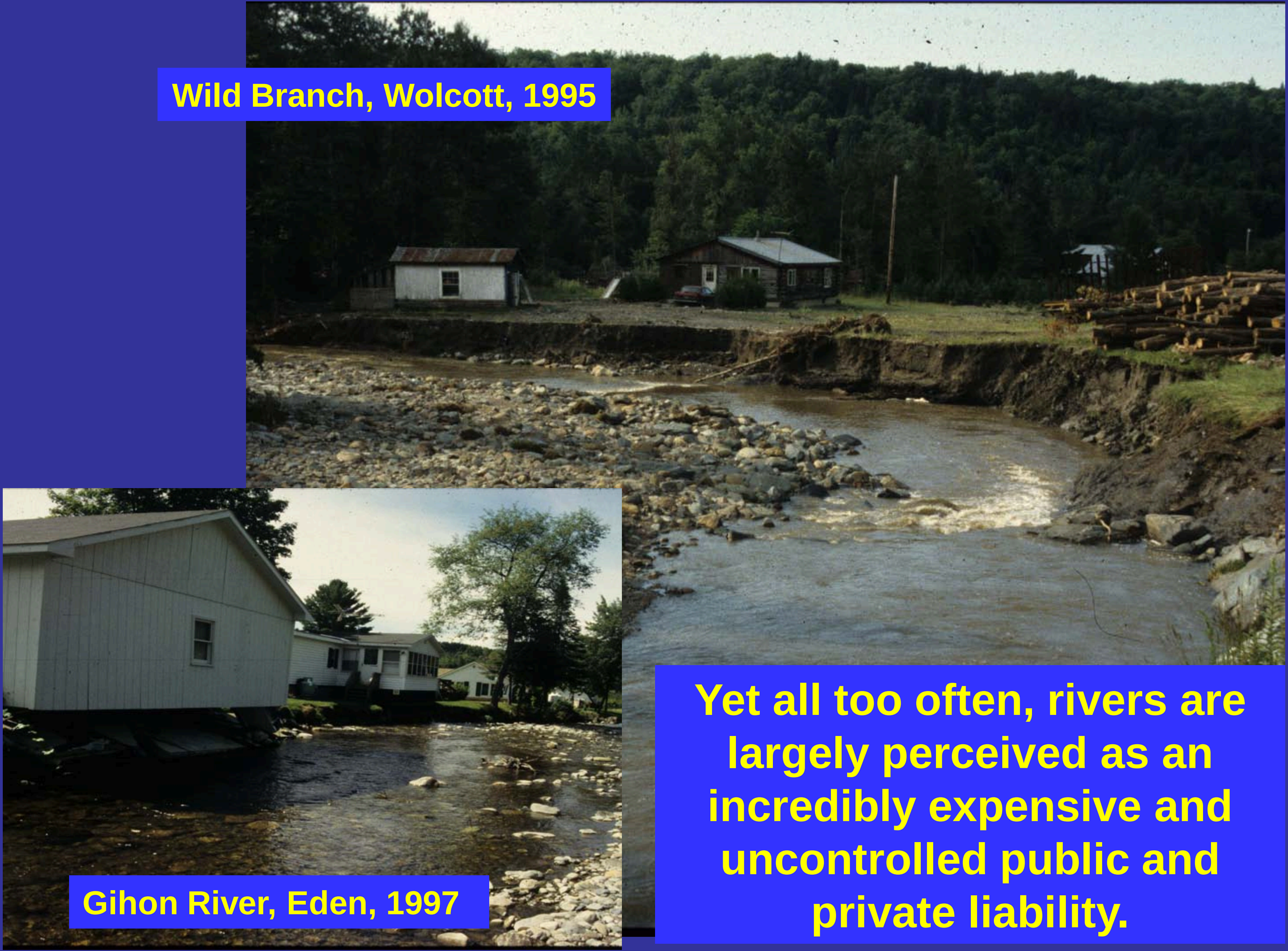
Flood Hazards and the Clean Water Act

VT Dept. of Environmental Conservation
River Management Program

Rivers Are of Inestimable Value to Everyone

Tyler Branch, West Enosburg, 2006

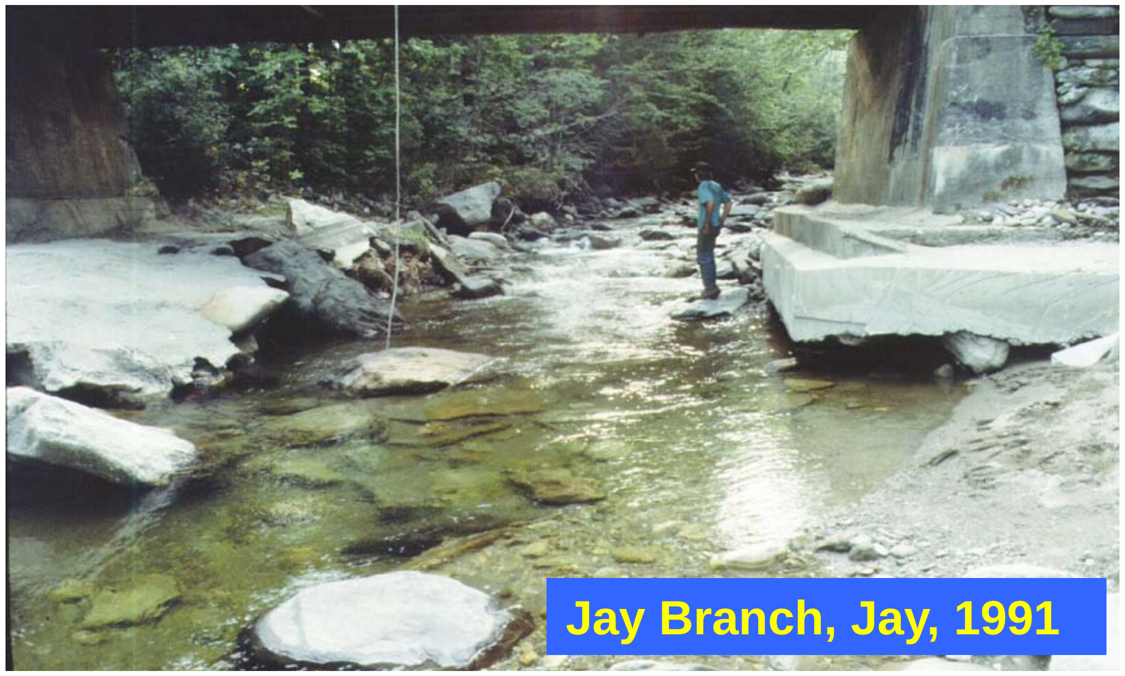


Wild Branch, Wolcott, 1995

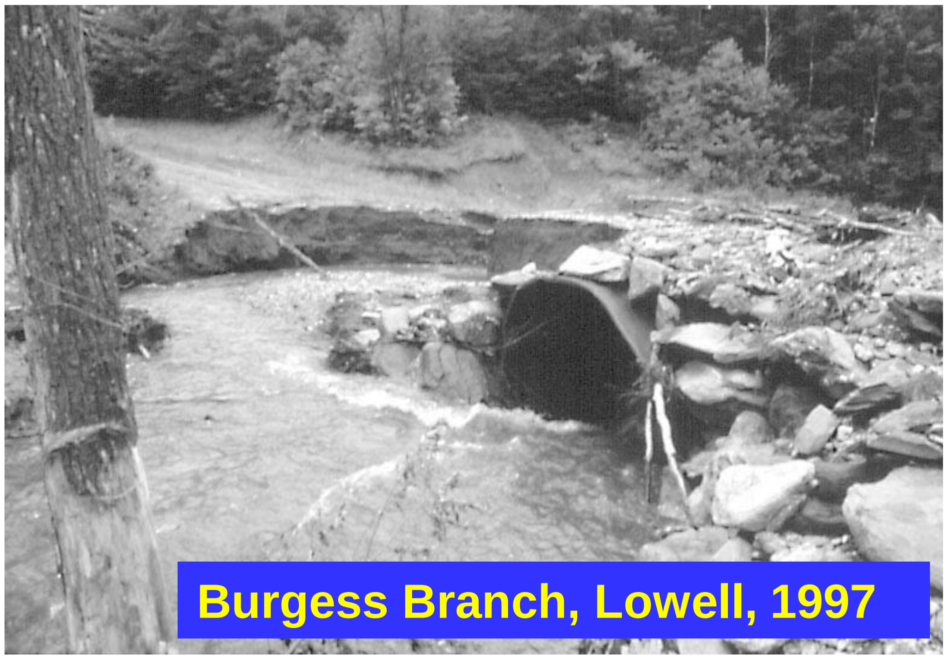
Gihon River, Eden, 1997

Yet all too often, rivers are largely perceived as an incredibly expensive and uncontrolled public and private liability.

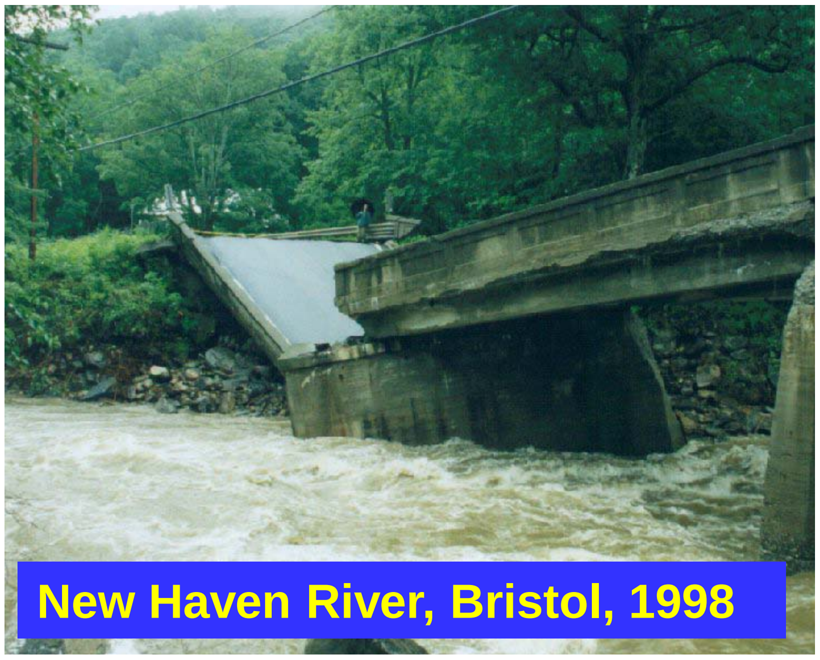
Public transportation infrastructure interfaces dramatically with fluvial systems costing nearly $60 million in VT in the 1990’s alone.



Jay Branch, Jay, 1991



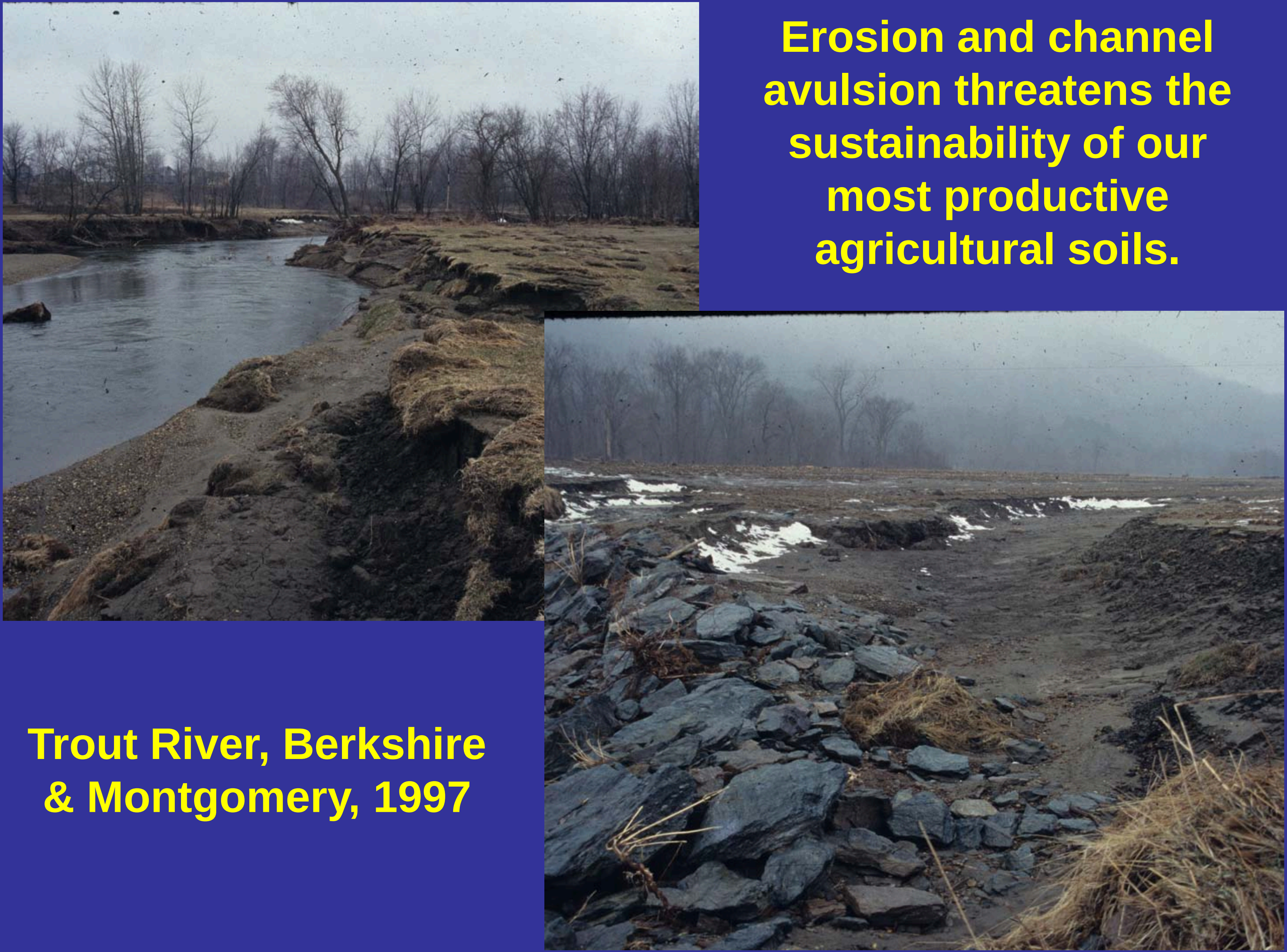
Burgess Branch, Lowell, 1997



New Haven River, Bristol, 1998

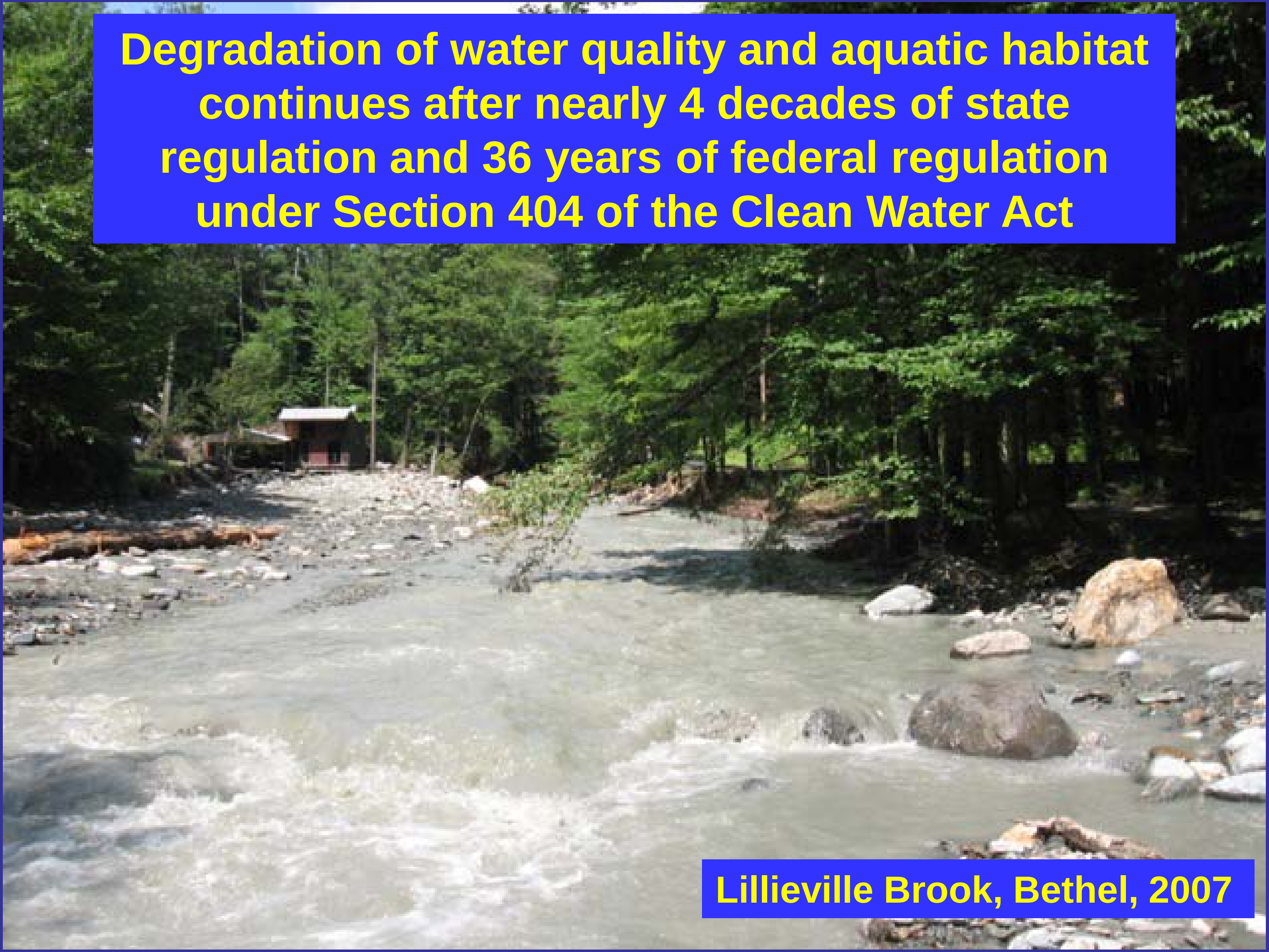
Irreconcilable conflicts between unwise land use investments and the dynamic nature of fluvial systems are becoming more frequent and widespread.

Erosion and channel avulsion threatens the sustainability of our most productive agricultural soils.



