Geomorphic Stream Design and Installation: Lessons Learned

ENTSC SCIENCE AND TECHNOLOGY WEBINAR

July 31, 2013

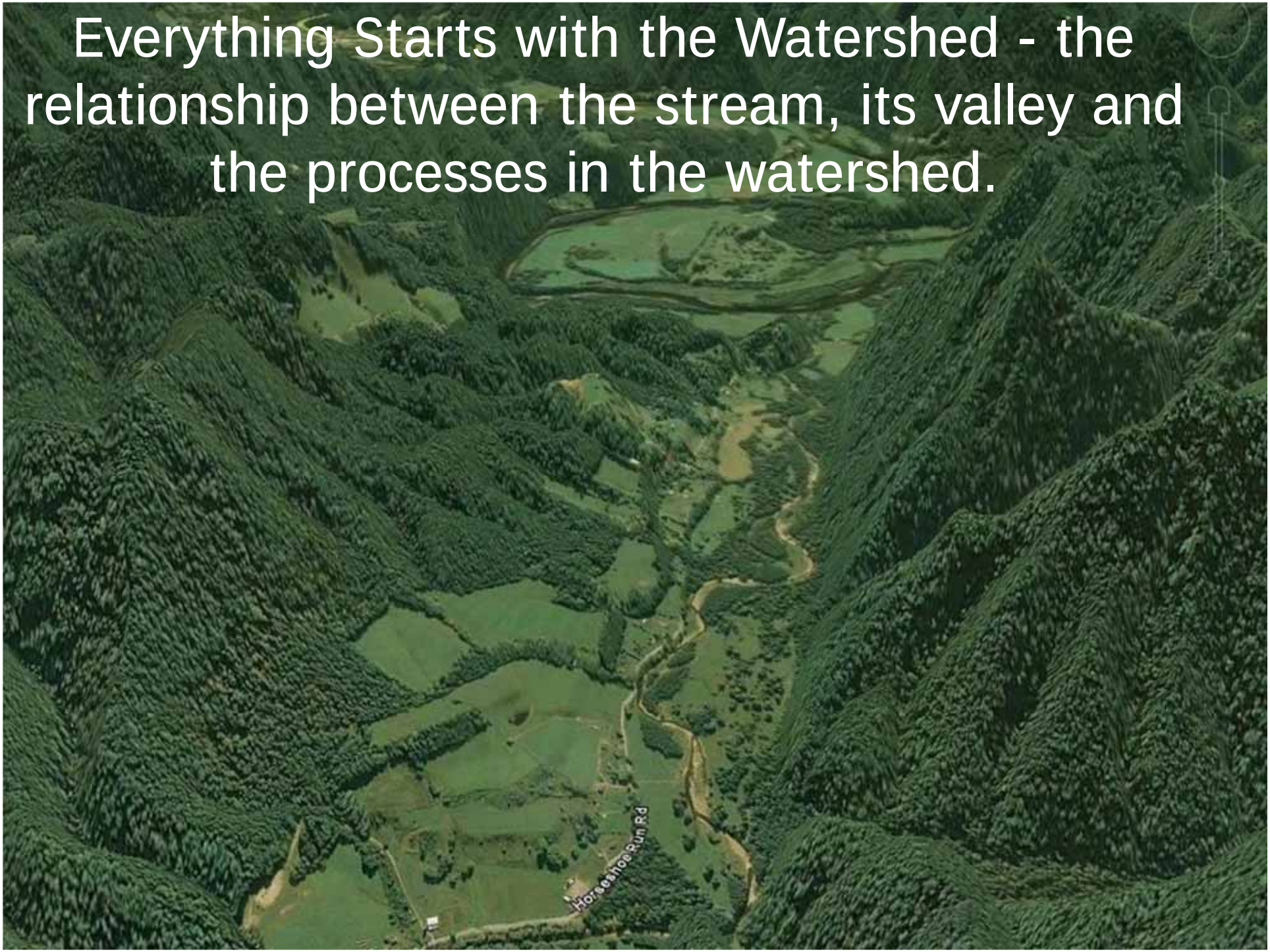
NRCS

GEOMORPHIC STREAM DESIGN

Reclamation of the landform and stream system based on the principles of applied fluvial geomorphology

- Other acronyms
  - NSD – Natural Stream Design
  - NCD – Natural Channel Design
  - NSCD – Natural Stream Channel Design
  - NSR – Natural Stream Restoration

Everything Starts with the Watershed - the relationship between the stream, its valley and the processes in the watershed.



STREAM PROCESSES

- Stream Functions
- Channel Morphology
- Stream Attributes
- Bankfull Discharge
- Morphological Characteristics
- Sediment Transport

NATURAL STREAM FUNCTIONS

- Transport water
- Transport sediment
- Transport energy
- Aquatic organism habitat
- Terrestrial organism habitat

A STABLE STREAM

transports the water and sediment produced by its watershed, such that over time it maintains its dimension, pattern, and profile, while neither degrading nor aggrading *Rosgen, 1996*

Interrelated Stream Attributes

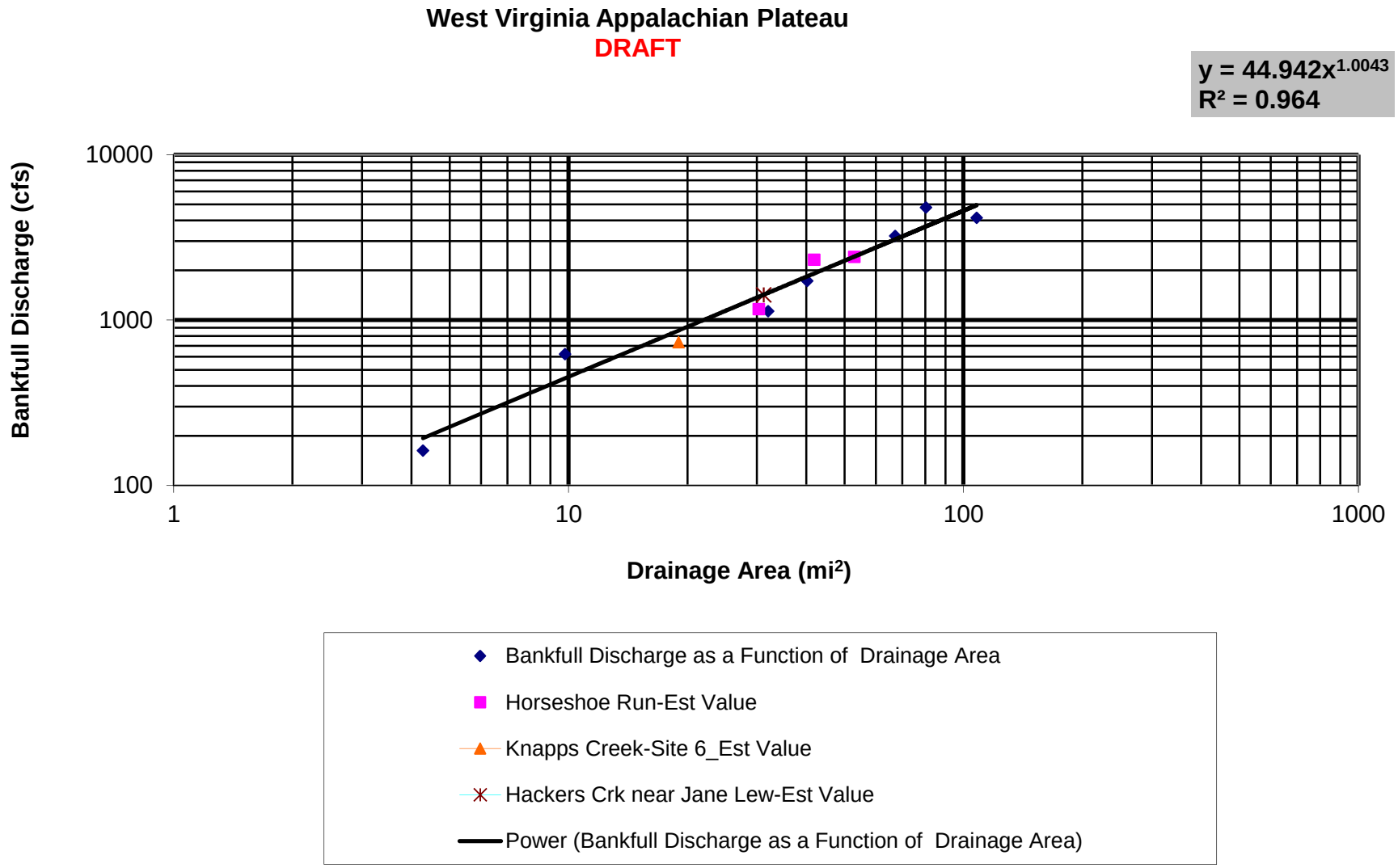
- Bankfull width
- Bankfull depth
- Slope
- Velocity
- Flow resistance (roughness)
- Sediment size
- Sediment load
- Bankfull discharge

What is Bankfull Discharge?

