

From Sky to Stream: A Systems Approach to Water Management

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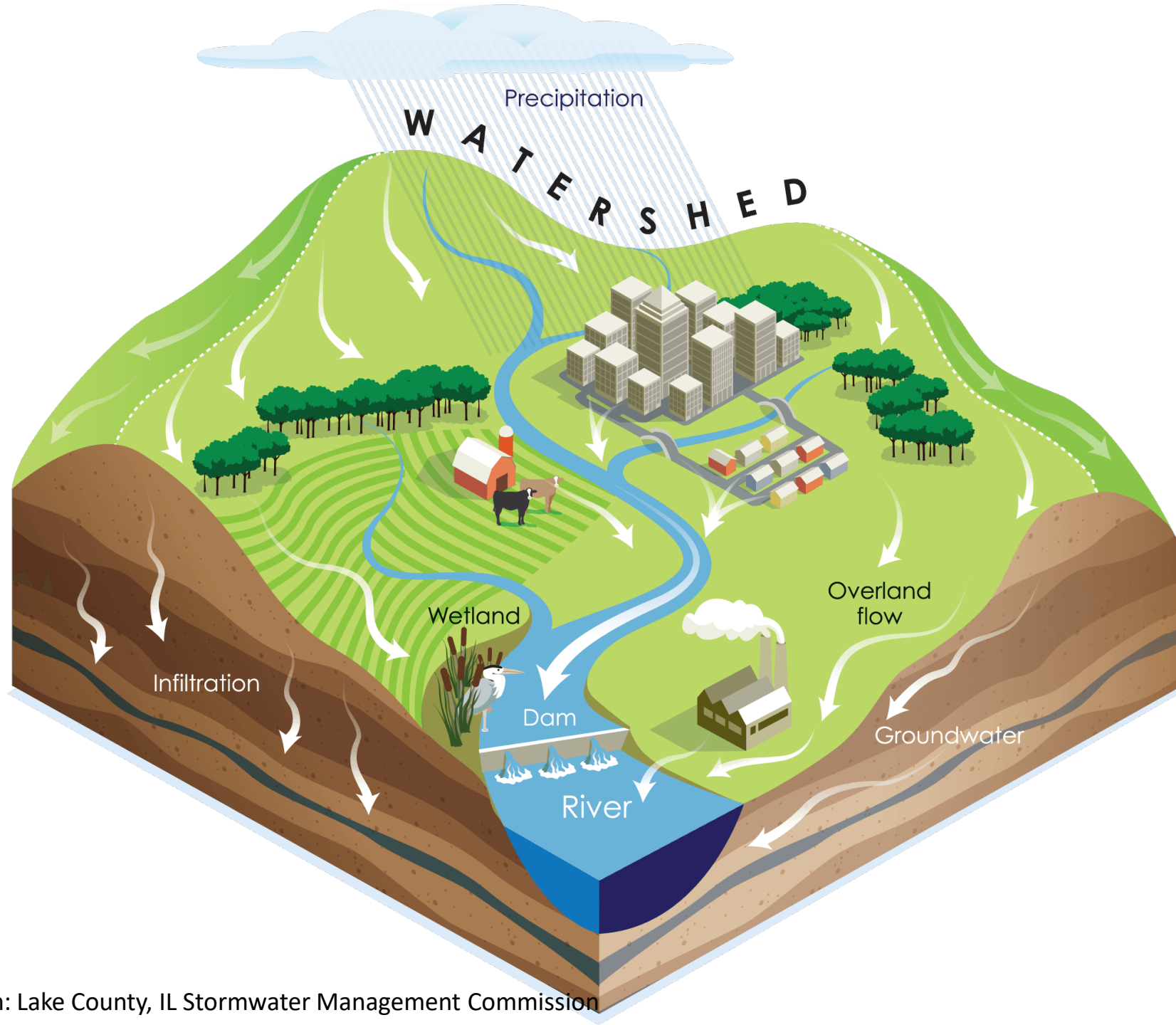
Kansas State University, Manhattan, Kansas

Overview

Why does a river look the way it does?

Why does a river act the way it does?

How can we manage rivers in agricultural landscapes?





Herkimer, Kansas



Grantville, Kansas

NEBRASKA

Omaha

Des Moines



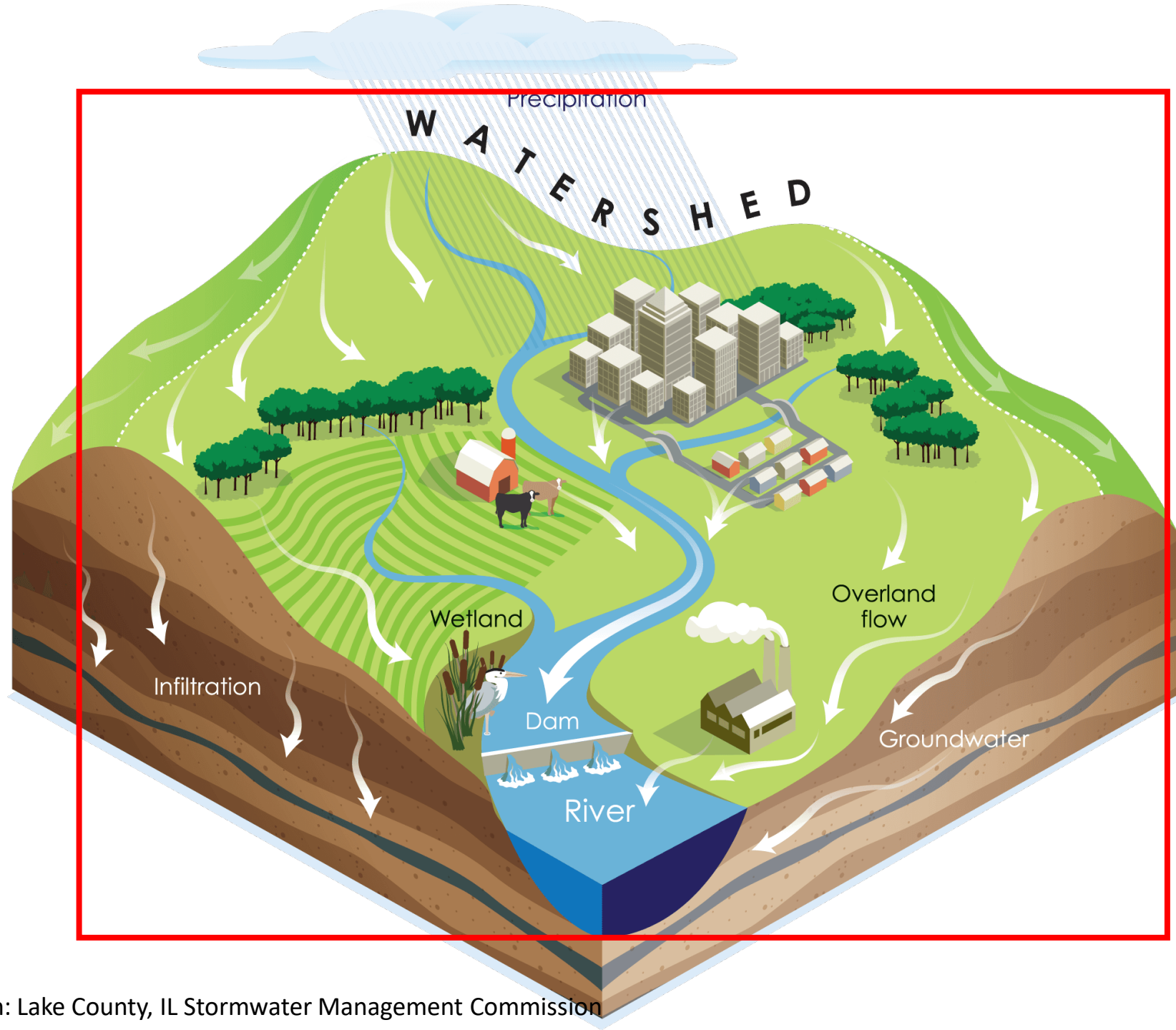
Manhattan, Kansas

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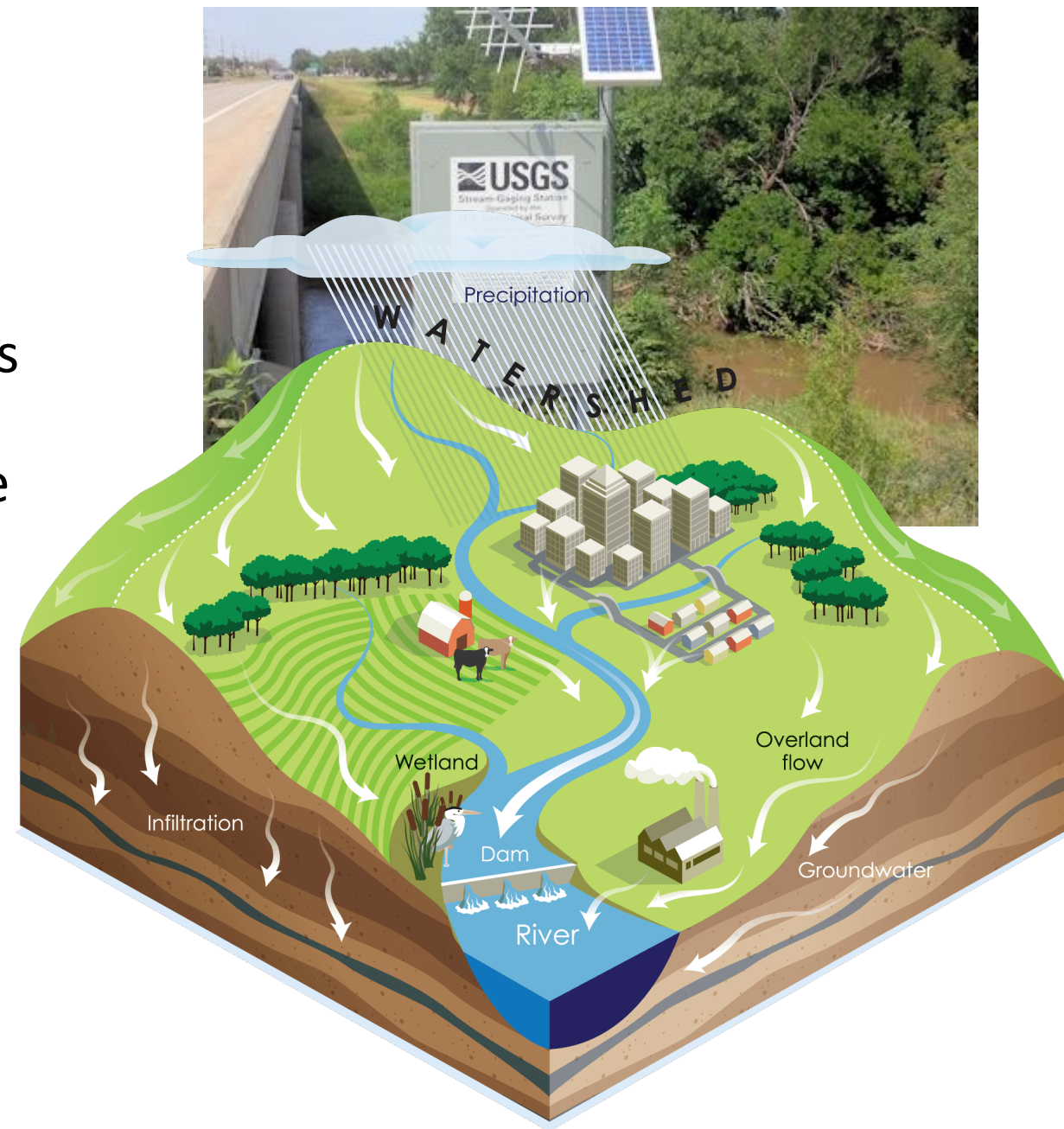
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What is a watershed?