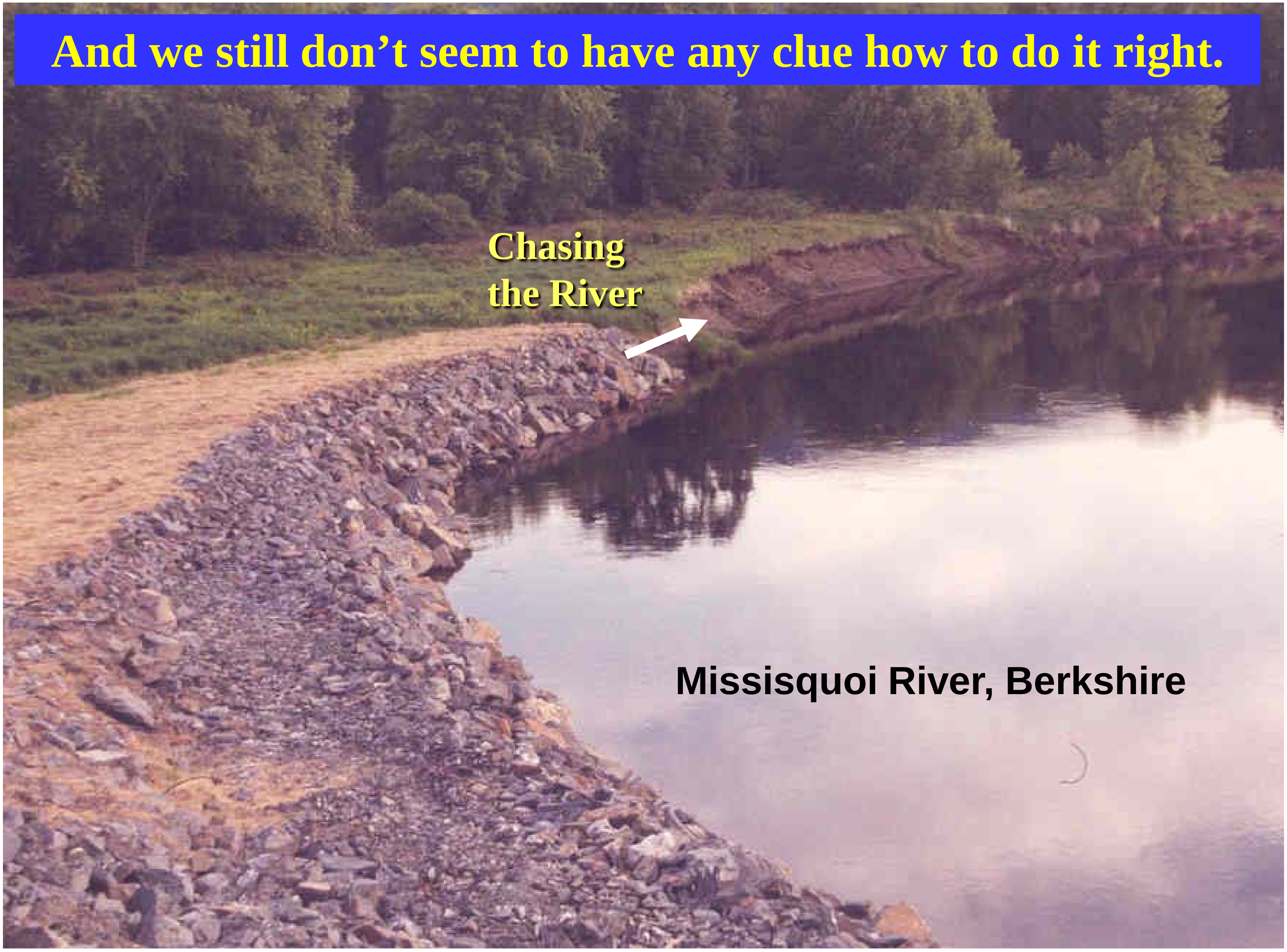
Trout River, Berkshire & Montgomery, 1997

Degradation of water quality and aquatic habitat continues after nearly 4 decades of state regulation and 36 years of federal regulation under Section 404 of the Clean Water Act



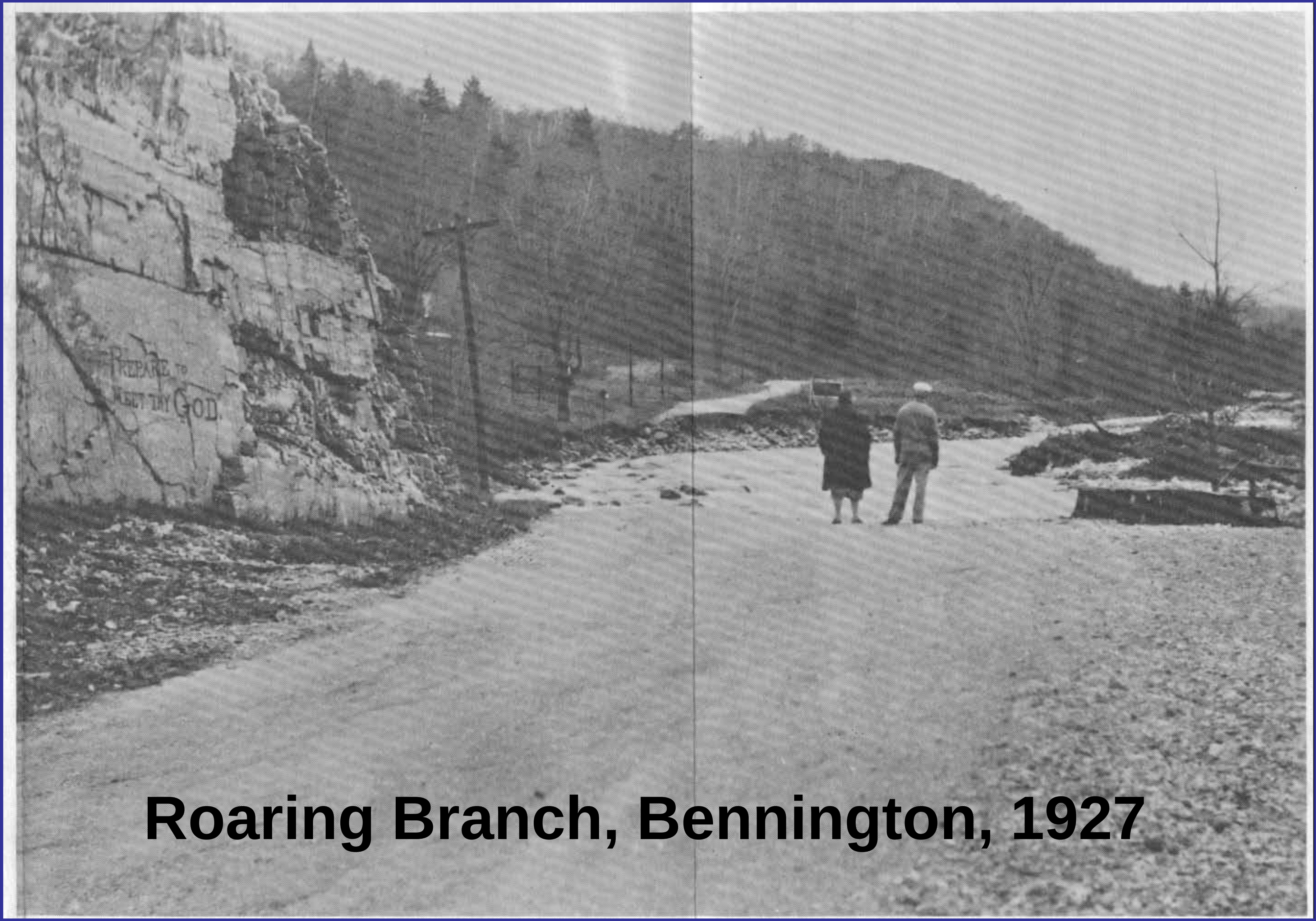
Lillieville Brook, Bethel, 2007

And we still don't seem to have any clue how to do it right.



Chasing the River

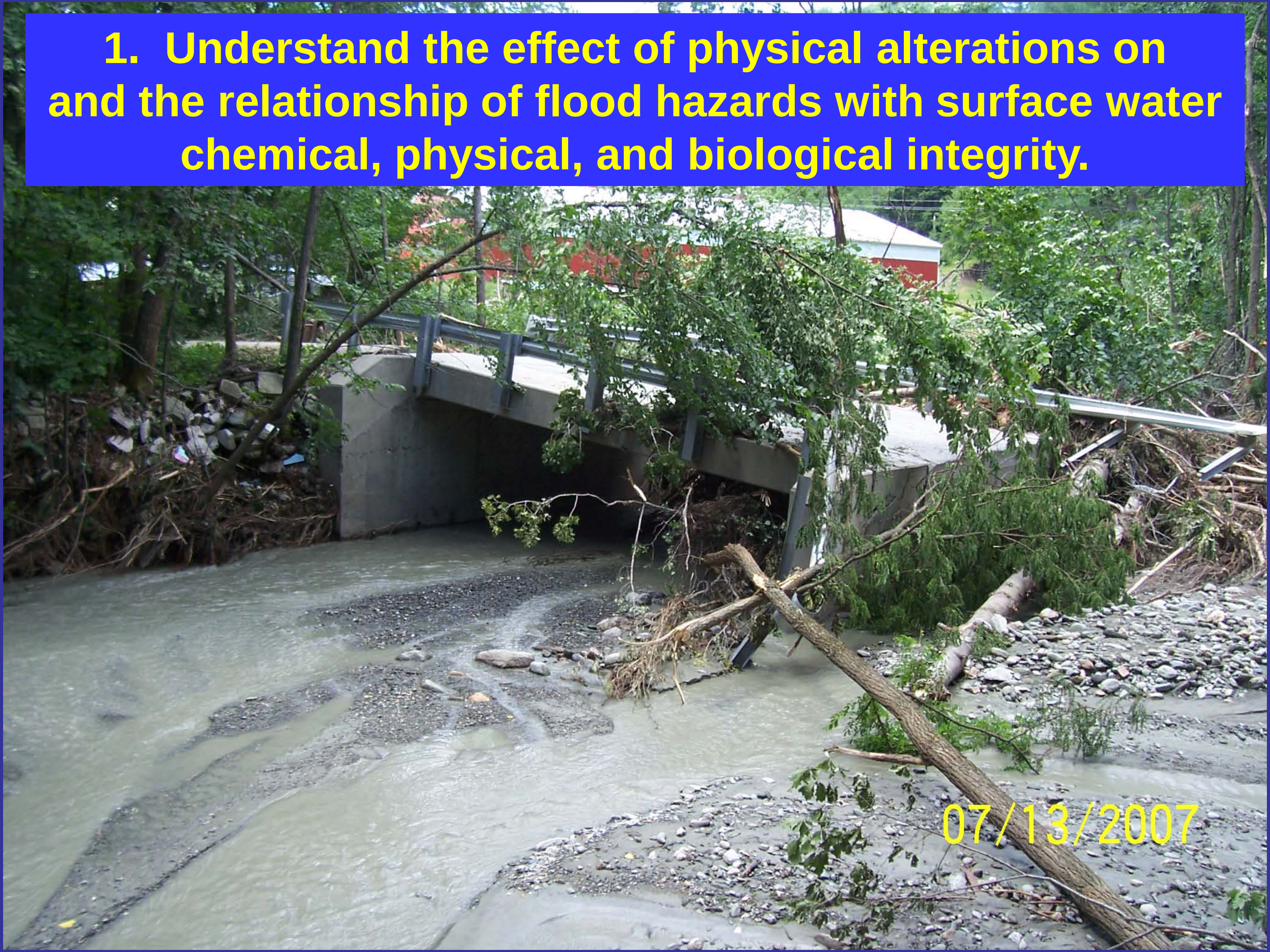
Missisquoi River, Berkshire



Roaring Branch, Bennington, 1927

PRESENTATION OBJECTIVES

1. Understand the effect of physical alterations on and the relationship of flood hazards with surface water chemical, physical, and biological integrity.



07/13/2007

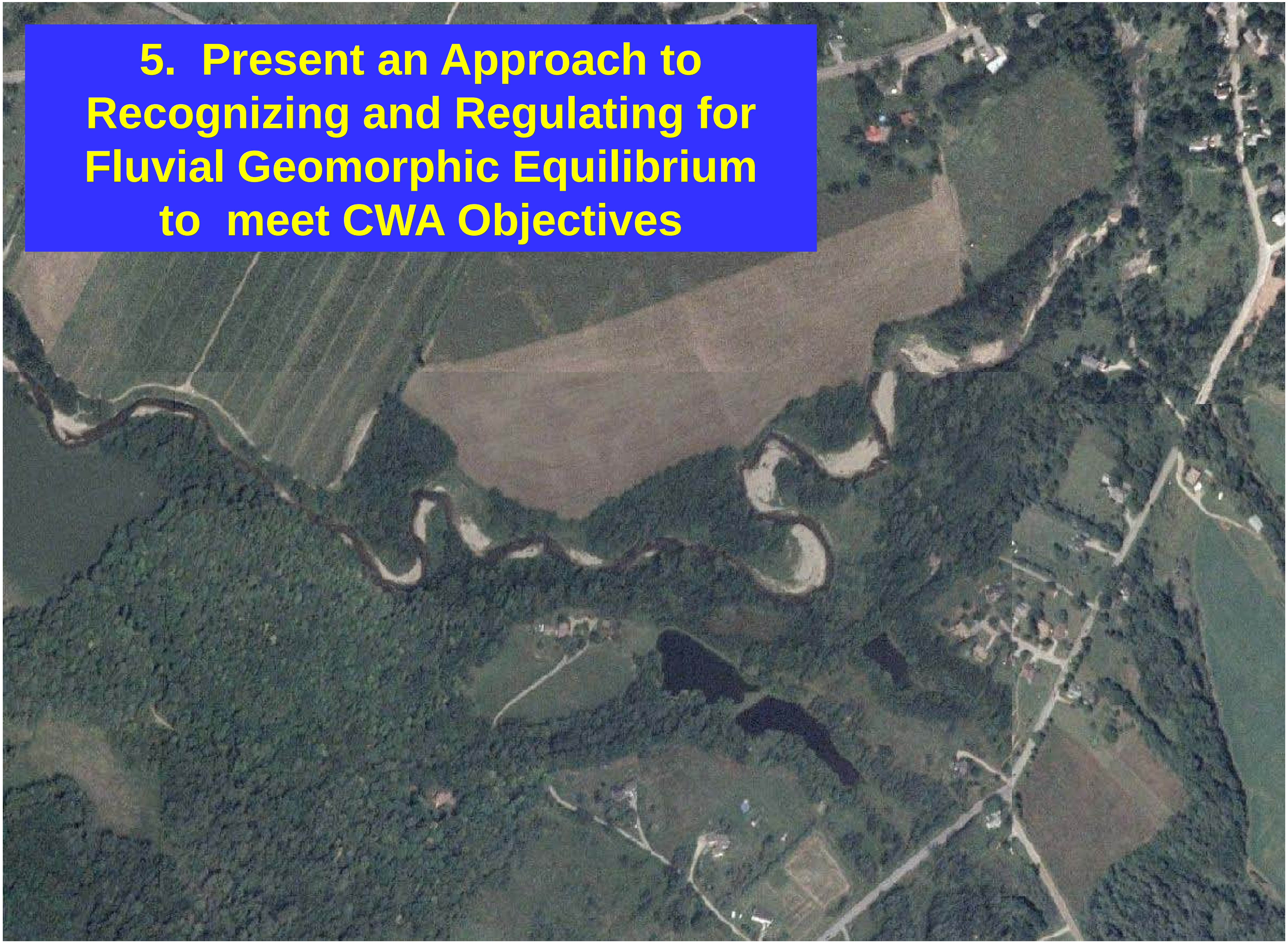
2. Recognize the Extent to Which Rivers Have Been Altered

Change in physical regimes and habitat loss are rooted in our history.

3. Build a spatial and temporal understanding of rivers and streams as dynamic fluvial systems, and why this recognition is critical for federal & state regulatory programs.

4. Consider that the ecological impact of discharged or retained fill as a pollutant may often be far exceeded by its impact as a physical encroachment.

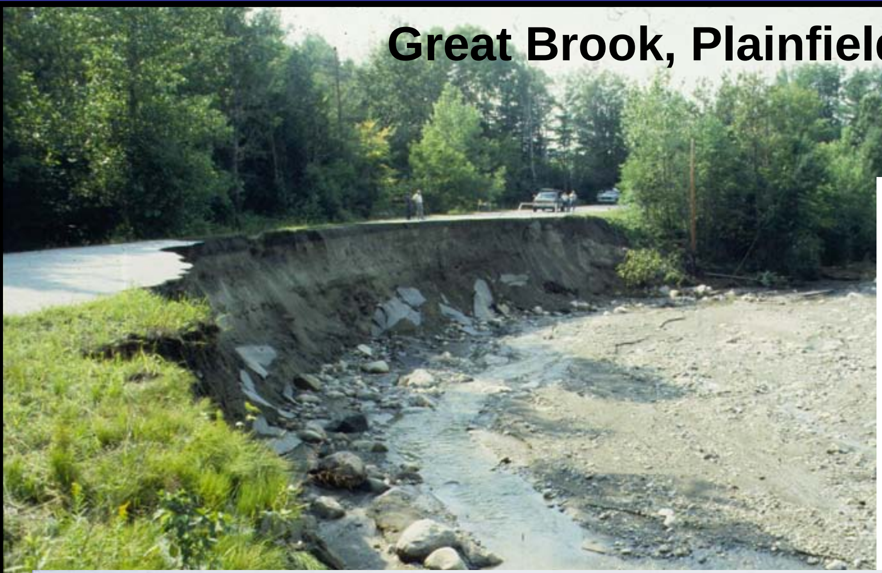
07/16/2007



5. Present an Approach to Recognizing and Regulating for Fluvial Geomorphic Equilibrium to meet CWA Objectives

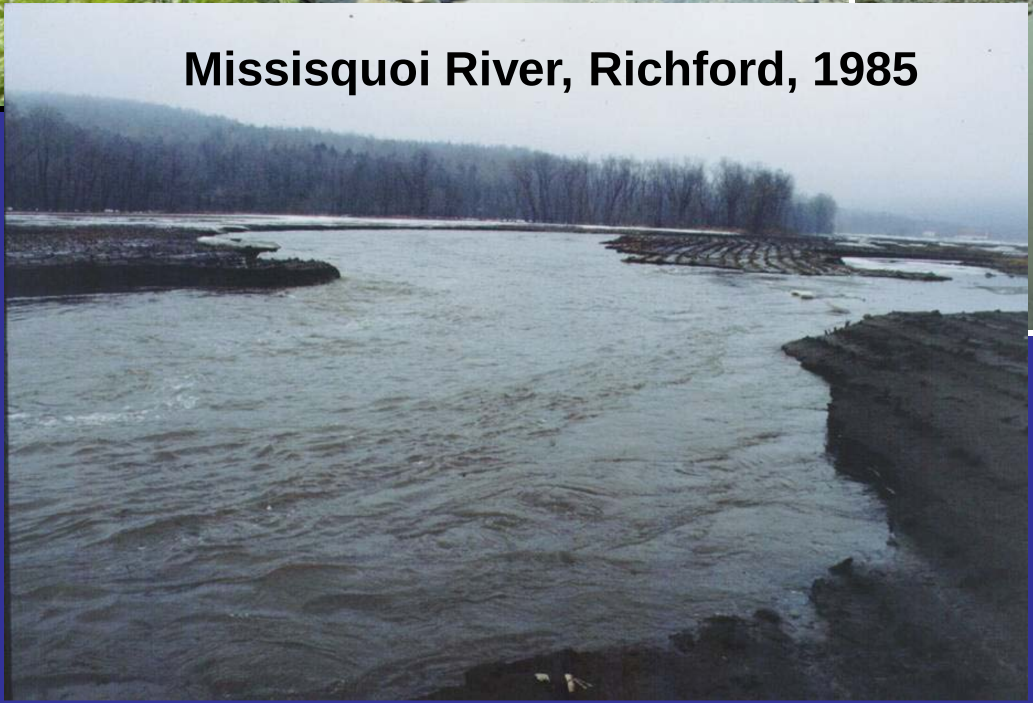
The Relationship of Flood Hazards and Ecological Integrity

Periodic Economic Loss and Social Disruption Result from Frequent Devastating Flood Events on Statewide, Regional and Sub-watershed Scales.