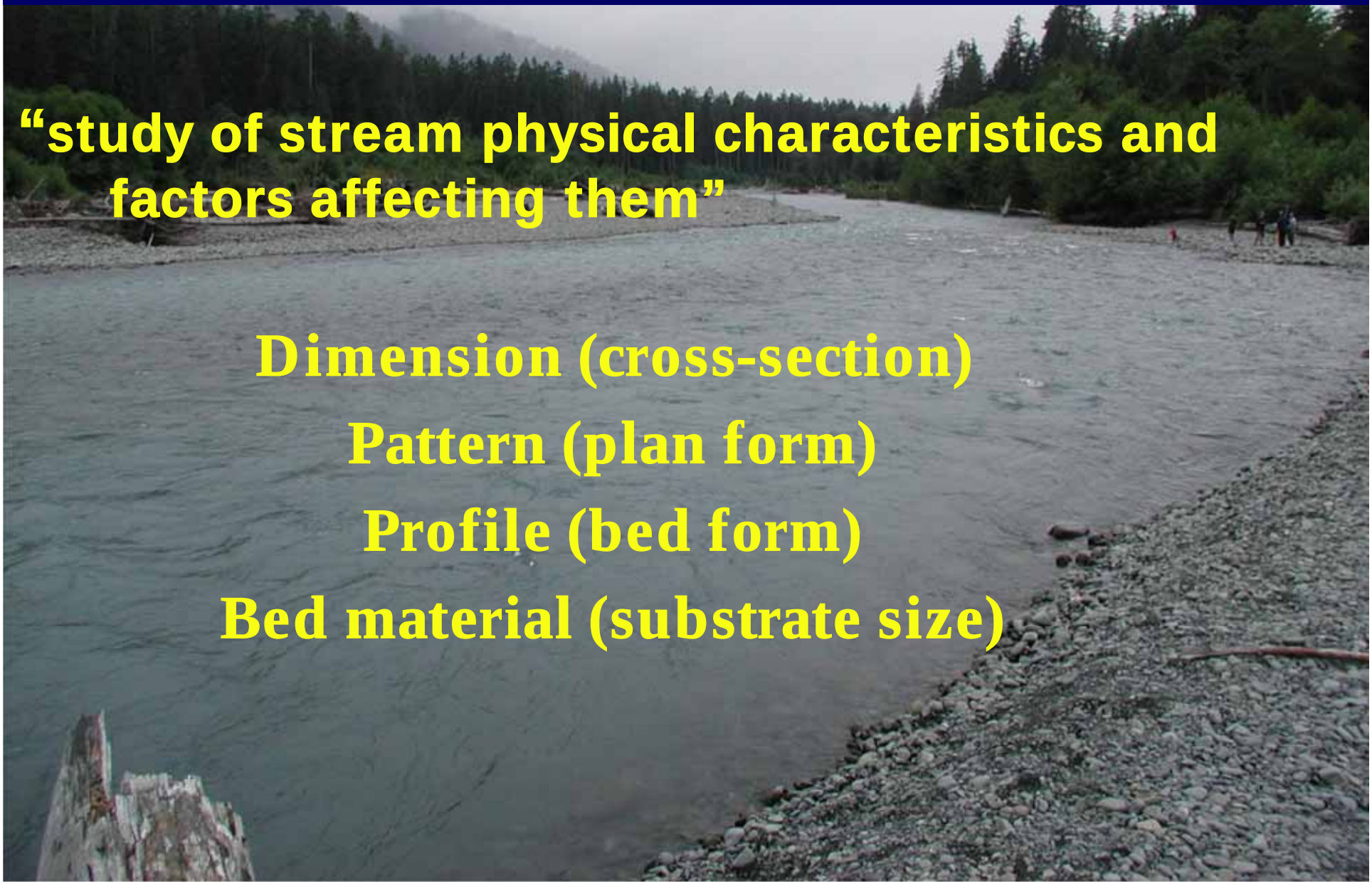
- **Bankfull Discharge** (Q) -- Fills a stable channel up to the elevation of the "active" floodplain.
- Represents a **breakpoint** between processes of channel formation and floodplain development
- **Return period (rural) = 1.2 – 1.8 years**
  - **Note: Good rule of thumb for rural Eastern US. Return interval may be different in other locations.**
- Assumed to be equal to **Effective Q** and **Dominant Q**
- **Reference discharge** for natural stream channel design


▪Field identification of bankfull elevation
▪Estimate bankfull discharge
▪Validate bankfull discharge using regional curve

Regional Curve



MORPHOLOGICAL CHARACTERIZATION OF STREAM



"study of stream physical characteristics and factors affecting them"

Dimension (cross-section)

Pattern (plan form)

Profile (bed form)

Bed material (substrate size)


Bed Material

Sediment Transport

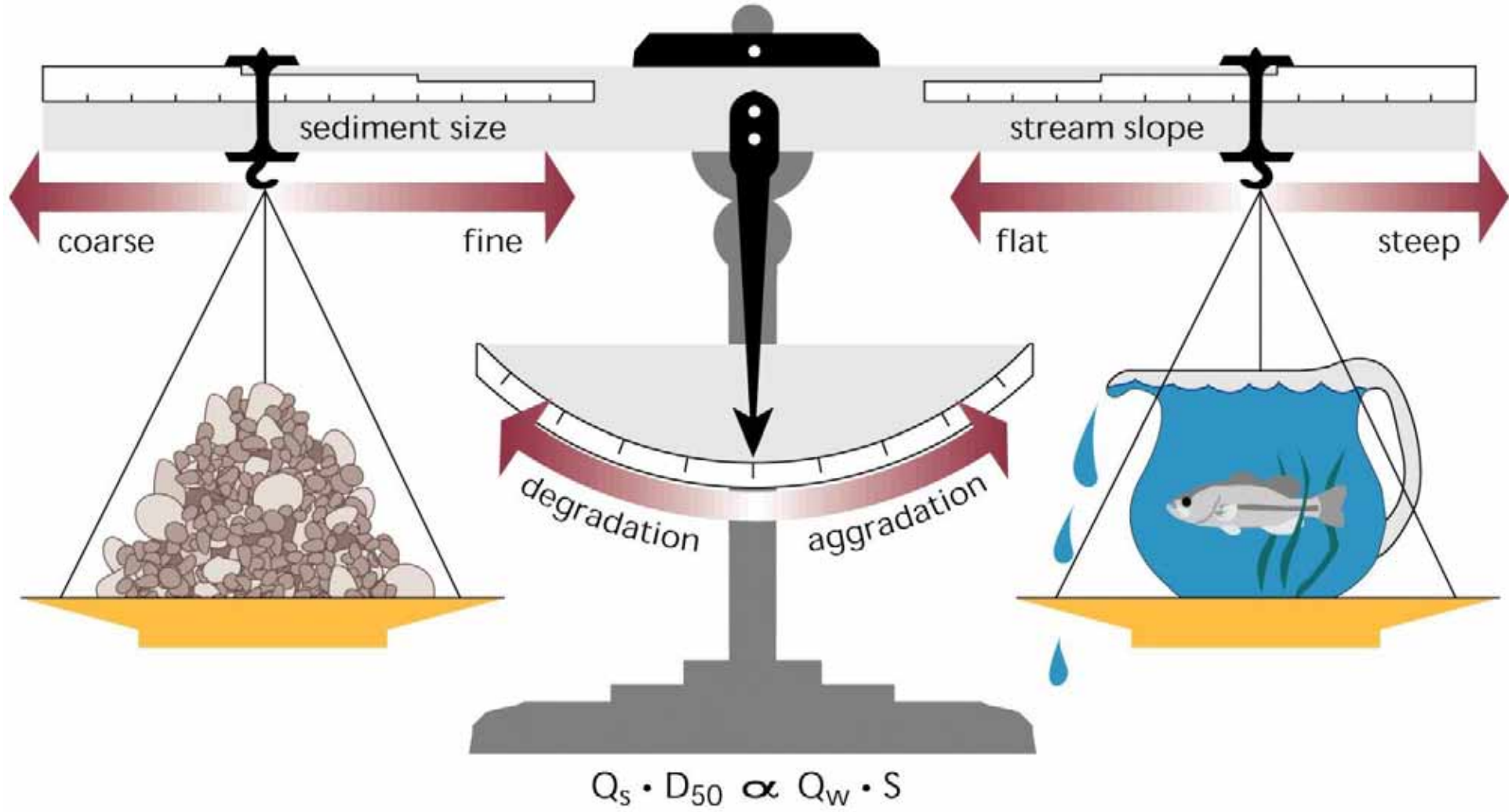
Total Sediment Load = Dissolved Sediment + Suspended Sediment + Bedload

