RIVER RESTORATION
Fundamentals

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Objectives

- *Develop a basic understanding of how streams function*
- *Appreciate some of the less intuitive points about streams, floodplains and riparian areas*

Why do streams do what they do?

Will we propose a solution that will help?

Can we do *anything* that helps?
Gunnysack
Creek

We will make all problems
as simple as possible.
But not more so.

- Albert Einstein

Common Sense is the collection of all our prejudices learned by age 18....
- Albert Einstein

Everybody wants to tap the Columbia! *Shown below are seven of the plans most frequently suggested for developing new irrigation water in the West. Biggest is NAWAPA (solid blue line), which would bring water from Alaska and Canada and spread it over most of the West, even linking up with the Great Lakes via canals. But that would take 30 years, cost $100 billion. In the center of current debate are the Pirkey (dashed blue line), the Dunn (dashed black line) and the Nelson (dotted blue line), all of which would use Snake or Columbia water. Udall and NESCO plans would transfer water from northern California rivers to Southern California, Arizona.*

How DYNAMITE streamlines streams

Straightening of Pequest River in New Jersey by CCC workers stopped its yearly floods. Formation of new channel is seen at right. Note temporary dam at left to provide volume of water for scouring blasted channel.

Explosion of dynamite charge by propagation excavates new channel.

Immediately after explosion, water is entering new channel, whose banks will be smoothed and "stream-lined" by the speedier flow of water.

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.

In many instances straightening out a stream has doubled its capacity for disposing of run-off water.

DYNAMITE may be used most efficiently and economically in taking the kinks out of a crooked stream. The dynamite is loaded along the length of "cut-off" channel. When fired, the dirt and other debris is heaved high in the air and is scattered over the adjoining territory—leaving practically no spoil-banks. In addition to the material actually thrown out, much dirt is loosened and is later scoured out by the water which rushes swiftly through the straightened channel.

Du Pont Dynamite has straightened many thousands of miles of crooked streams. Du Pont engineers have worked for years to develop the best blasting methods for the cleaning out and straightening of streams. All their data is in a 48-page book, "Ditching with Dynamite." It is for your use. Write for it.

Dynamite can help you do other jobs, too. It can help you build highways, dams; fight soil erosion; work quarries. Du Pont has an explosive for every purpose.

DU PONT

REG. U.S. PAT. OFF.

E. I. du Pont de Nemours & Co. Inc.
Explosives Department
6107 du Pont Building
Wilmington, Del.

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Balancing Stream Management

Flooding

- Lower velocities
- More in-channel roughness
- Sediment deposition

Erosion

- Higher velocities
- More "efficient" channels
- Sediment transport

Elevation Matters

Channel Forming Flow

- Often called bankfull, but that is a misnomer
- The flood elevation where the channel does the most ‘work’ (moving sediment and water)
- Look for the gravel and sand deposits to determine CFF elevation

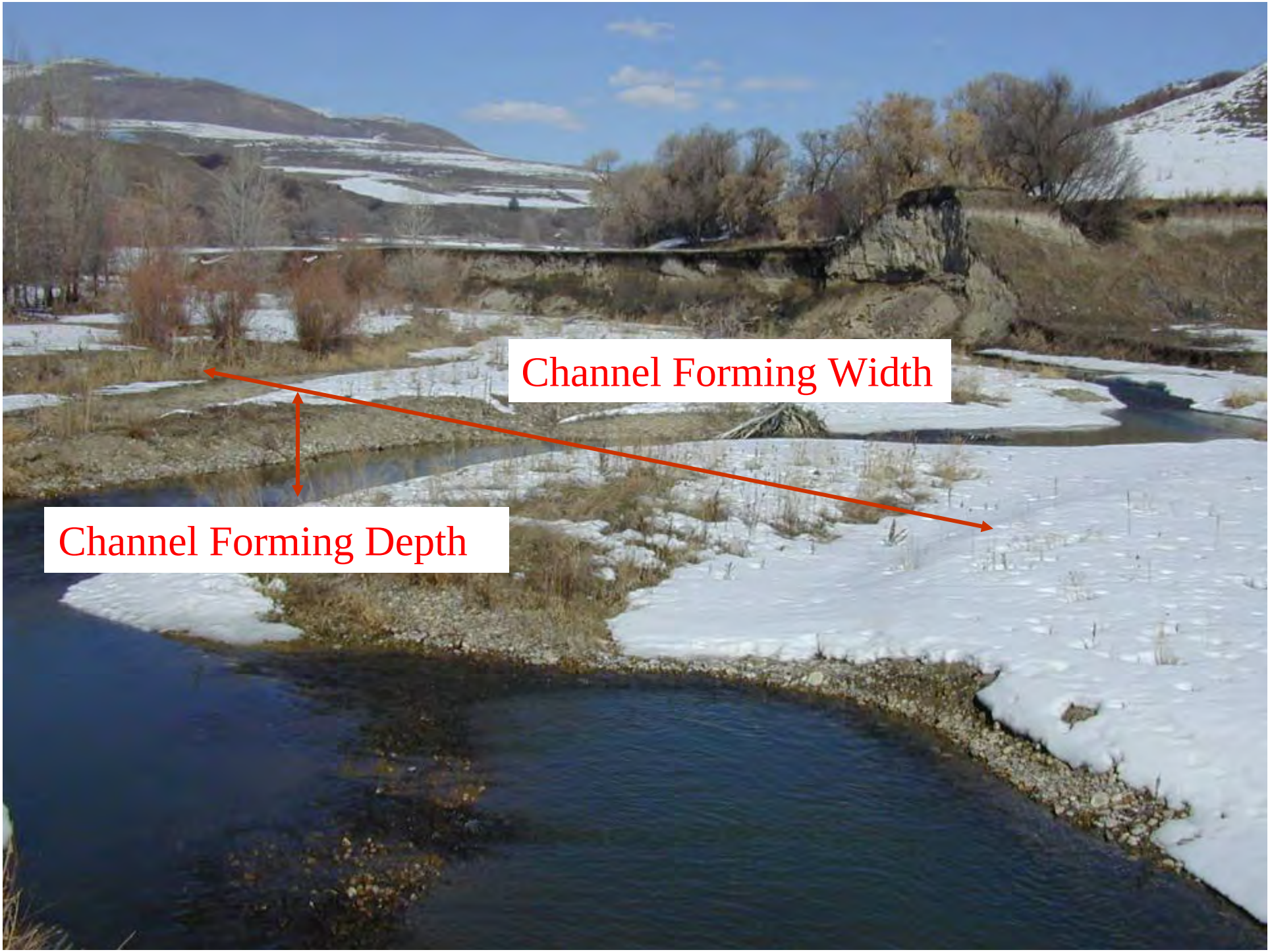
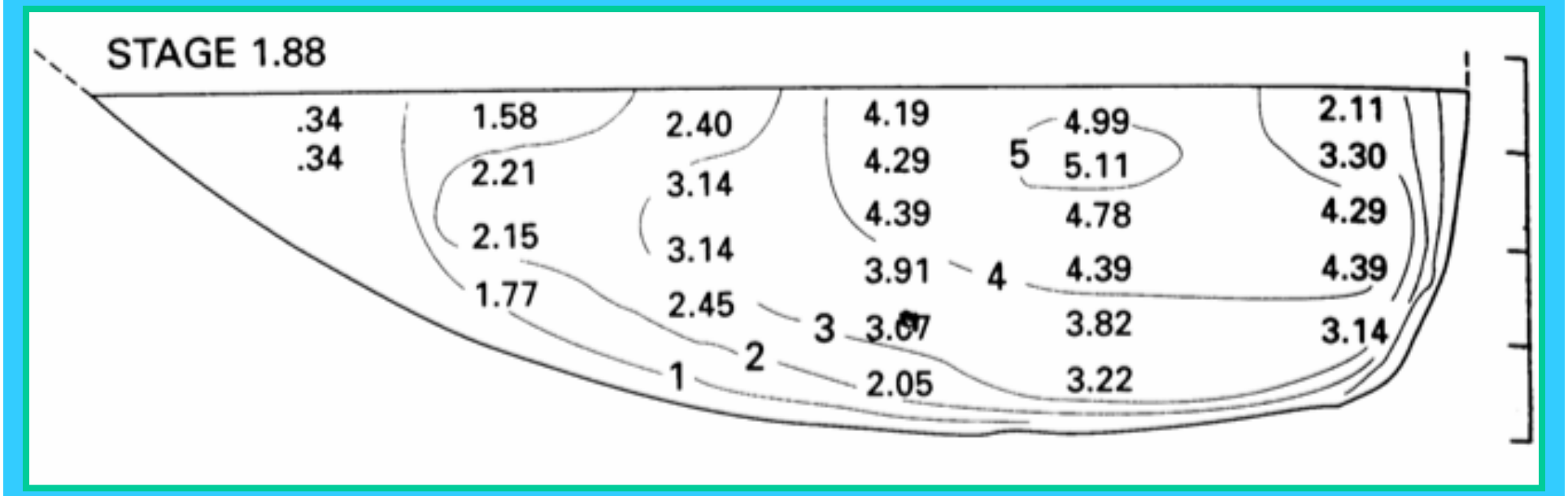