Great Brook, Plainfield, 1990

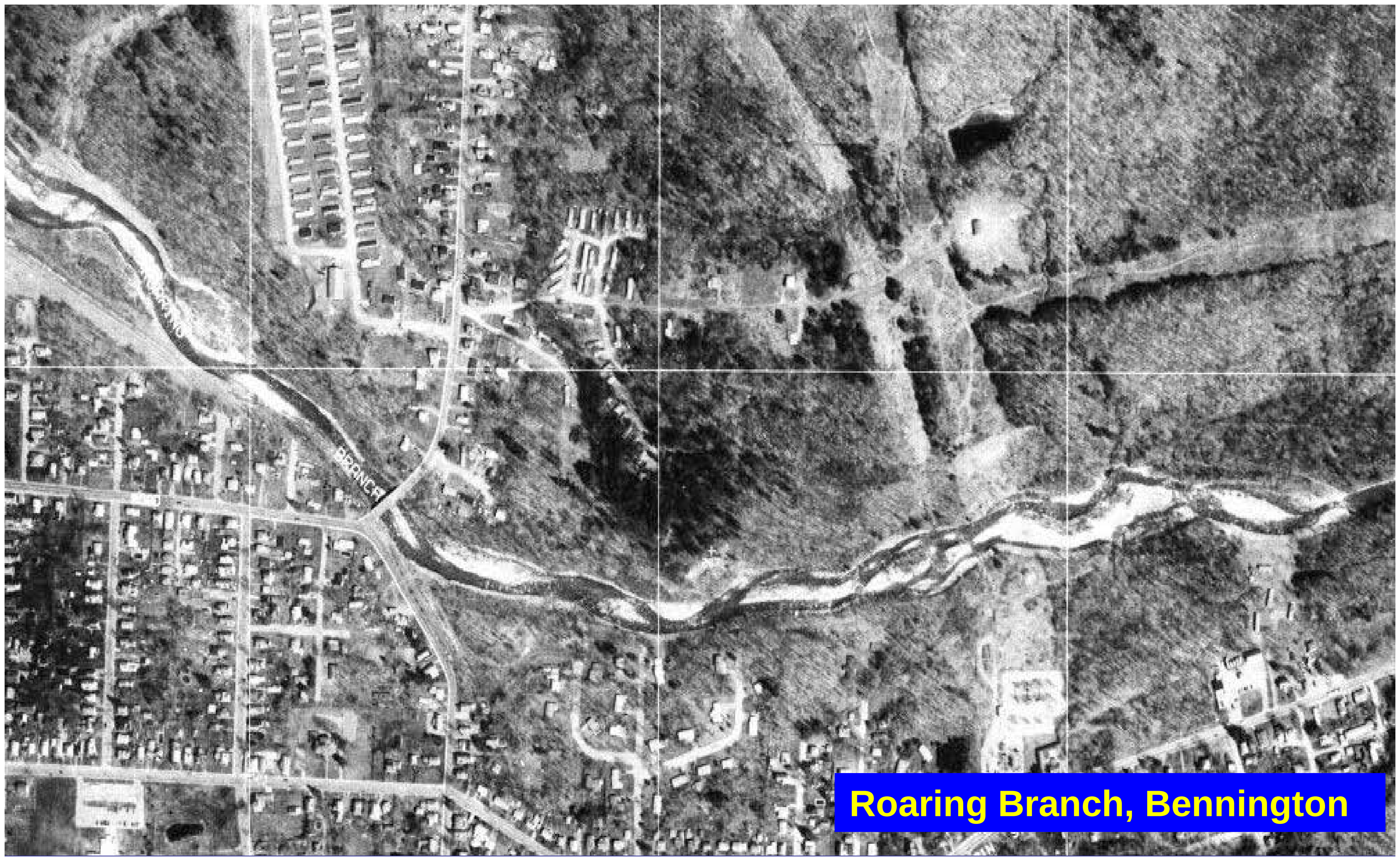
Mad River, Warren, 1998



Missisquoi River, Richford, 1985

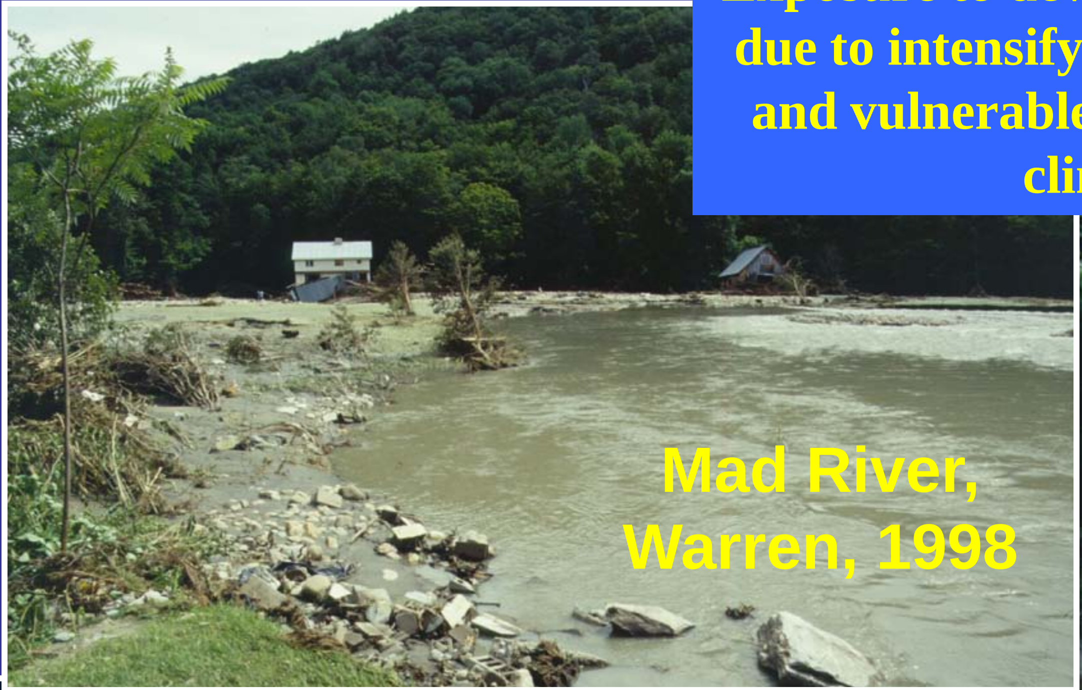
Pervasive stream channel instability and water quality degradation profoundly diminish the ecological and economic potential of riparian lands, river systems and receiving waters for Vermont’s communities.

Community relationships with fluvial systems are typically unsustainable, squander remaining flood attenuation assets, and degrade and devalue available ecosystem benefits.

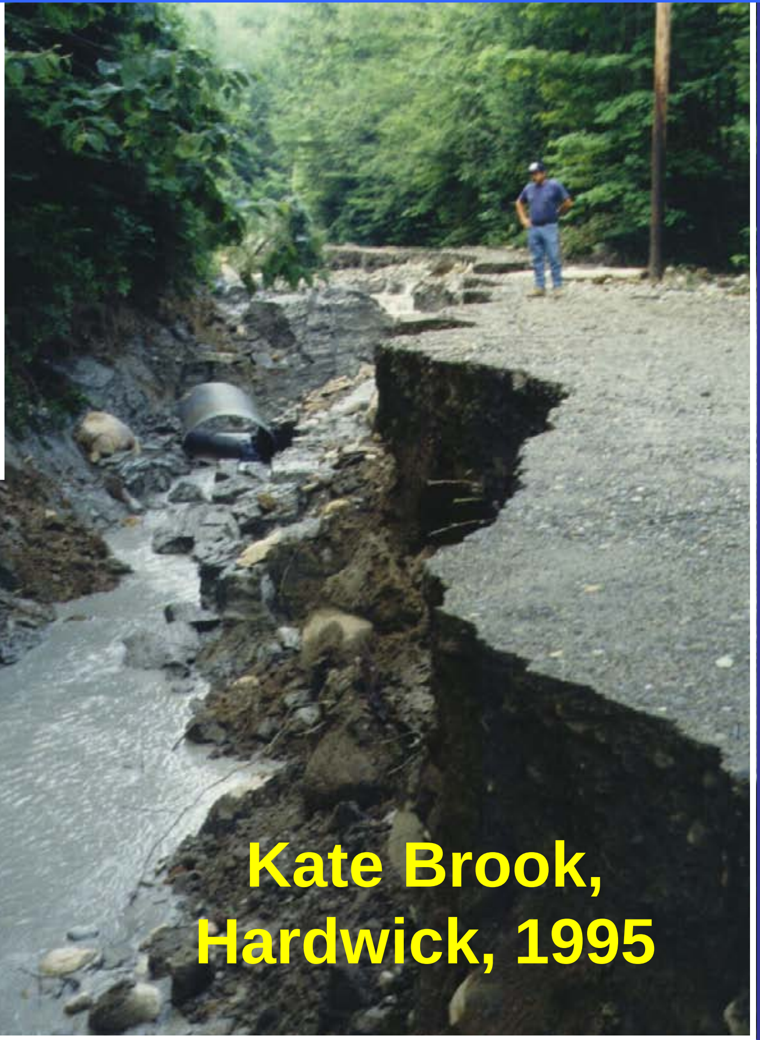


Roaring Branch, Bennington

Exposure to devastating flood events is increasing due to intensifying land development in sensitive and vulnerable areas, and potentially by global climate destabilization.



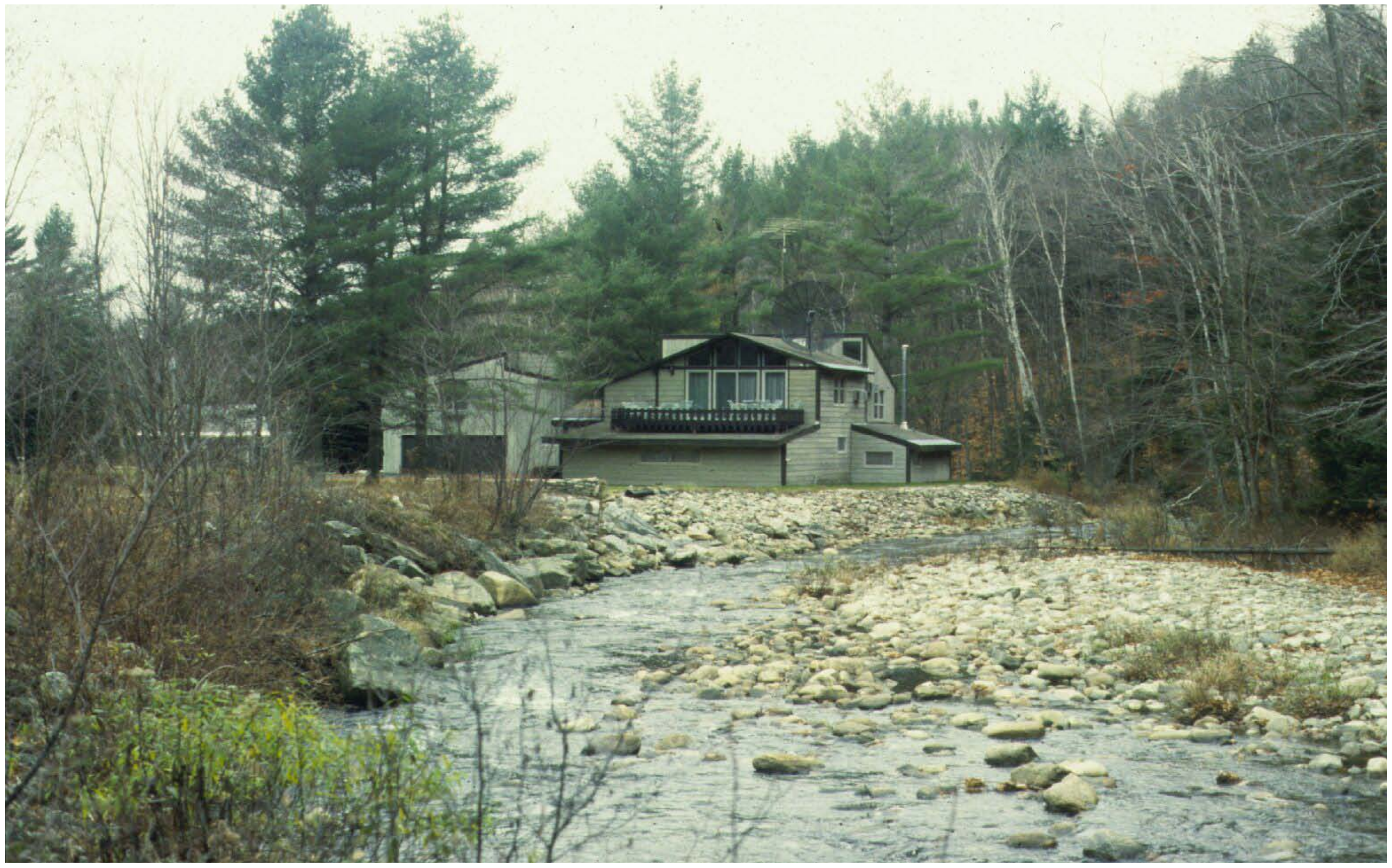
Mad River, Warren, 1998

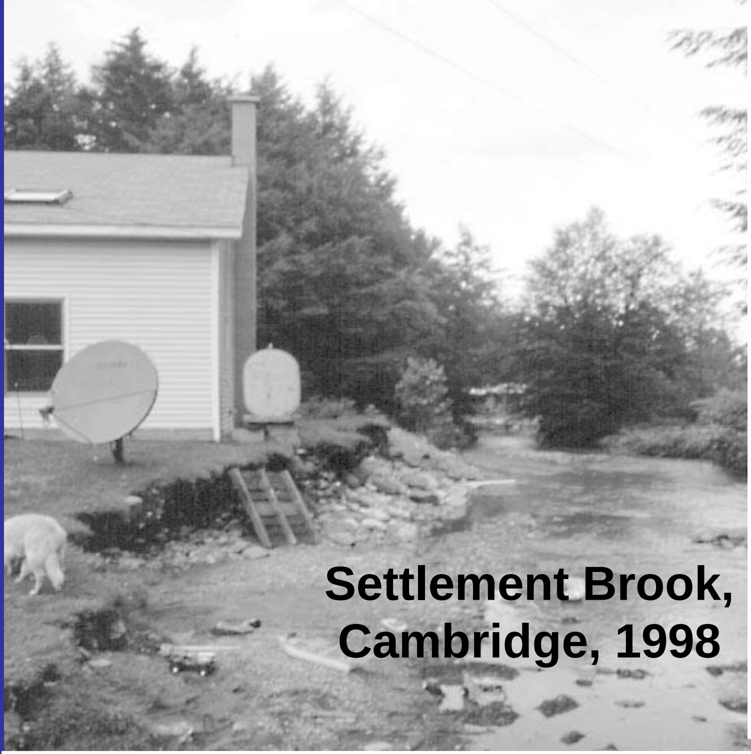


Kate Brook, Hardwick, 1995

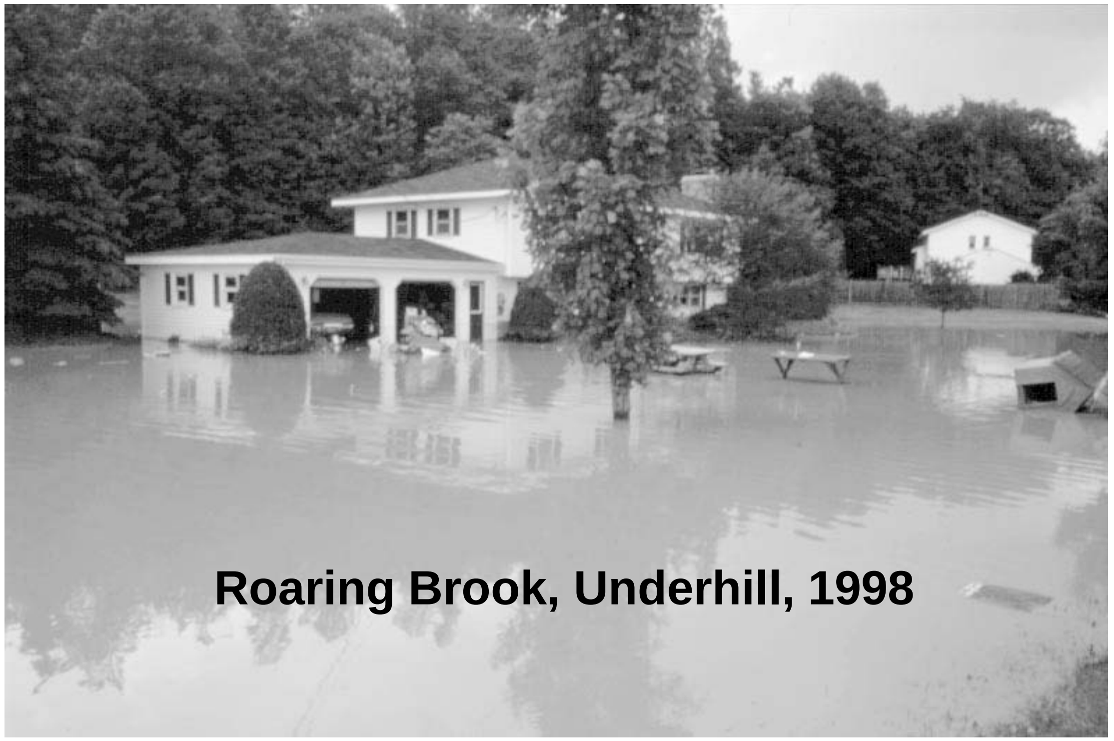
Great Brook, Plainfield, 1990

Current state and federal regulatory actions often complement a flawed disaster recovery safety net that rewards all eligible individuals and towns regardless of how recklessly public and private investment, development, and growth management decisions are made at the state or local level.