Bedload: material that rolls, skips, slides or hops along the bottom of the stream

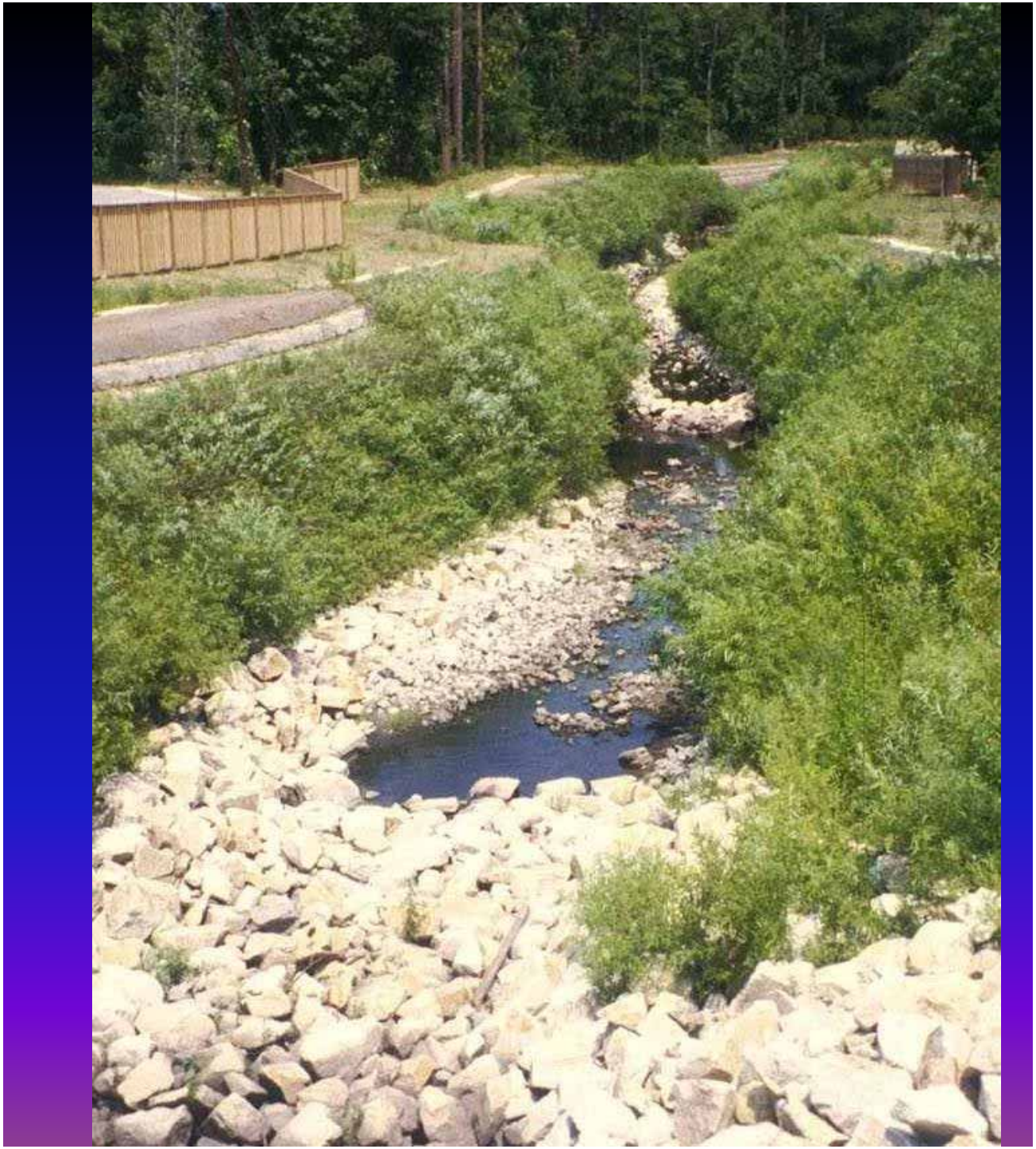
Capacity: total load that can be transported by a stream (maximum volume of sediment & debris that stream can carry) related to discharge

Competence: stream's ability to move large particles available to the stream system as bedload

Lane's Stream Balance Relationship



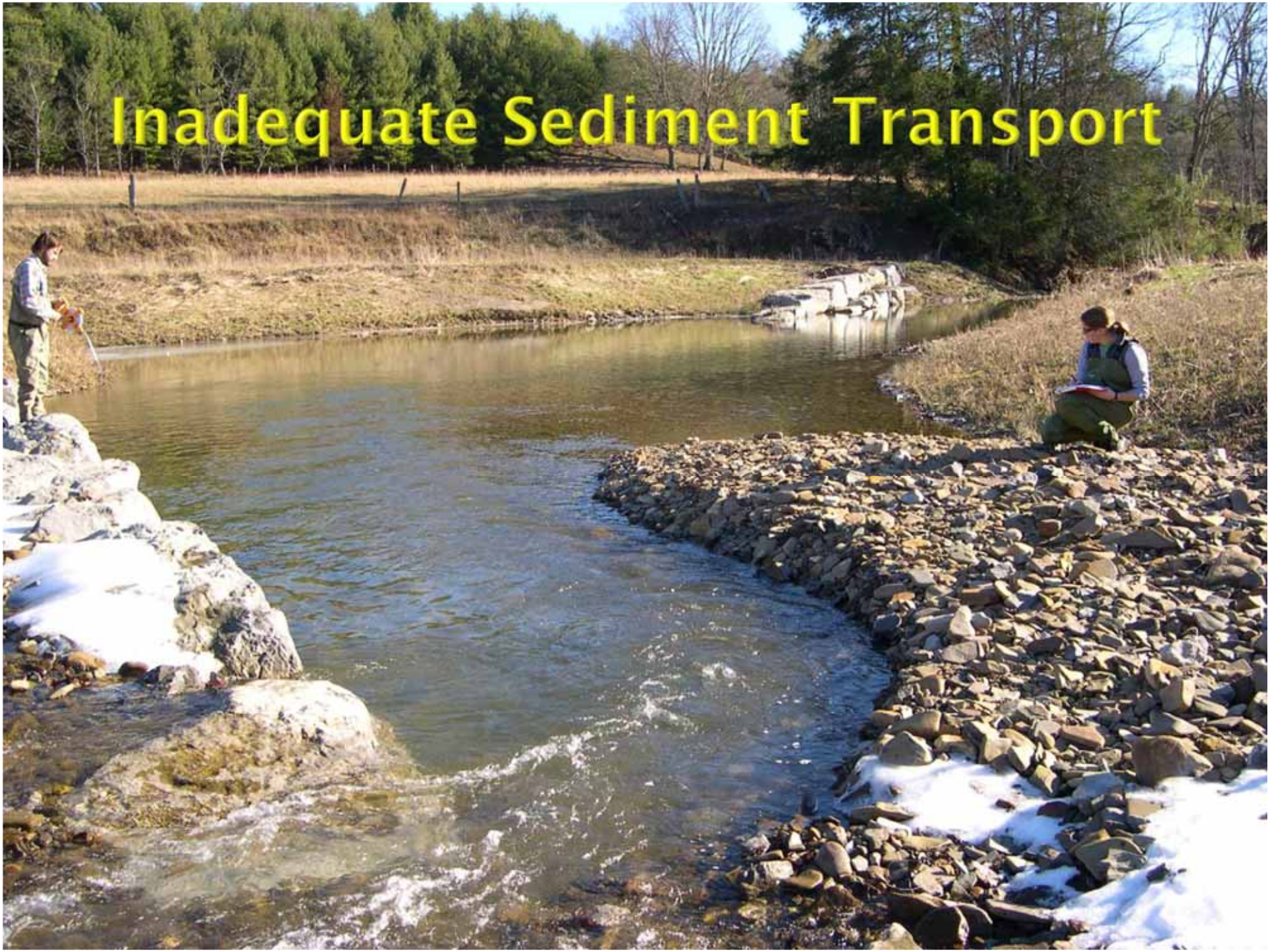

Common Objectives of Geomorphic Stream Design Projects
Restoration of Stream Functions:
– Hydrology
– Hydraulic
– Geomorphology
– Physiochemical
– Biology