Channel Forming Width
Channel Forming Depth

Fig. 1.19 – Bankfull discharge. This is the flow at which water begins to leave the channel and move onto the floodplain.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).

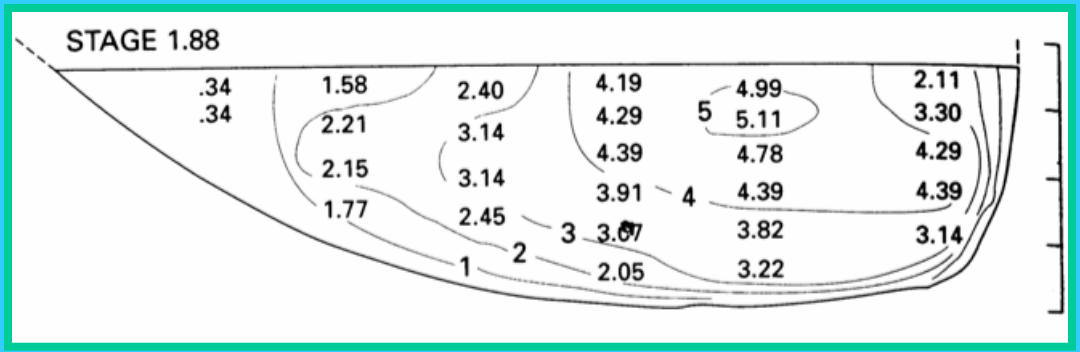
Rivers Flow in Corkscrews

Properties of Open Channel Flow: Velocity Distribution



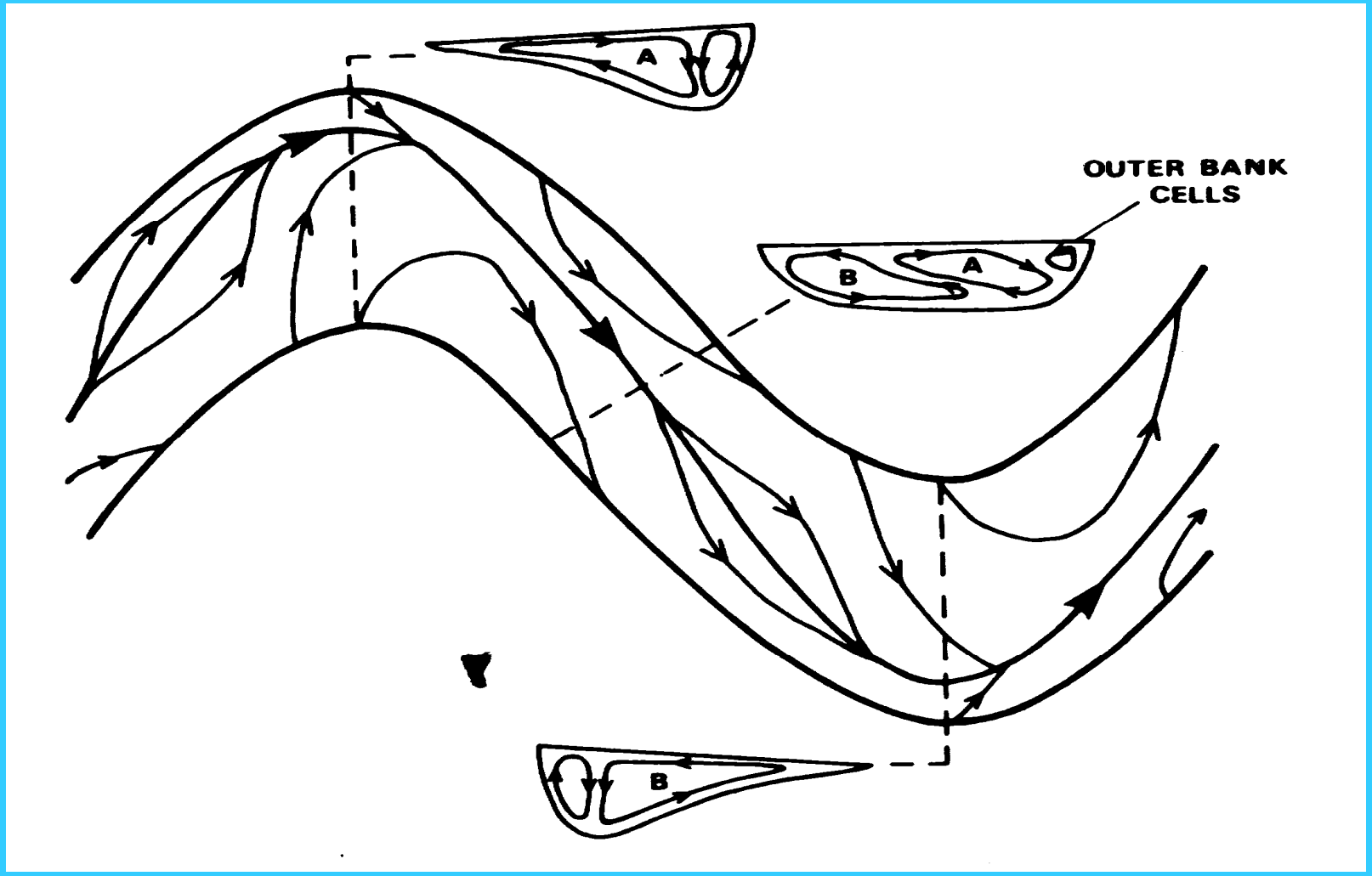
Leopold, 1994

Properties of Open Channel Flow: Velocity Distribution



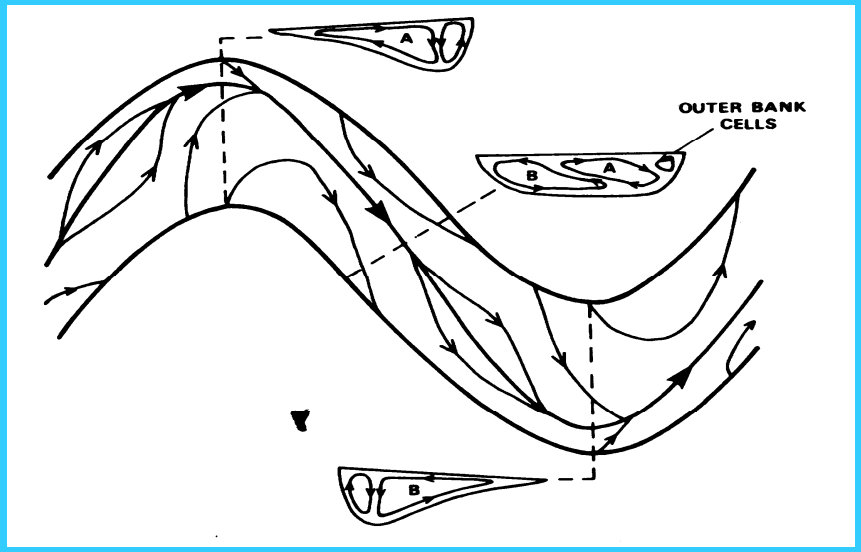
- Usually logarithmically distributed