- Definition: The area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel
- Like a “bowl”
- Other names:
 - Drainage area
 - Basin
 - Drainage basin
 - Catchment
 - Others?



Every watershed is different.

- Varying shapes and sizes
- Cross political boundaries

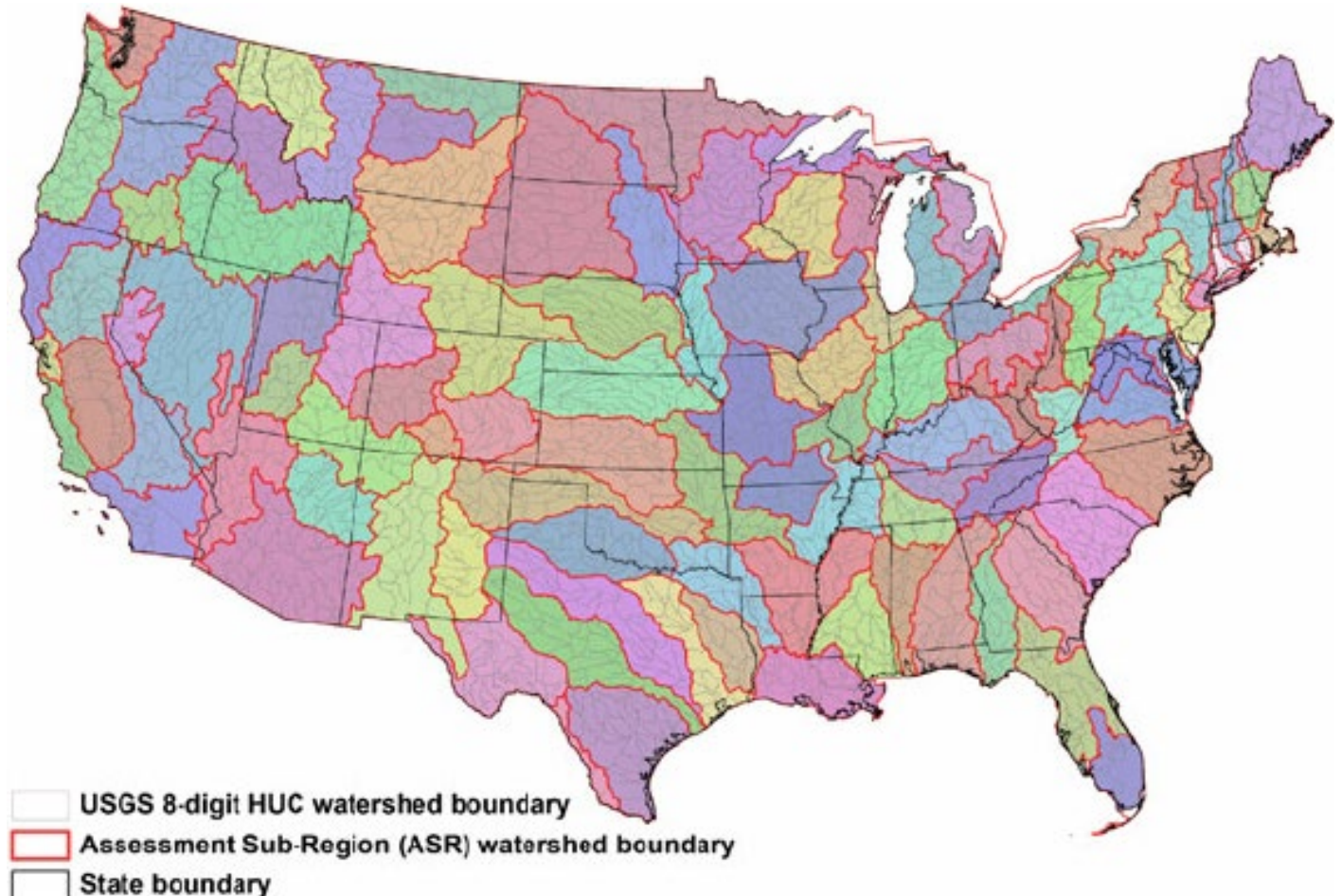


Image from: USGS

Mississippi River Basin Example



Mississippi River Basin Example

Watershed boundaries are relative, it depends on the outlet.



What is a river?



Definition: A natural stream of water of fairly large size flowing in a definite course or channel or series of diverging and converging channels.
(Dictionary.com)



Definition: A dynamic combination of water, sediment, aquatic organisms, riparian vegetation, and [wood] all participating in a complex dance from the point of origin, or headwaters, toward the ocean or basin where the journey ends.
(Nature.com)