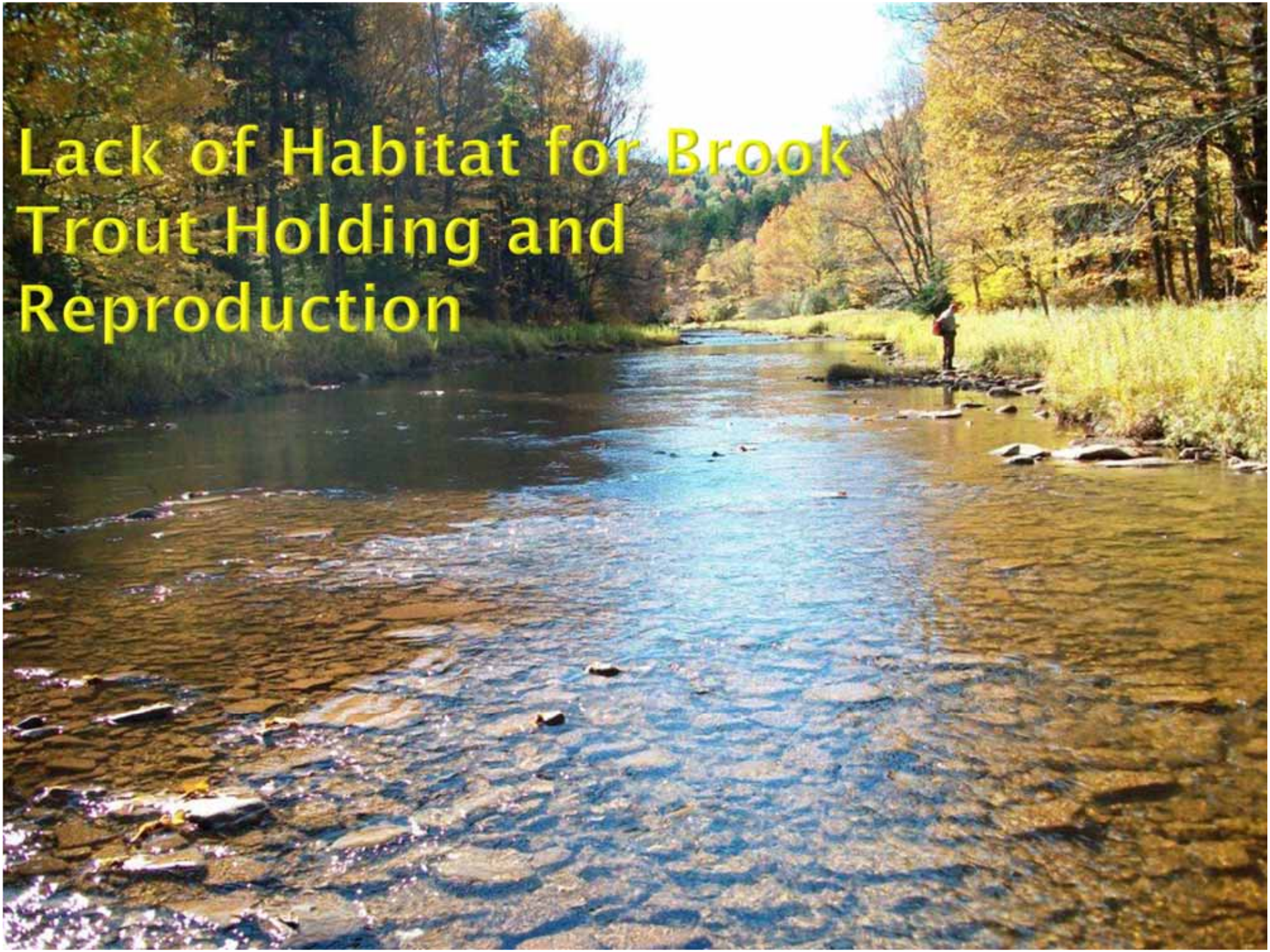
This traditional design approach meets one of the stated objectives – Hydraulic (you have a stable channel to transport flow)


Geomorphic design approach meets the objectives of restoring hydrology, hydraulics, geomorphology; and when addressed in the design, will support restoration of physiochemical and biological functions over time.