- Relative roughness determines the distribution shape
- The lower the relative roughness, the steeper the velocity gradient away from the banks
- The steeper the gradient, the more erosive
- Velocity distribution induces vortical flow

Properties of Open Channel Flow: Vortical Flow



Properties of Open Channel Flow: Vortical Flow

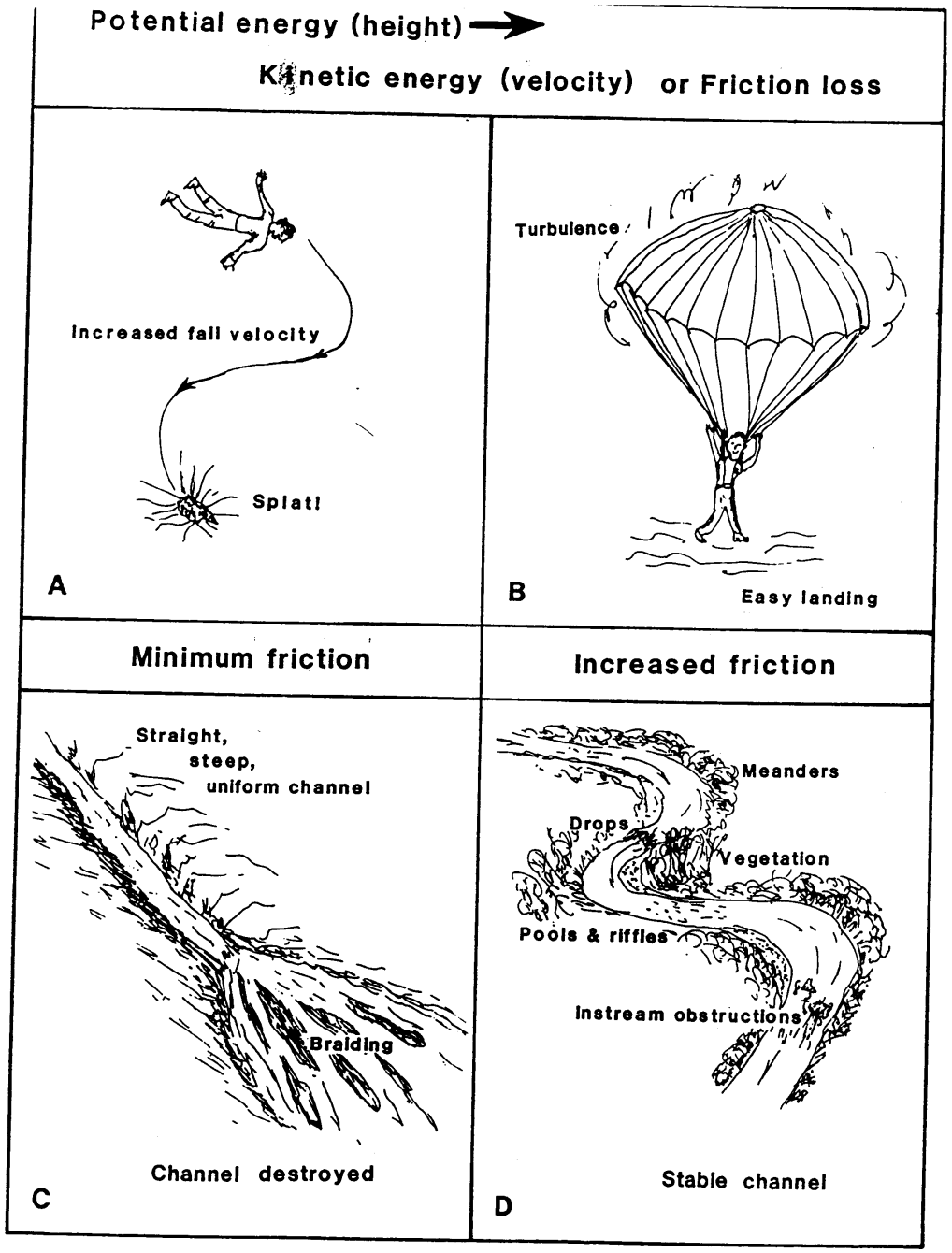
- Conceptually, the stream flows in helix pairs (corkscrews)
- Each helix contains the same amount of energy
- Size of the helix is proportional to channel roughness
- Small helix is very erosive