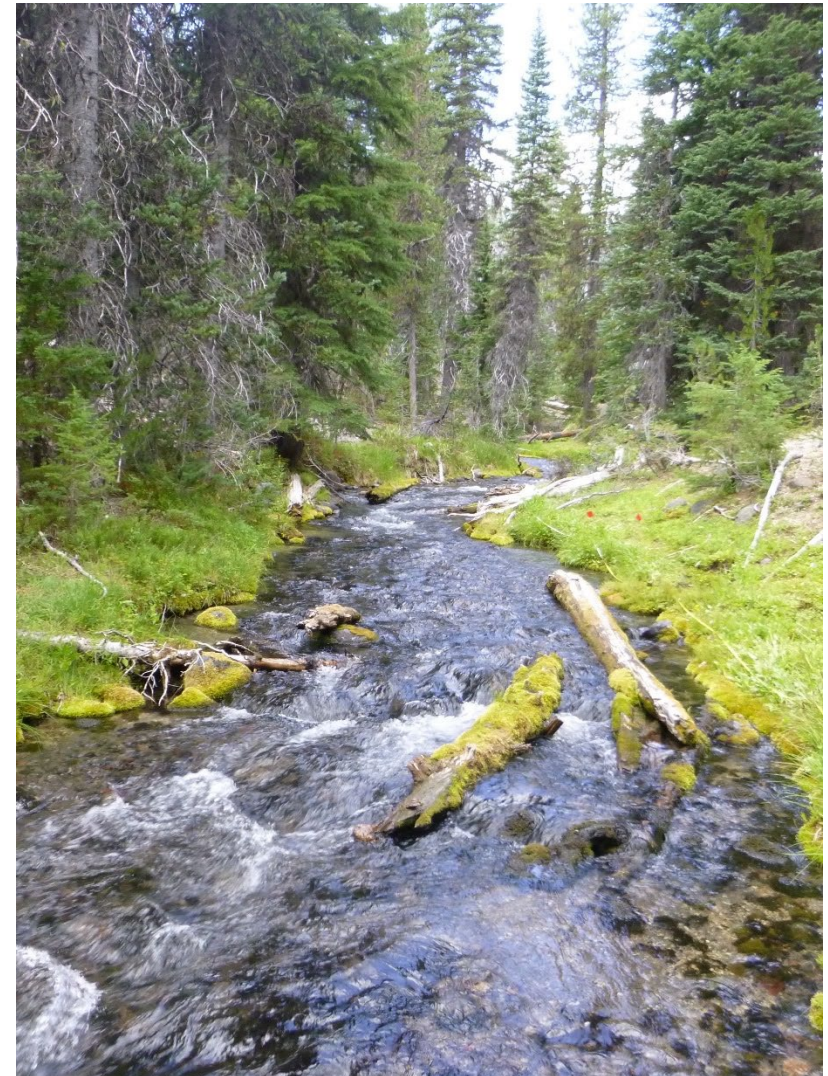


Photo by Ernie McNair



Photo by: Tiffany Hagler-Geard, ABC News

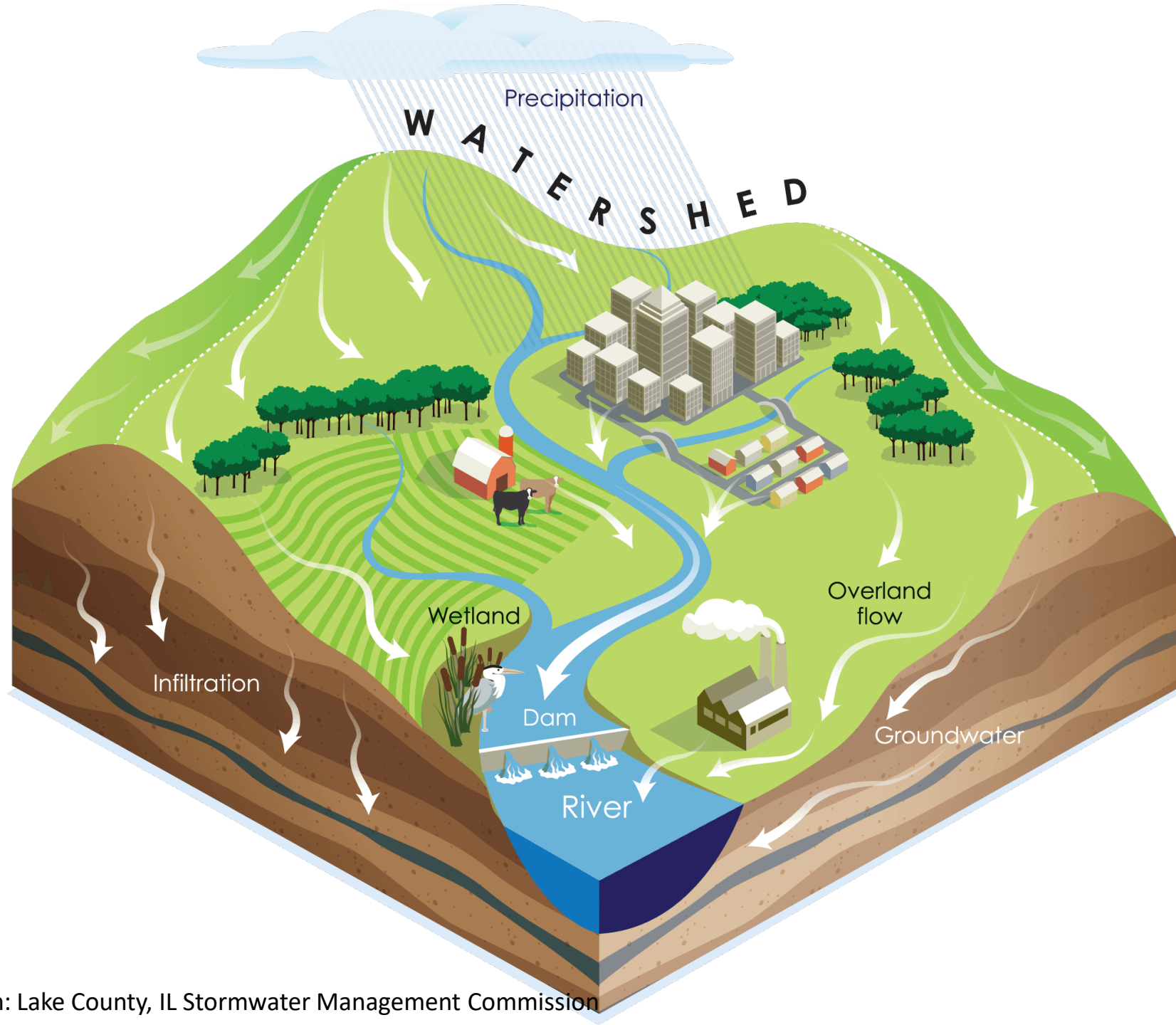


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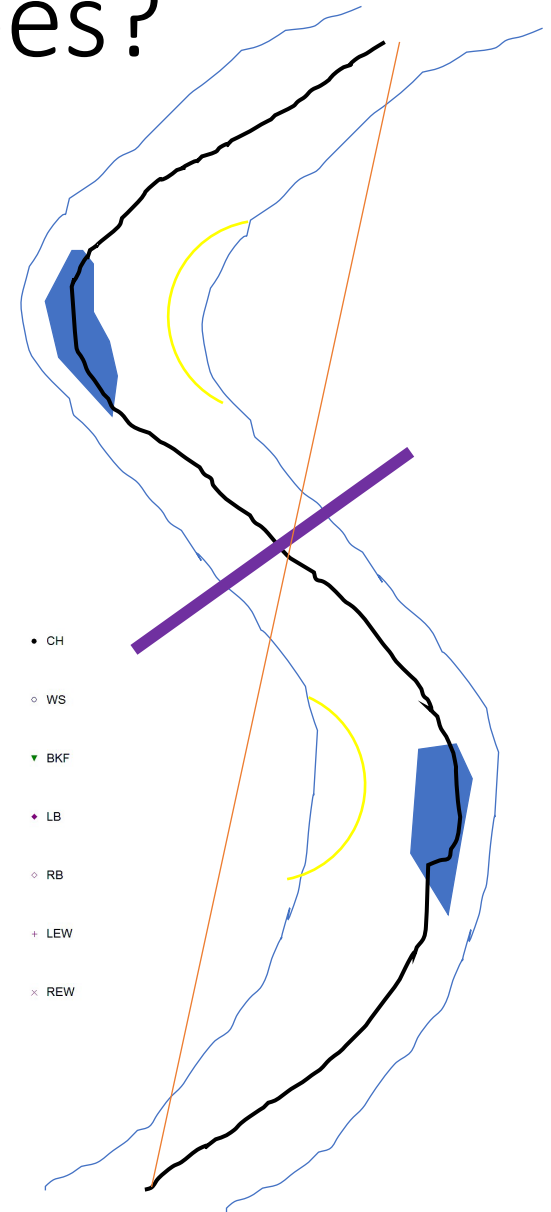
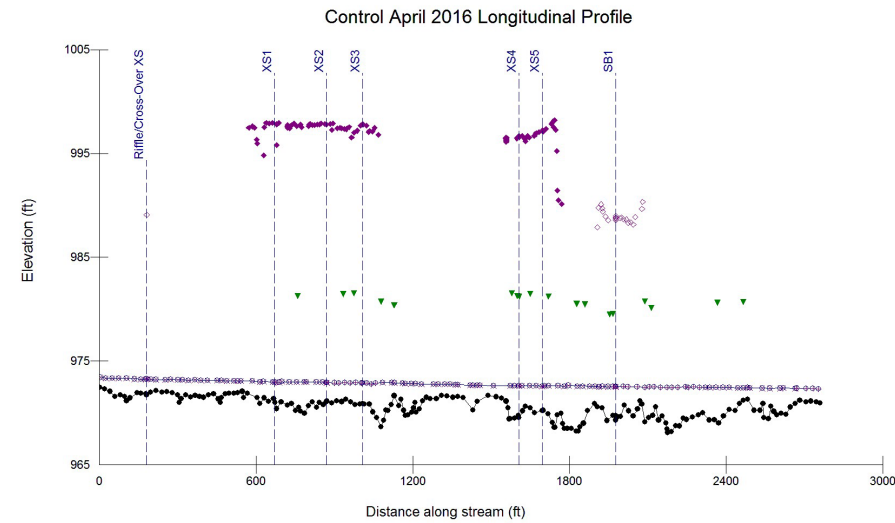
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How can we manage rivers in agricultural landscapes?



Why does a stream look the way it does?

- Streams vary in:
 - Dimension – Cross sectional area
 - Profile – Bankfull slope
 - Pattern – Sinuosity
- These depend on:
 - Bankfull flow
 - Produced sediment load
 - Boundary conditions
 - Channel evolution



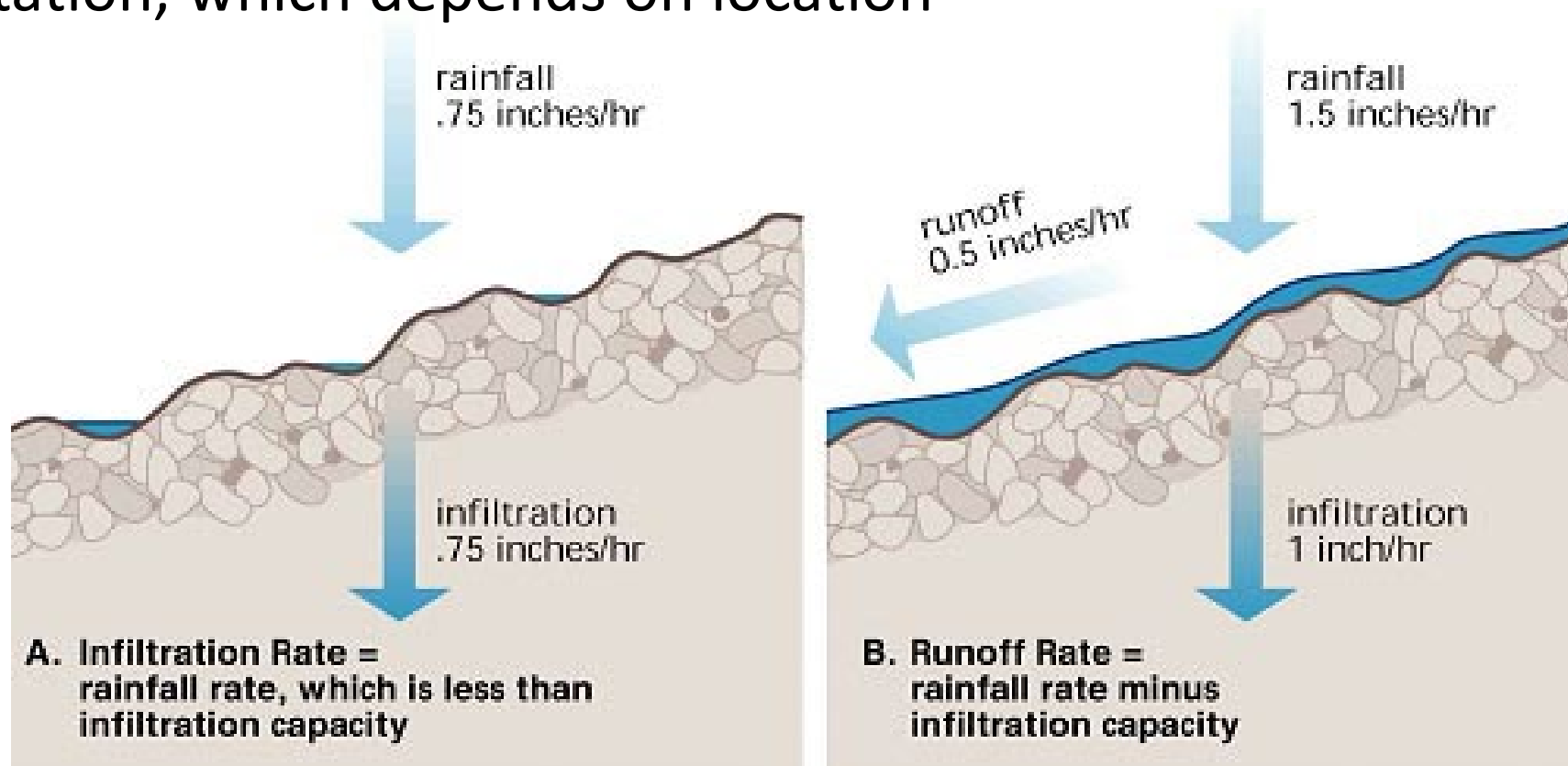
Bankfull flow

- Definition: Occurring when surface runoff reaches an incipient floodplain
 - Has an average 1-2 year return interval
 - Floodplain elevation on stable streams



Every river has a different bankfull flow.