Inadequate Sediment Transport
Due to Incorrect Structure
Selection


Inadequate Sediment Transport


Improper Use of
Double Wing Deflector

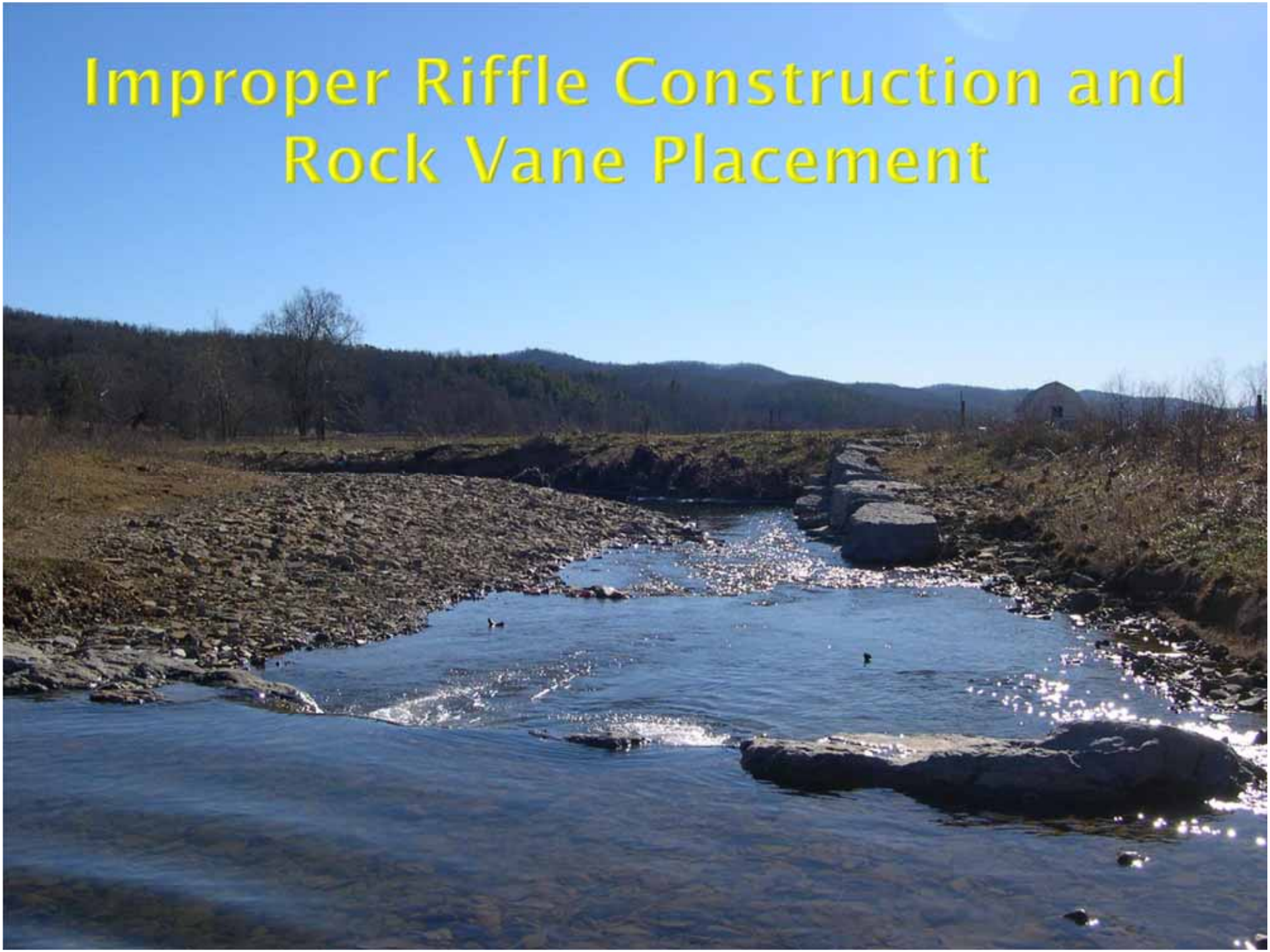

Lack of Habitat for Brook Trout Holding and Reproduction

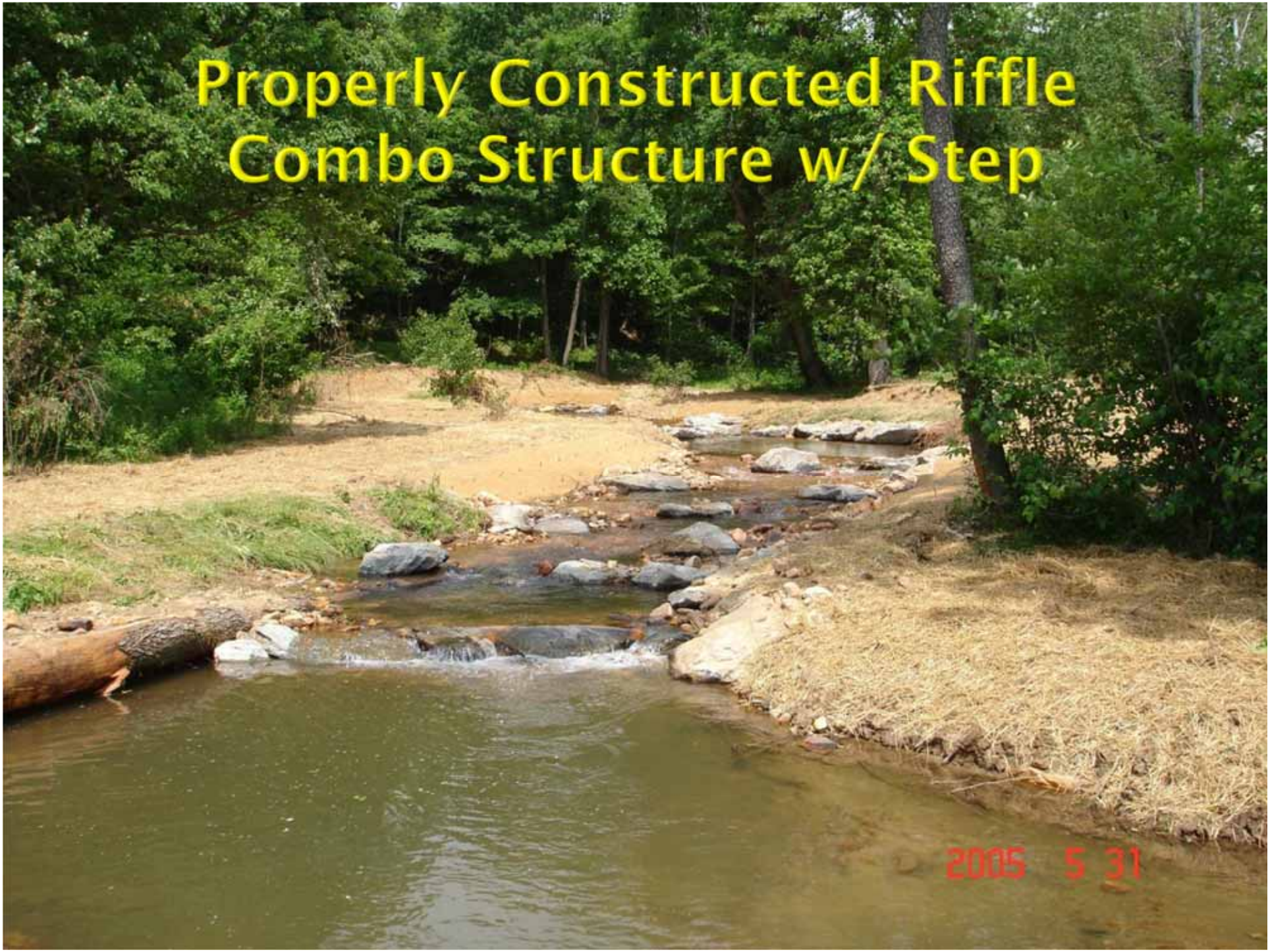

Pre-Construction
Width/depth Ratio Too High


Post-Construction

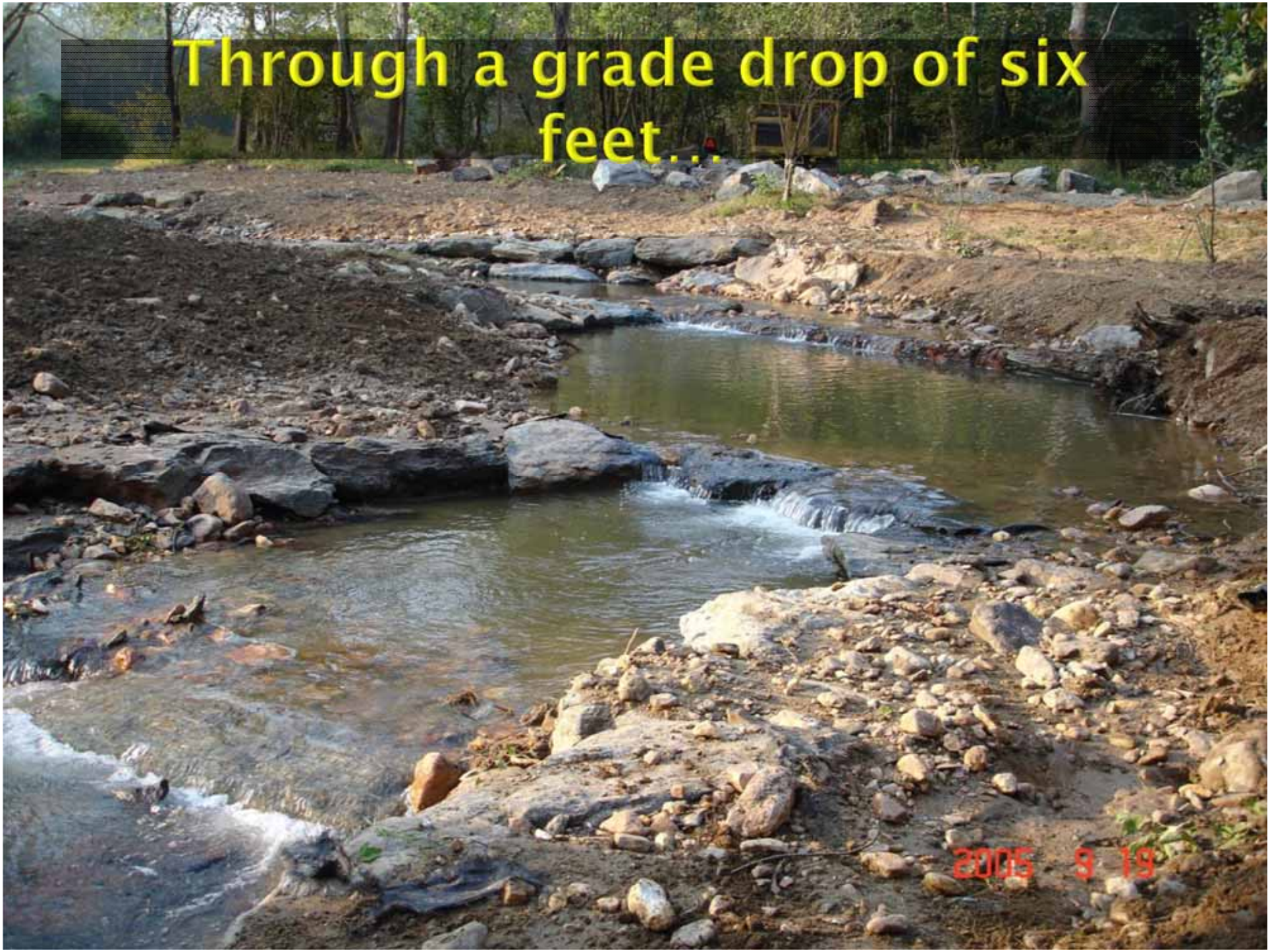

Improper Riffle Construction

Improper Riffle Construction and Rock Vane Placement




Properly Constructed Riffle
Combo Structure w/ Step
2005 5 31


Transition from Rosgen
Stream Type C4 to Type B4c
2005 9 19
Proper energy dissipation…