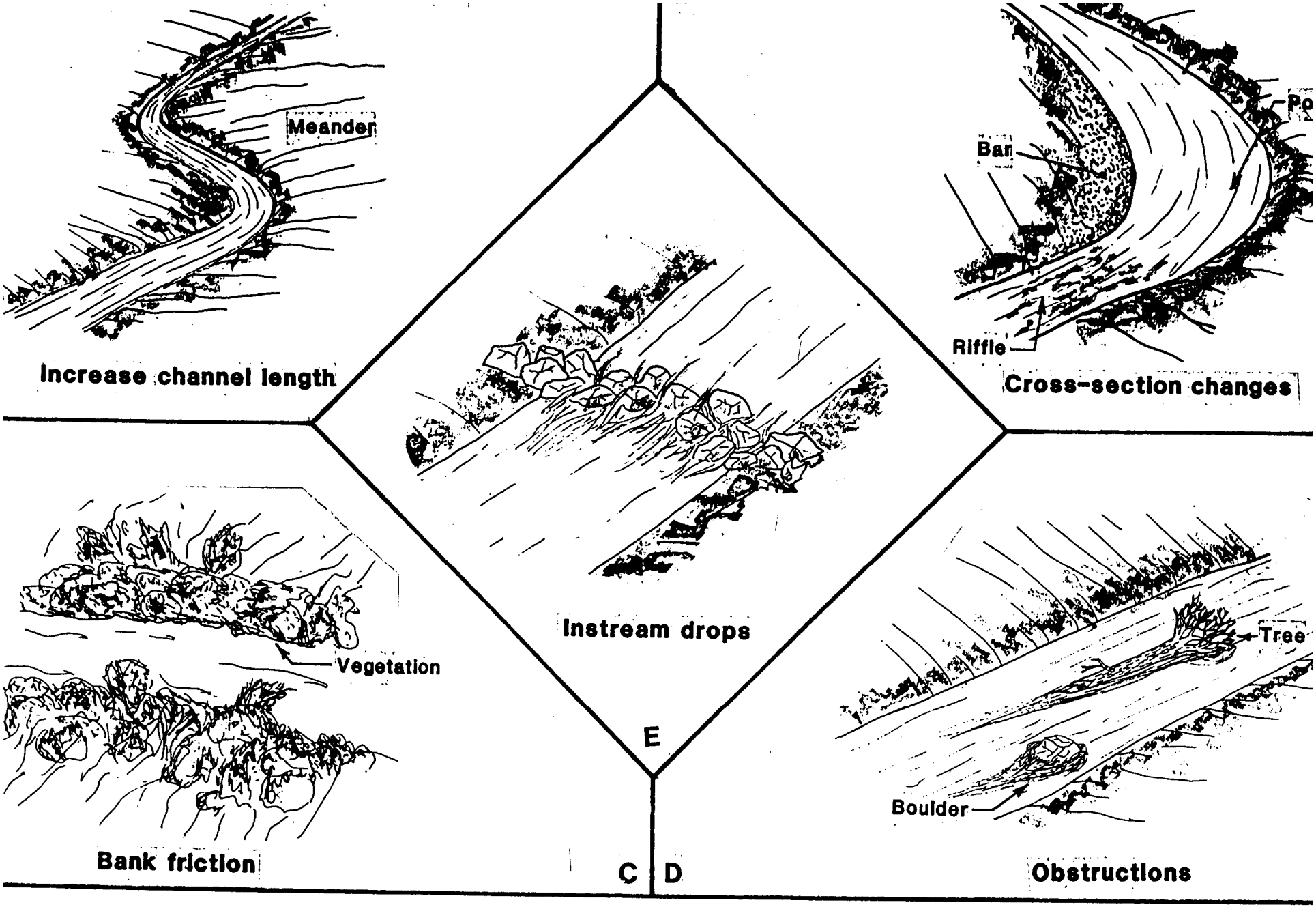
Properties of Open Channel Flow: Bed and Bank Roughness

- Relative bank roughness may determine where bank erosion will take place.
- Bed material size compared to depth is called relative roughness. High values indicate constantly changing stream. Low values more stable streams.