Depends on runoff, which depends on infiltration, which depends on precipitation, which depends on location



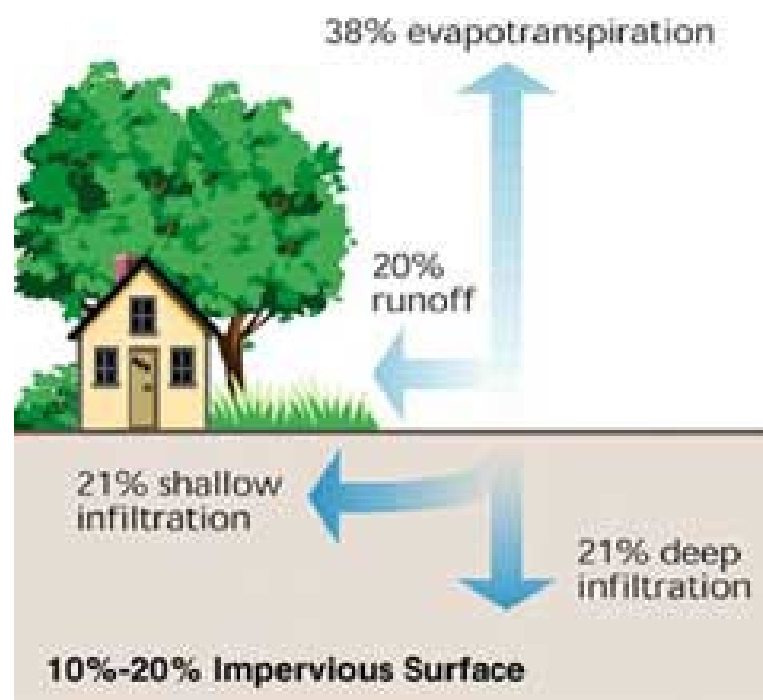
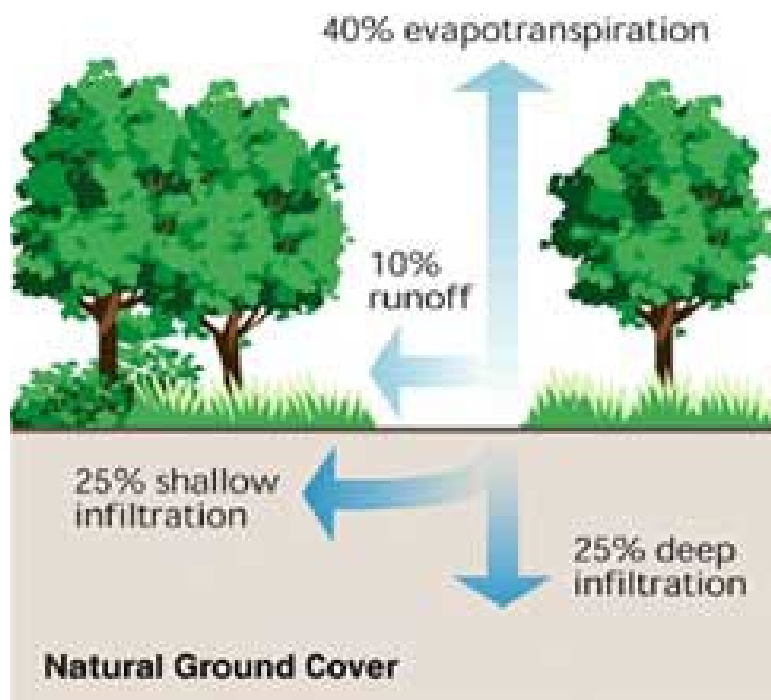
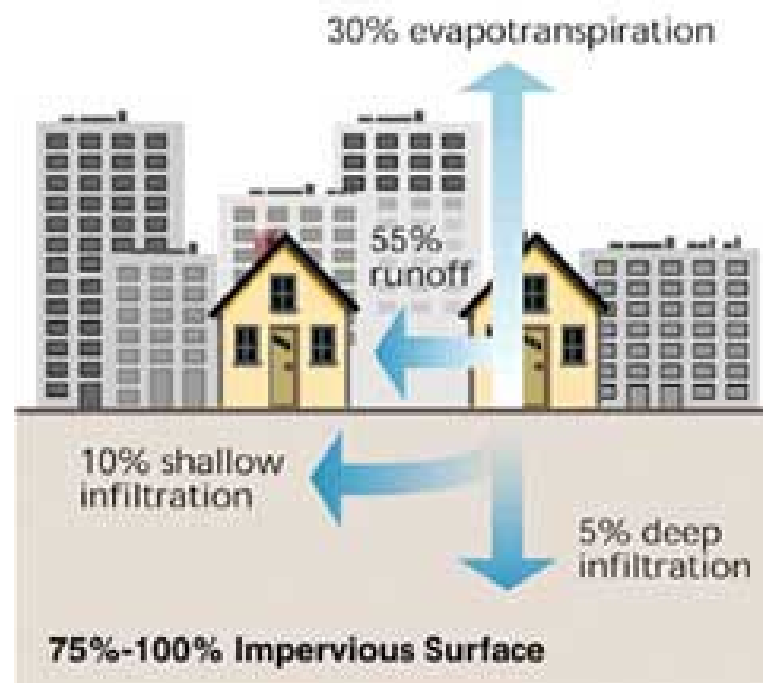
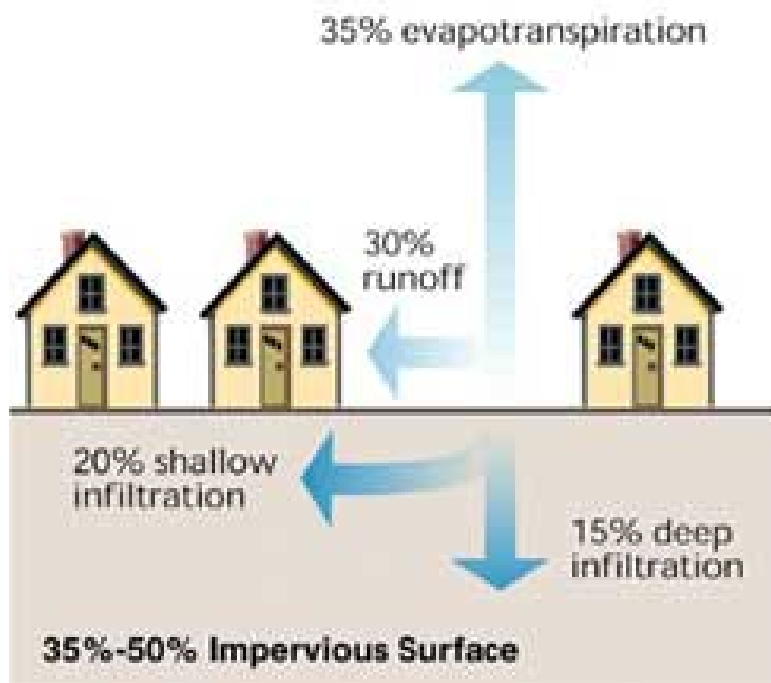


Image from Federal Interagency Stream Restoration Working Group (FISRWG)

While soil characteristics, land slope, and rainfall intensity greatly influence infiltration....