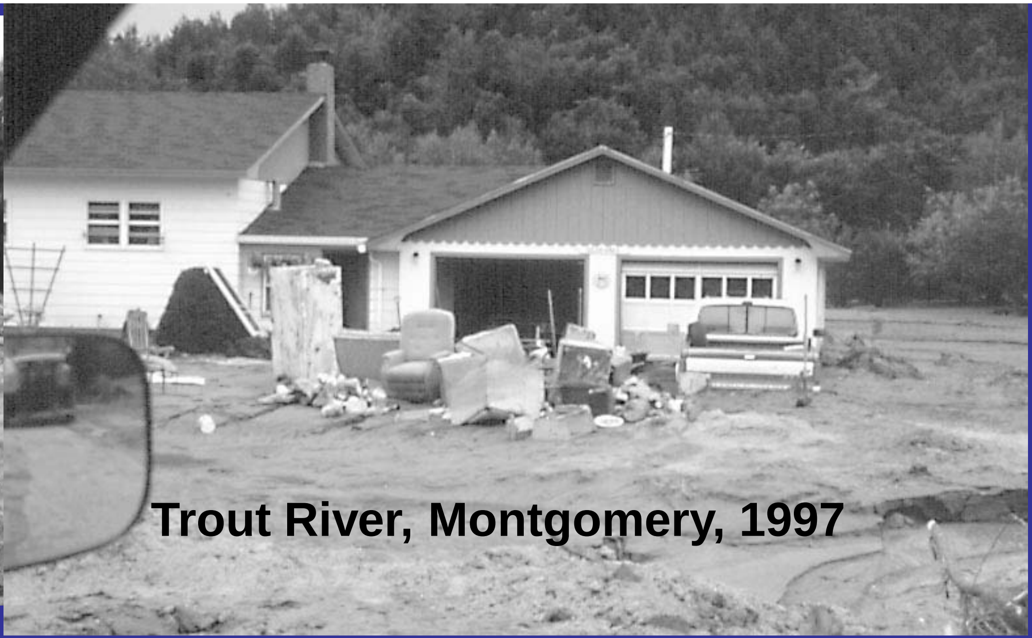


Settlement Brook, Cambridge, 1998



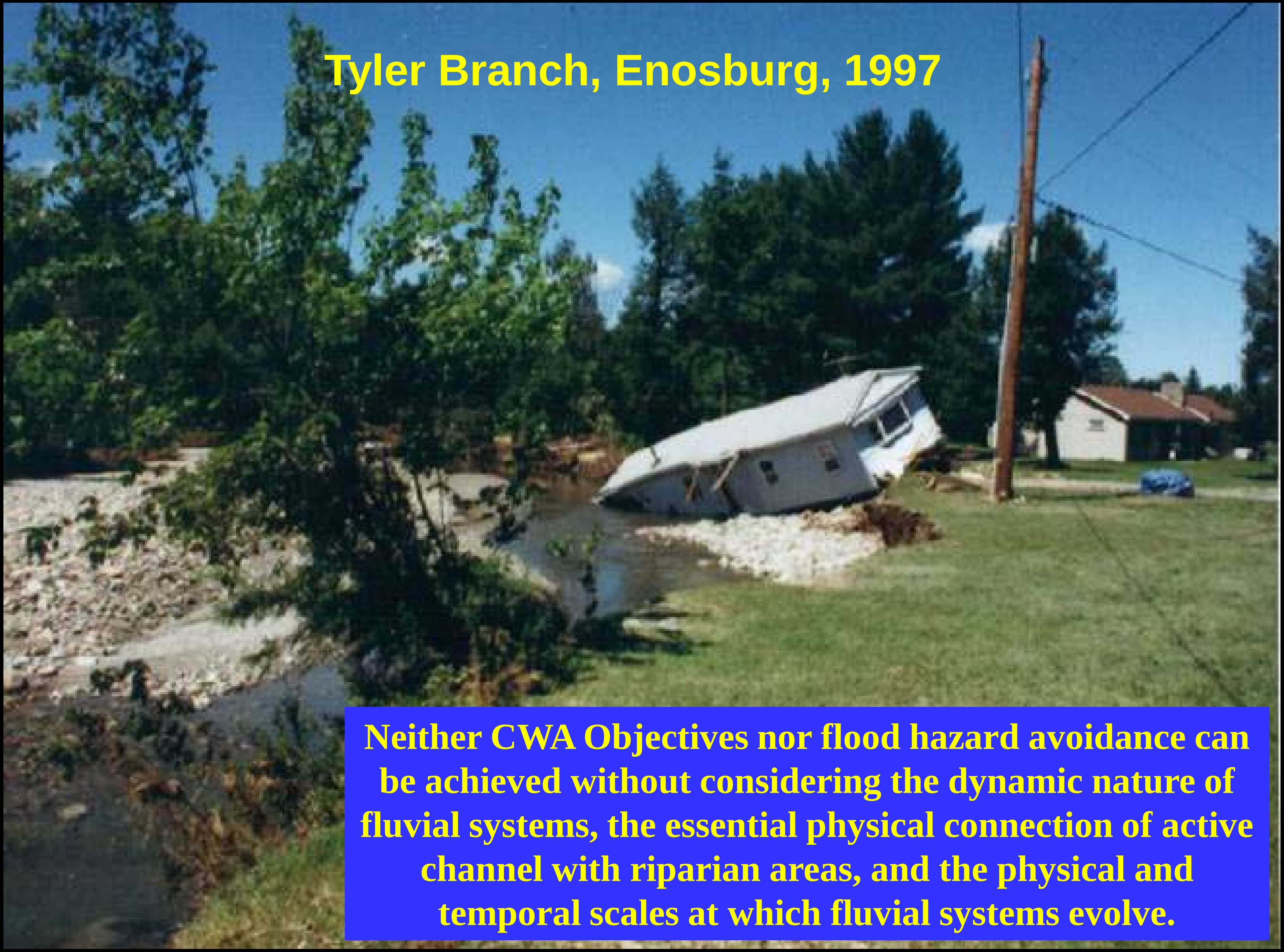
Roaring Brook, Underhill, 1998

West Hill Brook, Montgomery, 1997



Trout River, Montgomery, 1997

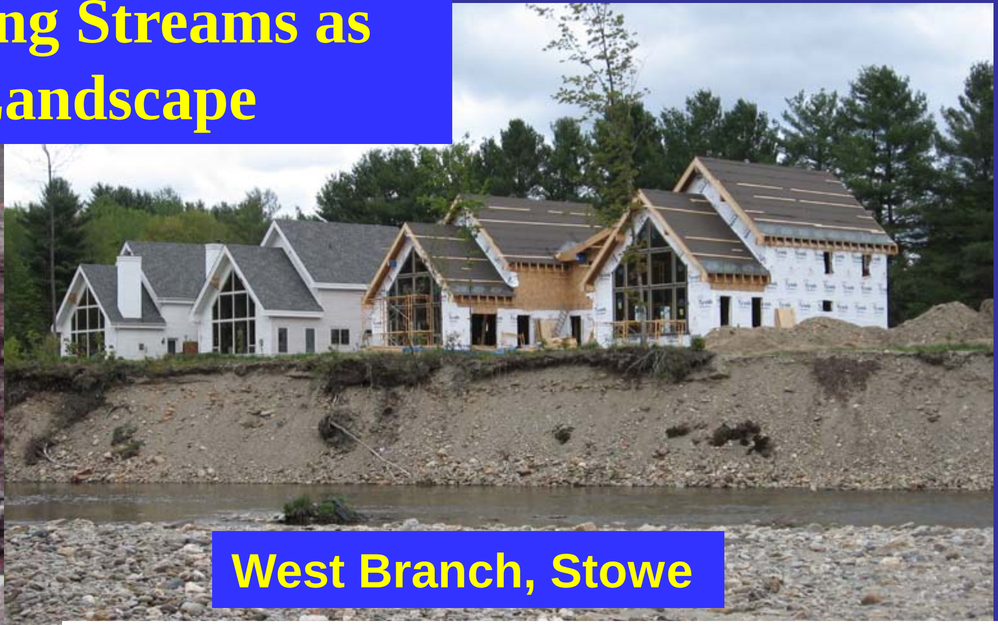
Tyler Branch, Enosburg, 1997



Neither CWA Objectives nor flood hazard avoidance can be achieved without considering the dynamic nature of fluvial systems, the essential physical connection of active channel with riparian areas, and the physical and temporal scales at which fluvial systems evolve.

The Consequences of Treating Streams as Static Elements of the Landscape

Tweed River, Pittsfield

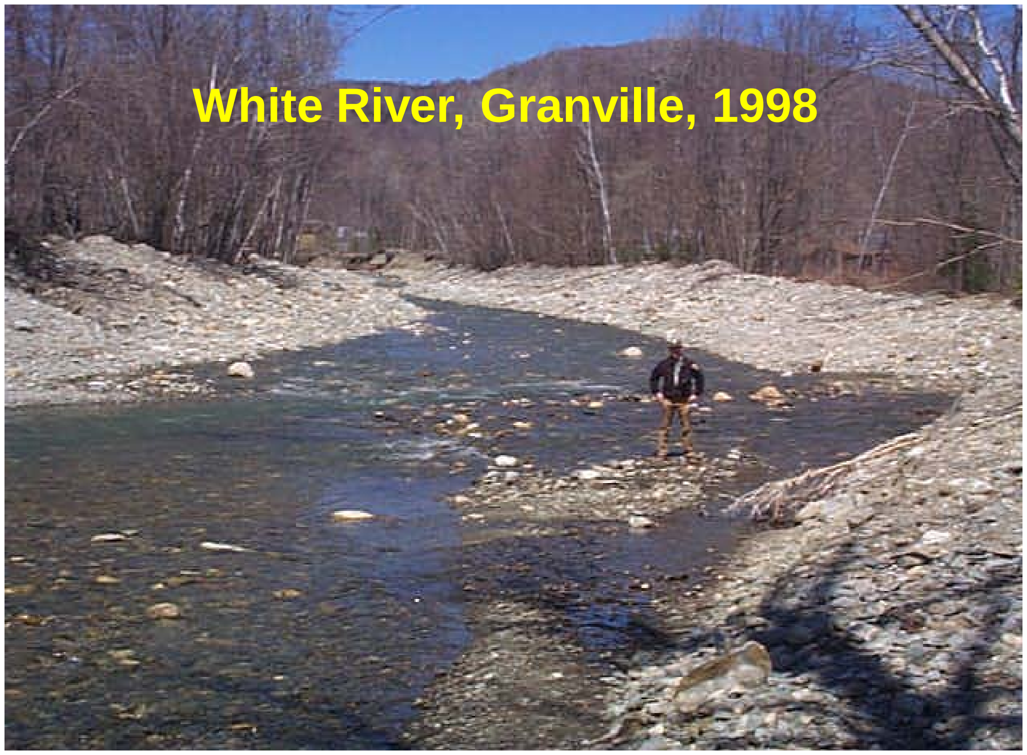


West Branch, Stowe

Unnamed Brook, Barre Town

West Branch, Stowe

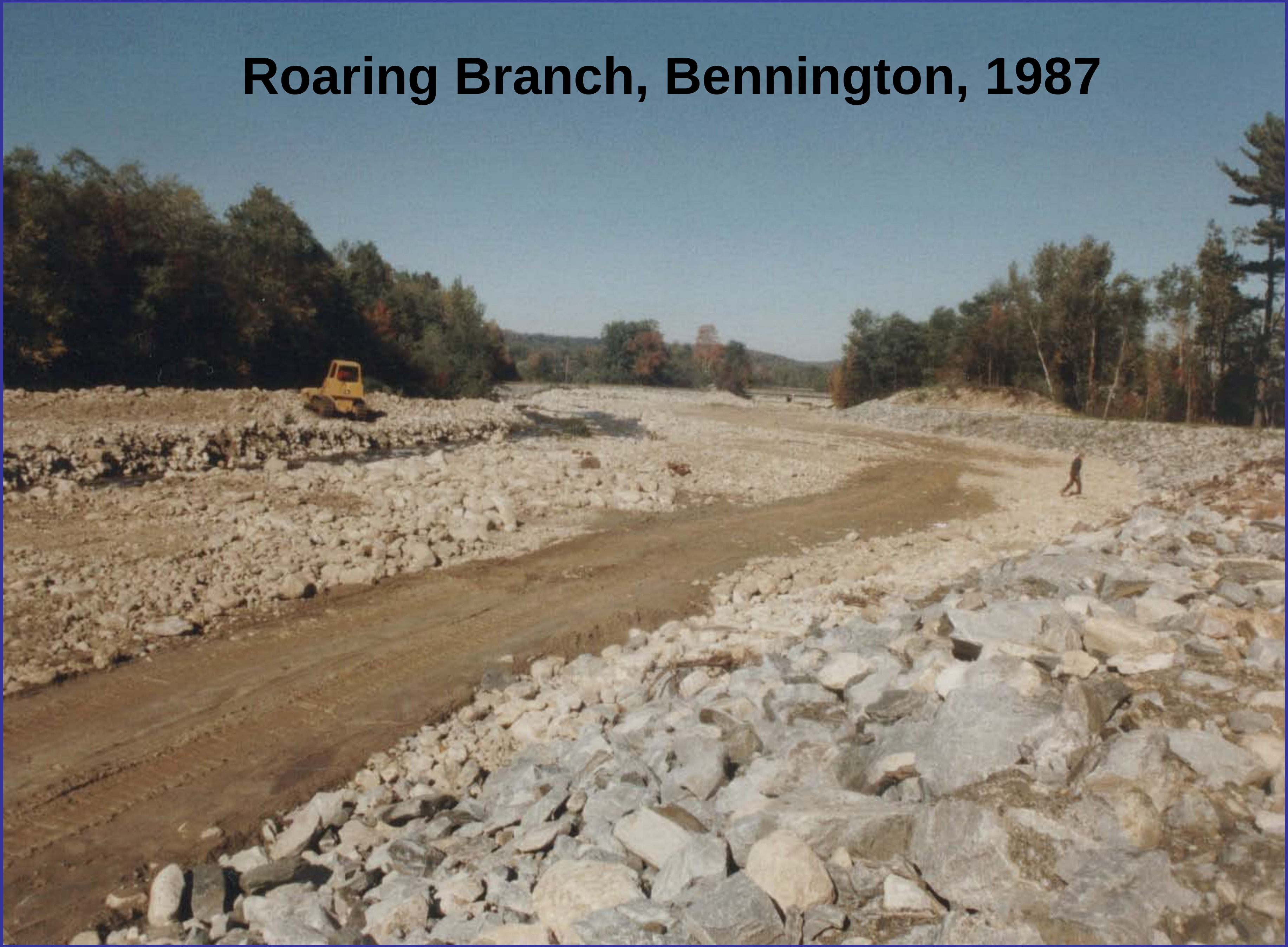
Flooding, stream channel erosion, and water quality and aquatic resource degradation are primarily a result of the pattern of river corridor land use and infrastructure investment.

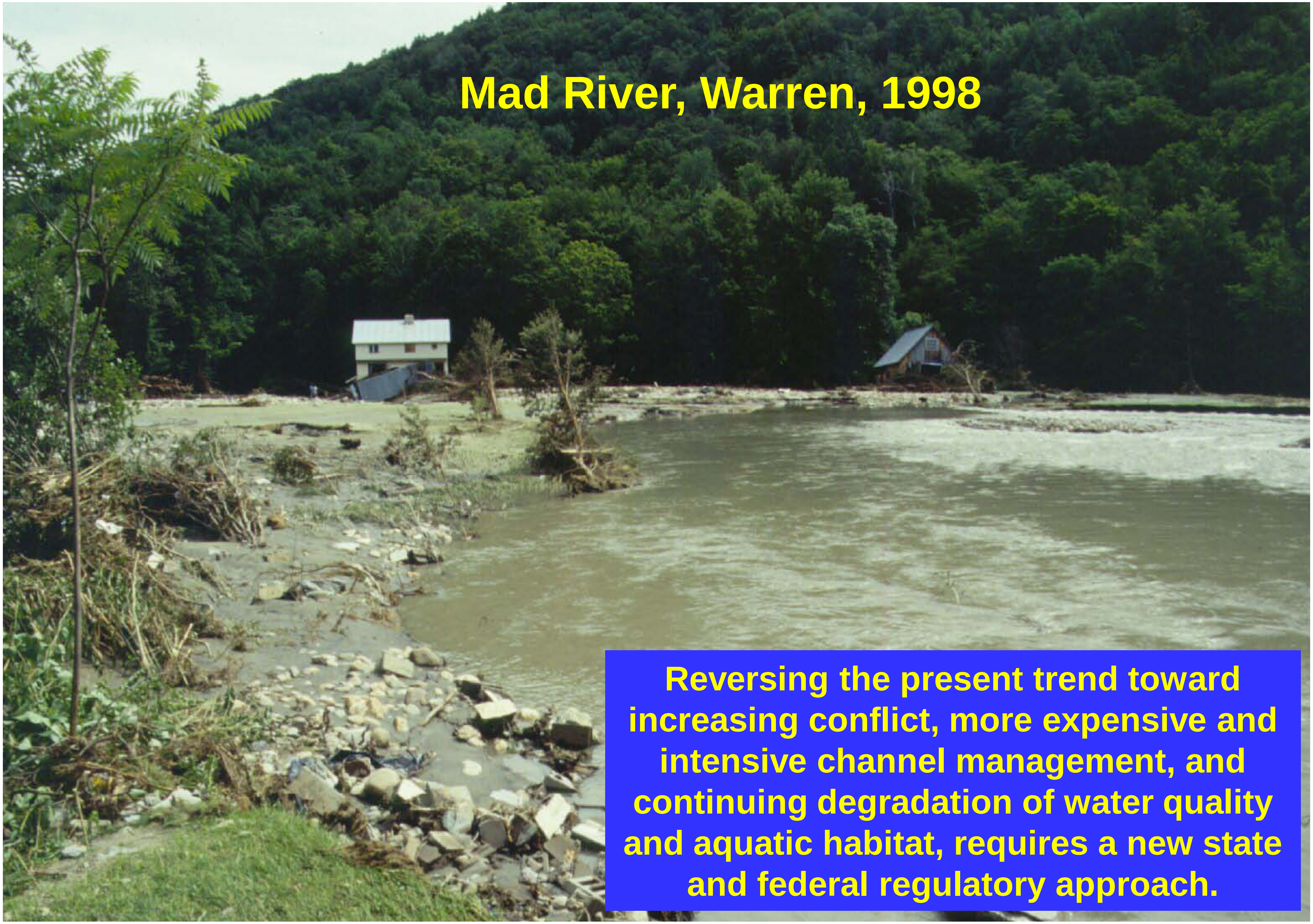

White River, Granville, 1998


Roaring Branch, Bennington 1987

And are perpetuated by the on-going channel and flood plain management activities intended to reconcile widespread conflicts with the dynamic nature of fluvial systems.

Roaring Branch, Bennington, 1987

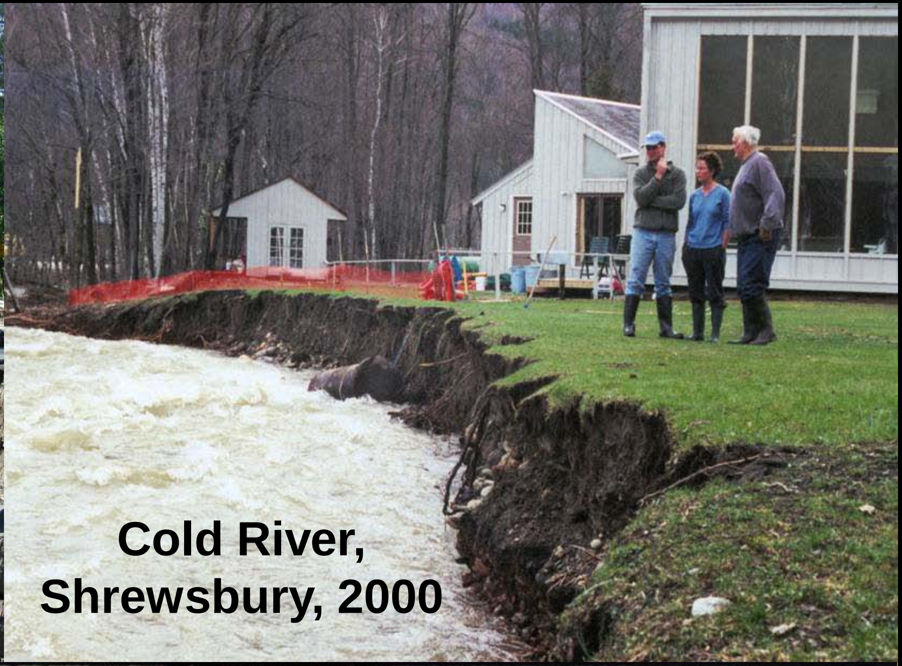


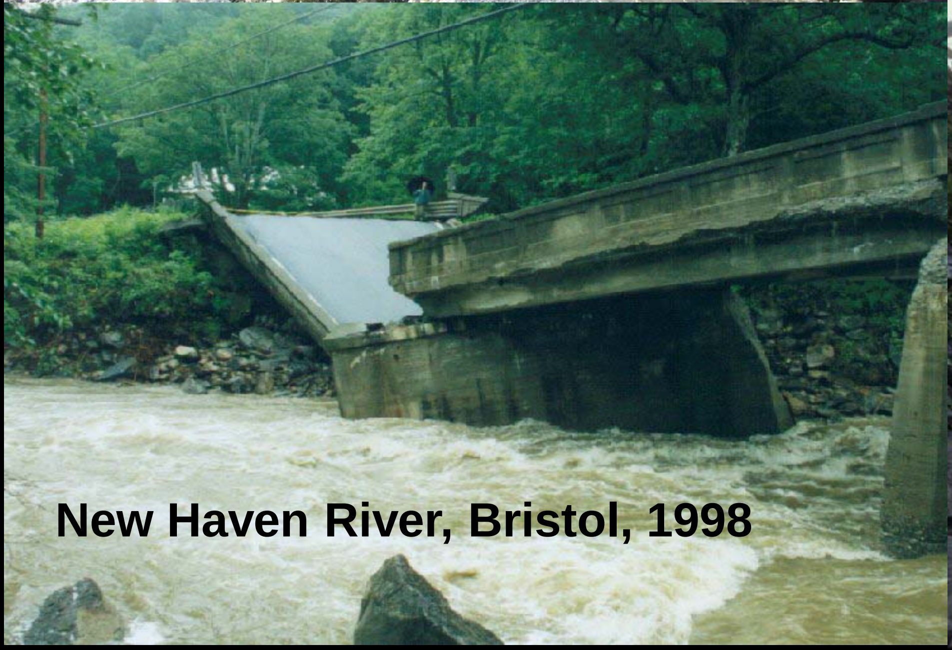


Mad River, Warren, 1998

Reversing the present trend toward increasing conflict, more expensive and intensive channel management, and continuing degradation of water quality and aquatic habitat, requires a new state and federal regulatory approach.