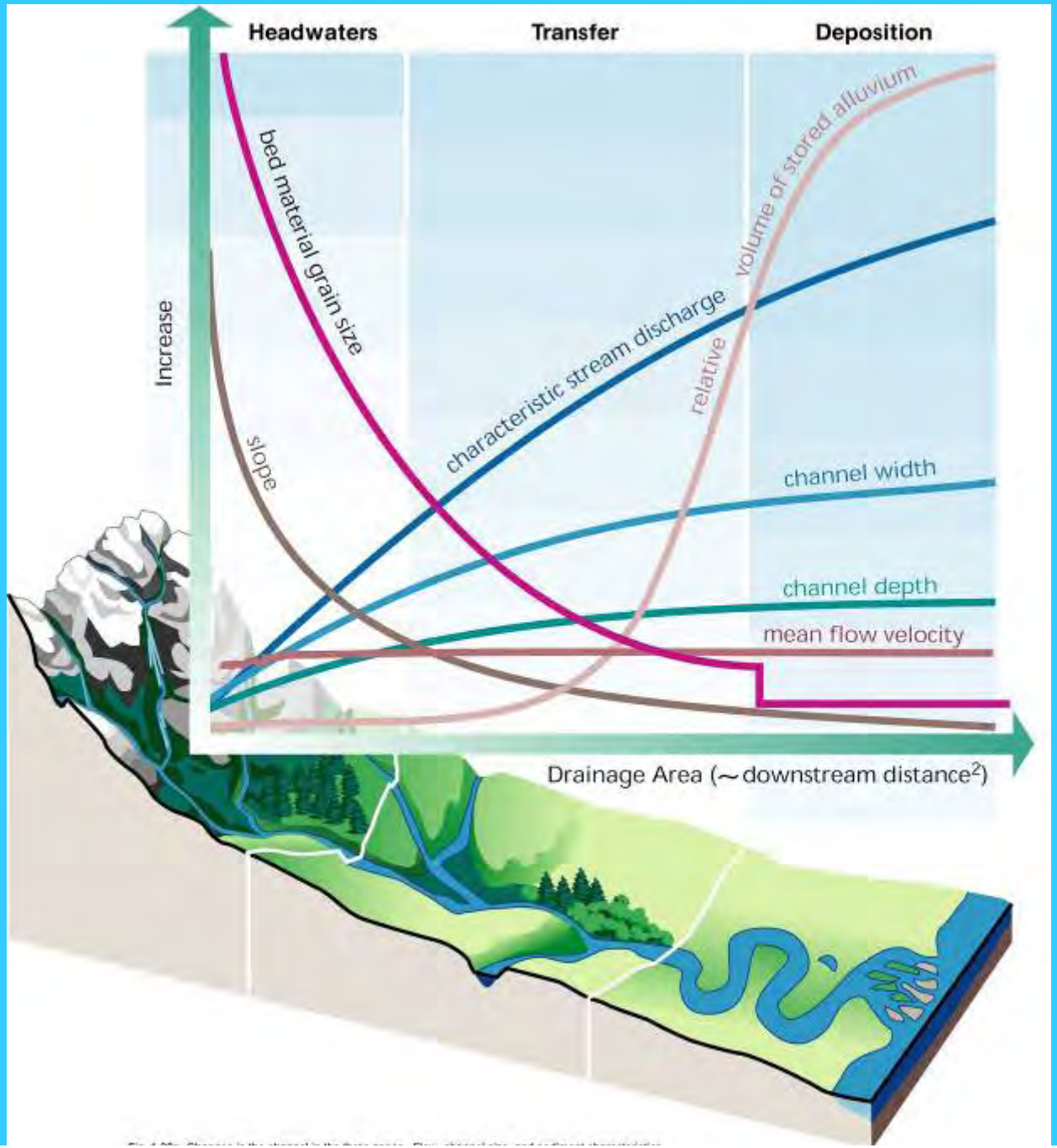
Roughness Matters

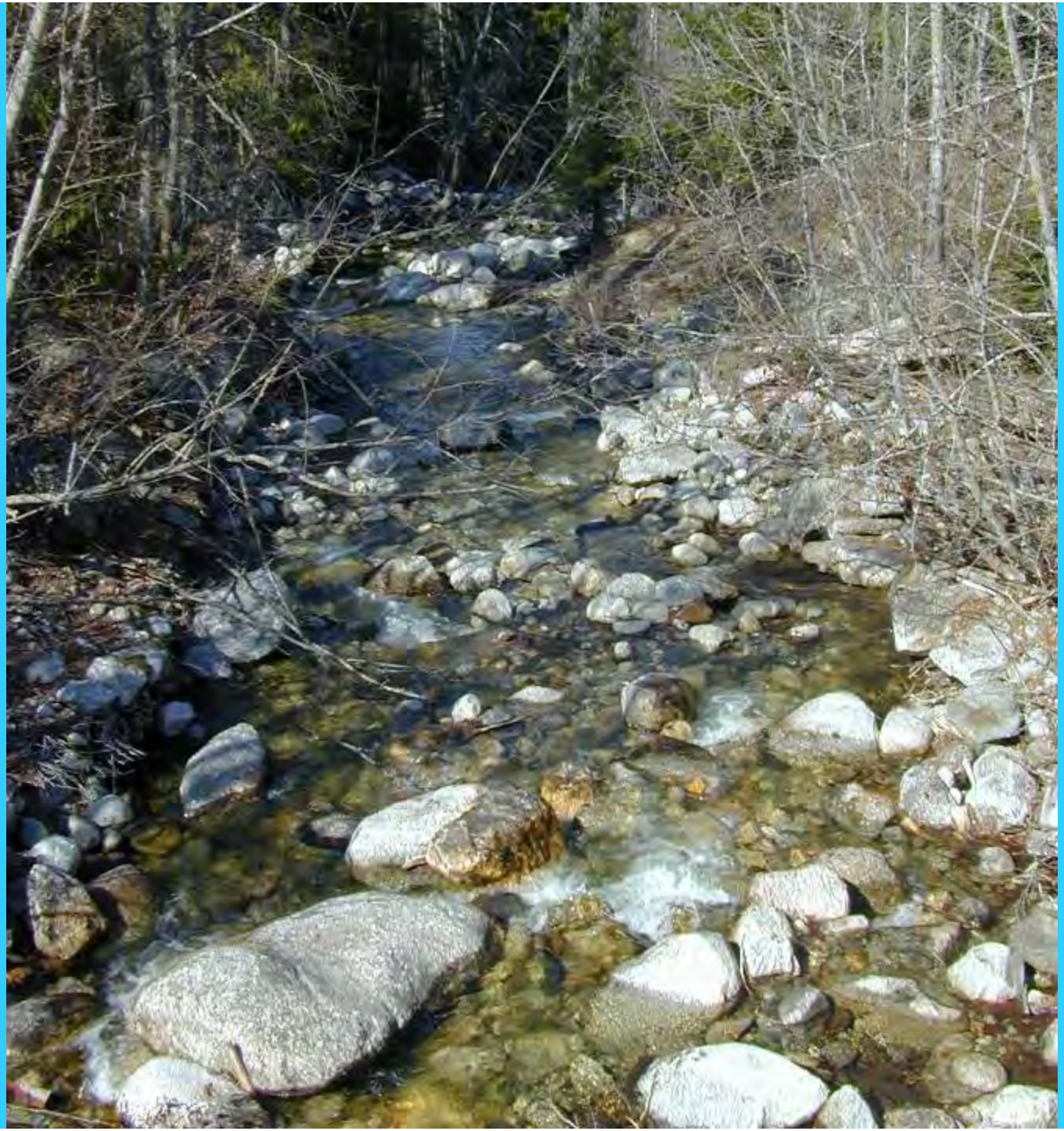


GRAVITY SYSTEMS



Energy Dissipation Methods

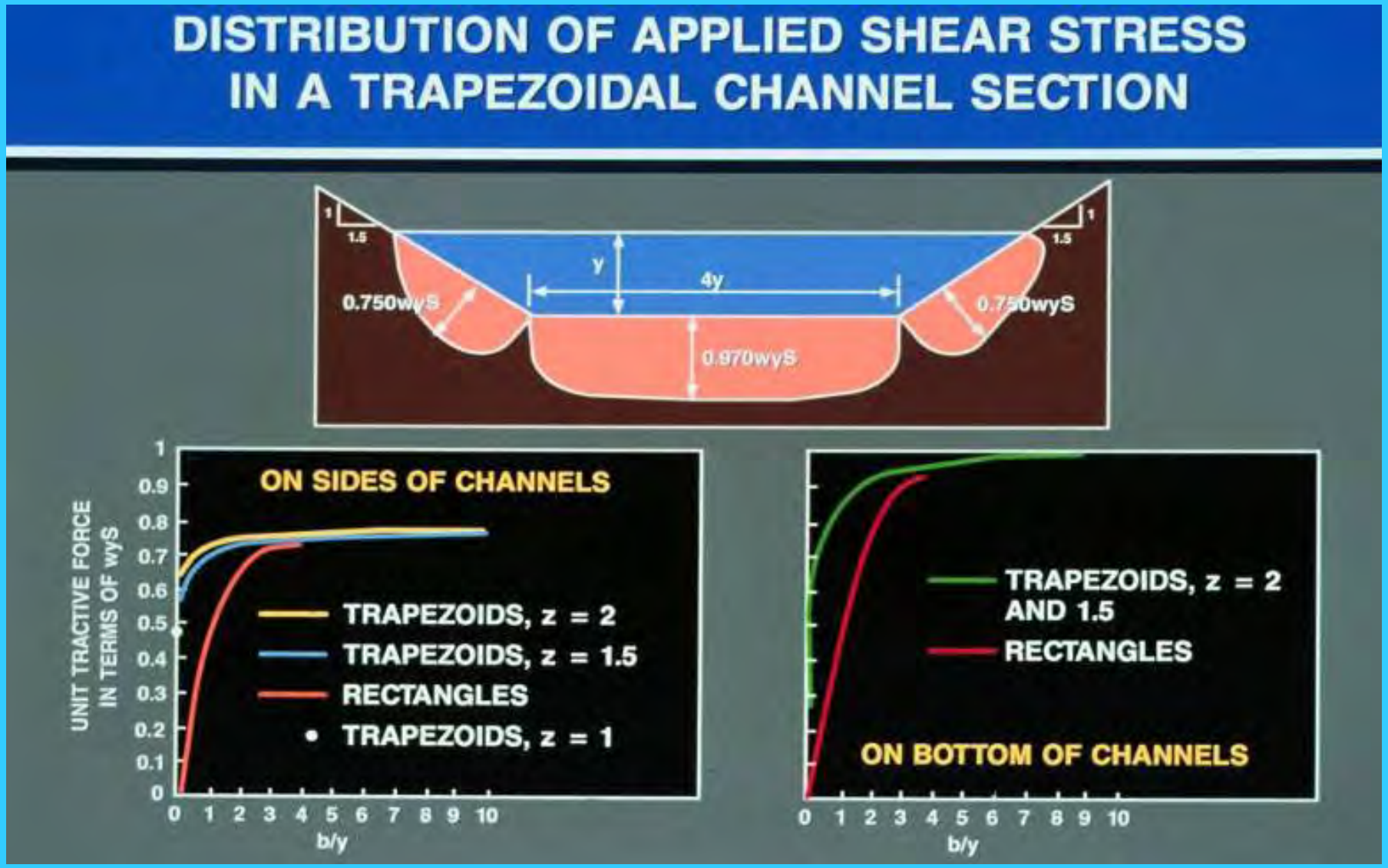

Headwaters
Transfer
Deposition
Increase
bed material grain size
slope
characteristic stream discharge
relative volume of stored alluvium
channel width
channel depth
mean flow velocity
Drainage Area (~downstream distance²)



10 5'9

Sediment Makes Roughness

Calculating Bed Shear Stress:



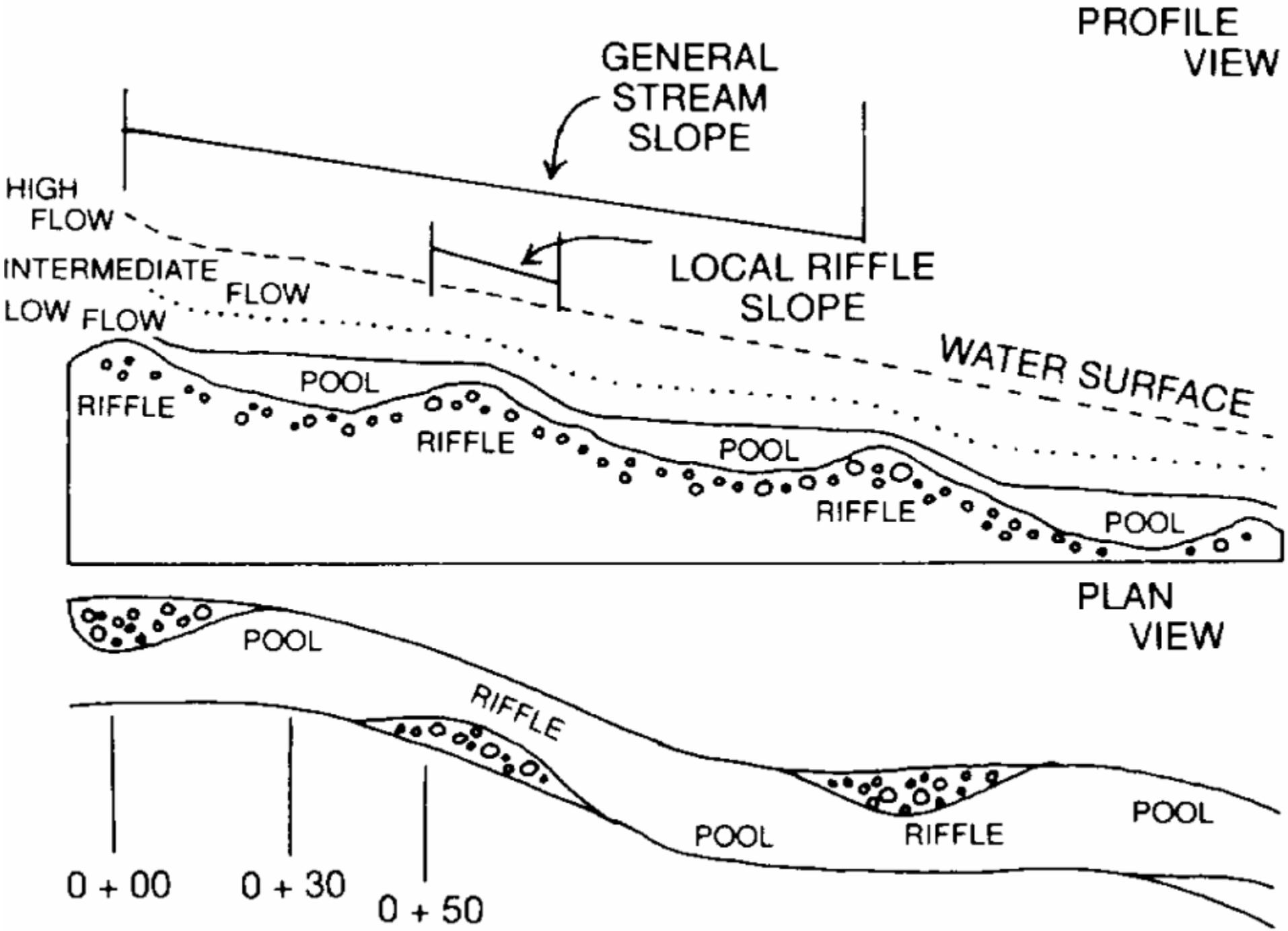
Calculating Bed Shear Stress:

For water flowing over a flat plate, with the surface and bed slopes are identical, and the depth and velocity constant and the width is infinite, the shear force per unit area exerted on the bed is given by:

$$\tau_o = \gamma d S$$

If the width is limited, the Hydraulic Radius replaces the depth:

$$\tau_o = \gamma R S$$


PROFILE VIEW
GENERAL STREAM SLOPE
HIGH FLOW
INTERMEDIATE FLOW
LOW FLOW
LOCAL RIFFLE SLOPE
WATER SURFACE
RIFFLE
POOL
RIFFLE
POOL
RIFFLE
POOL
PLAN VIEW
POOL
RIFFLE
POOL
RIFFLE
POOL
0 + 00
0 + 30
0 + 50

