environmental Technology

Assessing Flood Risk in the Lamprey River Watershed, NH

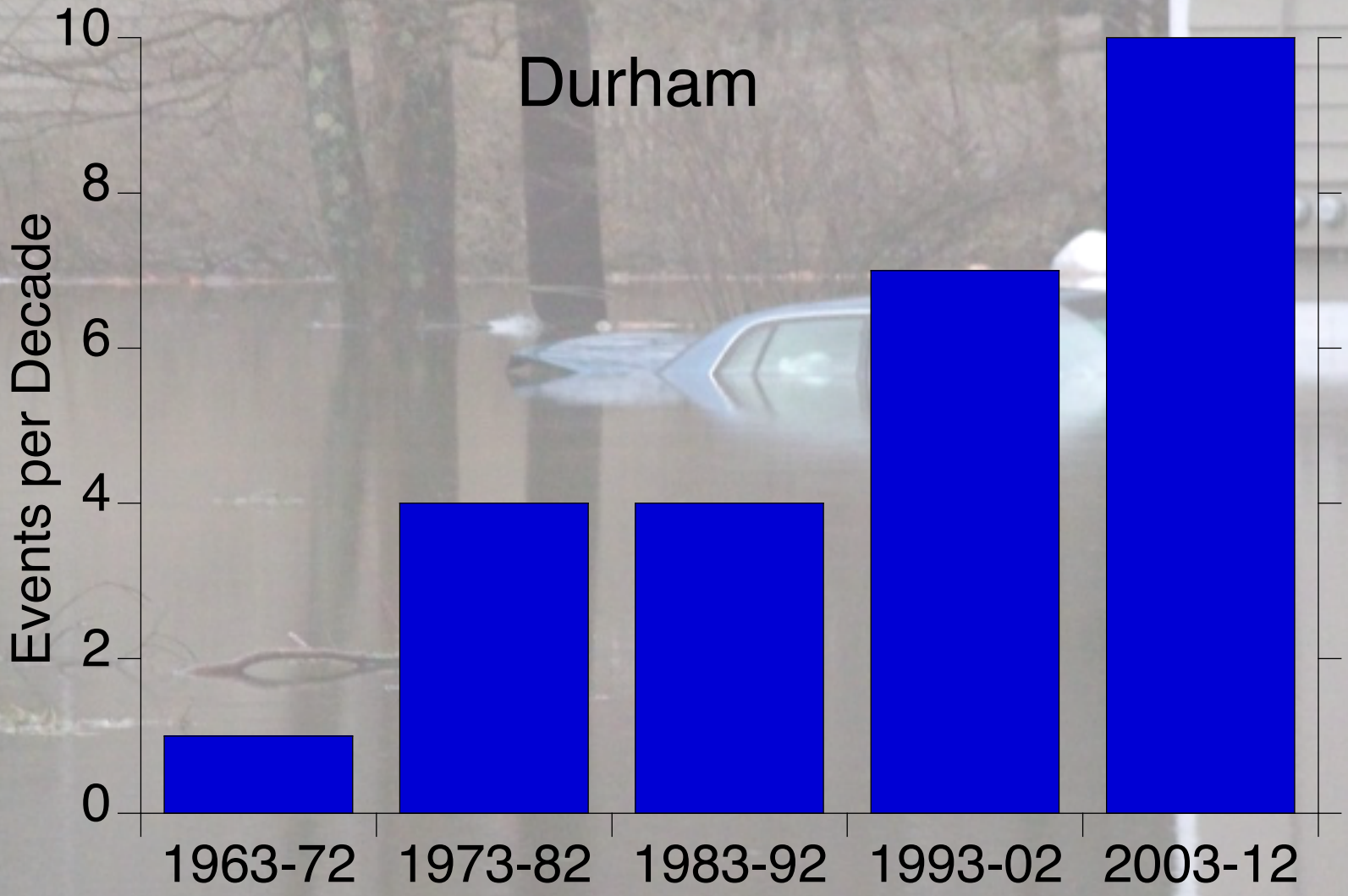


Funded by NOAA/UNH Cooperative Institute for Coastal and Estuarine Environmental Technology

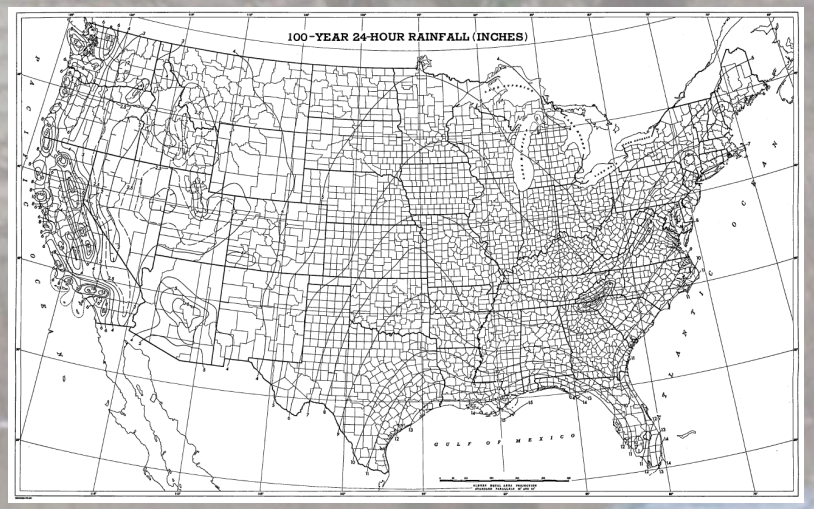
5 Decades of Population Growth and Development



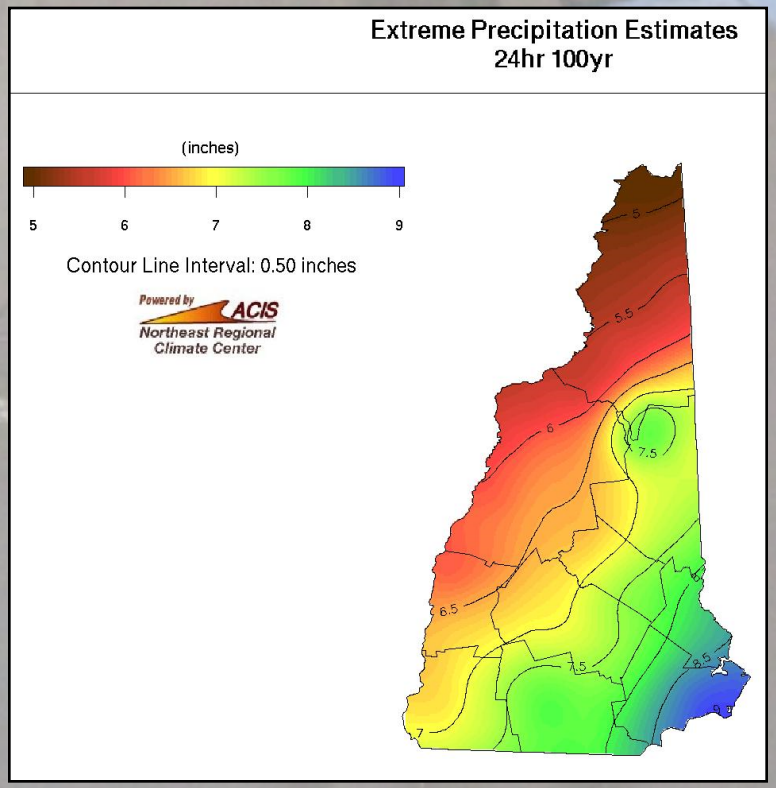
4 Inch Precipitation Events by Decade 1963 – 2012