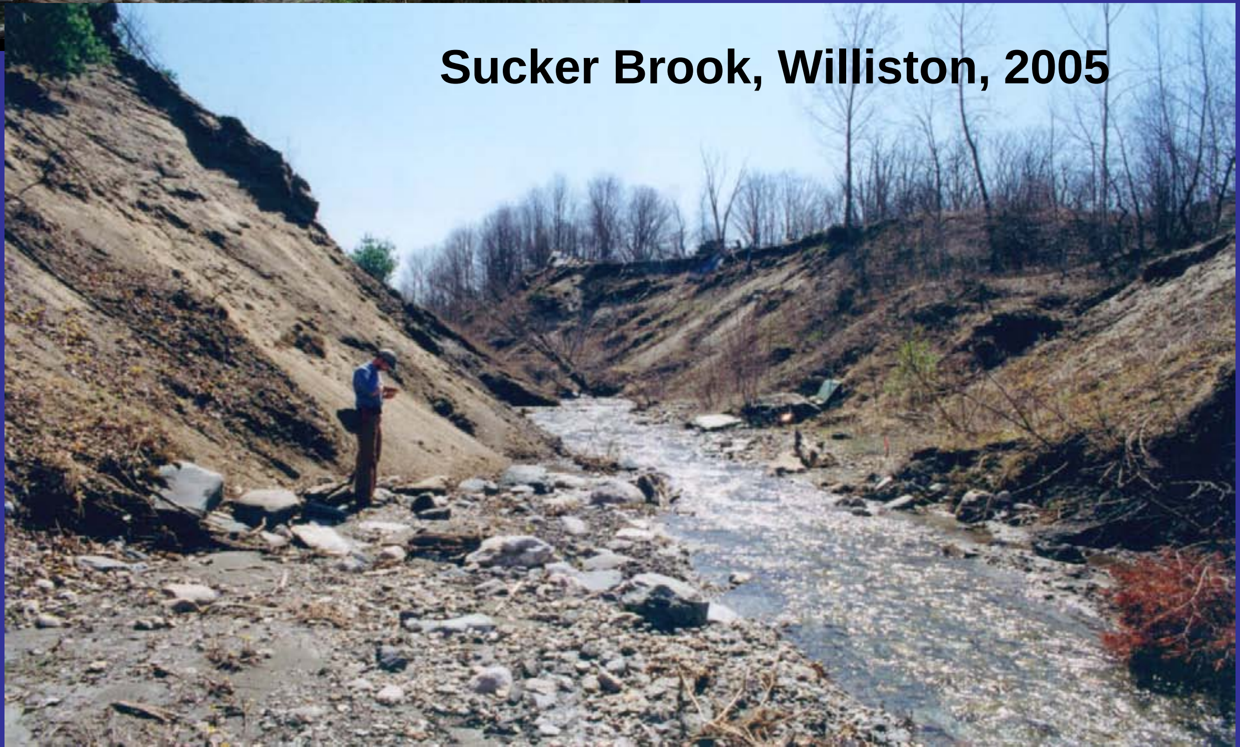

Honey Brook,
Barre, 2007


Cold River,
Shrewsbury, 2000


New Haven River, Bristol, 1998


Miller Run, Sheffield, 1990

Unnamed Tributary to
Lake Carmi, Franklin 2006



Sucker Brook, Williston, 2005

Flood Hazard Implications of Current Policies that Allow for Maintenance and Retention of River Corridor Encroachments

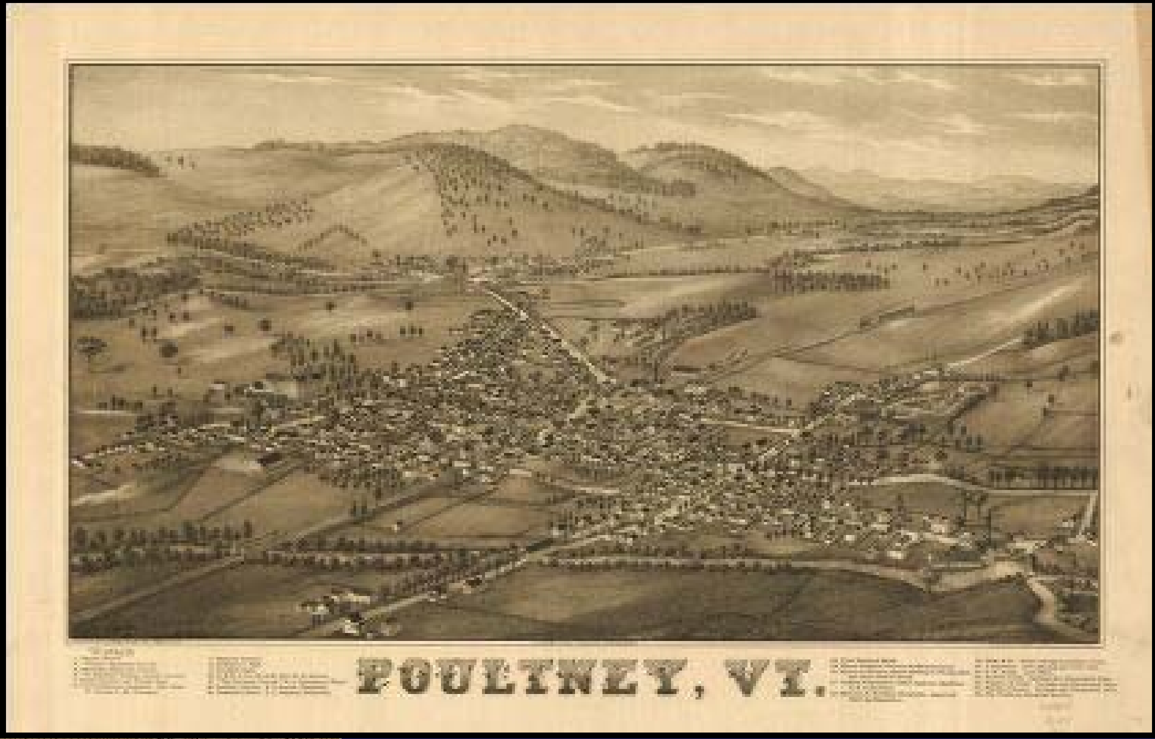
- Local governments and individuals increasingly vulnerable to disastrous flood and erosion loss;
- Permanent, unrecoverable destruction of fluvial ecosystem services;
- Upward spiral of state and municipal expenditures for flood and fluvial erosion hazard recovery and mitigation;
- Ever increasing discharges of sediment and nutrients into downstream receiving waters;
- Degradation of flood plain agricultural soils;
- Devastation of aquatic and riparian habitats, ecological diversity, water quality, and human recreational use; and
- The only remaining option to be implementation, and maintenance forever, of the European Model of river control (channelize, dredge, and armor), at enormous, unsustainable public cost and loss of fluvial ecosystem services.

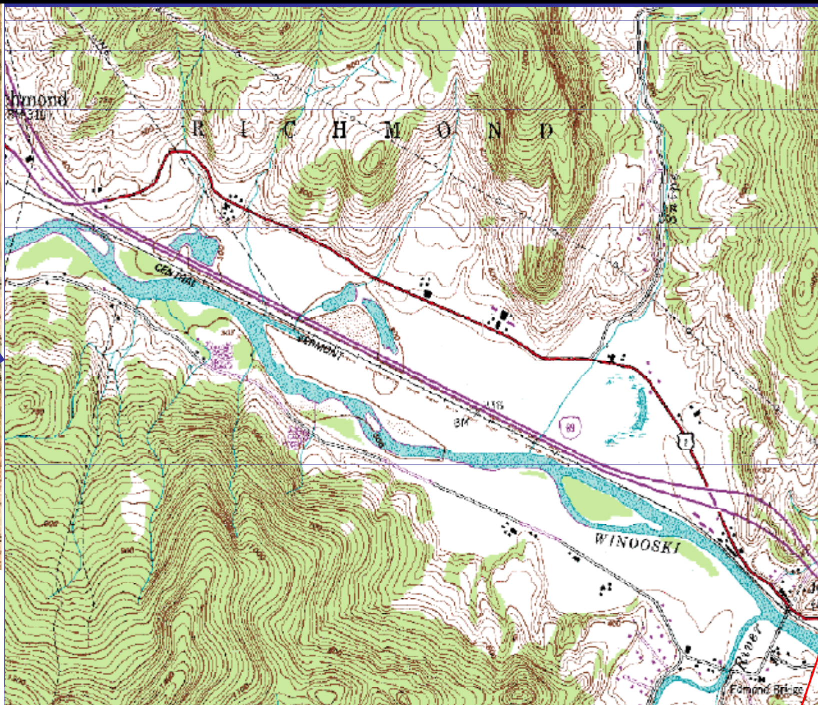
Fluvial Geomorphology is a unifying principal supporting watershed scale resource protection, growth management, flood hazard mitigation & avoidance, and sustaining chemical, physical, and biological integrity of surface waters.

The physical condition of the fluvial system is a direct reflection of watershed health, a primary influence on public health, safety and welfare, and a direct indicator of ecological well-being.

How, Why and To What Extent Have Our Rivers Been Physically Altered?

Many, if not most, New England streams have been altered so extensively as to provide nothing even close to their chemical, physical and biological potential.





HOW DYNAMITE *streamlines streams*

Practically every farm in the heavy crop-producing areas of the United States needs some ditching, and there is hardly a stream in the entire boundary of the Union that does not need to be corrected to give better service in discharging the large amounts of waste water from heavy rains, and to protect low lands.

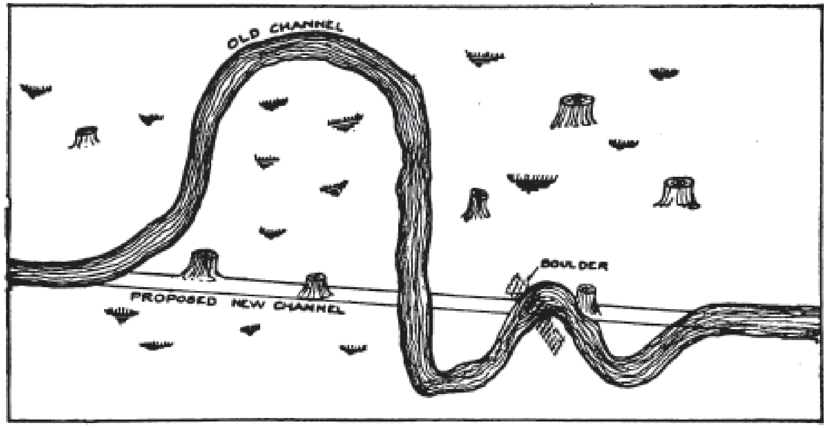
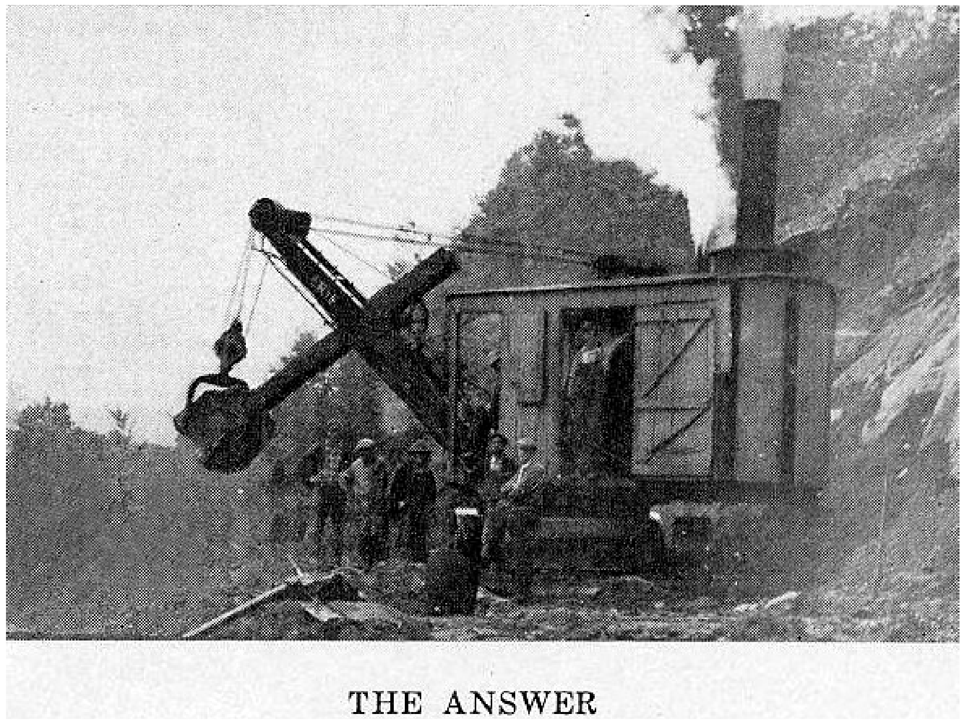


FIG. 54. DIAGRAM OF STREAM TROUBLES THAT MAY BE CORRECTED BY BLASTING.

CROOKED STREAMS are a menace to life and crops in the areas bordering on their banks. The twisting and turning of the channel retards the flow and reduces the capacity of the stream to handle large volumes of water. Floods result. Crops are ruined. Lives are lost. Banks are undermined, causing cave-ins that steal valuable acreage.

Truncated (cut-off) meanders, and abandoned flood plain to accommodate railroad construction, Winooski River, Middlesex, 1927

Increasing mechanization in the 1900’s ramped up our ability to channelize and constrain rivers. Channelization activities increased dramatically after the 1927 and 1938 floods then reached a crescendo after WWII with most Soil Conservation Districts obtaining surplus bulldozers, draglines and cable shovels putting them to work full time straightening and dredging streams throughout the New England landscape.


THE ANSWER


Third Branch White River Randolph, 1927

VERMONT HISTORICAL SOCIETY

Straight Channels

Post Flood Channelization Castleton River, Castleton, 1927

VERMONT HISTORICAL SOCIETY

Up to 75% of Stream Miles have been Modified to Accommodate Roads, Railroads, Agriculture and Other Land Uses

And a large percentage of river alteration projects today are intended to sustain these modified or channelized conditions within which maintaining chemical, physical, and biological integrity is impossible.

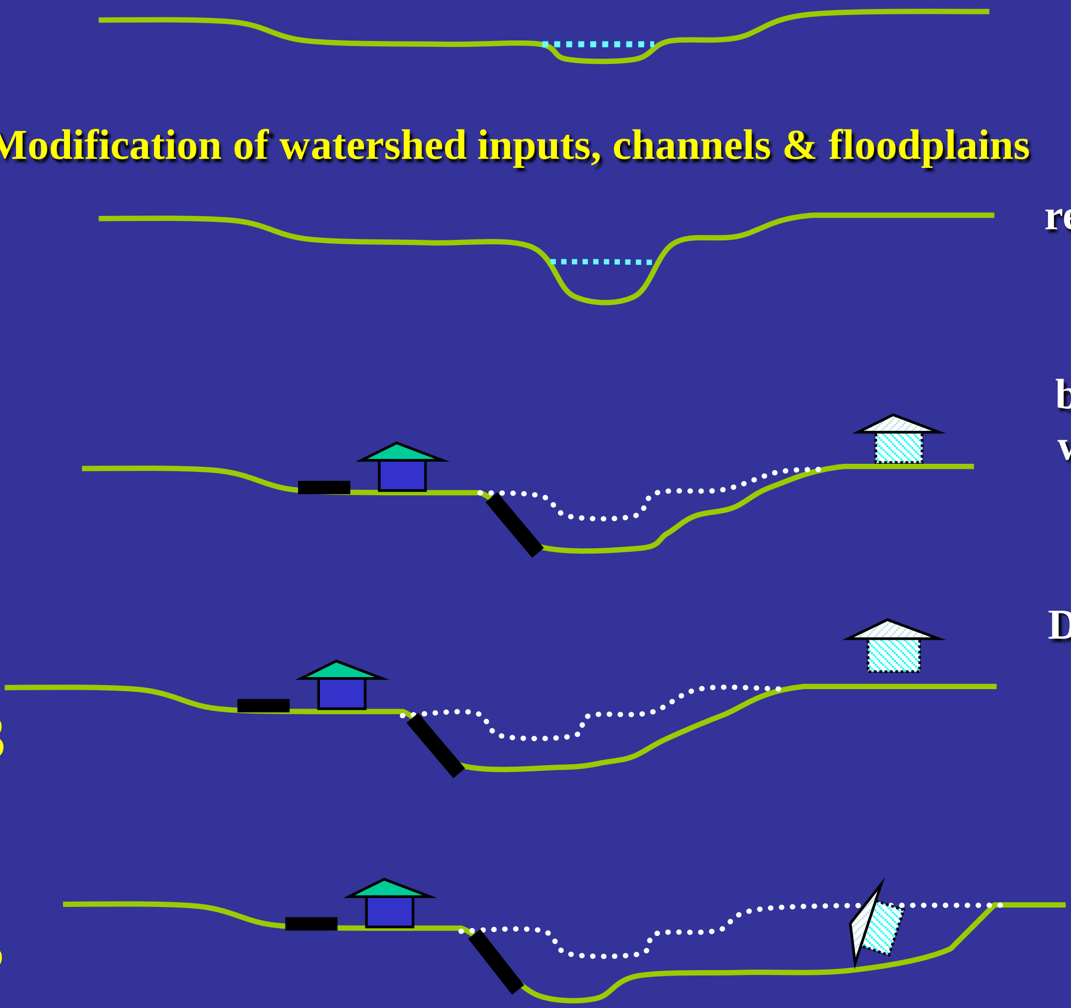
Roaring Branch, Bennington, 1987

Don’t let her move.