Through a grade drop of six feet…
2005 9 19


...in 200 linear feet of stream
2005 9 19

Bioengineering (or Soil Bioengineering)

- Applied science
- Combines mechanical, biological and ecological concepts
  - Surface erosion control
  - Habitat enhancement
  - Aesthetic improvement
  - Soil reinforcement
  - Bank armoring
  - Grade stabilization
- Creates a living structure for slope stabilization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Brush mattress - Rosgen Type E

Brush Layering with Rock Vanes

Restored Bank

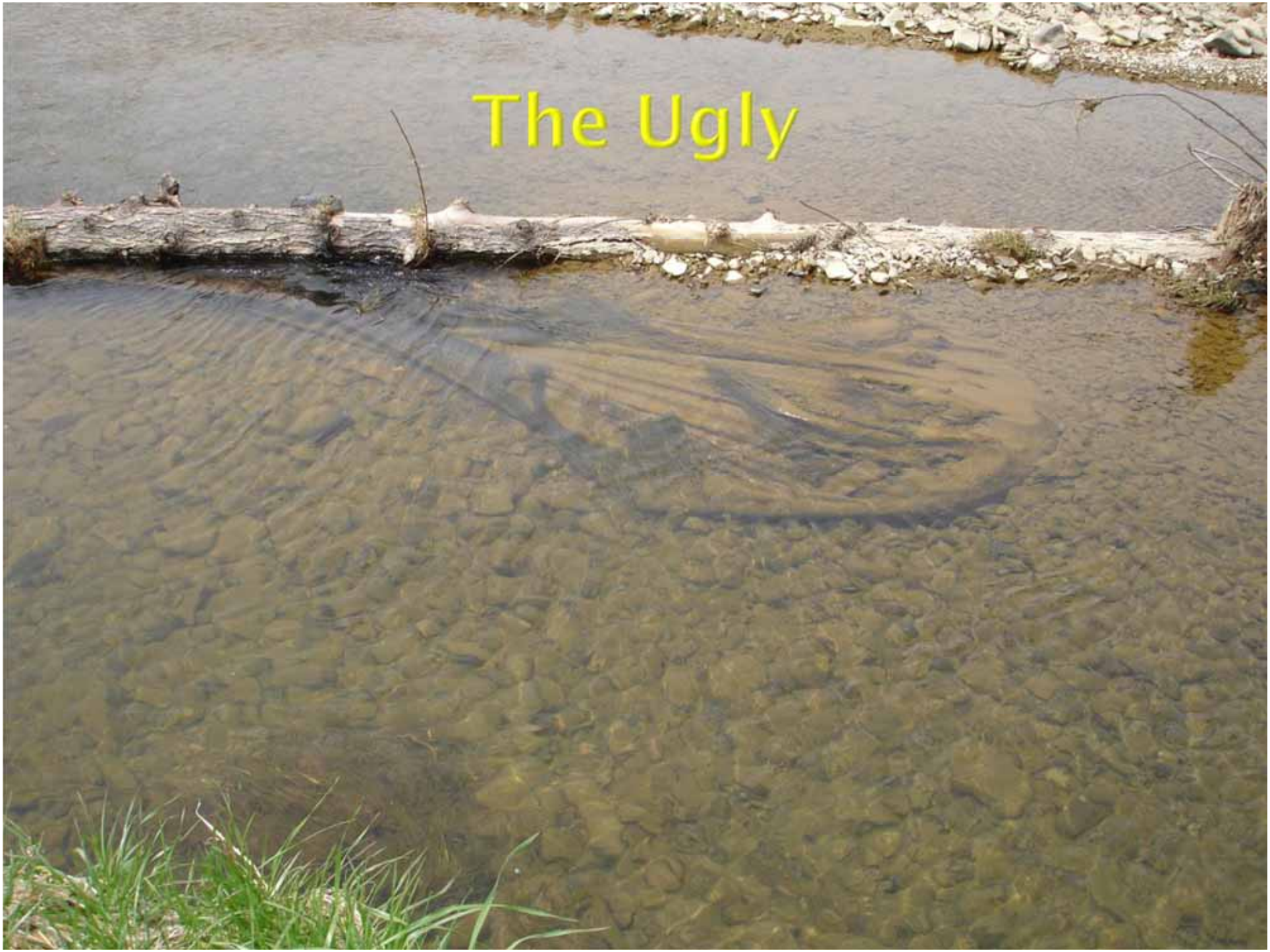
Horseshoe Run – Falls Site – Preconstruction 8-2006
View looking downstream towards confluence with Cheat River

Horseshoe Run – Falls Site – Post-construction 6-2007
View looking downstream toward confluence with Cheat River