24 hour 100-year Rainfall – Design Storm



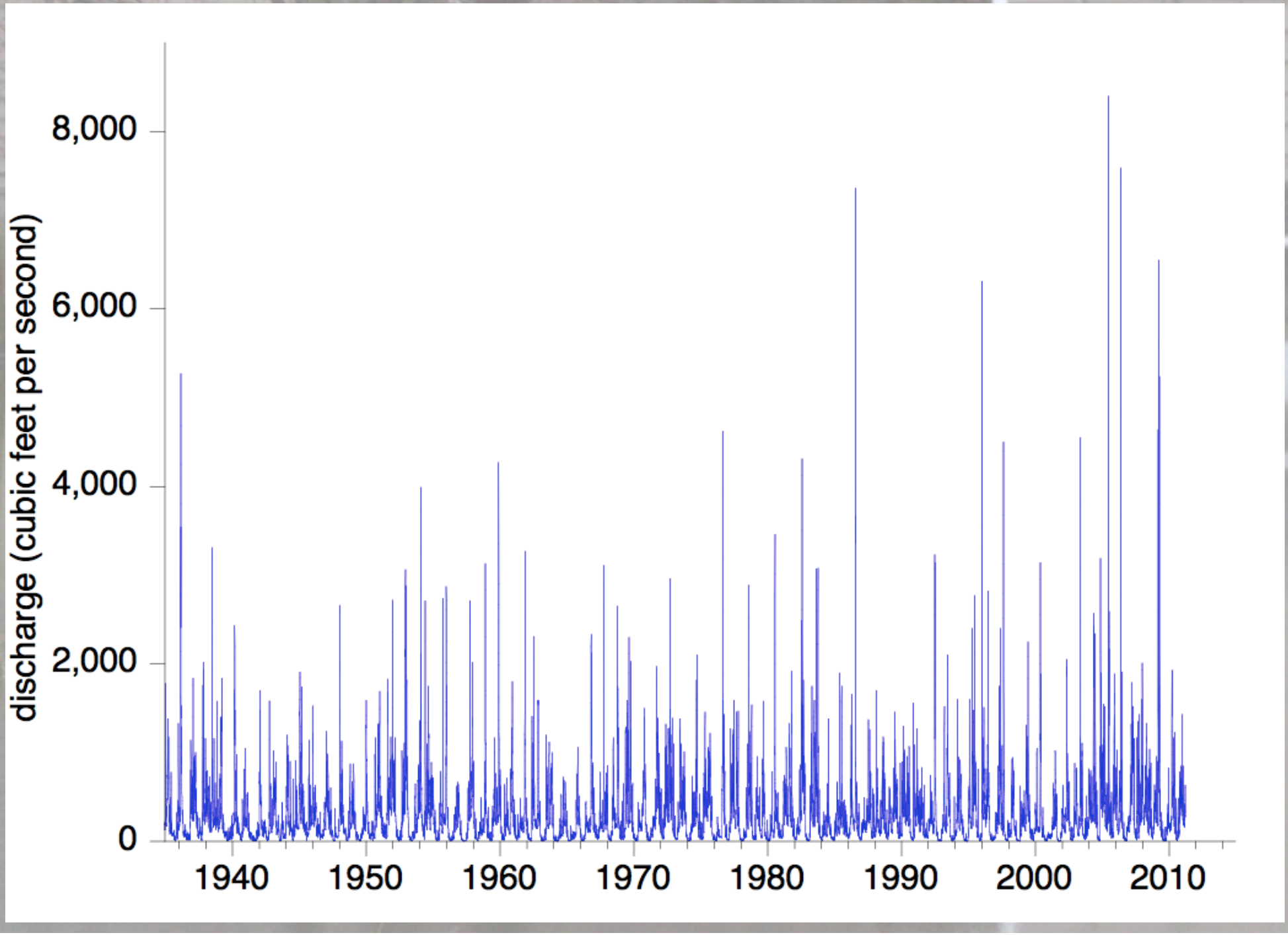
TP-40 Rainfall Frequency Atlas used for effective conditions = 6.3” (1938-1957)



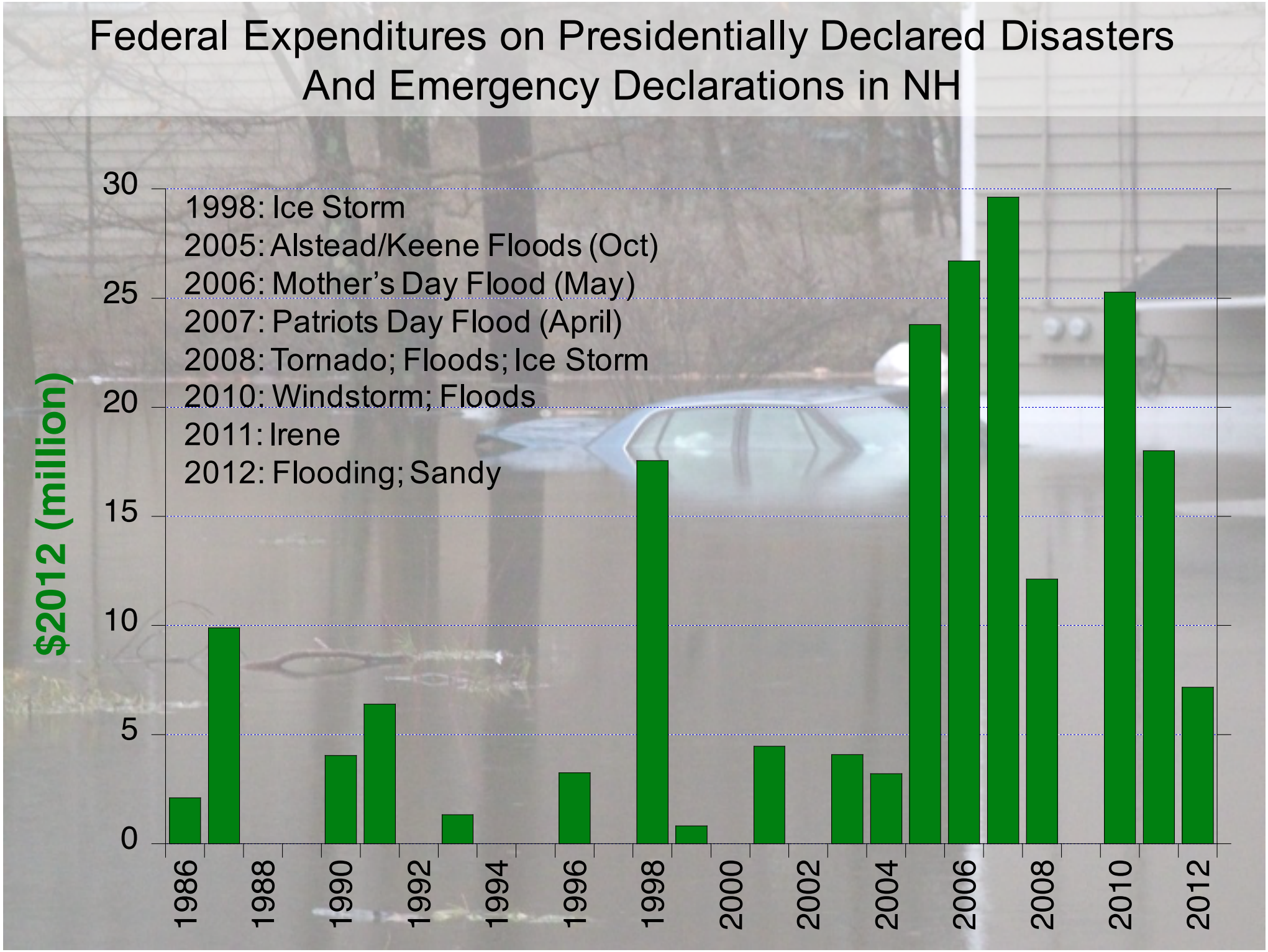
Northeast Regional Climate Center Atlas for Extreme Precipitation for current conditions = 8.5”

http://precip.eas.cornell.edu/

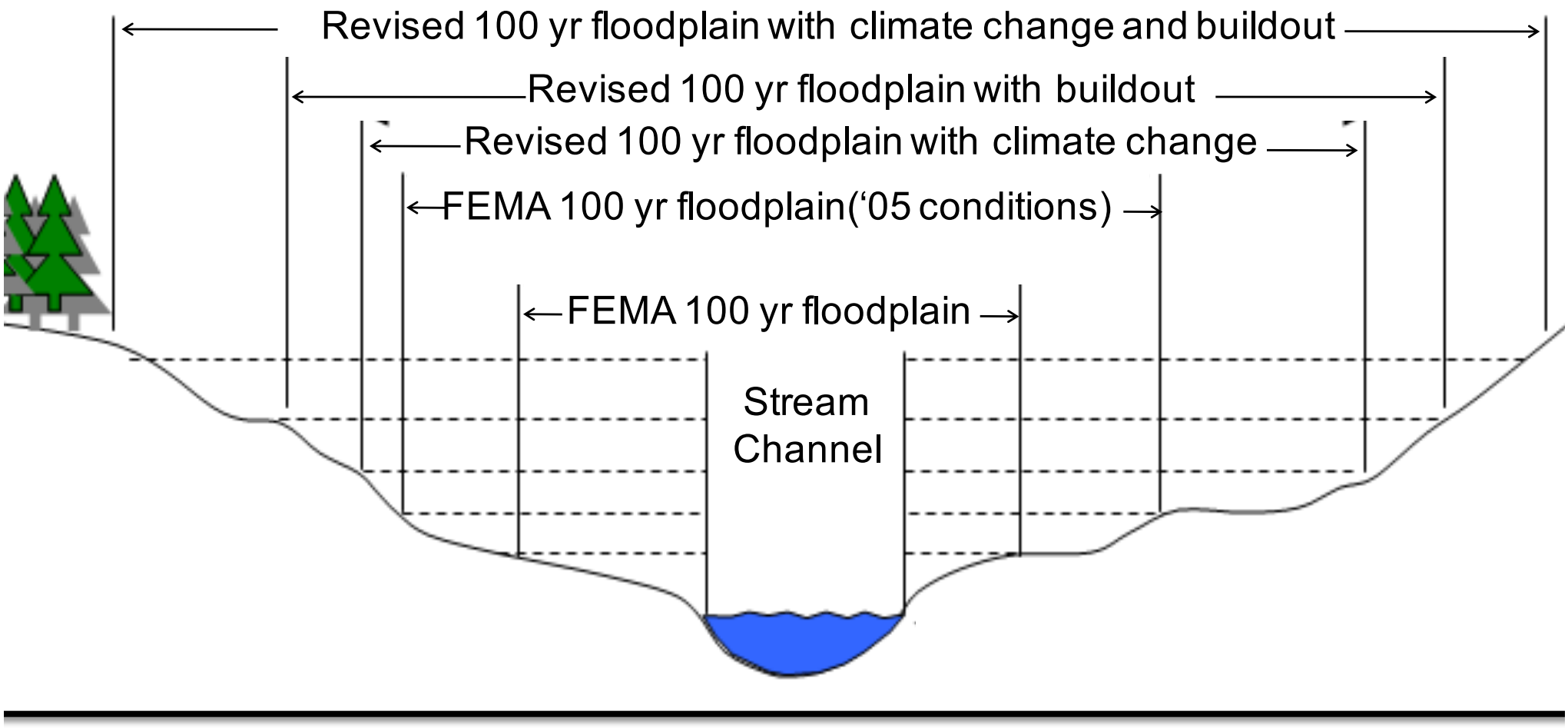
Daily Discharge, Lamprey River 1934 - 2012