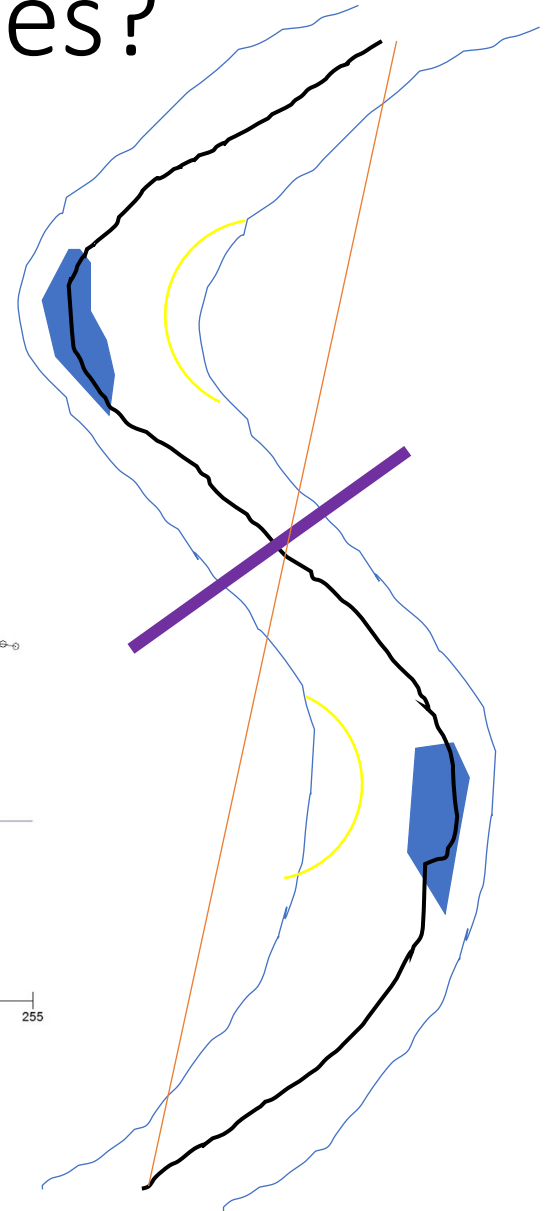
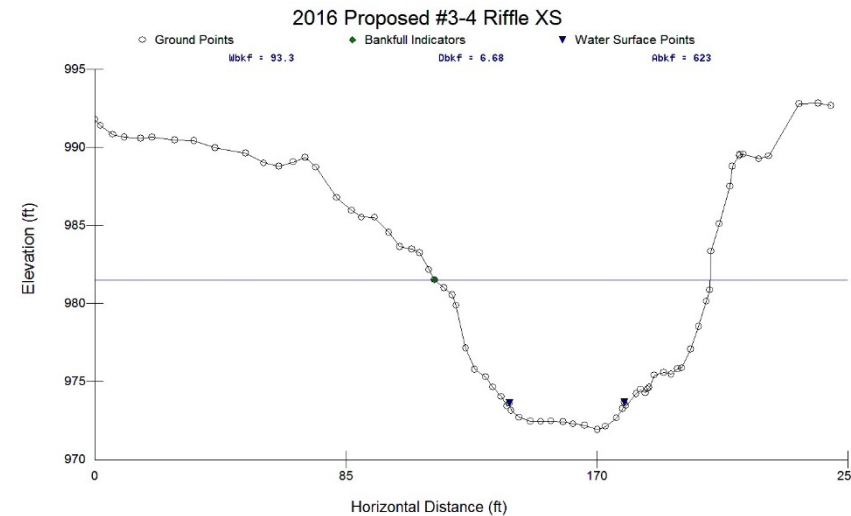
Land cover has the largest effect on infiltration.



We will revisit this later.

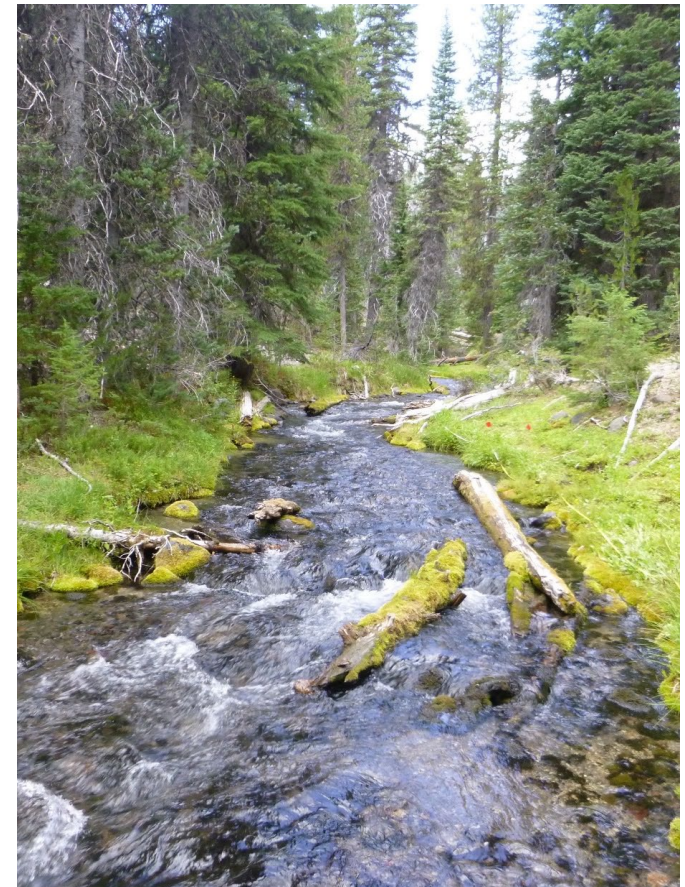
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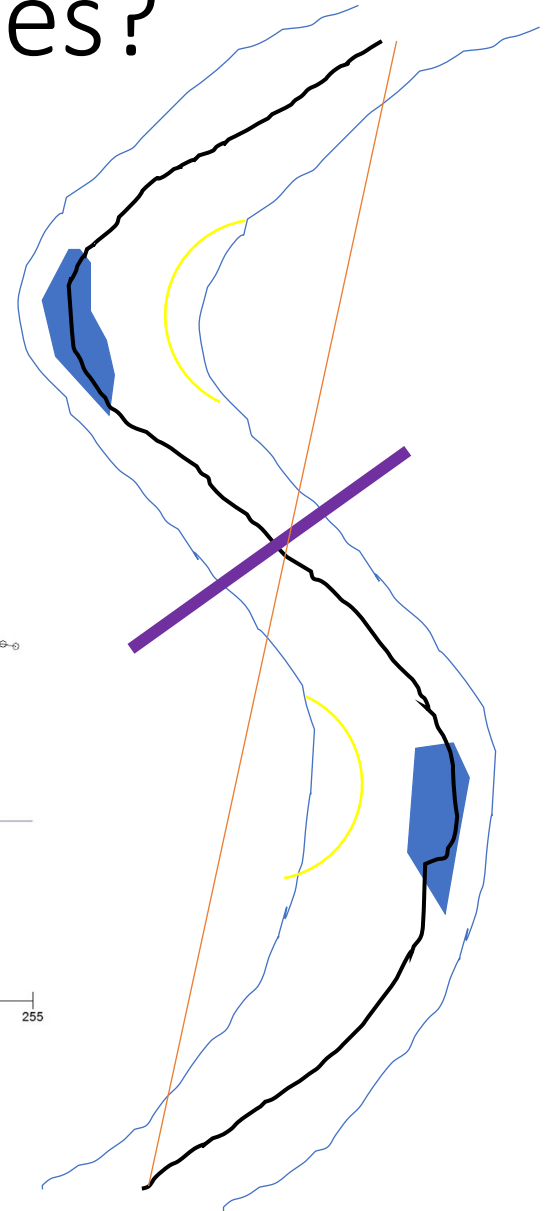
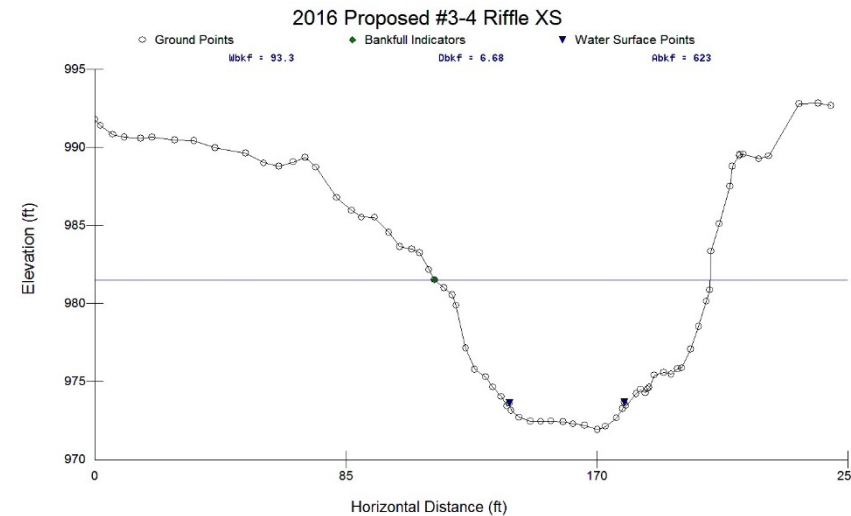
Sediment Load

- Depends on land exposure (which is influenced by climate and/or man) as well as soil/geology.



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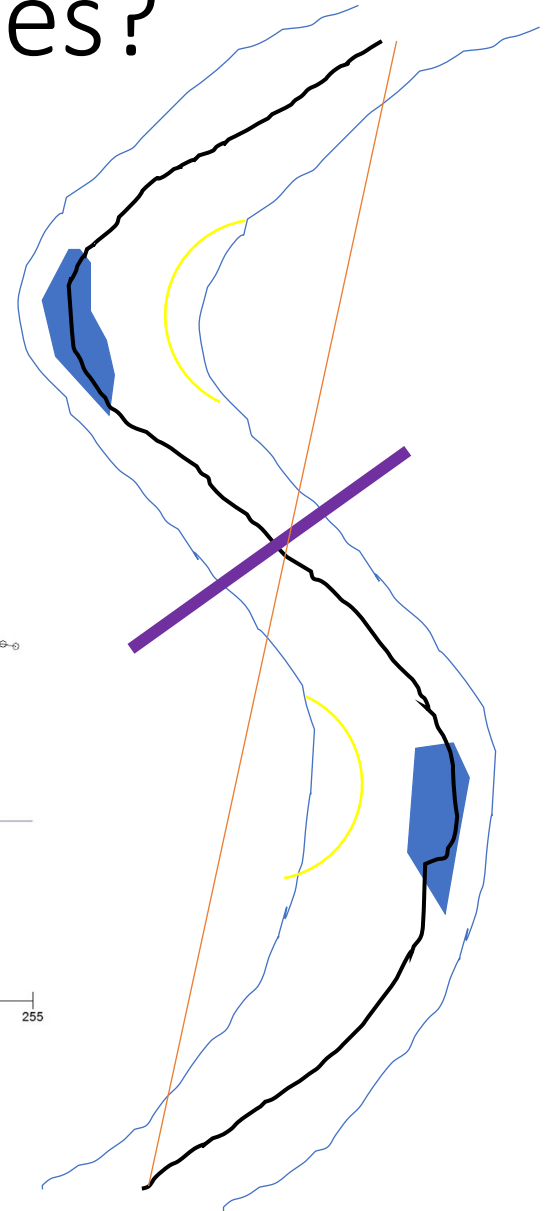
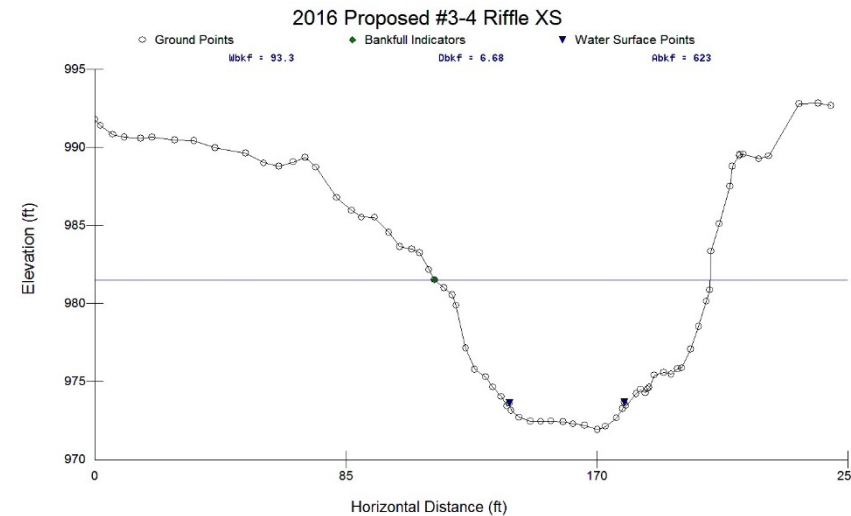
Boundary Conditions

- Soil physical properties and geology, within the channel and its watershed
- Streambank height and angle
- Vegetation cover and root depth
- Bed sediment
- Valley slope



Why does a stream look the way it does?

