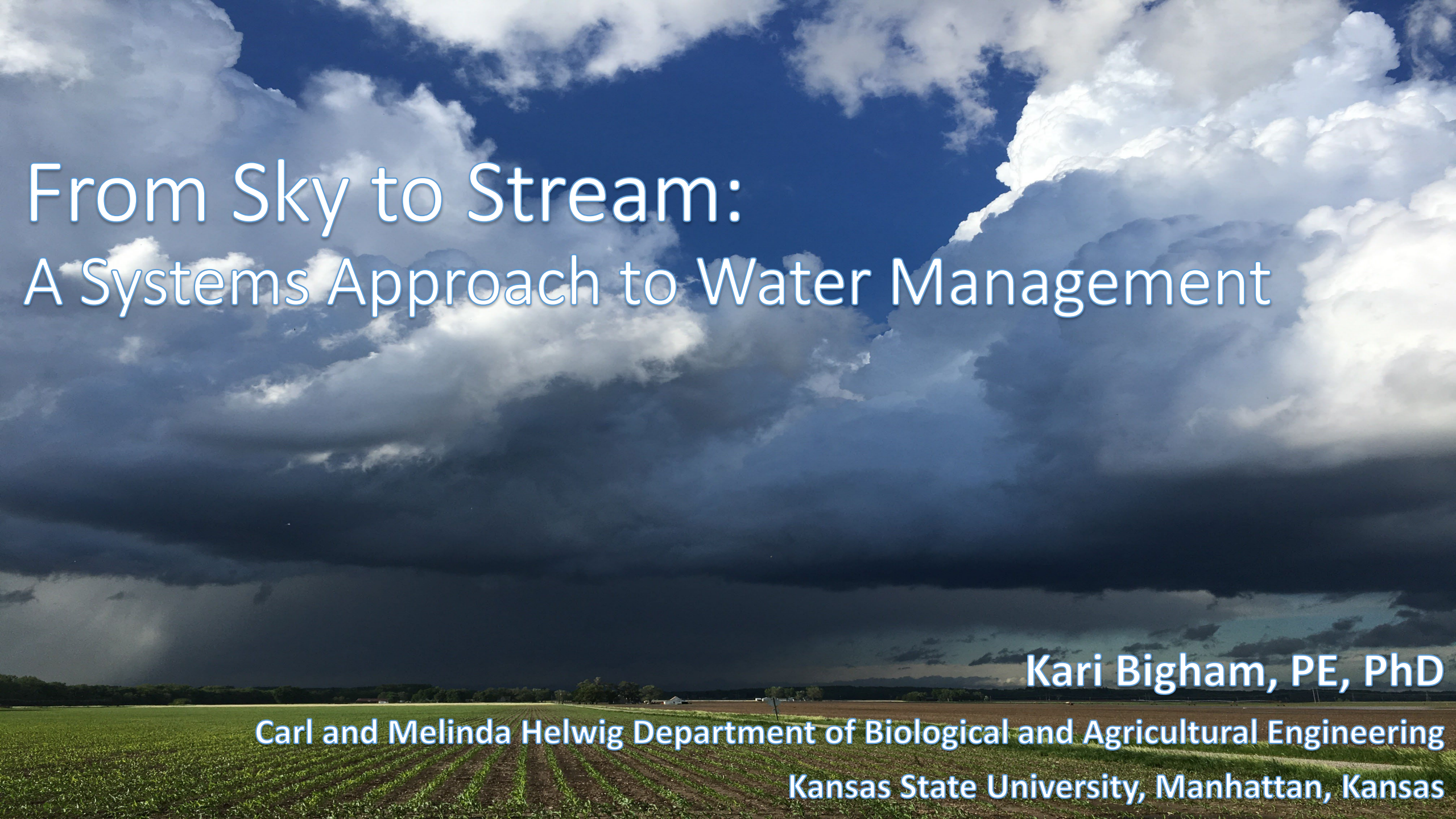

From Sky to Stream:
A Systems Approach to Water Management

Kari Bigham, PE, PhD

Carl and Melinda Helwig Department of Biological and Agricultural Engineering

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?