Federal Expenditures on Presidentially Declared Disasters And Emergency Declarations in NH



Changing Floodplains with Changing Climate & Land Use

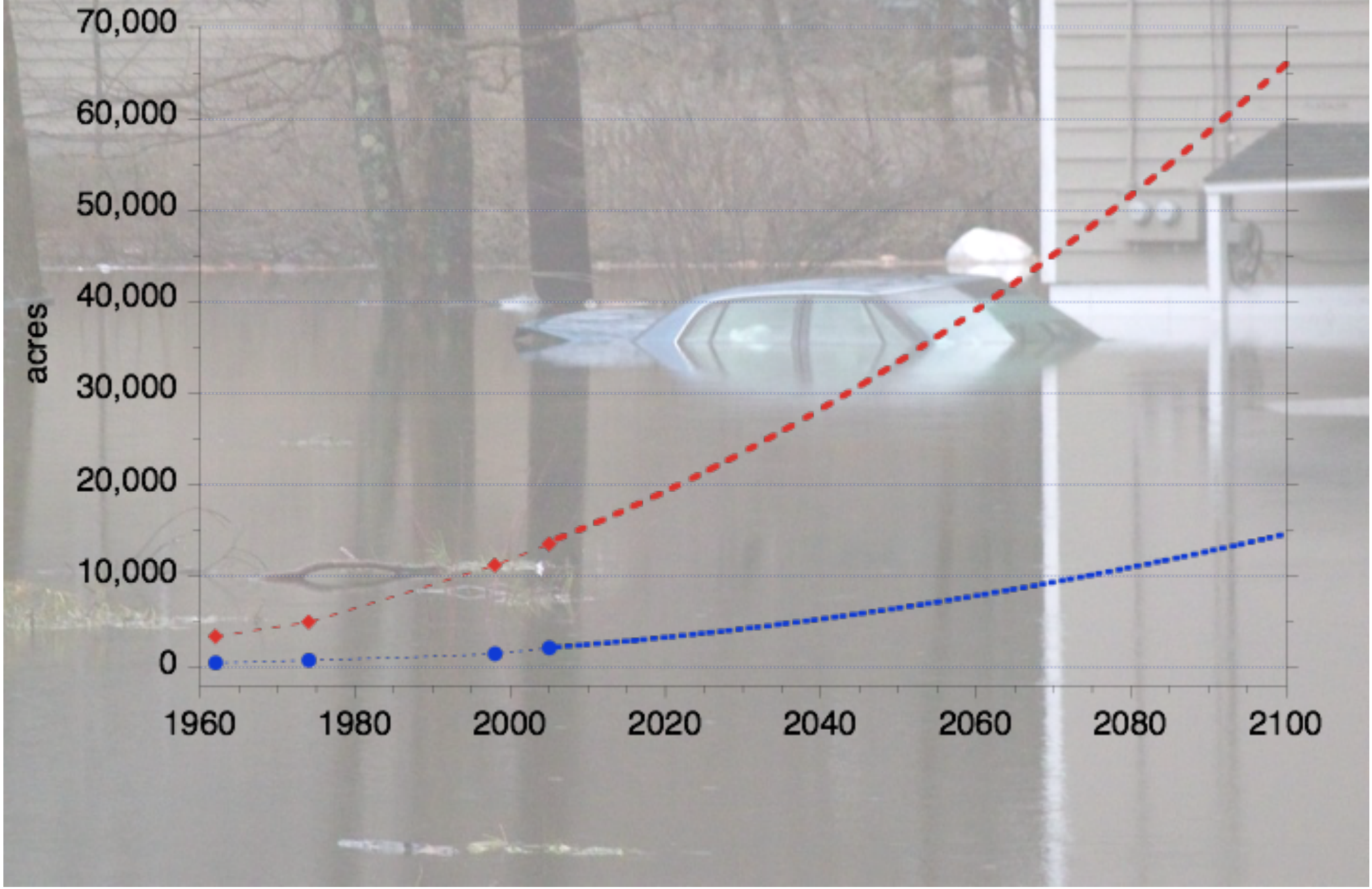


Land Use & Climate Scenarios

Land Use Conditions	Max 24-hr Precipitation (in)			
	FIRM	Current Climate	2050	2100
FIRM	6.3			
2005		8.5		
Conventional Build-out			8.5	11.4*
Build-out with LID			8.5	11.4*

*Represents maximum value from downscaling output from four GCMs (CCSM, GFDL, HADCM3, PCM) for a high emissions scenario (A1Fi)