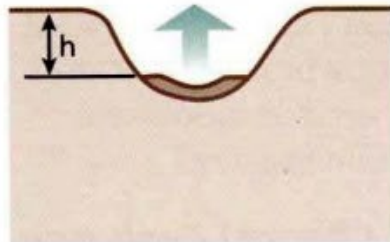
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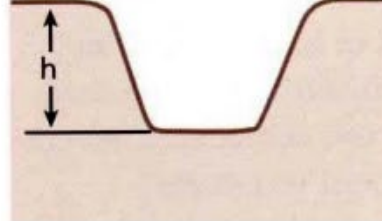
Why does a stream act the

CHANNEL EVOLUTION MODEL (SIX STAGES) Simon and Hupp, 1986

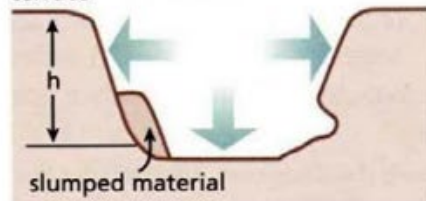
Class I. Sinuous, Premodified
 $h < h_c$



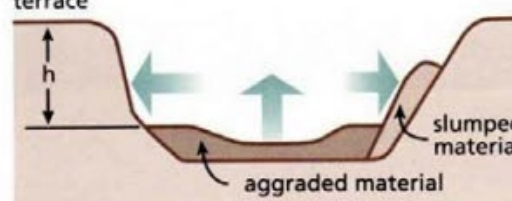
Class II. Channelized*
 $h < h_c$
floodplain



Class IV. Degradation and Widening
 $h > h_c$
terrace



Class V. Aggradation and Widening
 $h > h_c$
terrace



*Anthropogenic

August, 1935

AMERICAN FORESTS

385

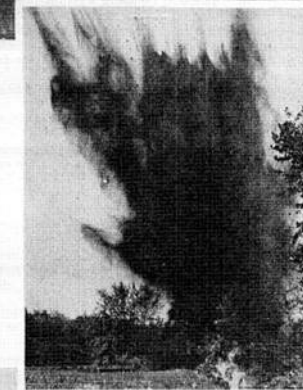
How DYNAMITE *streamlines streams*



Straightening of Pequest River in New Jersey by CCC workers stopped its yearly floods. Location 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.



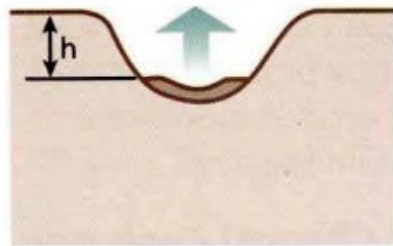
E. I. du Pont de Nemours & Co. Inc.
Explosives Department
6107 du Pont Building
Wilmington, Del.

When Writing Advertisements, Mention AMERICAN FORESTS

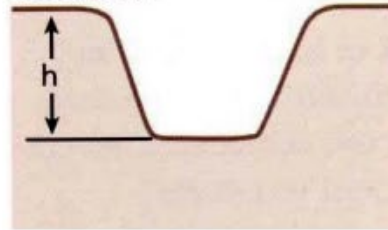
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CHANNEL EVOLUTION MODEL (SIX STAGES) Simon and Hupp, 1986

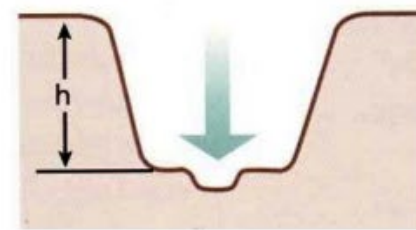
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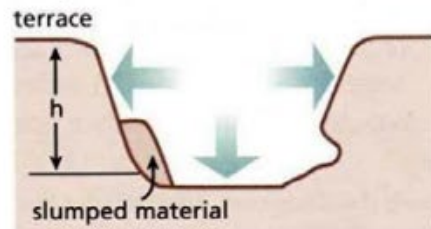
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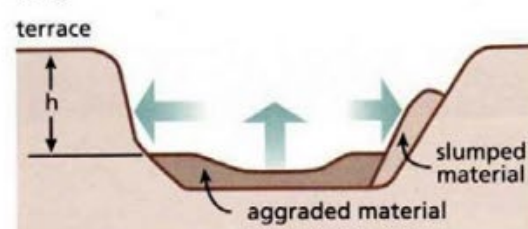
Class III. Degradation
 $h < h_c$



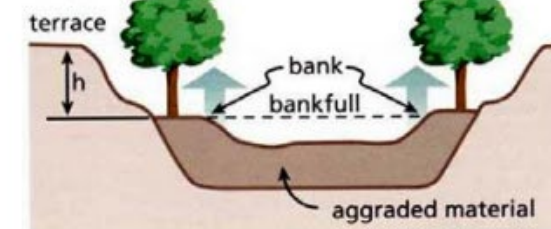
Class IV. Degradation and Widening
 $h > h_c$