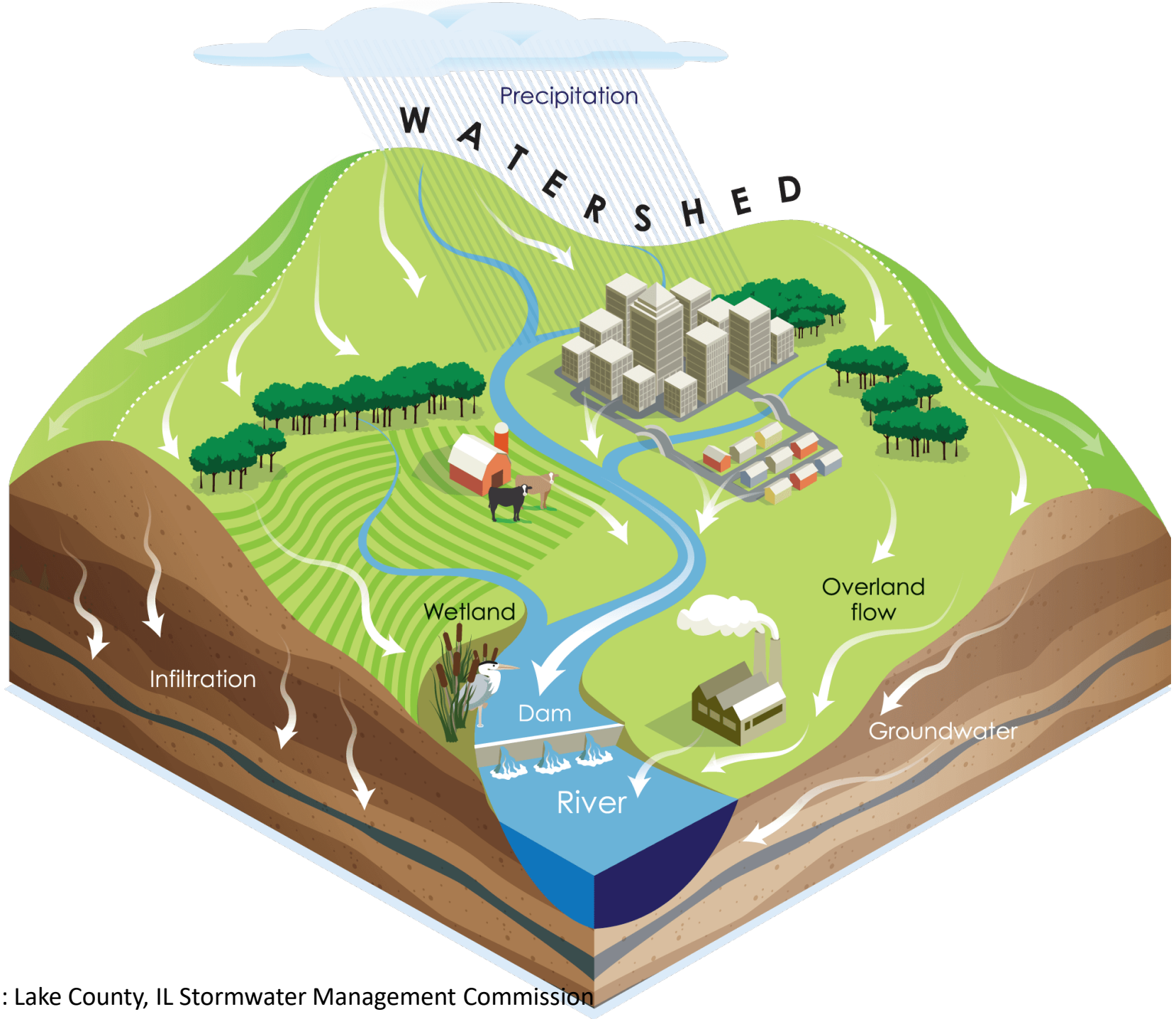

Image from: Lake County, IL Stormwater Management Commission