Lamprey River Watershed - Build Out Rates



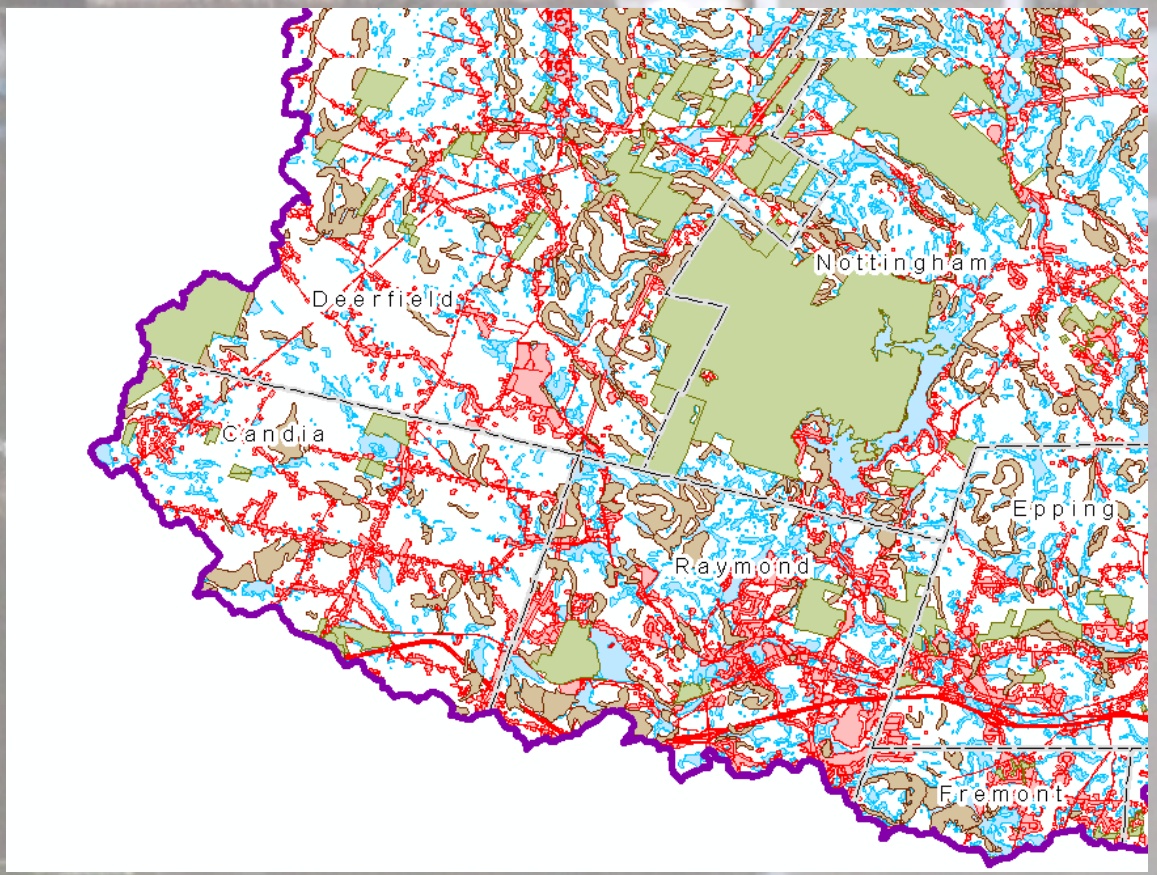
Mapping Buildout

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



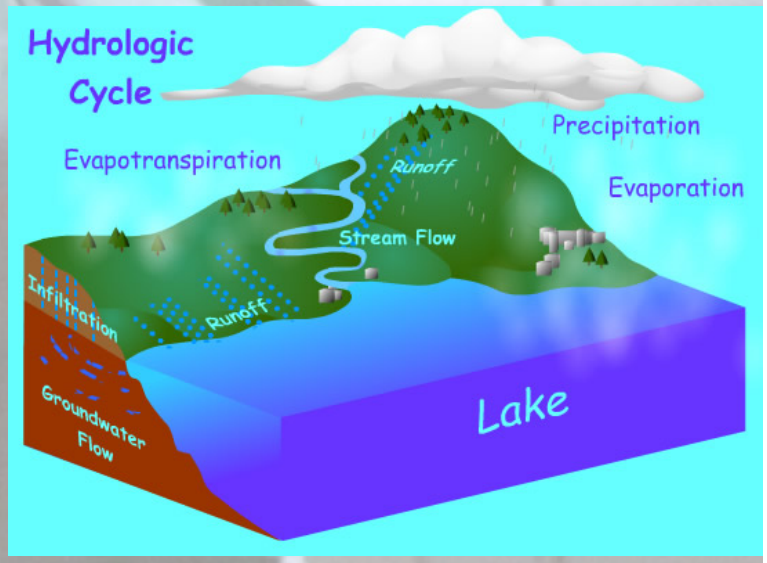
Hydrologic Methodology

- **FIS: Annual peak flow frequency analysis**
  - peak annual stream flow
  - standard deviation
  - weighted coefficient of skewness
- **Lamprey River Project:**

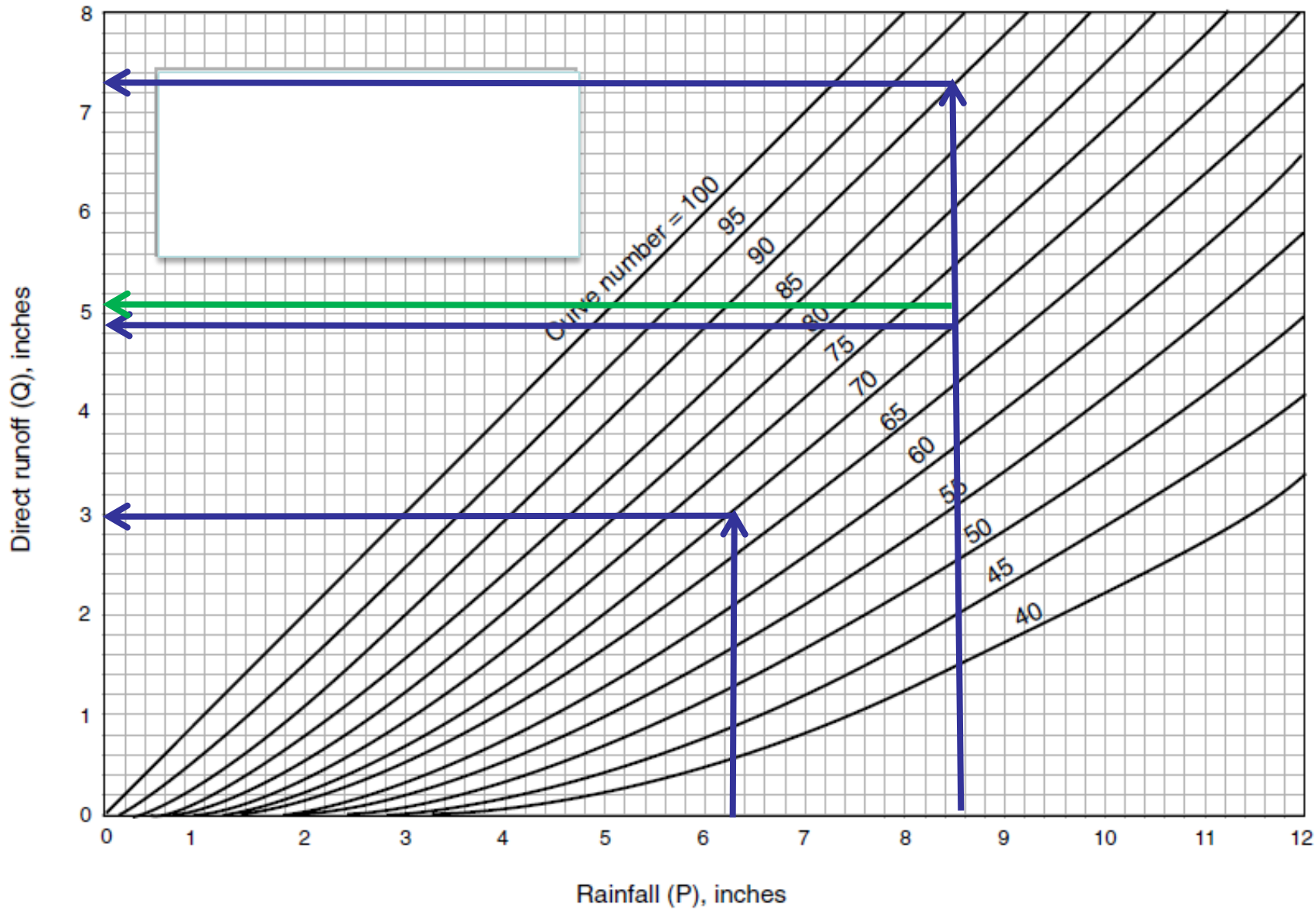
  Rainfall-Runoff Model
  - Watershed area
  - Time of concentration
  - Runoff curve number (CN)

  Hydrologic Modeling: HEC-HMS

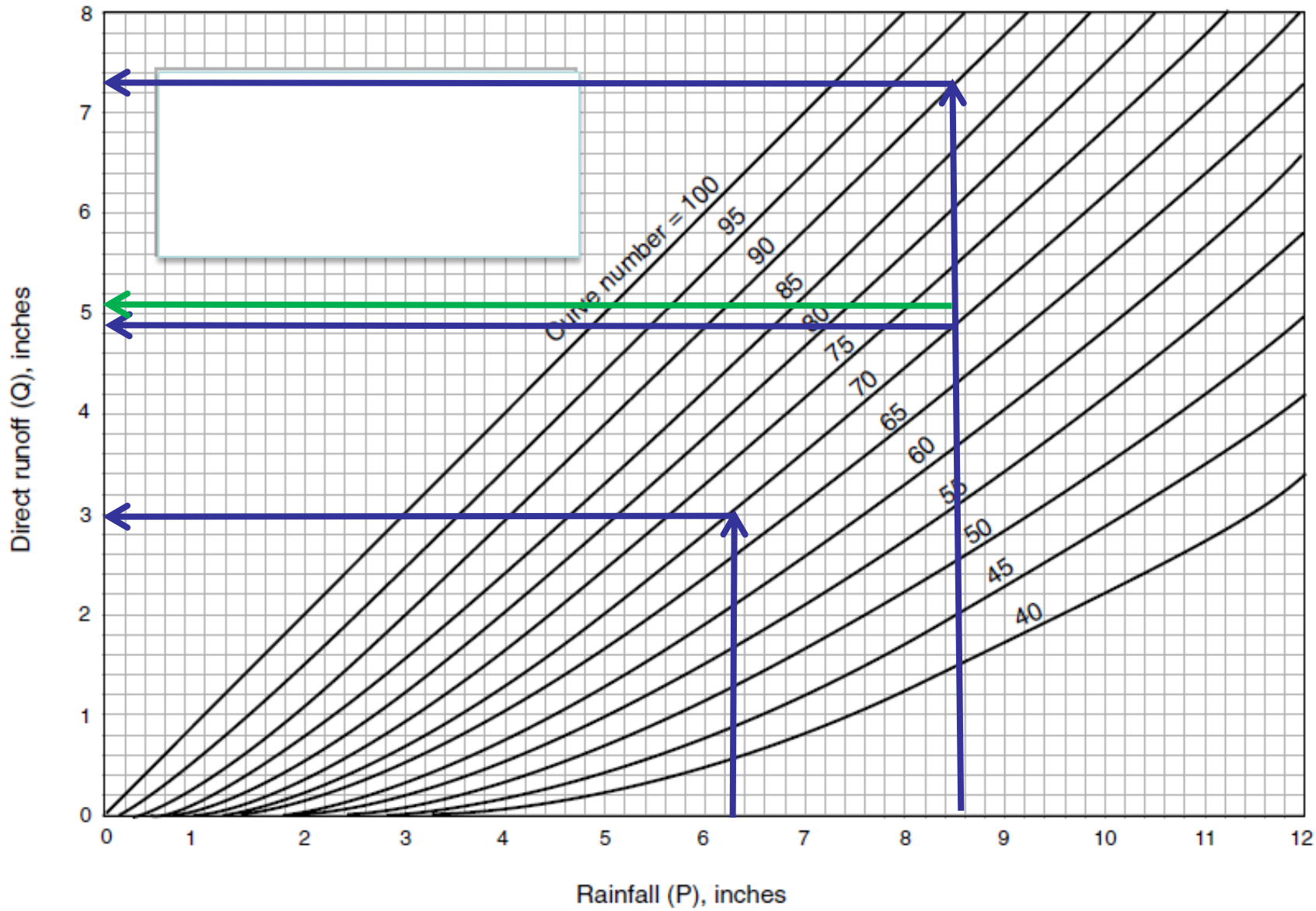
  Hydraulic Modeling: HEC-RAS



Rainfall – Runoff Relationship based on Curve Number (CN)