Class V. Aggradation and Widening
 $h > h_c$



Class VI. Quasi Equilibrium
 $h < h_c$



*Anthropogenic

My observation
in Breadbasket
of the US:
Stages IV and V

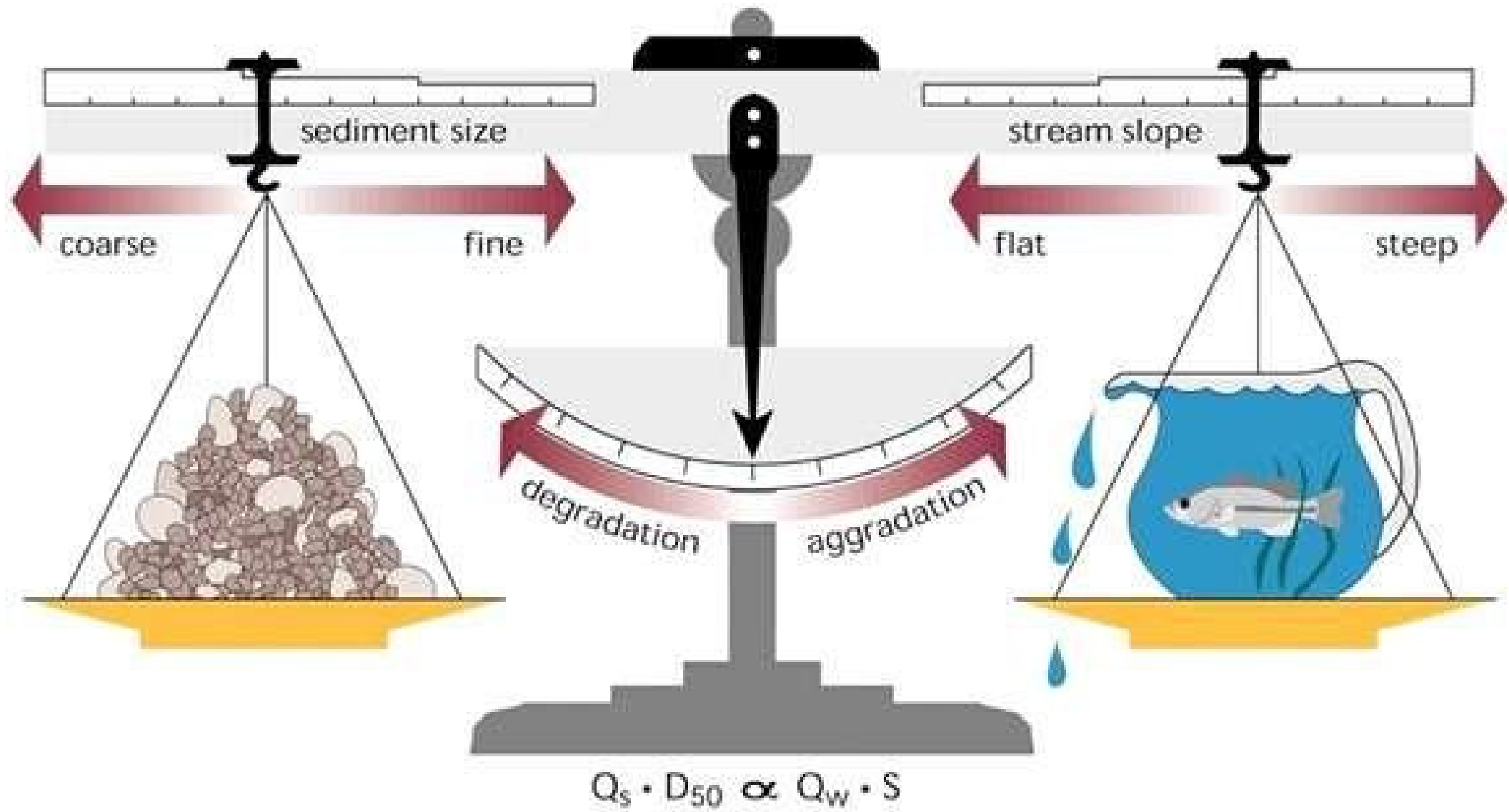


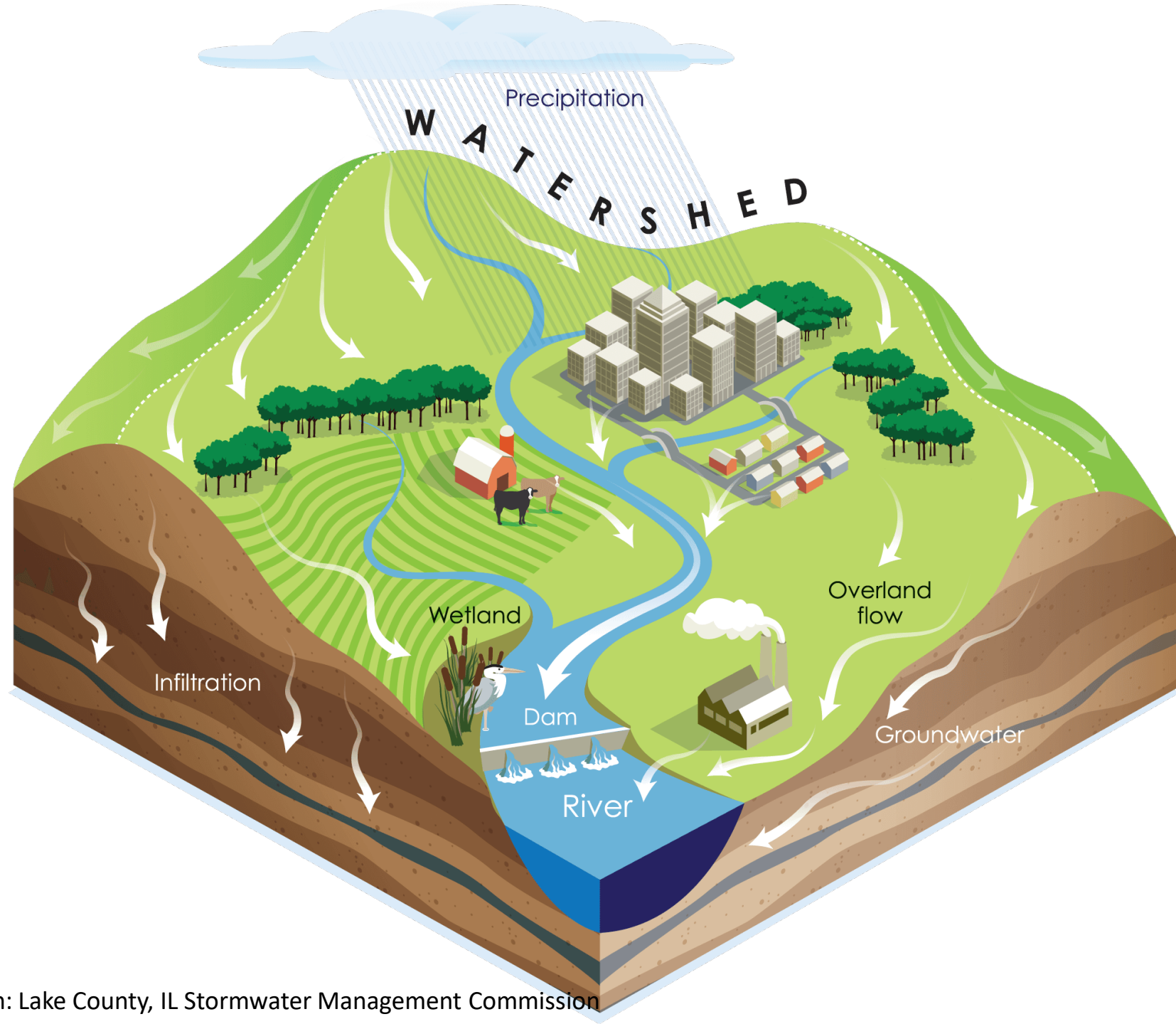
Image from Rosgen (1996)

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How can we manage rivers in agricultural landscapes?



How can we manage rivers in ag landscapes?

Passive restoration

1. Implement watershed BMPs
2. Give the stream space and leave it alone
 - Less predictable but can be effective in streams where space is plentiful

Active restoration

1. Implement watershed BMPs
2. Physically changing stream to more stable form
 - Best approach when space is limited and immediate improvements to water quality, habitat, etc. are needed

Step 1: Watershed BMPs

- Purpose: Treat the cause, not the symptoms
- BMPs should always be the first priority
- Determine the post-BMP flow and sediment for stream restoration design....



Image from: No-Till Farmer

Prairie to Ag Land Example

- Prairie, some forest prior to European settlement
- Late 1800s – Early 1900s – converted to ag land
- Today (1557 acres):
 - 74% cropland
 - 12% pasture
 - 10% forest
 - 4% residential