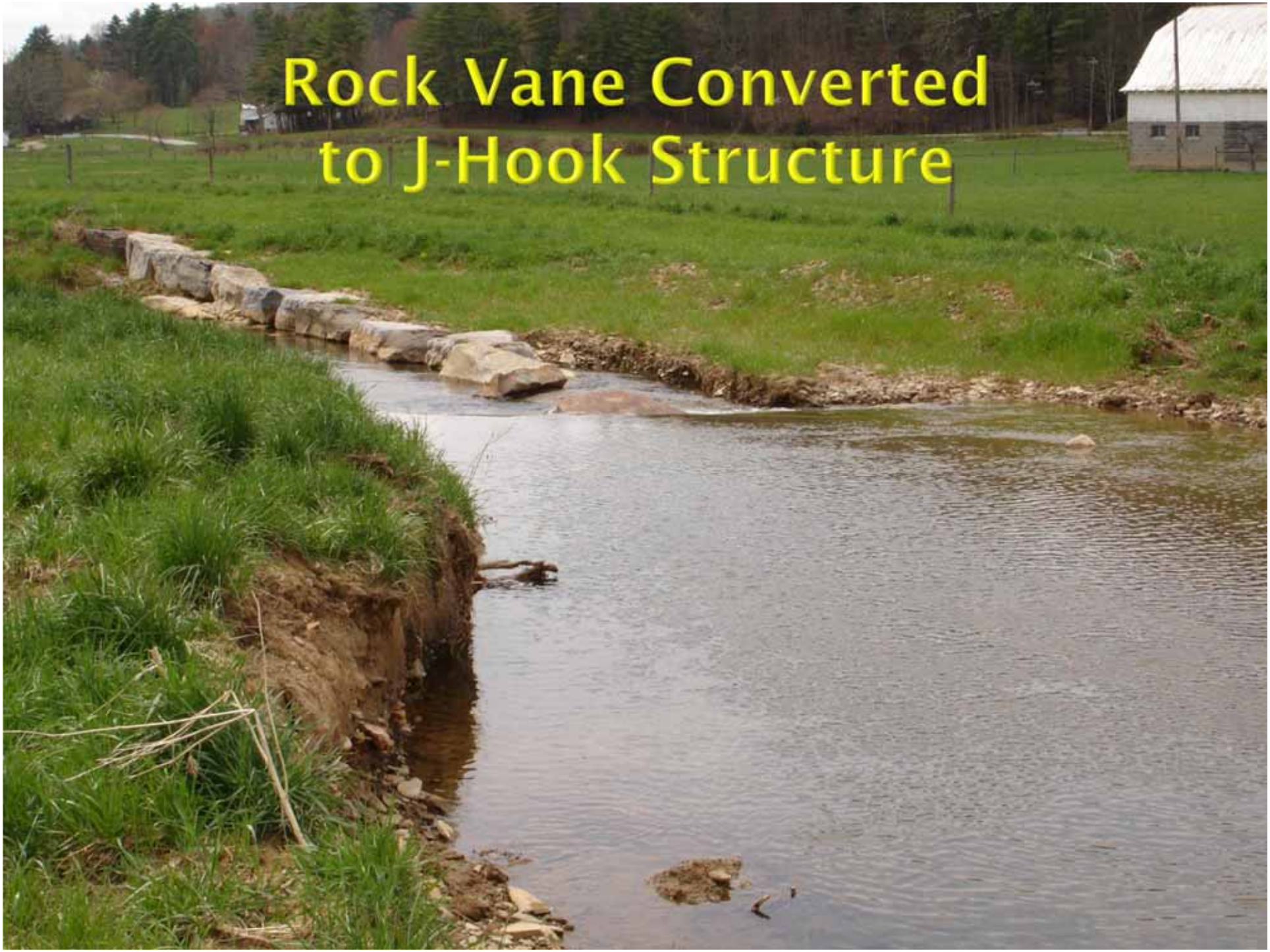

Fall 2007


The Good


The Bad - Failed Combo Structure

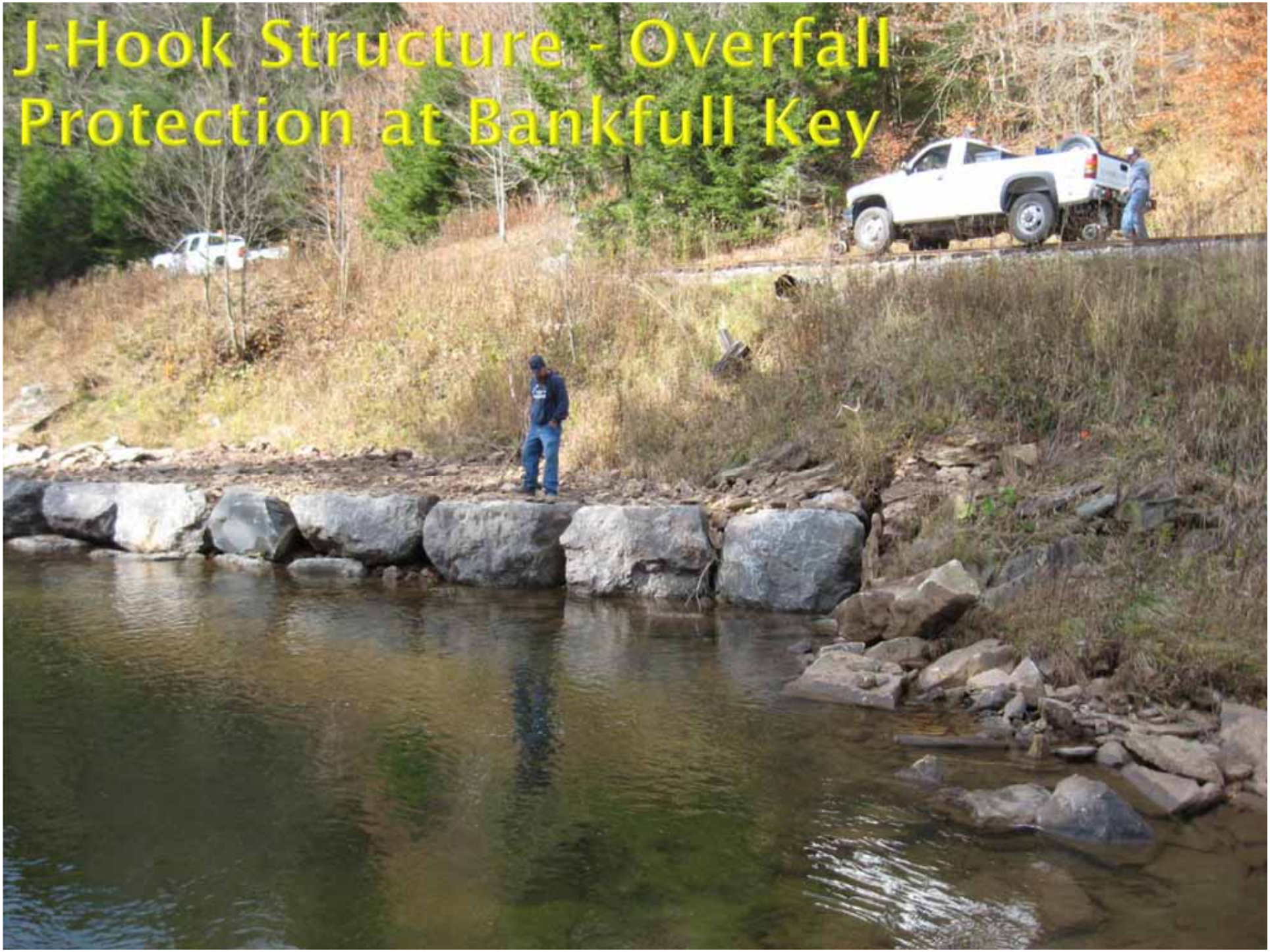

The Ugly

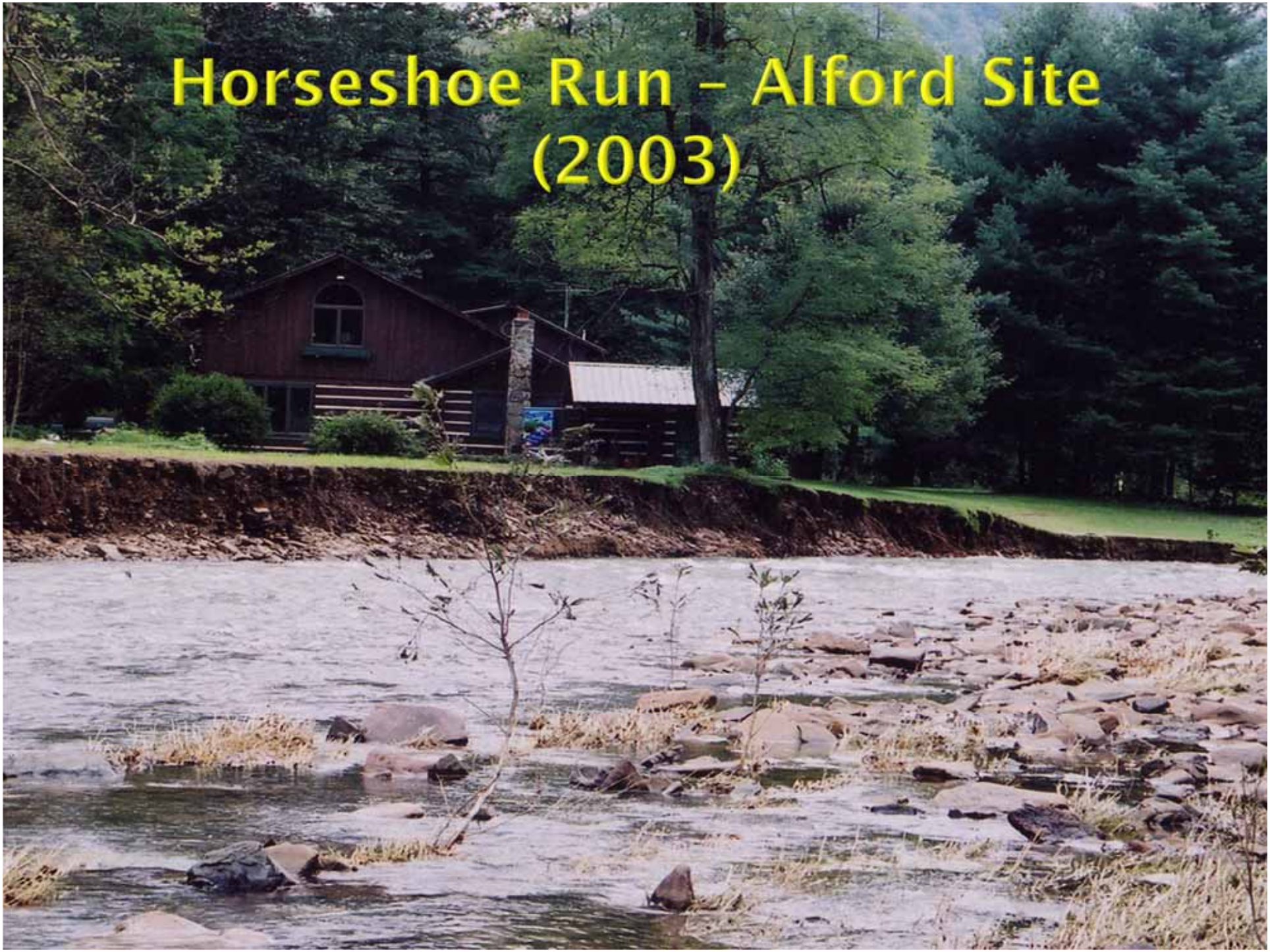

Installation of Combo Structure
installed without woven
geotextile


Rock Vane Converted
to J-Hook Structure

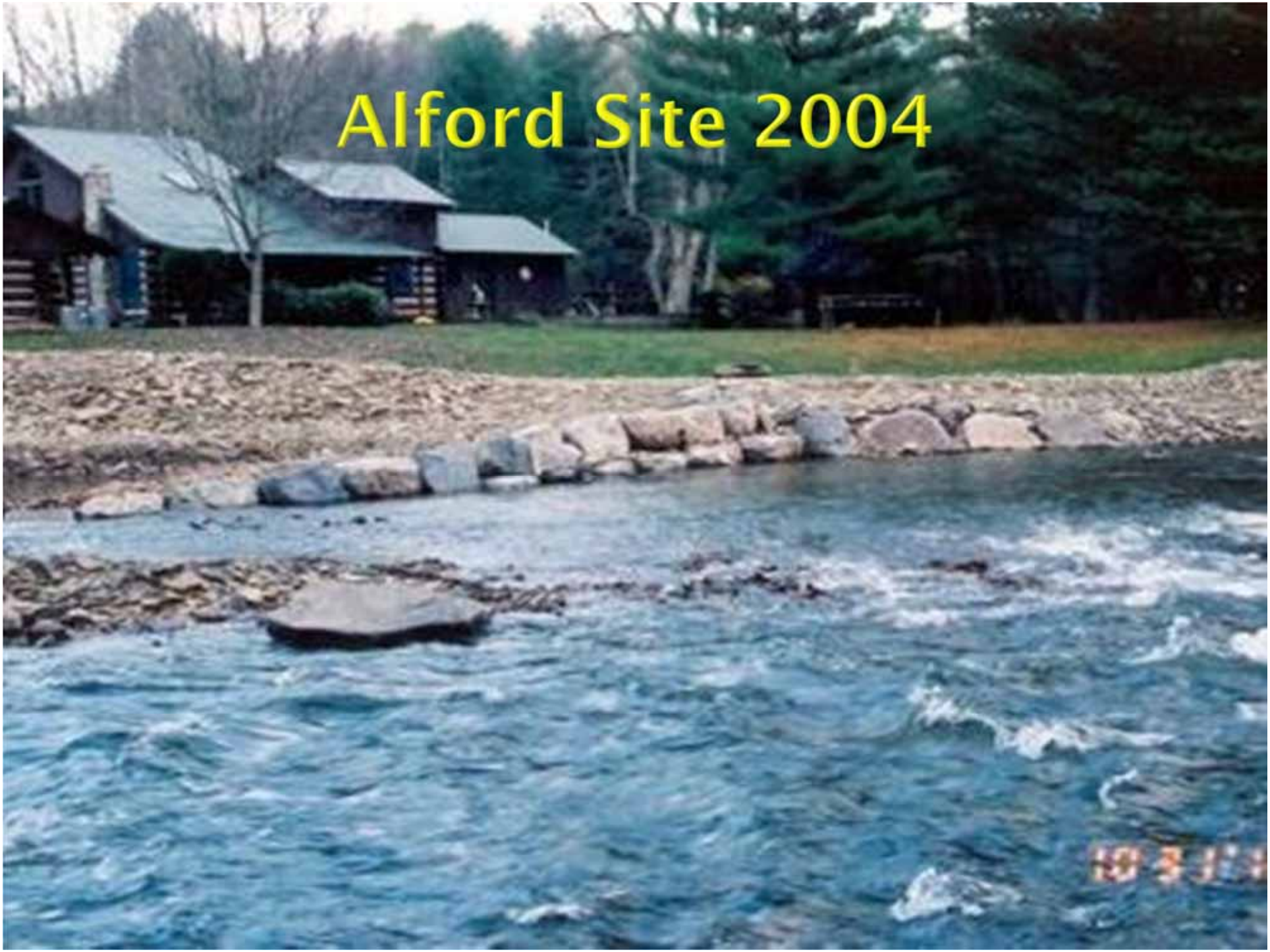

Contractor Error


Flexibility during