Rainfall – Runoff Relationship based on Curve Number (CN)

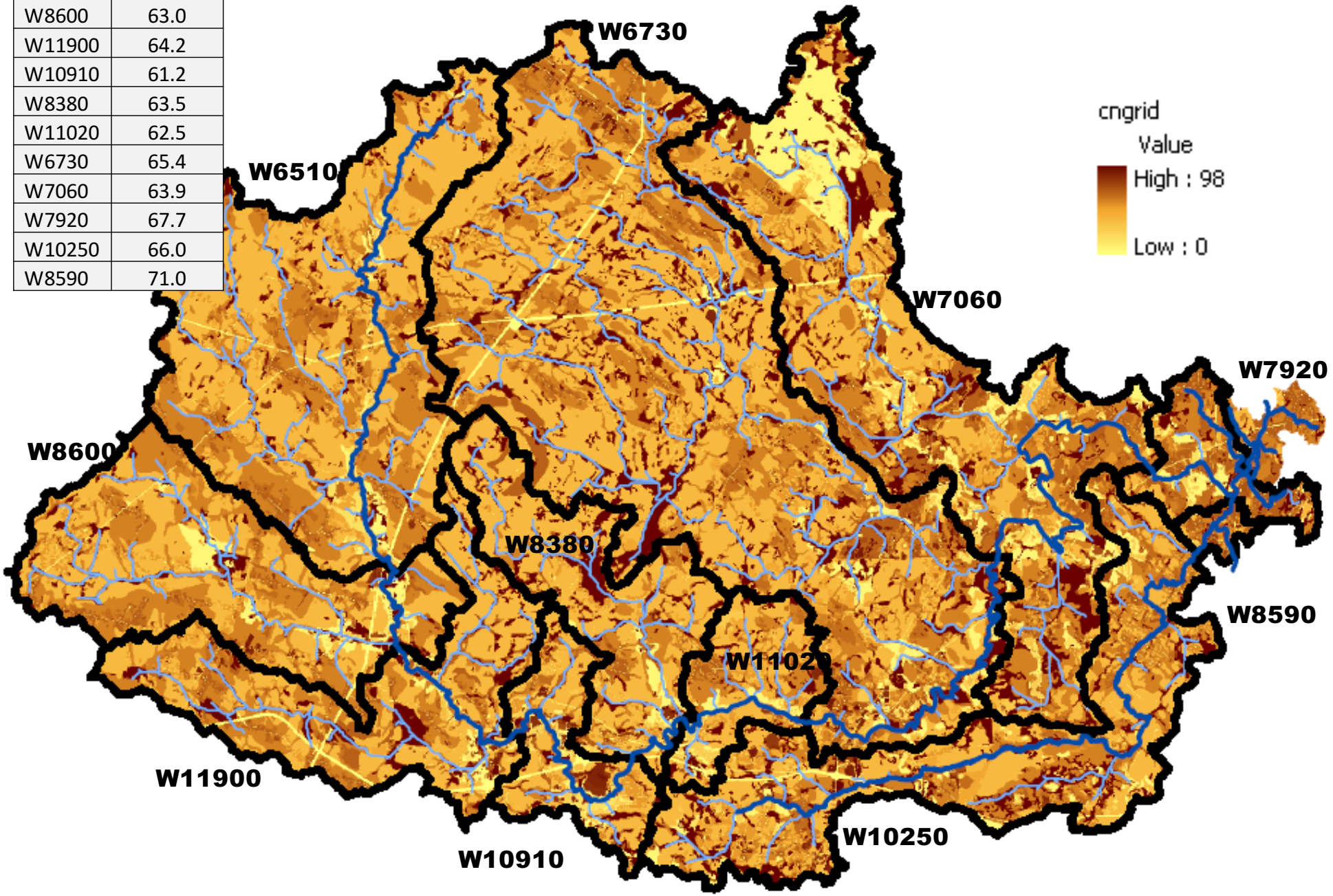


Hydrologic Modeling: HEC-HMS

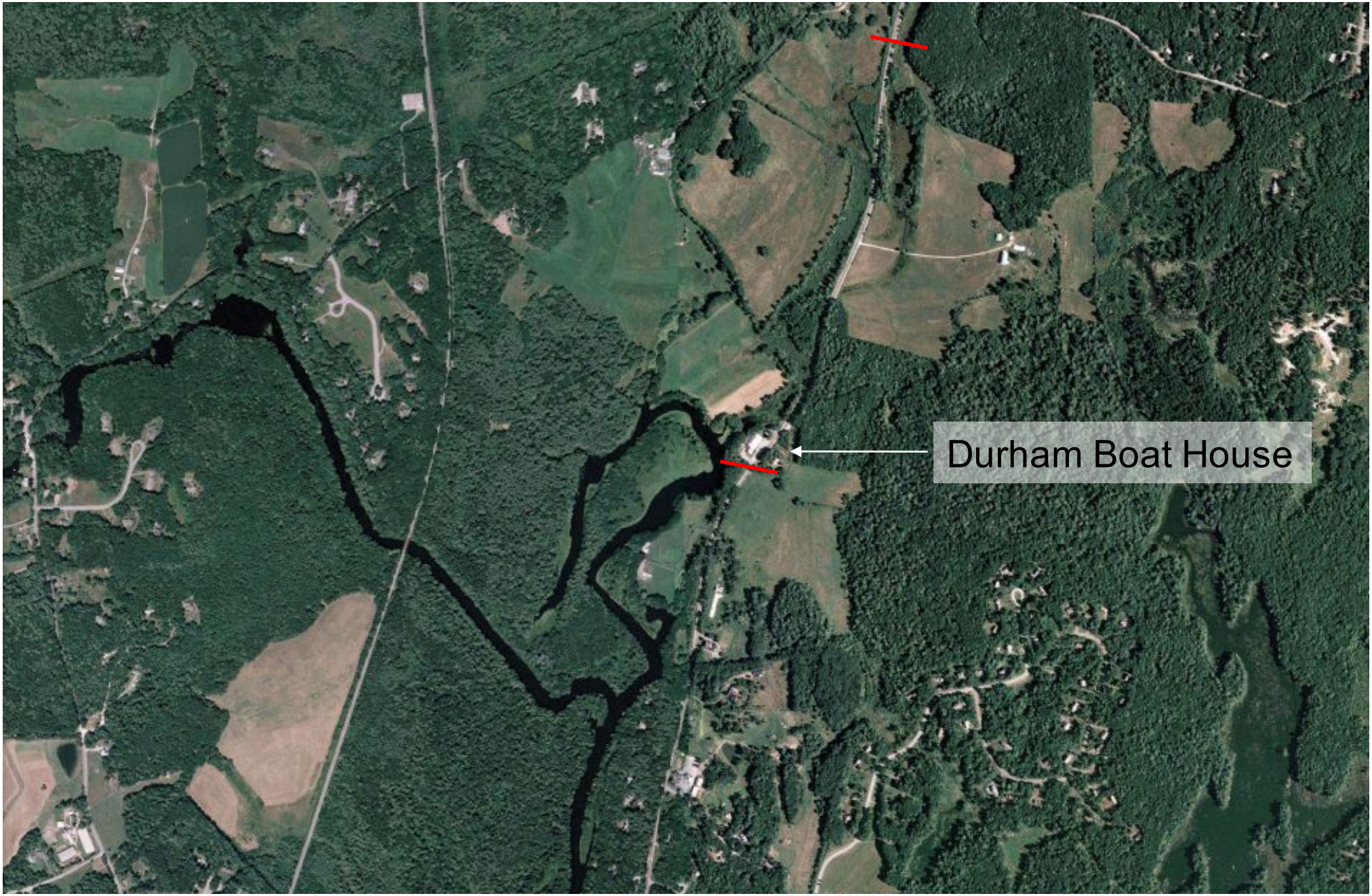
Hydraulic Modeling: HEC-RAS

Curve Number based on 2005 Land Use and Soil Type

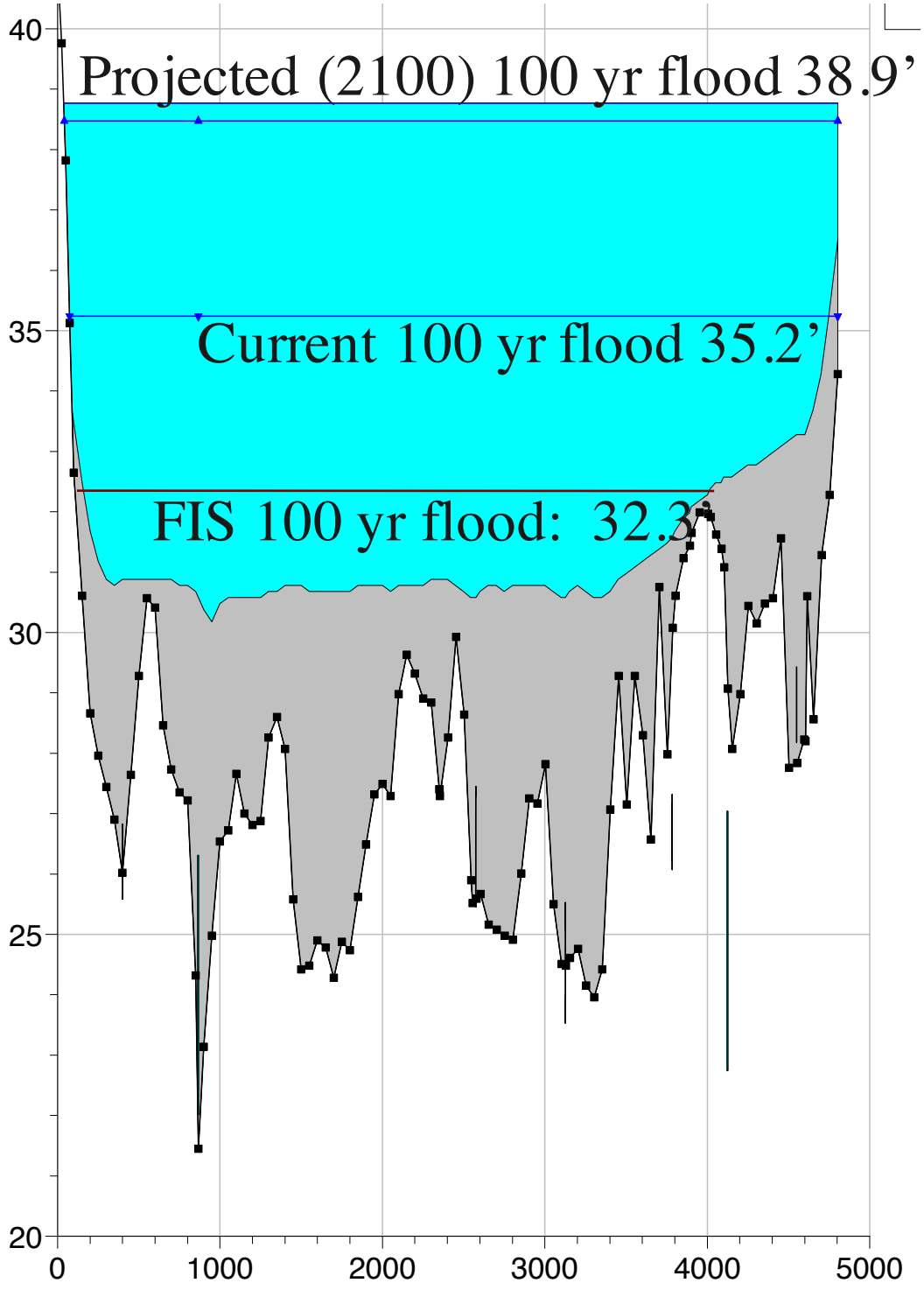
Subbasin	CN
W6510	62.5
W8600	63.0
W11900	64.2
W10910	61.2
W8380	63.5
W11020	62.5
W6730	65.4
W7060	63.9
W7920	67.7
W10250	66.0
W8590	71.0



Hydraulic Calibration – Results for RT108



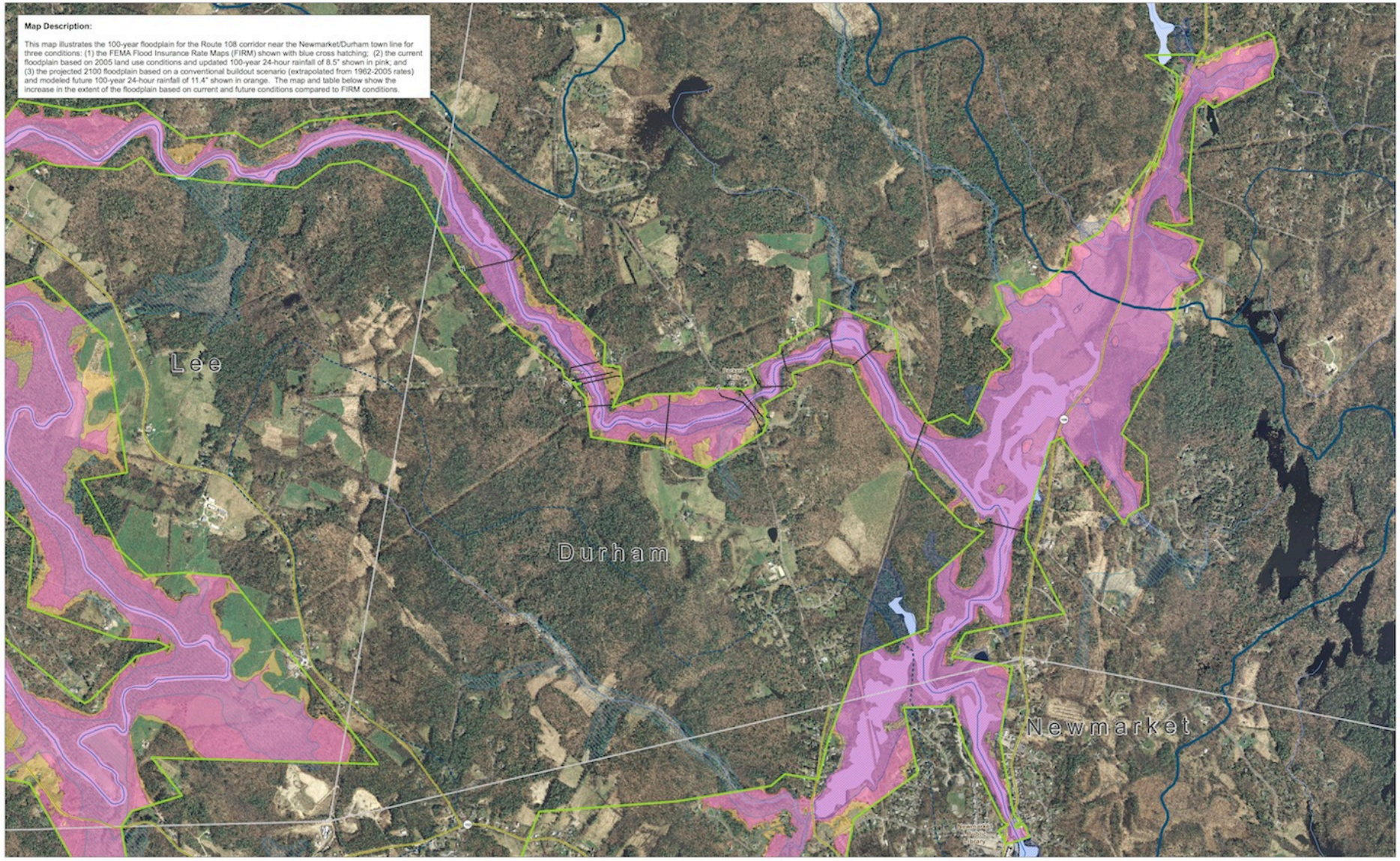
Rte 108
100 yr Flood
Elevation



100-Year Floodplains in the Lamprey River Watershed: Flood Insurance Rate Maps (FIRMs), Updated (2005) Conditions, and 2100 Conventional Buildout

Durham/Route 108 Corridor Panel

University of New Hampshire



Map Key:

- Updated (2005) 100-Year Floodplains
- 2100 100-Year Floodplains: Conventional Buildout
- Effective Zone AE 100-Year Floodplains: Special Flood Hazard Areas with Base Flood Elevations (BFEs) determined
- Effective Zone A 100-Year Floodplains: Special Flood Hazard Areas with no Base Flood Elevations (BFEs) determined
- A — Effective Cross Sections
- Limits of Inundation Mapping
- Lamprey River Watershed Boundary
- Subwatershed Boundaries
- Lamprey River
- River and Stream Networks
- Town/County Bounds
- State roads
- Local roads