Friedrichs Fork of
Raemer Creek

Legend

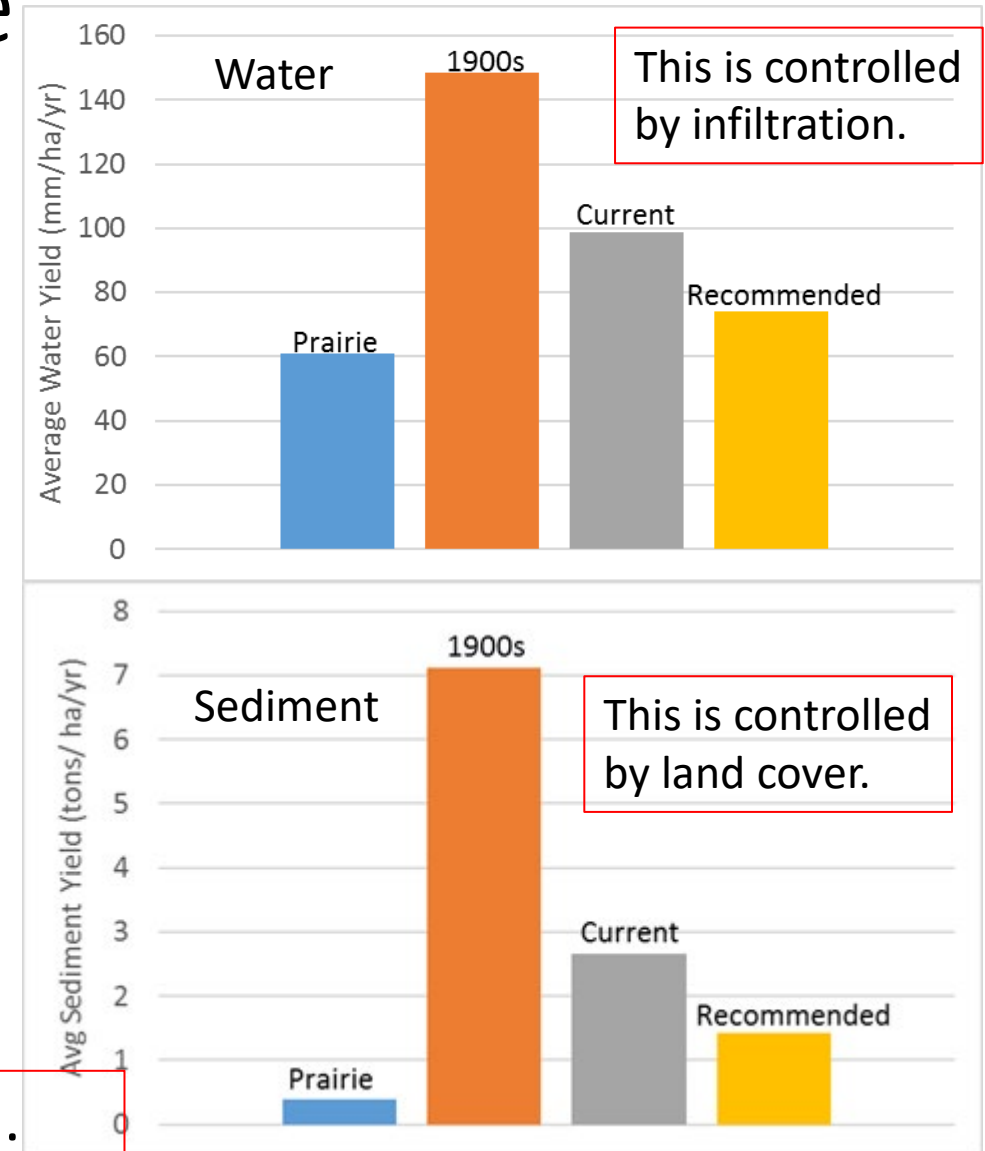
- Basin
- Reach

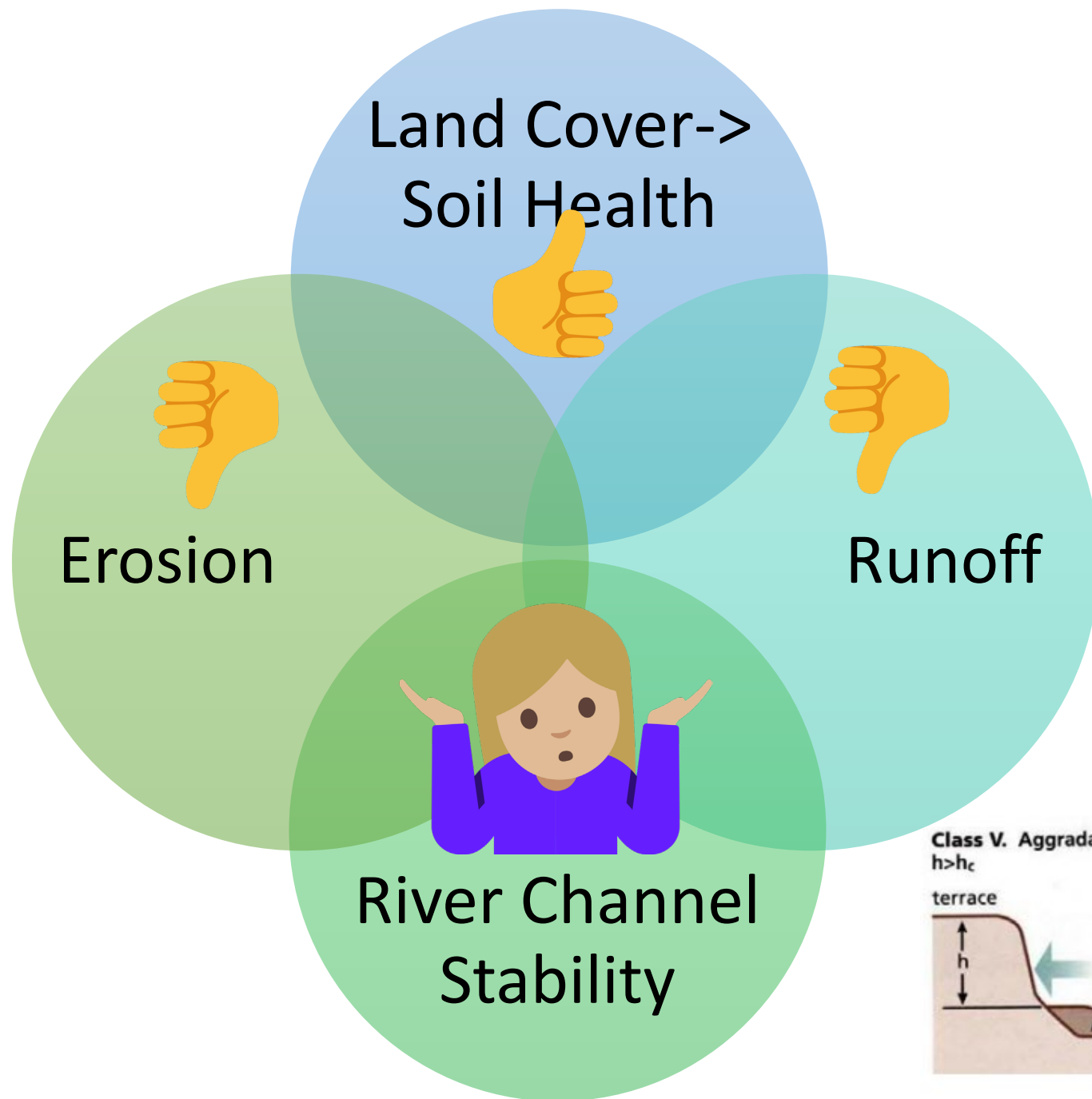


Prairie to Ag Land Example

- Prairie: Pre-European settlement conditions (Prairie/Forest)
- 1900s: Early 1900s ag management conditions (Tilled land, no conservation)
- Current: Current ag management conditions (no till, crop rotation)
- Recommended: Proposed conservation (plus cover crops, precision agriculture technology, and filter strips)

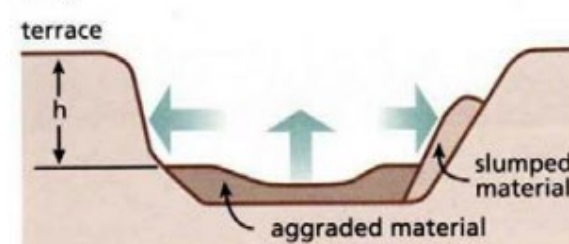
Recall: **Land cover** has the largest effect on infiltration.





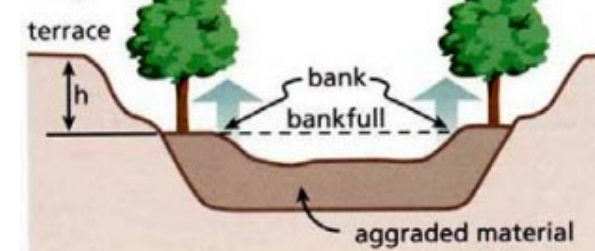
Class V. Aggradation and Widening

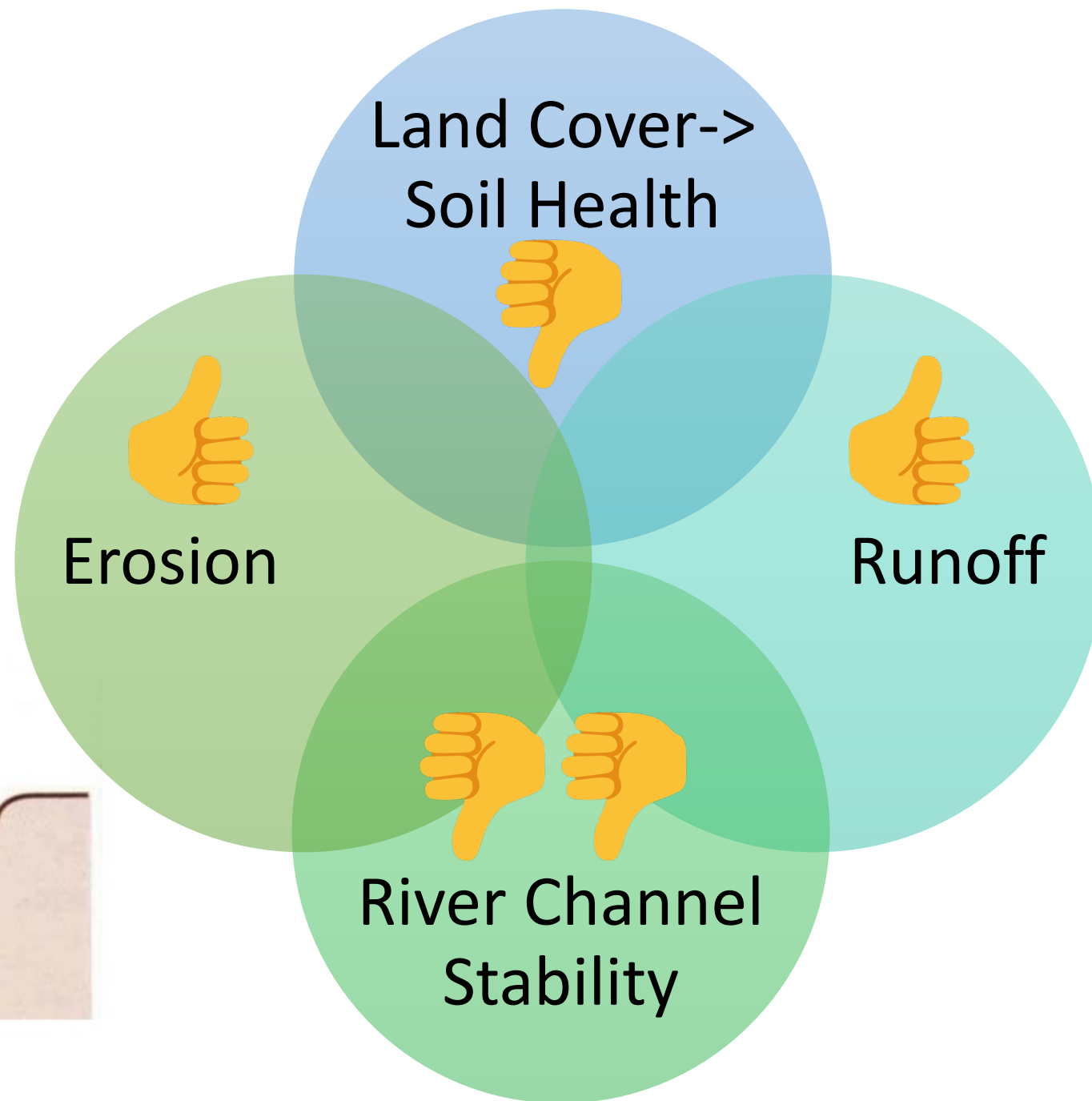
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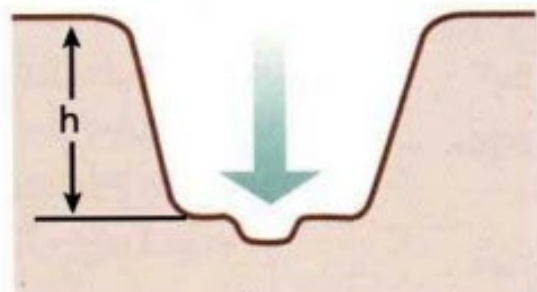
Class VI. Quasi Equilibrium

$$h < h_c$$





Class III. Degradation
 $h < h_c$



Changing behavior has cumulative impacts.



How can we manage rivers in ag landscapes?

Passive restoration

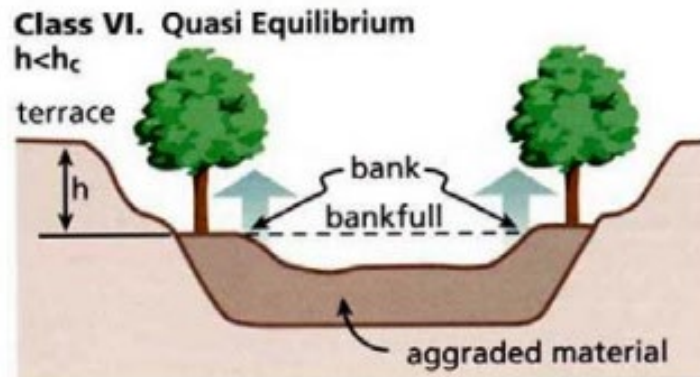
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Stream Restoration

- Design and construction of a vertically- and laterally-stable, floodplain-connected channel that is capable of carrying the bankfull flow and its produced sediment load
- *Recall*: “Floodplain” floods every 1-2 years



Important: Any kind of stream work requires federal permitting and a licensed engineer.

Streambank Stabilization

- A single technique or system of techniques that maximize localized streambank shear strength and/or minimize the forces acting on a streambank with the intent of halting or slowing lateral retreat
- Installed as:
 - Part of stream restoration
 - Stand-alone project on a site-to-site basis
 - If done this way – make sure grade control is incorporated in design if necessary!!



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