West Branch, Stowe, 2008

The Physical Imperatives of Fluvial Systems are Predictable and are Temporally Connected at Time Scales Spanning Generations

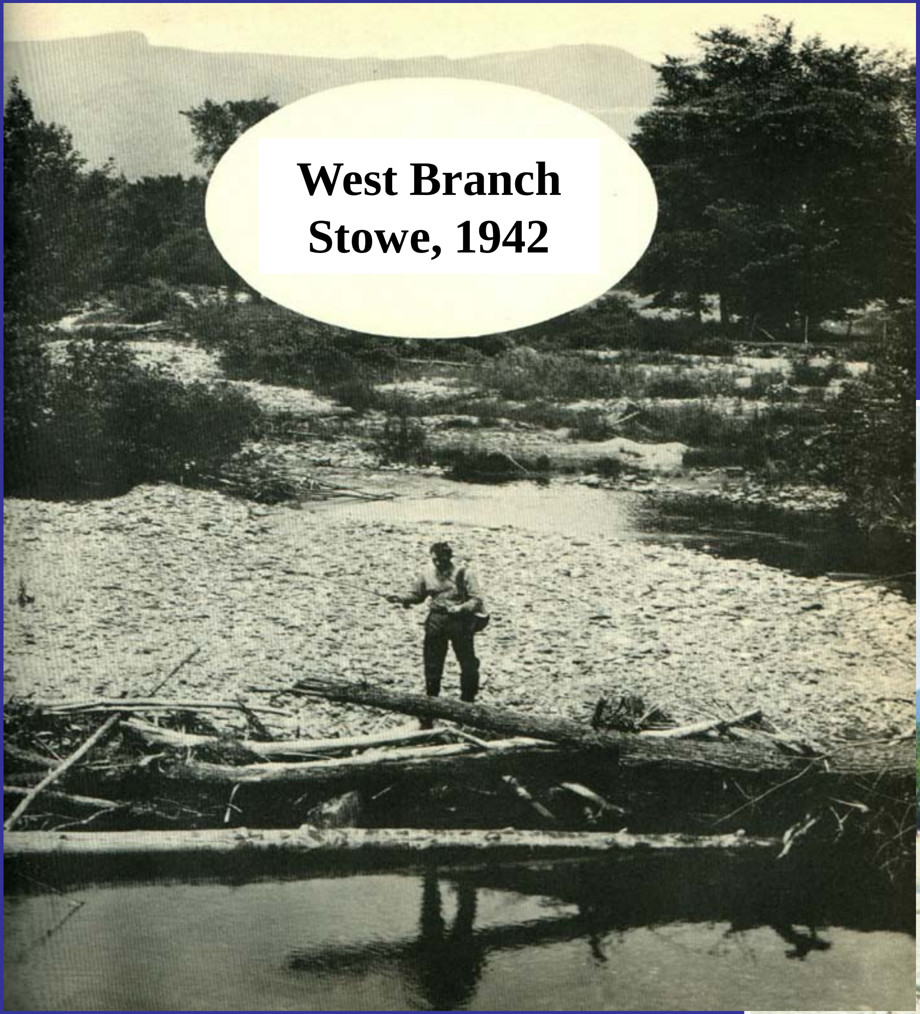
Explaining Channel Evolution and Fluvial Geomorphic Equilibrium



Modification of watershed inputs, channels & floodplains

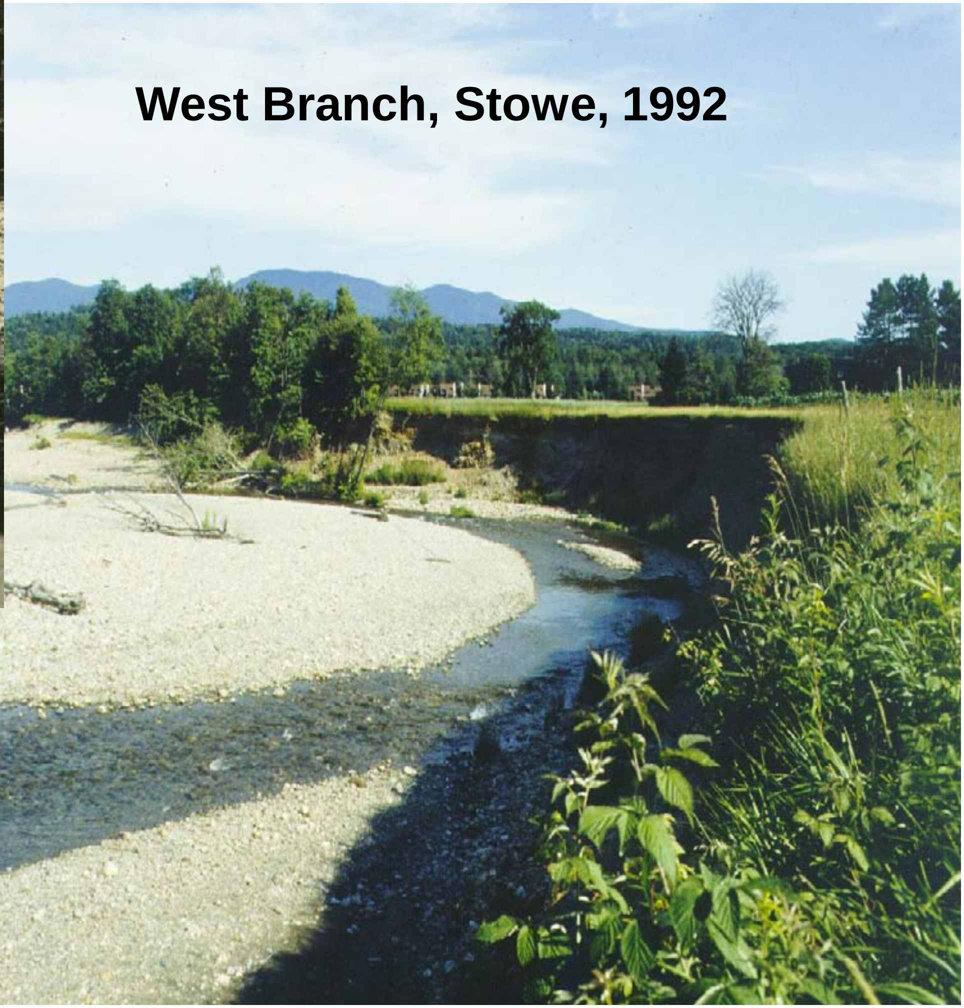
Stage		
1	Pre-1800	Equilibrium condition
2	Pre-1900	Geomorphic response begins
3	1927	Widening to balance energy with boundary conditions
4	1973	Developing new flood plain
5	20??	Equilibrium condition

After Shumm, et.al.



West Branch
Stowe, 1942

1942 photo illustrates the equilibrium condition (Stage 1). Note the 3-4 ft. high bank in the background. Good access to flood plain, active sediment storage. Then decades of development, gravel mining and flood plain encroachment ensued.



West Branch, Stowe, 1992

1992 photo illustrates the incised and redeveloping flood plain (Stage 4). Former flood plain is top of right bank (10 ft. incision).

Stage 2 Incised & Straightened

Rugg Brook,
St. Albans Town

Stage 3
Incised and Widening

Trout River, Montgomery

Stage 3 Incised and Widening

Trout River, Montgomery

Stage 4
Incised &
Meandering

Trout & Missisquoi Rivers, Berkshire

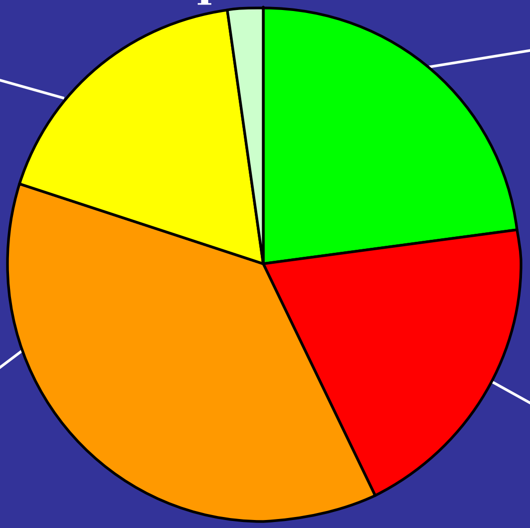
Stage 4 Incised & Meandering, Building New Flood Plain at Lower Elevation

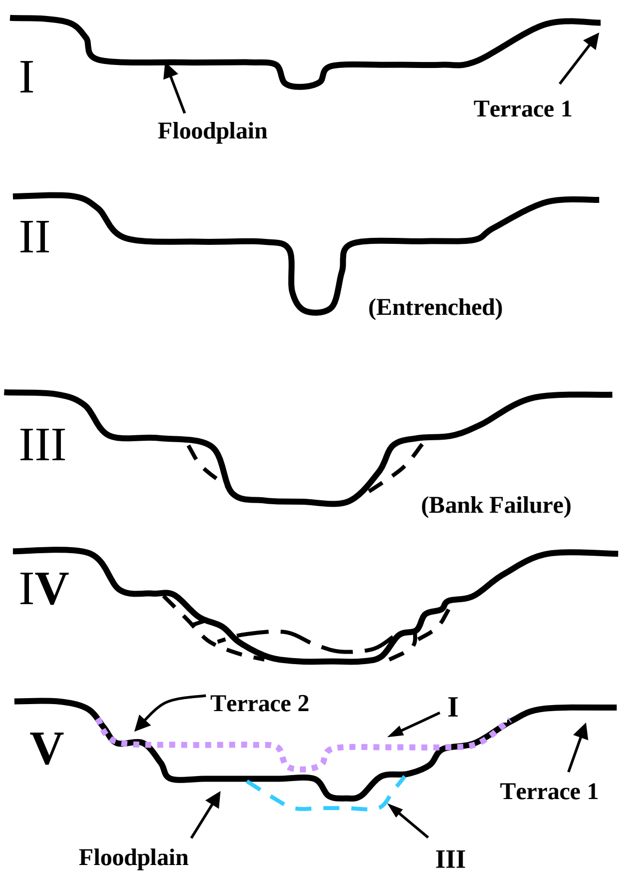
West Branch, Stowe

Evolution Stage	*Number of Miles*	*Percent Length*
I	239	22.5%
II	210	19.8%
III	423	40.0%
IV	168	15.8%
V	20	1.9%
Total	1,060	100.0%

Data as of 4-22-08

75%
VT Assessed Streams in Disequilibrium, Lacking Access to a Floodplain

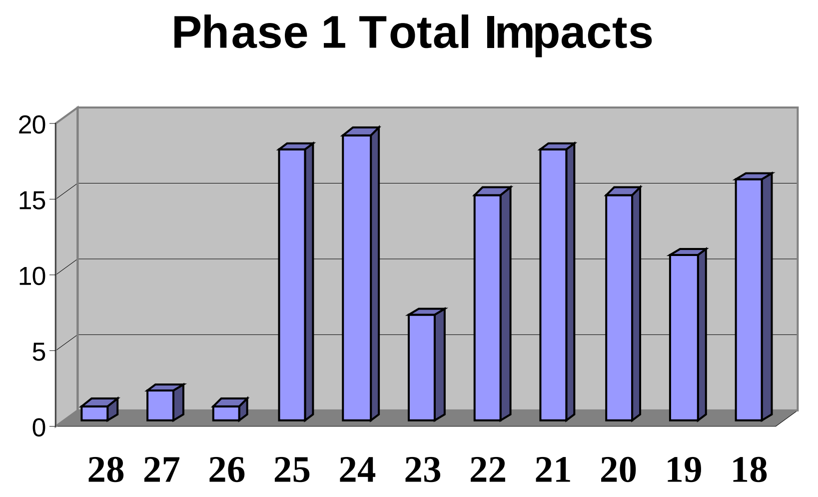


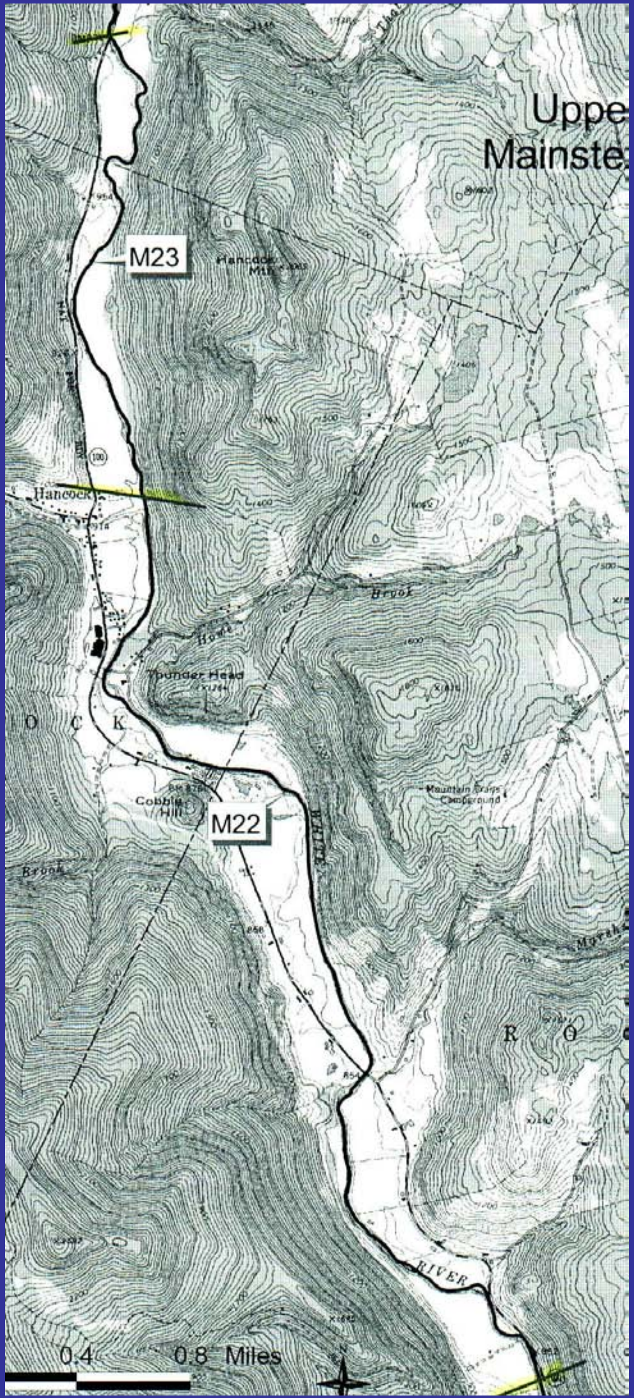


White River Phase 1 Results

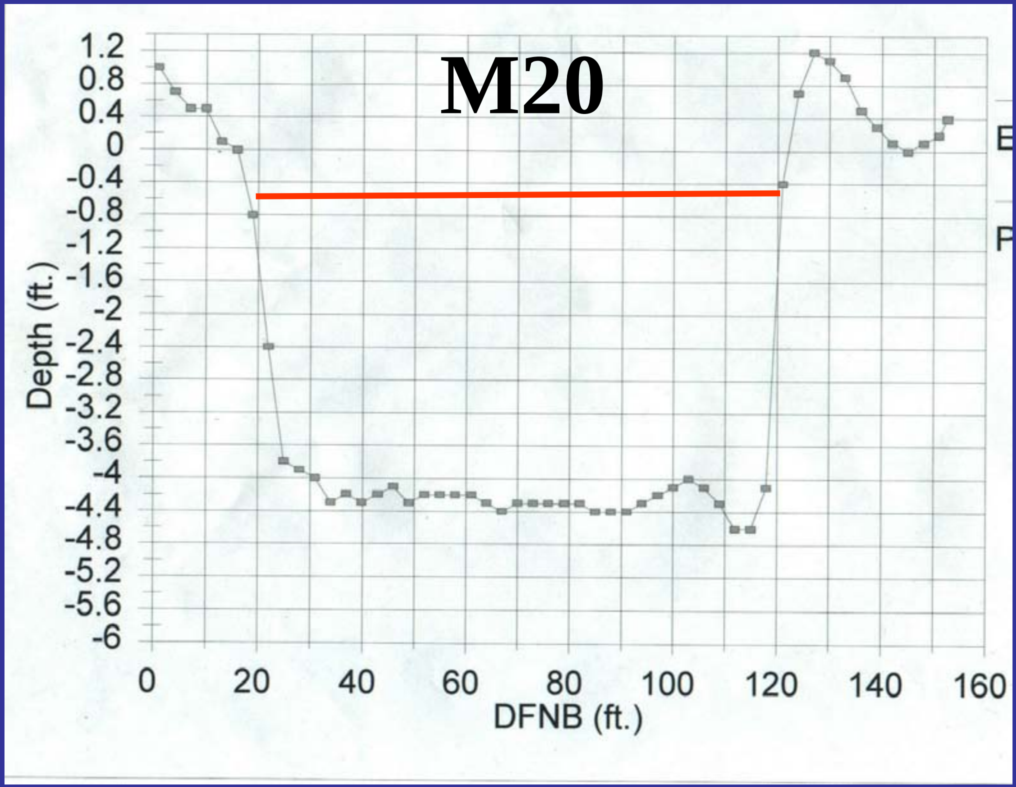
19.1 miles of low gradient, alluvial channel
1.3 miles in naturally confined by valley
17.8 miles in unconfined, broad valley
(all straightened)

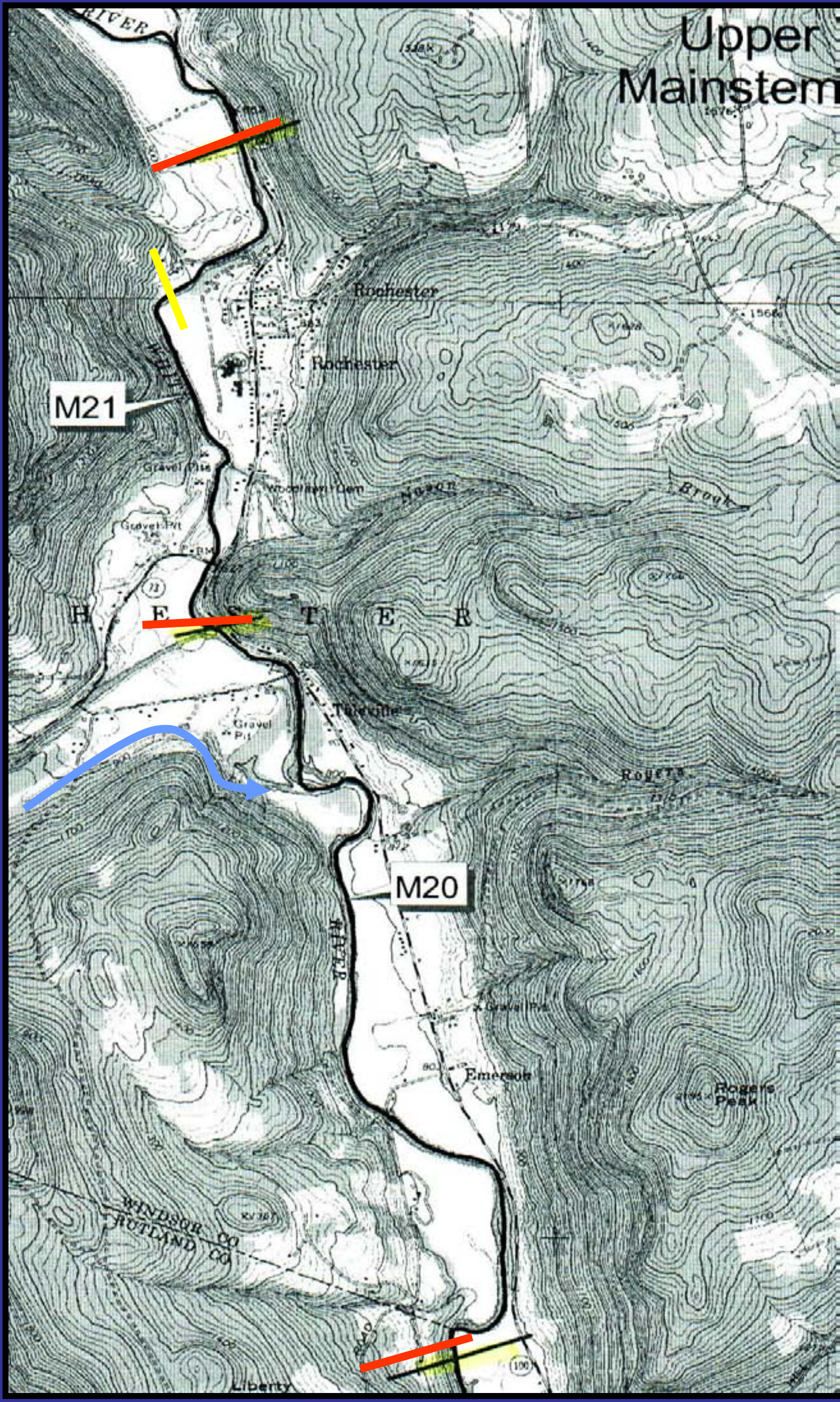
70% still in straightened planform
14% beginning to re-meander
9% measures having full meanders