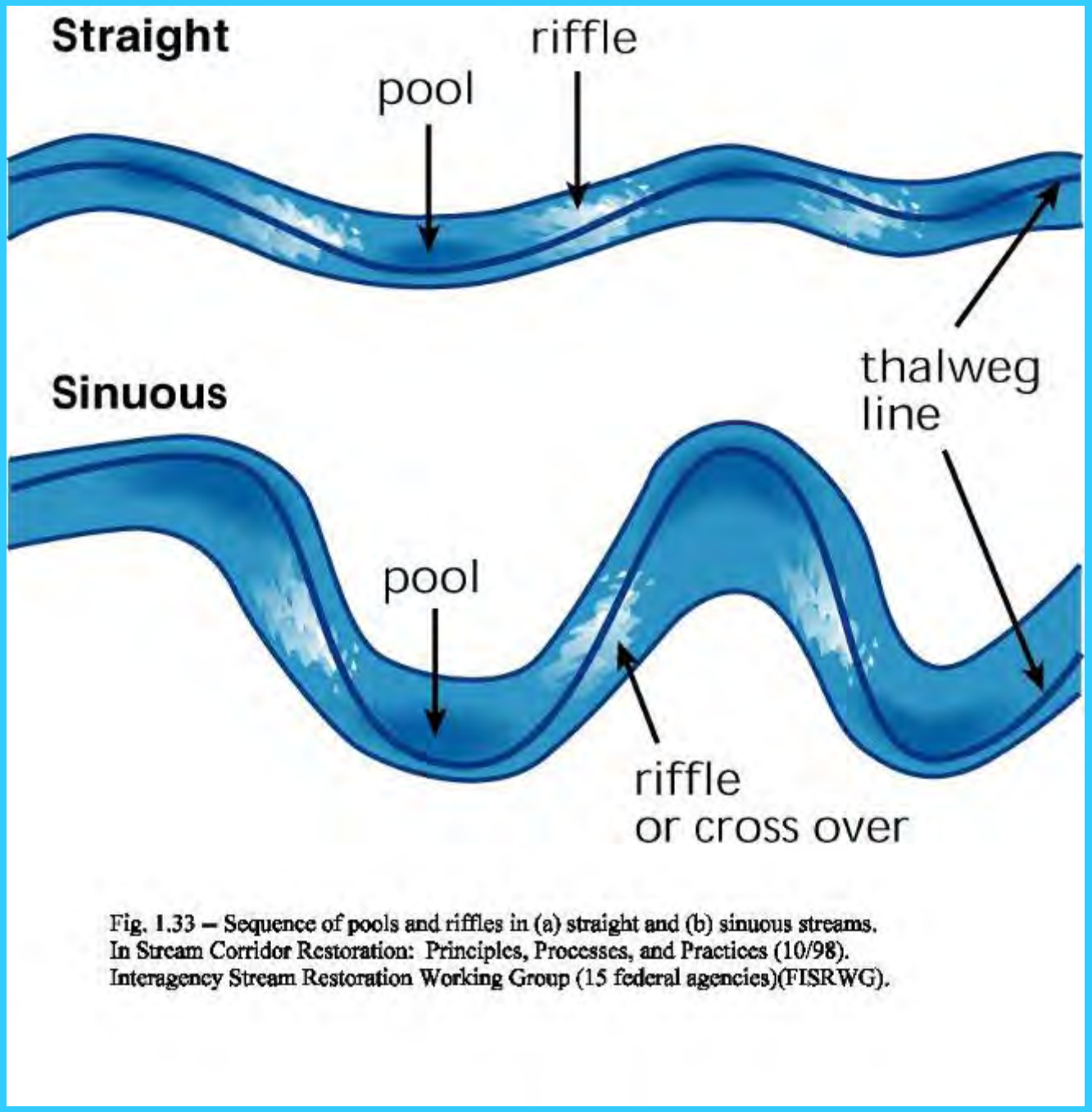


Fig. 1.33 – Sequence of pools and riffles in (a) straight and (b) sinuous streams.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).

Floodplains Matter

General Riparian Vegetation Concepts

Riparian vegetation is important because:

- It Stabilizes streambanks with extensive root systems.
- Shades the water
- Improves water quality
- Provides fish and wildlife habitat
- Builds streambanks by catching sediment