Herkimer, Kansas

Grantville, Kansas

Manhattan, Kansas

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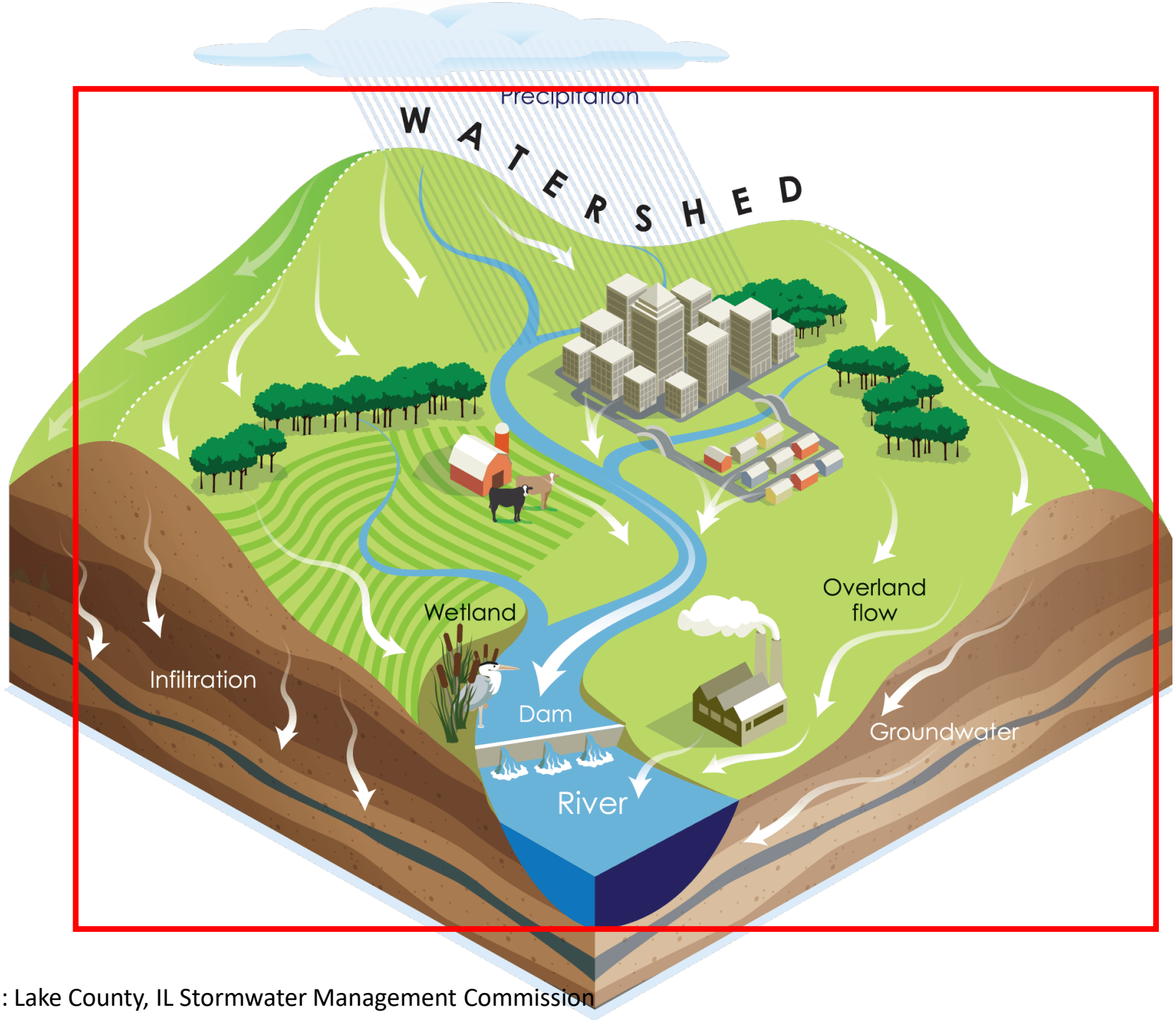
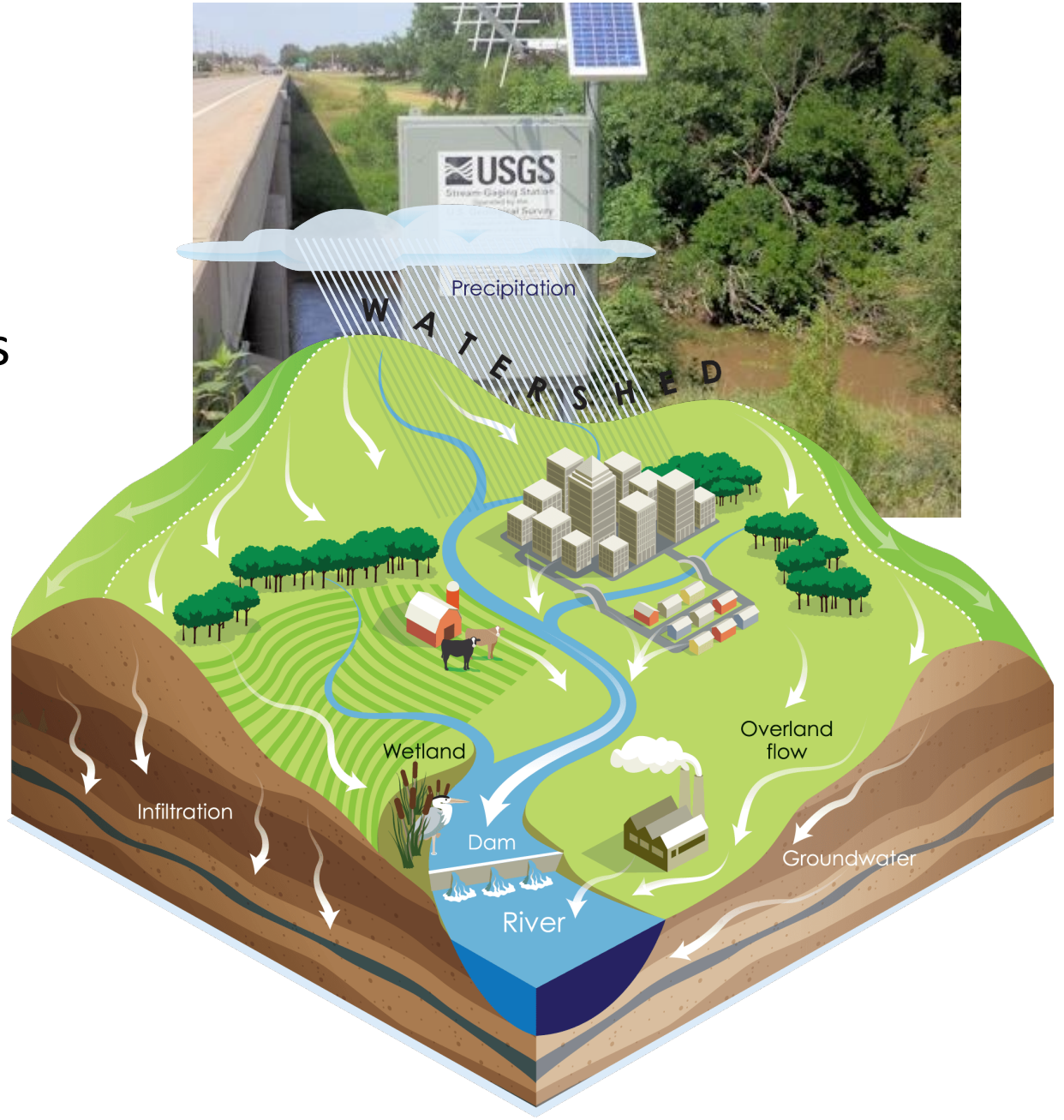