Figures showing the surface water elevations and water discharge at each cross section for each scenario can be viewed in a separate document available on the project web site: http://100yearfloods.org

Acreage Summary:

Town	Total Acreage in Watershed	Acreage within Area Mapped	100-Year Floodplains: Inundation Acreage within Area Mapped				Residential/Commercial/Industrial Land Use: Total Acreage in Watershed	
			FIRM 2005	Updated (2005) Conditions (based on 8.5" rainfall)	2100 Buildout (based on 11.4" rainfall)		Updated (2005) Conditions	2100 Buildout Conditions
					Conventional	LID		
Barrington	4,344	0	—	—	—	—	332	1,877
Brentwood	810	0	—	—	—	—	166	304
Candia	11,917	16	6	8	11	8	1,237	7,845
Deerfield	28,733	0	0	0	0	0	1,657	13,287
Durham*	4,994	802	499	567	625	567	667	2,182
Epping	16,752	2,495	899	923	1,026	923	2,062	10,523
Exeter	1,549	0	—	—	—	—	120	529
Fremont	2,999	0	—	—	—	—	333	1,961
Lee	7,927	1,217	551	756	916	756	1,311	4,439
Newfields	2,612	52	24	24	26	24	328	1,204
Newmarket	8,559	1,804	430	641	741	641	1,701	4,203
Northwood	7,549	0	—	—	—	—	621	4,998
Nottingham	30,681	0	—	—	—	—	2,108	12,691
Raymond	12,273	2,324	874	993	1,113	993	2,184	7,180
Strafford	256	0	—	—	—	—	5	10
Total Watershed*	**137,745**	**8,912**	**3,309**	**3,907**	**4,461**	**3,907**	**14,850**	**72,838**

* Table includes acreage of flooding in bypass over the Oyster River in Durham.

Technical Notes:

The updated and projected floodplains were modeled using FEMA approved methodologies (watershed hydrology using the US Army Corps of Engineers [USACE] Hydrologic Engineering Center Hydrologic Modeling System [HEC-HMS]; hydraulic analysis using the USACE Hydrologic Engineering Center River Analysis System [HEC-RAS]). The hydraulic model included 262 river cross sections: 115 sections from the original FIS dataset, 46 sections from recent field survey and other analyses, 101 additional sections and extended embankment elevations generated from 2011 LiDAR imagery (2-meter digital elevation model, 15-cm vertical root mean square error). Reaches without surveyed cross-sections (Pecassic River and Moonlight Brook) used topography generated by LiDAR, and assumed channel geometry.

The 100-year 24-hour rainfall depth for the period: (1) from 1938-2010 (8.5") derived from the Northeast Regional Climate Center (http://www.precip.net); (2) up to 2100 (11.4") derived from the largest 24-hour rainfall event from downscaled model output from four global climate models.

Future land use extrapolated from 1962-2005 historical buildout rates, current zoning, and Conventional or Low Impact Development.

The effective FIRM base flood elevations based on NAVD29 datum; the 2005, 2050, and 2100 base flood elevations based on the NAVD88 datum.

While this map is not a legally binding document, federal and state guidance encourages the use of the most current information available to support community-based planning and zoning. A detailed analysis of legal issues associated with using this map (or others in this series), written by the Vermont Law School, is available at the project web sites listed below. Legal FEMA effective Flood Insurance Rate Maps (FIRMs) maps are available online at: http://www.grant.unh.edu/firms

More project information and maps are available at: http://www.grant.unh.edu/Map/Library?ProjectMaps or http://100yearfloods.org. Detailed methodology is also described in: Schilz, A. 2011. Consequences of Changing Climate and Land Use to 100-Year Flooding in the Lamprey River Watershed of New Hampshire. MS Civil Engineering, University of New Hampshire, Durham, NH.

Map Data Sources:

Updated 100-year floodplains: Data from NOAA/CICEET funded proposal "Assessing the Risk of 100-year Freshwater Floods in the Lamprey River Watershed of New Hampshire Resulting from Changes in Climate and Land Use", C. Wake, Principal Investigator.

Effective Zones/Special Flood Hazard Areas: Effective DFIRM panels for Rockingham and Strafford Counties, May 17, 2005.

Surface Water: NH National Hydrography Dataset, April 2007.

Watersheds: NH Department of Environmental Services, September 2002.

Topography: National Elevation Dataset, 10-meter resolution Digital Elevation Model.

Transportation: NH Department of Transportation, April, 2010.

Photography: 1-foot resolution aerial photography, Spring, 2010.

Miles
0 0.05 0.1 0.2 0.3
Scale: 1:7,200
(1 inch to 600 ft.)

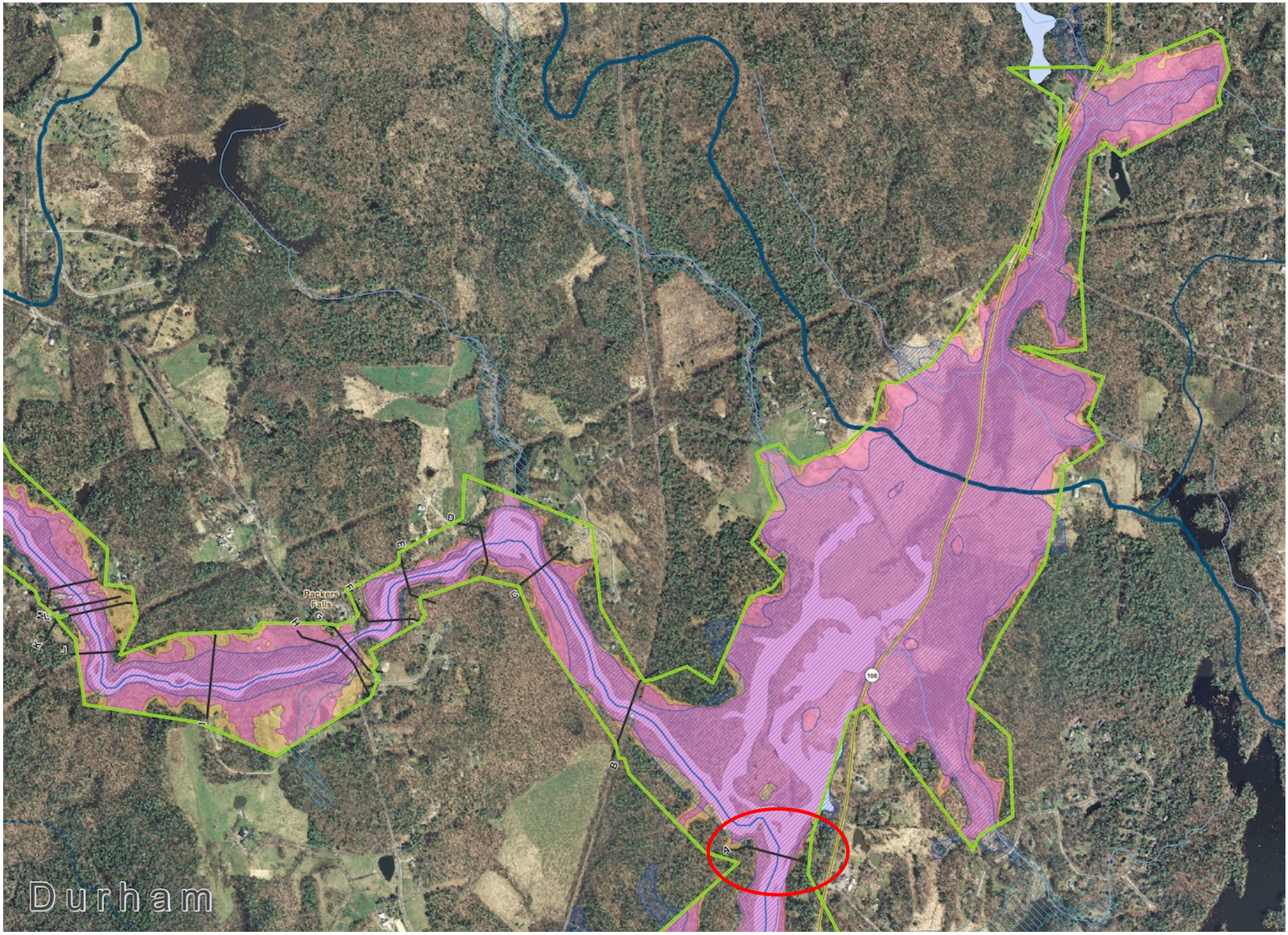
Watershed Location

Assessing Flood Risk in the Lamprey River Watershed

Support for this project was provided by the Cooperative Institute for Coastal and Estuarine Environmental Technologies (CICEET).