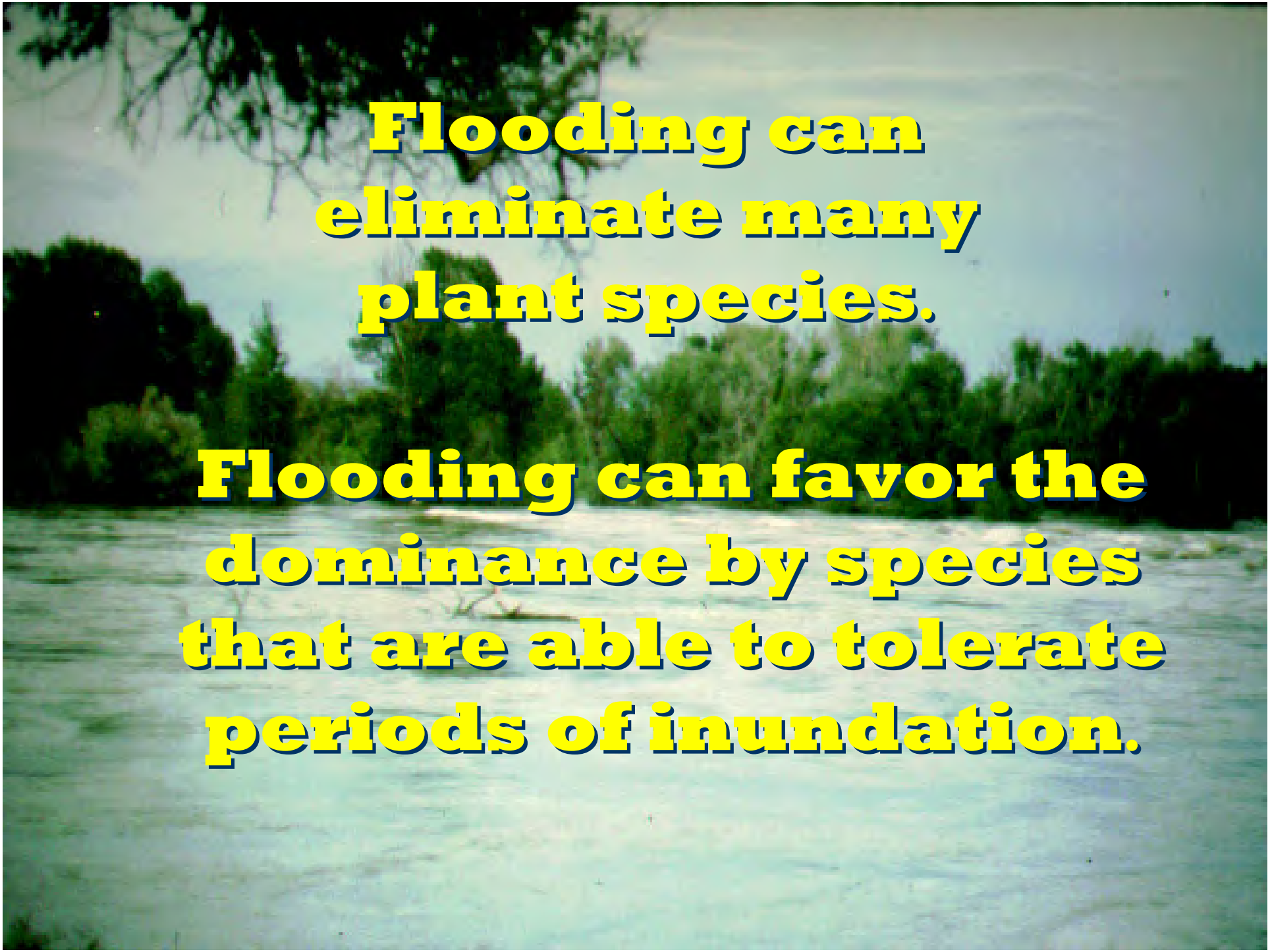
General Riparian Vegetation Concepts

Plant species composition varies among adjacent riparian plant communities.

WHY?

These communities differ mainly in their ability to obtain water along the moisture continuum from the water surface to the uplands.

The most obvious controlling influence on the Composition, Structure, and Diversity of Riparian Plant Communities IS?
FLOODING


Flooding can eliminate many plant species.
Flooding can favor the dominance by species that are able to tolerate periods of inundation.

General Riparian Vegetation Concepts

What is the most complex and diverse site on which to establish plants in a riparian zone?

It is NOT the wettest site!

It is NOT the driest site!

It is the area with the most diverse hydrologic regime!!!

General Riparian Vegetation Concepts

Riparian Plant diversity is high in riparian zones because of:

The intensity and frequency of floods.

Small-scale variations in topography and soils as a result of lateral migration.

Variations in climate as streams flow from high elevation to low elevation.

Disturbances to the riparian zone caused by upland changes.

General Riparian Vegetation Concepts

Riparian vegetation tends to be a patchwork of different plant communities of various ages and successional patterns.

Patchwork is a result of changing

- **Sediment types**
- **Sediment depths**

General Riparian Vegetation Concepts

Magnitude,

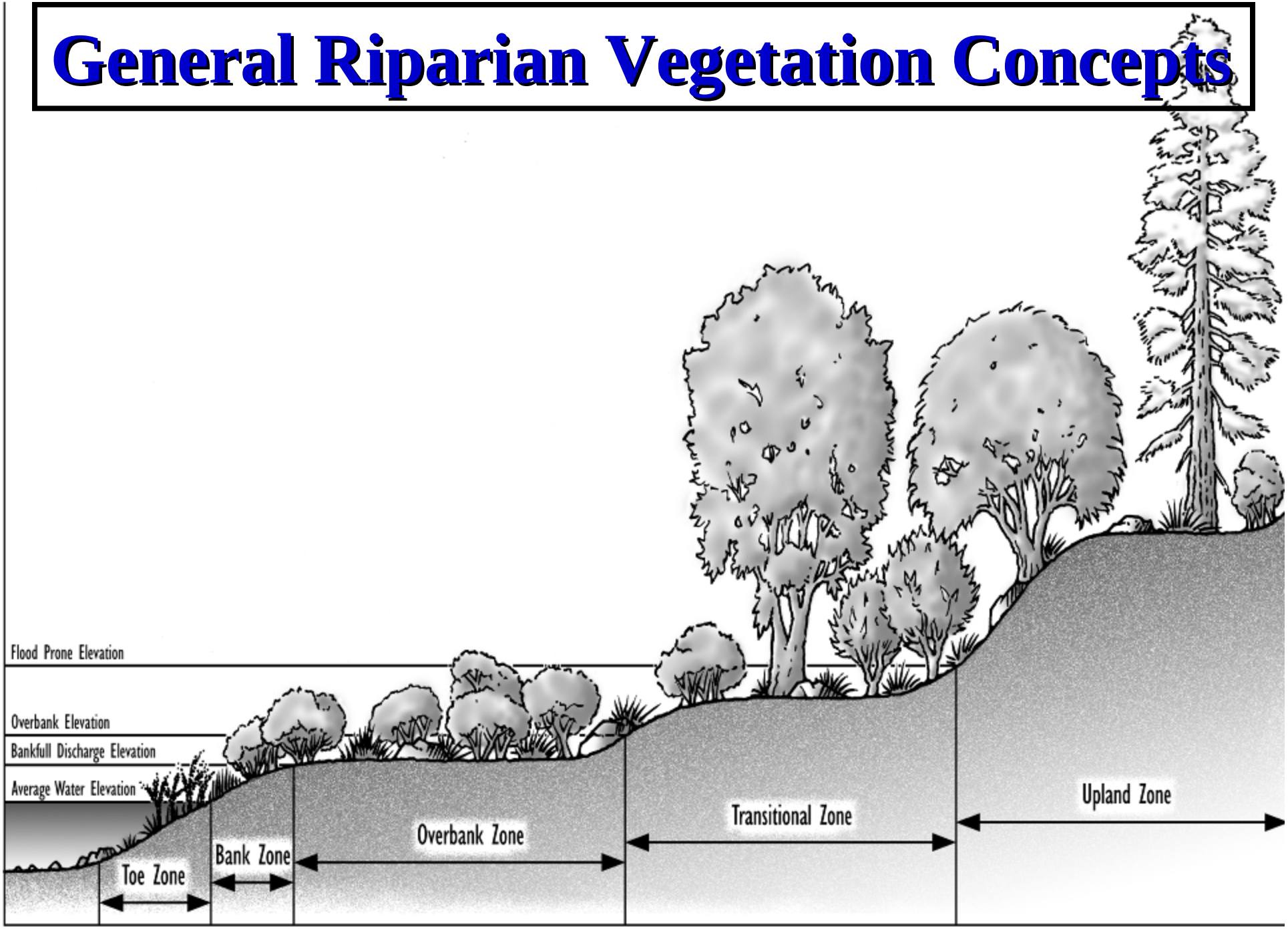
Frequency,

and Duration

of flooding decrease laterally from the active water channel

Successional stages within riparian areas are a function of the distance from the channel

General Riparian Vegetation Concepts



Recap

- Streams are not always intuitive
- Elevation Matters
- Rivers Flow in Corkscrews
- Roughness Matters
- Sediment Makes Roughness
- Floodplains Matter