Construction


J-Hook Structure - Overfall
Protection at Bankfull Key


Horseshoe Run – Alford Site
(2003)


Alford Site After Emergency Repair
November 2003


Alford Site 2004


Alford Reach – August 2007
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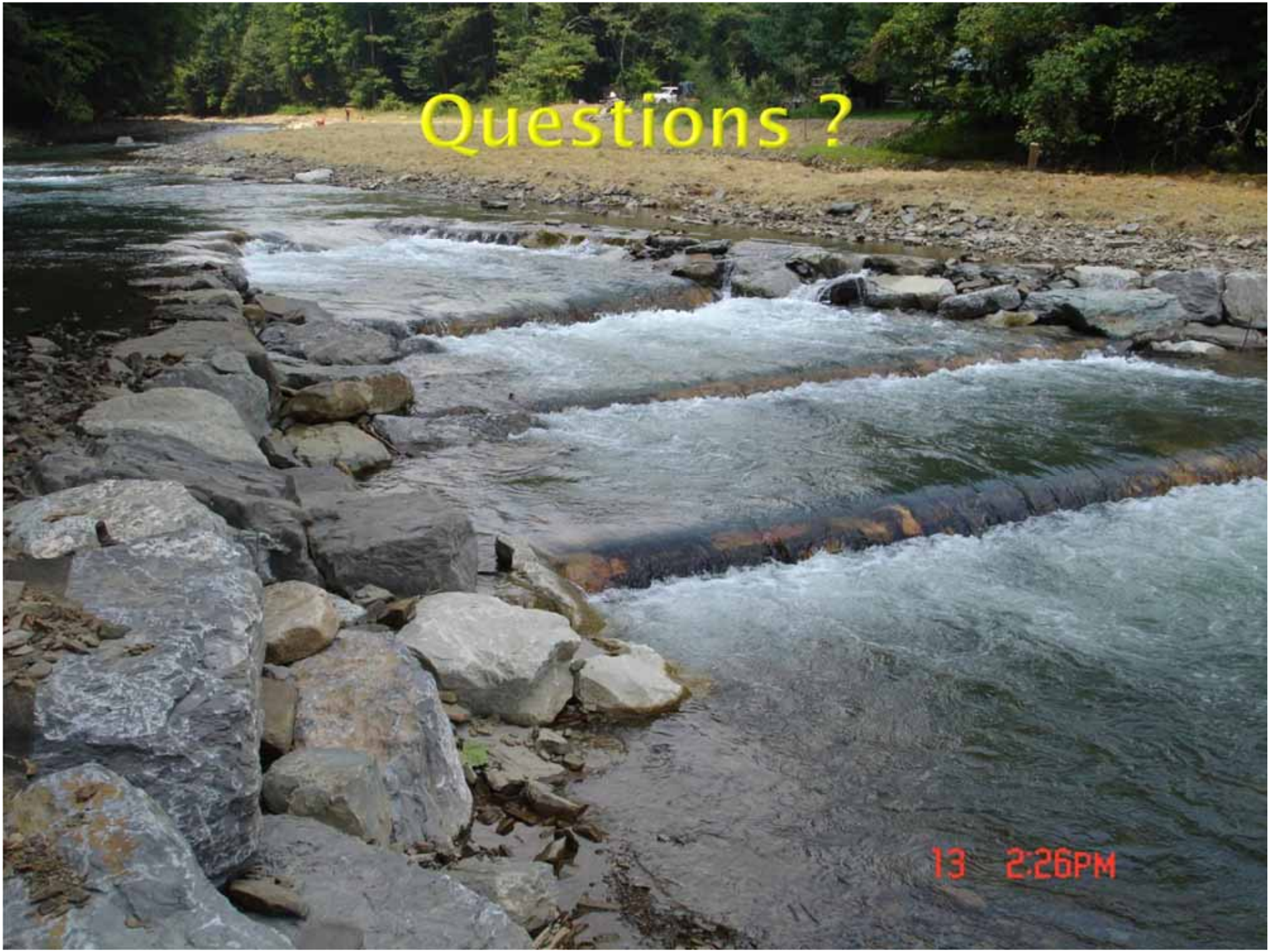
Questions ?
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