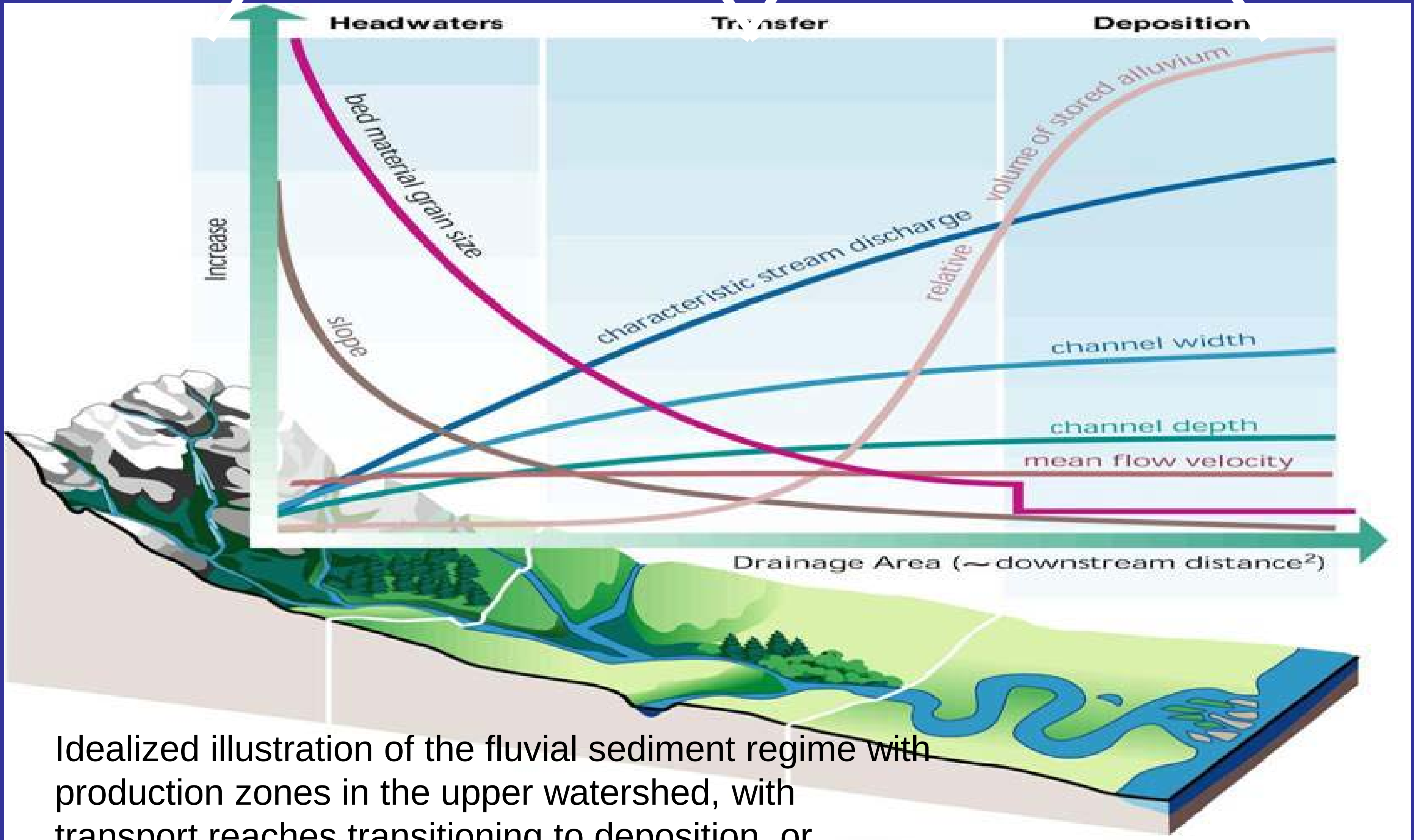
Reach	Stream Type	Incision Ratio	CEM
21B	C4	1.13	IV
21A	C4	1.81	III
20	C4	1.46	III





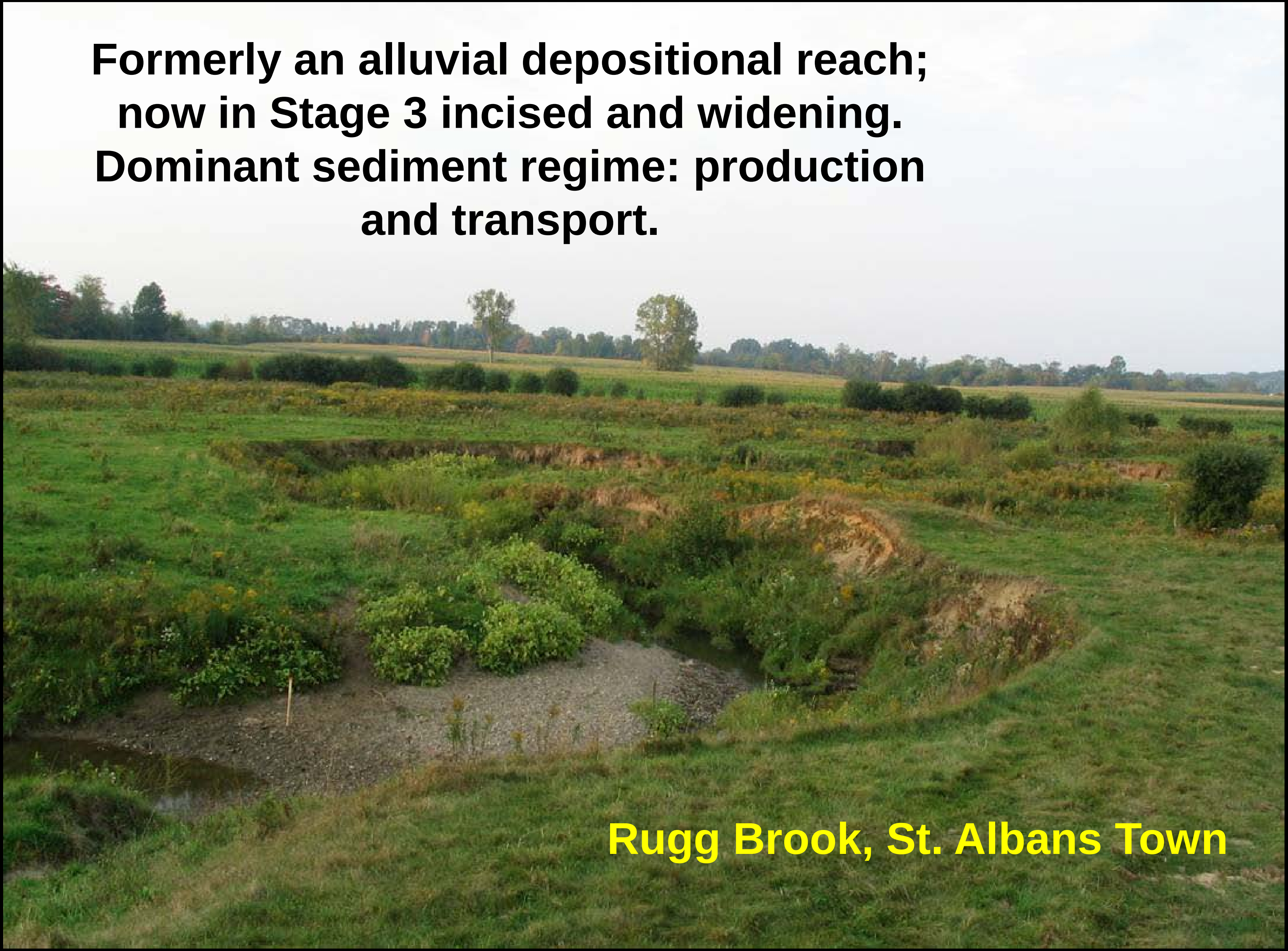
Sediment Source & Transport

Sediment Deposition & Response



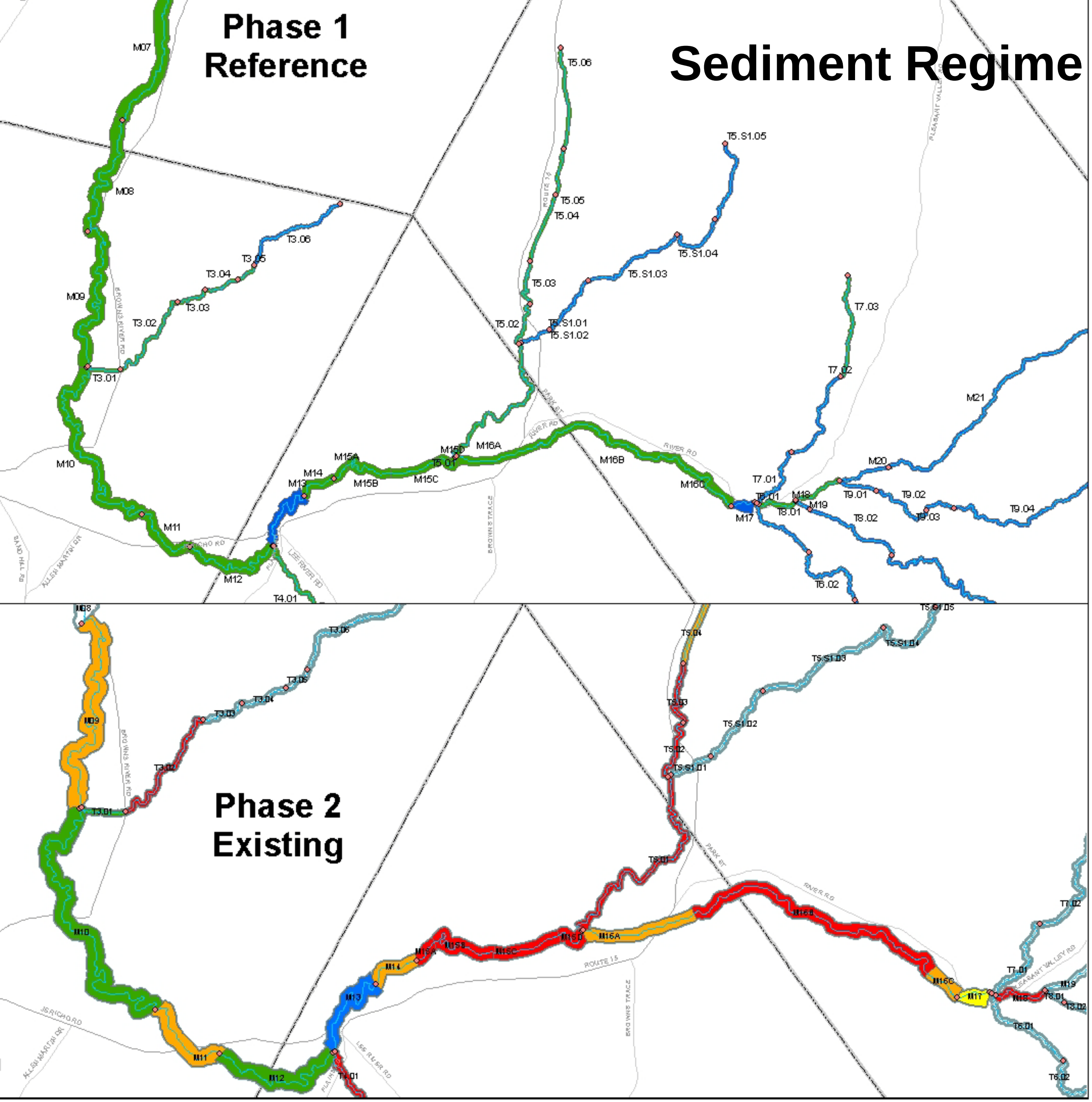
Idealized illustration of the fluvial sediment regime with production zones in the upper watershed, with transport reaches transitioning to deposition, or sediment and hydrologic attenuation reaches.

Formerly an alluvial depositional reach; now in Stage 3 incised and widening. Dominant sediment regime: production and transport.



Rugg Brook, St. Albans Town

Sediment Regime



Red: Source

Blue: Source and Transport

Yellow: Transport

Green: Depositional

Browns River, Underhill

Data Source: VT Stream Geomorphic Assessments

Depositional Streams Converted to Transport Streams

20%

Stage II Incised

40%

Stage III Widening

Data as of 4-22-08

Escalating Costs, Risks, and Degraded Chemical, Physical, & Biological Integrity

$

Floods and
Property Damage

$

Dredge, Berm
and Armor

$

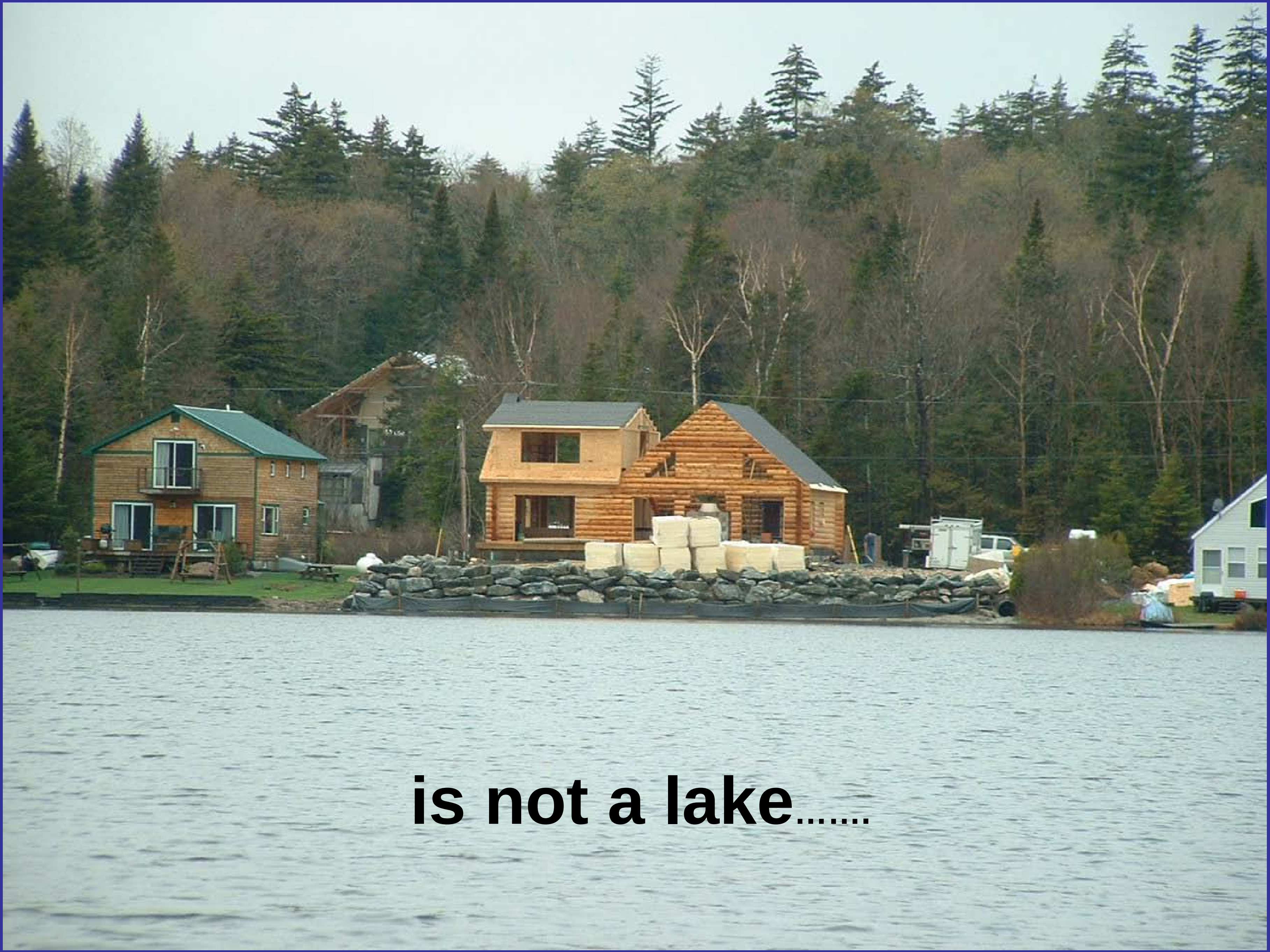
Encroachment

Fluvial Geomorphic Equilibrium allows the fluvial system to achieve its chemical, physical, and biological potential and minimize inundation and fluvial erosion hazards.

Elements of an Effective Fluvial Systems Regulatory Program that Manages for Fluvial Geomorphic Equilibrium as the Most Effective Strategy for Maintaining Chemical, Physical, & Biological Integrity

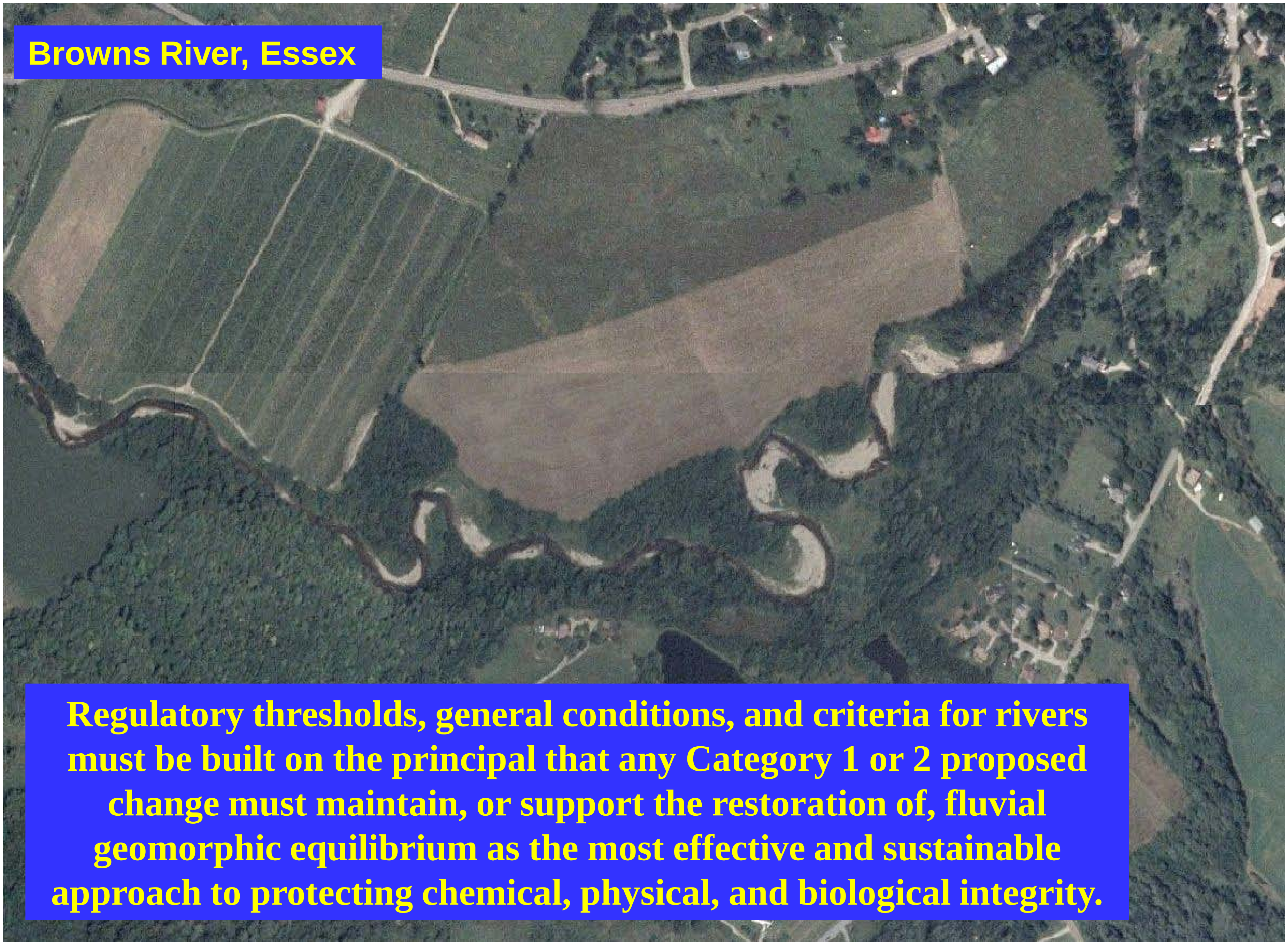
1. Within a regulatory context, a river……..