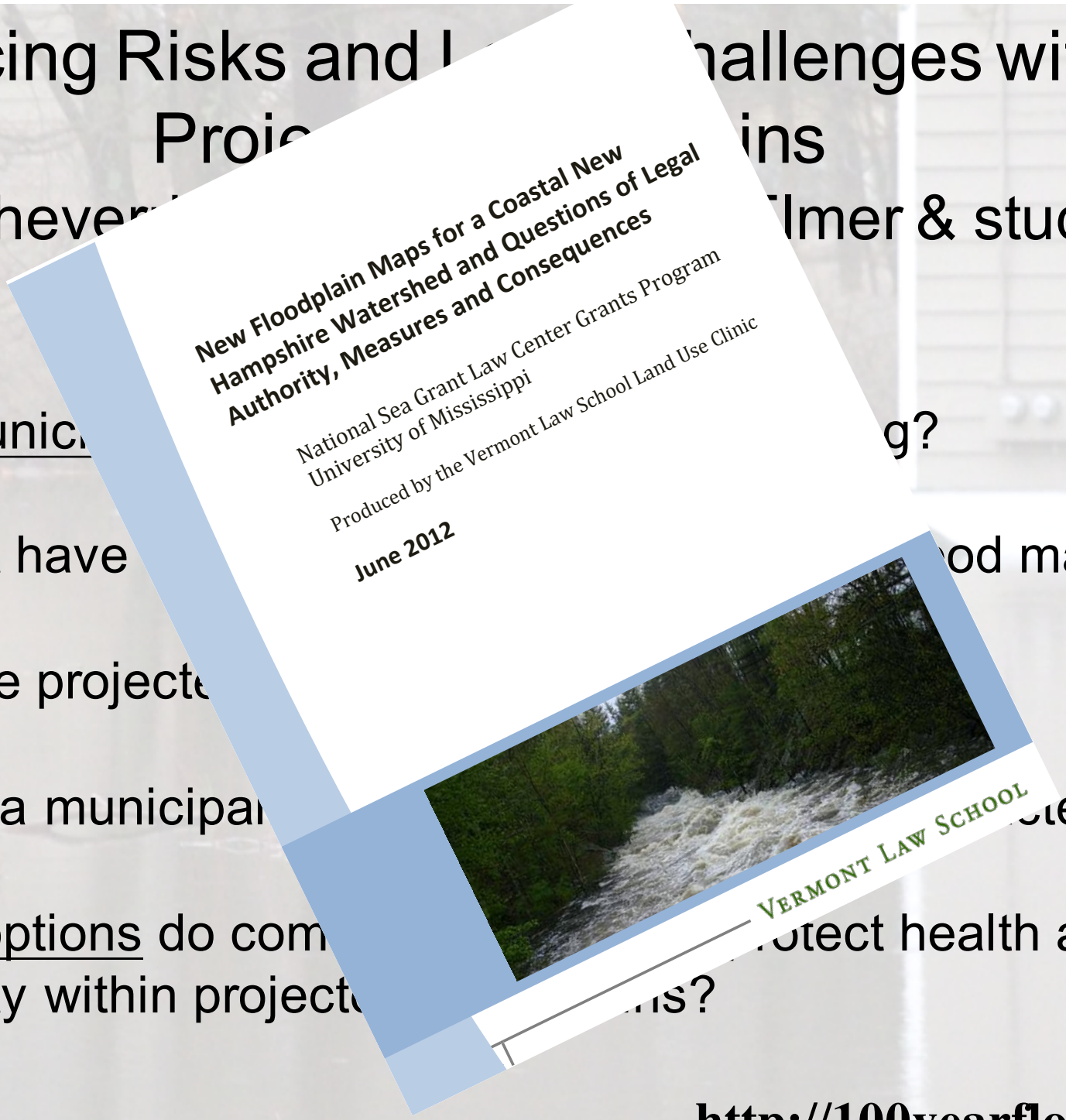
Map produced May, 2012

For further information about this project, please visit http://100yearfloods.org


Packers Falls
Durham
108

Reducing Risks and L hallenges within Proje ins

John Echever lmer & students



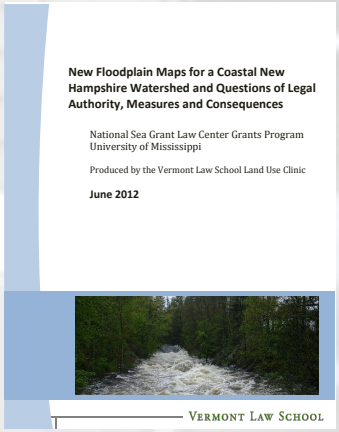
1. Is a munici g?
2. Does it have od maps?
3. Can the projecte
4. Would a municipa ted?
5. What options do com otect health and property within projecte ns?

http://100yearfloods.org

The Bottom Line

If a municipality seeks to influence development or redevelopment within the newly mapped floodplain:

- Use sound planning principles and practices
  - state desired conditions in appropriate plans
- Identify authorizing statutes
  - those related to land use and governance
- Be clear about the purpose of development restrictions
  - protect health and safety
- Preserve some economic viability of affected land
- Use your municipal tools – planning, non-regulatory and regulatory



http://100yearfloods.org

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
LAND RESOURCES MANAGEMENT
ALTERATION of TERRAIN BUREAU
29 Hazen Drive, PO Box 95, Concord, NH 03302-0095
Phone: (603) 271-2147 Fax: (603) 271-6588
Website: http://des.nh.gov/organization/divisions/water/aot/index.htm
For Permit Status: http://www2.des.state.nh.us/OneStop/Wastewater_Engineering_Site_Specific_Query.aspx

ALTERATION OF TERRAIN PERMIT APPLICATION

NOTE: CHANGE IN STANDARD OF PRACTICE

DRAINAGE ANALYSES

Please double-side 8 ½" x 11" sheets where possible but, **do not** reduce the text such that more than one page fits on one side.

☐ PE stamp

☐ Rainfall amount obtained from the Northeast Regional Climate Center- http://precip.eas.cornell.edu/. Include extreme precipitation table as obtained from the above referenced website.

☐ Drainage analyses, in the following order:

- Pre-development analysis: Drainage diagram
- Pre-development analysis: Area Listing and Soil Listing
- Pre-development analysis: Node listing 1-year (if applicable), 2-year, 10-year and 50-year
- Pre-development analysis: Full summary of the 10-year storm
- Post-development analysis: Drainage diagram
- Post-development analysis: Area Listing and Soil Listing
- Post-development analysis: Node listing for the 2-year, 10-year and 50-year
- Post-development analysis: Full summary of the 10-year storm

A. Three sets of 100-Year Floodplain maps

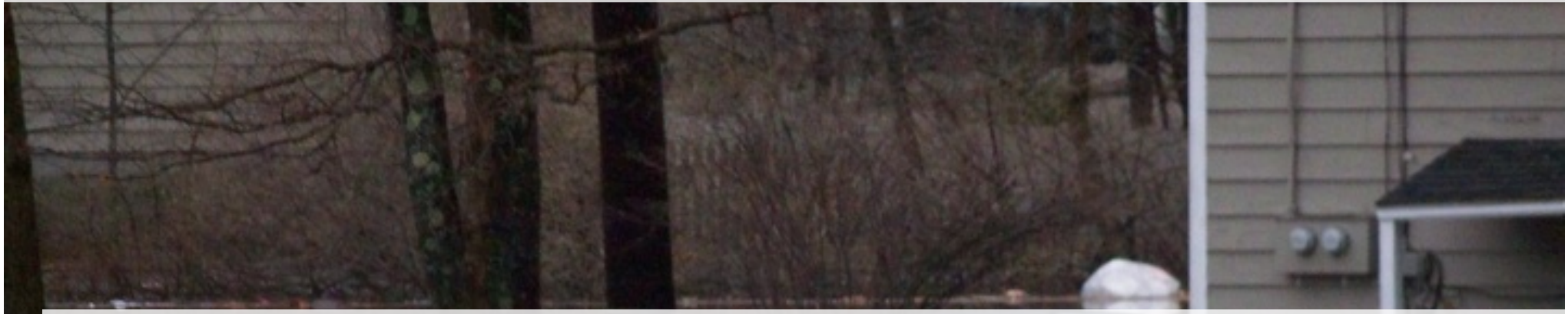
1. Lamprey River Watershed *(one map)*
2. Three floodplains on each map
   - FIRM (blue cross hatching)
   - Updated (2005) conditions (pink)
   - 2100 Conventional Buildout (orange)

   Three maps: Durham, Newmarket, Raymond
3. Three floodplains on each map
   - FIRM (blue cross hatching)
   - 2100 Conventional Buildout (orange)
   - 2100 LID Buildout (green)

   Three maps: Durham, Newmarket, Raymond

B. WSE & Discharge at all FIS Cross Sections

Past, Present, and Potential Future 100-year floods in the Lamprey River Watershed



http://100yearfloods.org

http://www.granit.unh.edu/

University of New Hampshire

Carbon Solutions New England™ CarbonSolutionsNE.org

SC

Antioch University New England

Great Bay National Estuarine Research Reserve

Fish & Game

NOAA