Roaring Branch, Bennington, 1987



is not a lake……

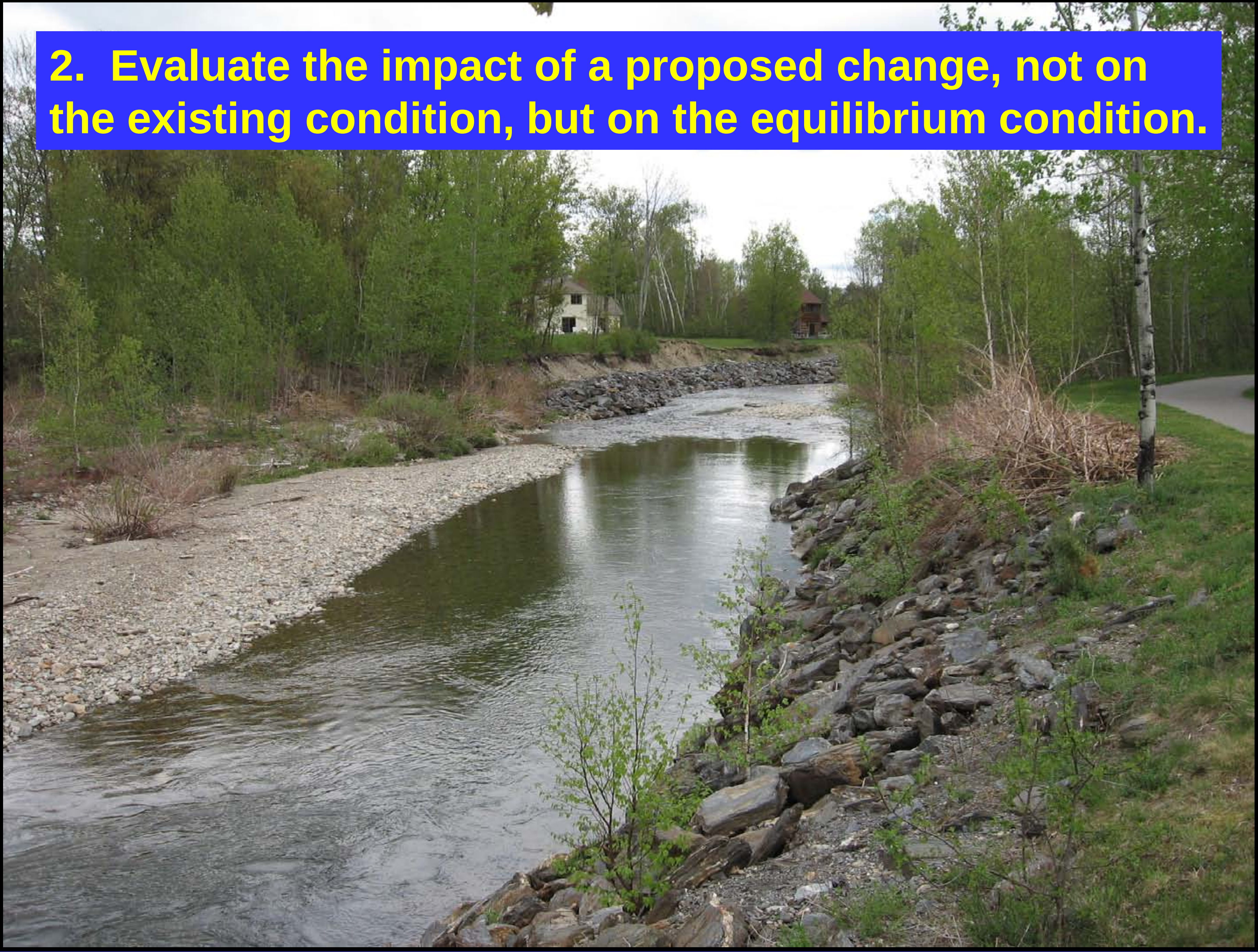
and is not a wetland.



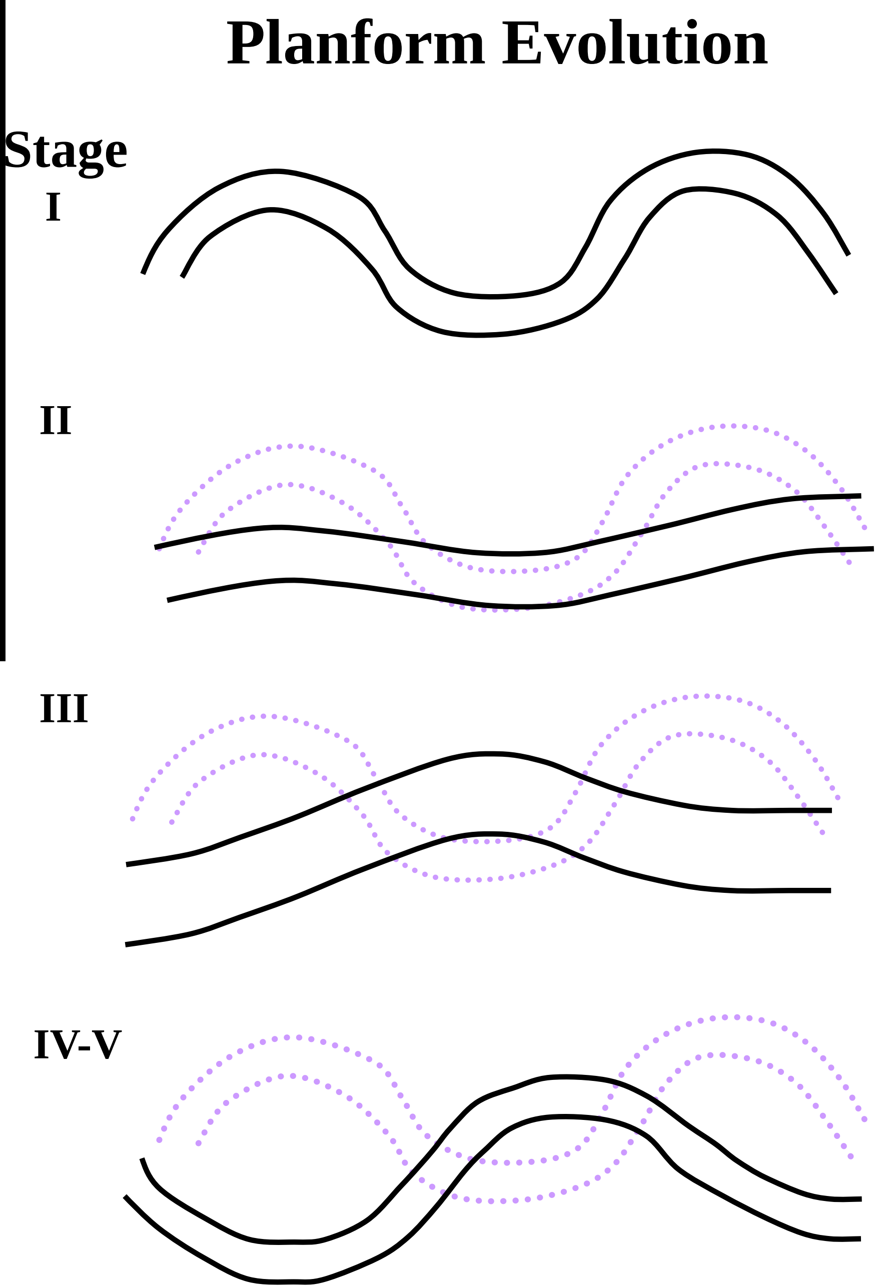
Browns River, Essex

Regulatory thresholds, general conditions, and criteria for rivers must be built on the principal that any Category 1 or 2 proposed change must maintain, or support the restoration of, fluvial geomorphic equilibrium as the most effective and sustainable approach to protecting chemical, physical, and biological integrity.

2. Evaluate the impact of a proposed change, not on the existing condition, but on the equilibrium condition.

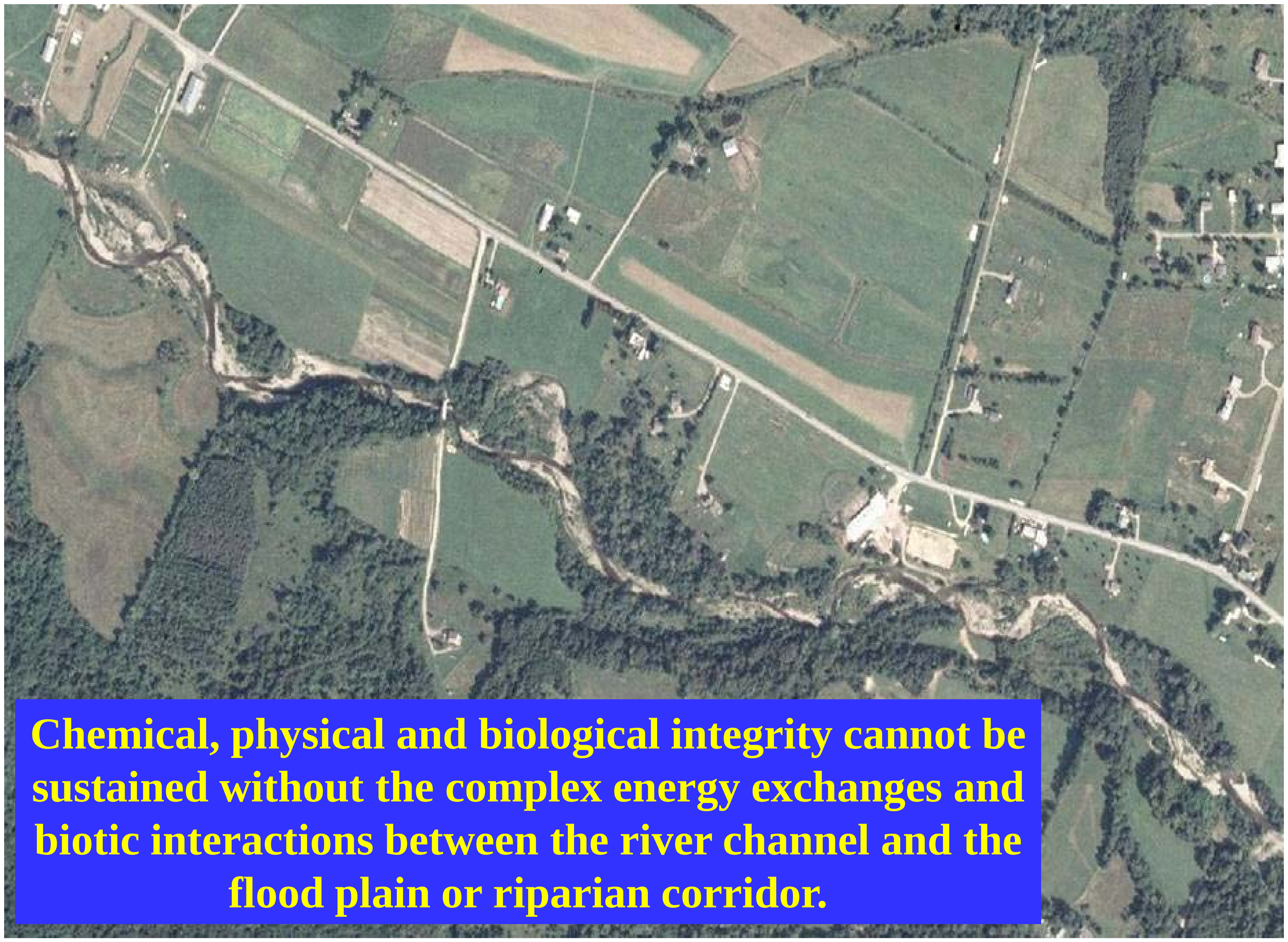


3. Recognize that CWA objectives cannot be achieved only by regulation of activities within OHW



Planform Evolution

Achievement of CWA objectives must start with a vision of an active river, with all of its parts, including features that move and change, those that store and transport, and those that accommodate the physical imperatives of the fluvial system over time.



Chemical, physical and biological integrity cannot be sustained without the complex energy exchanges and biotic interactions between the river channel and the flood plain or riparian corridor.

Belt Width B $= 3.7W^{1.12}$

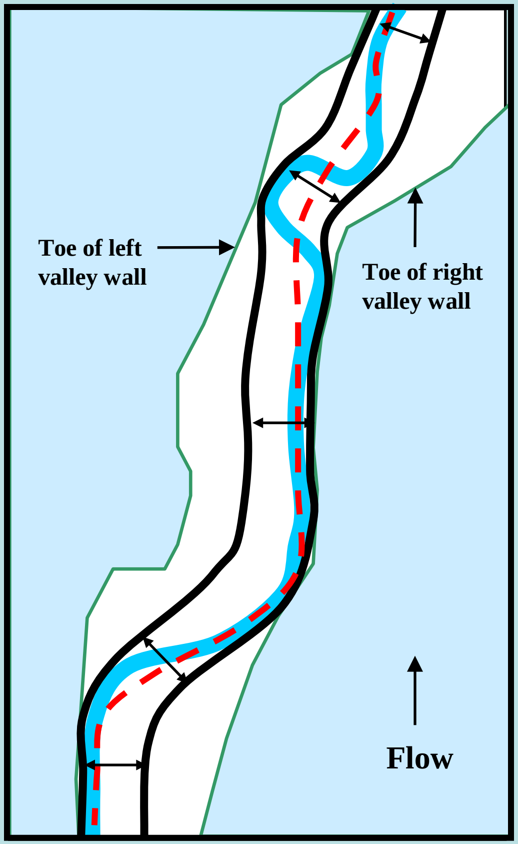
Channel Width $W = 13.1D^{0.44}$

D = drainage area

Alluvial channels

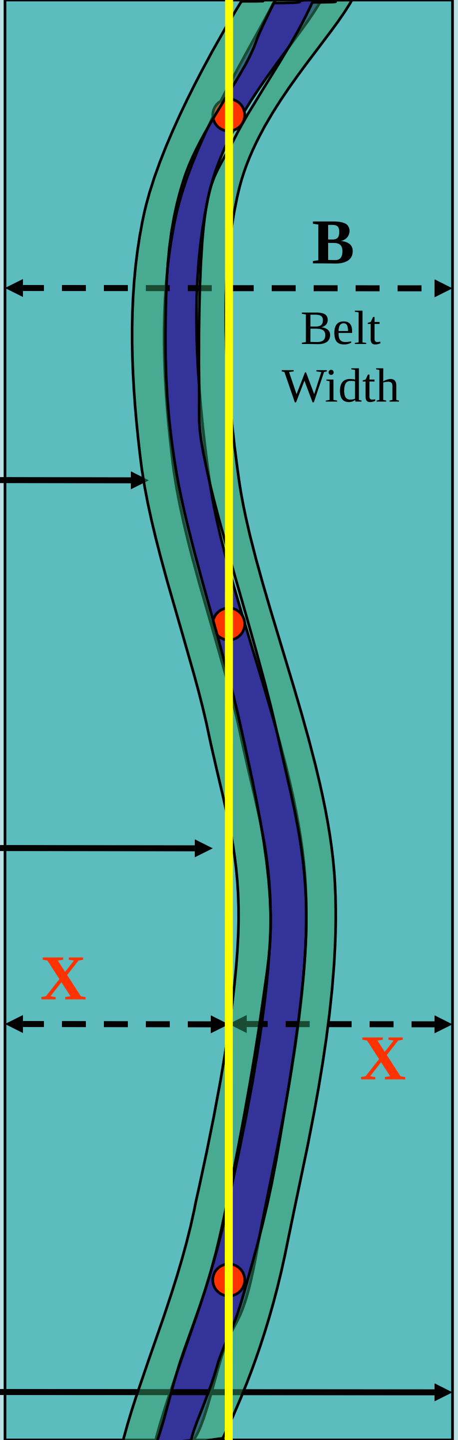
Meander width ratio

$$B/W \geq 6$$



Distance **X** is a function of

- drainage area
- stream width
- valley slope & width
- stream sensitivity



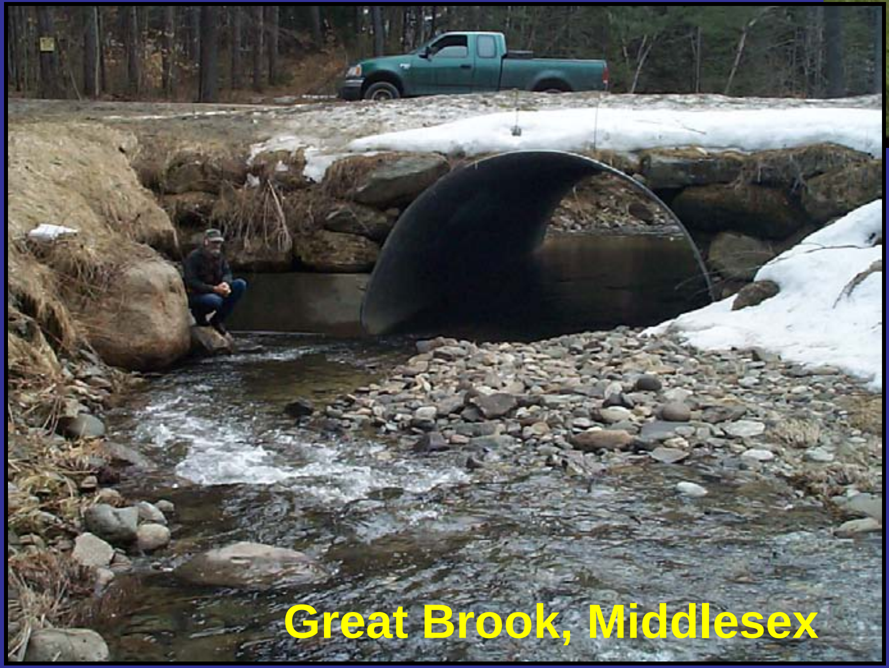
Vegetated Buffer

Meander Centerline MCL

Valley Toes

Lewis Creek, Starksboro

Loveland Brook, Richford



Great Brook, Middlesex

4. Sediment Transport Discontinuity as a Complement for AOP

Information about and publications by the

Vermont Agency of Natural Resources

River Management Program

Including the

Stream Geomorphic Assessment Protocols

are available at:

www.vtwaterquality.org/rivers