Image from: Lake County, IL Stormwater Management Commission

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

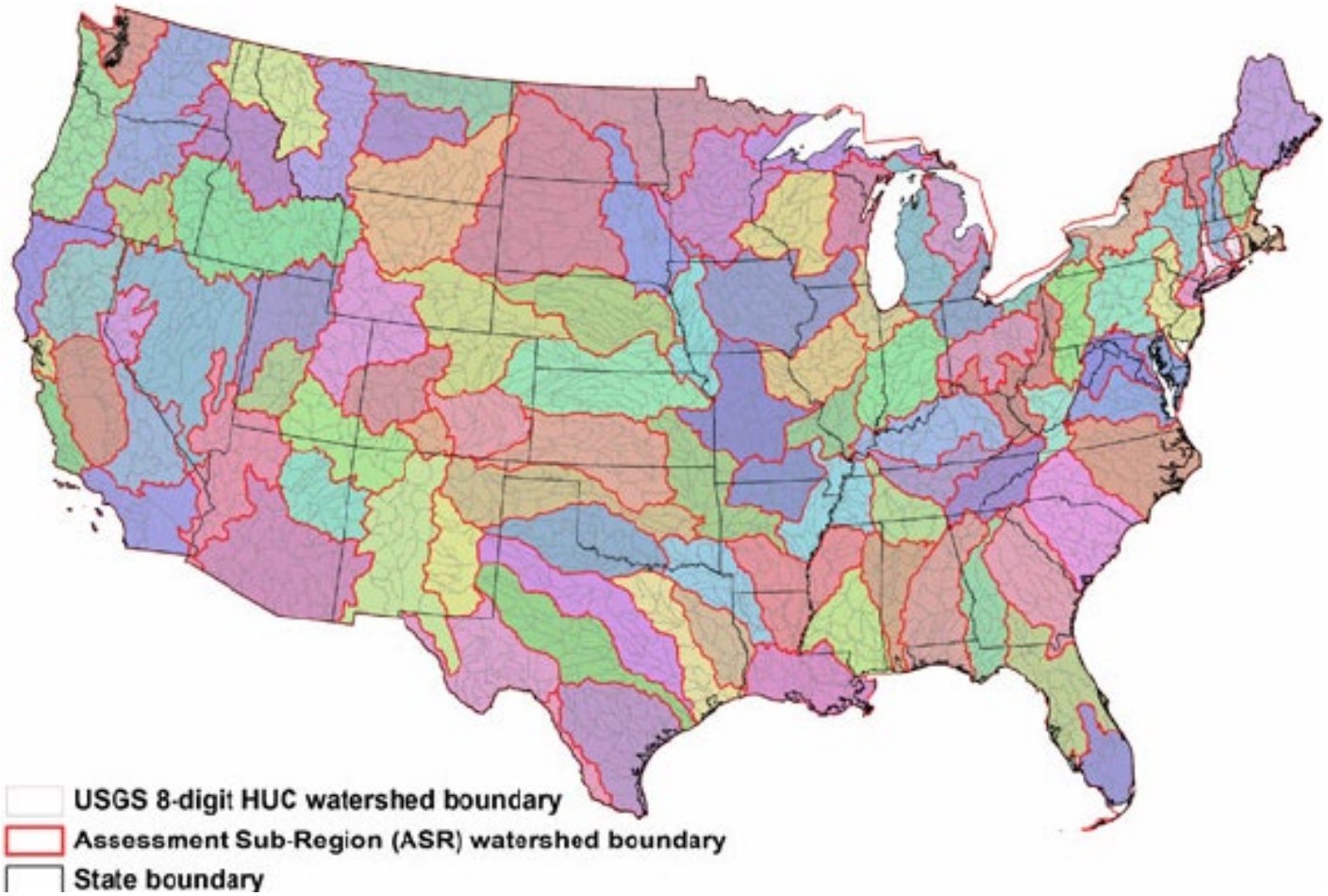


Image from: USGS

Mississippi River Basin Example

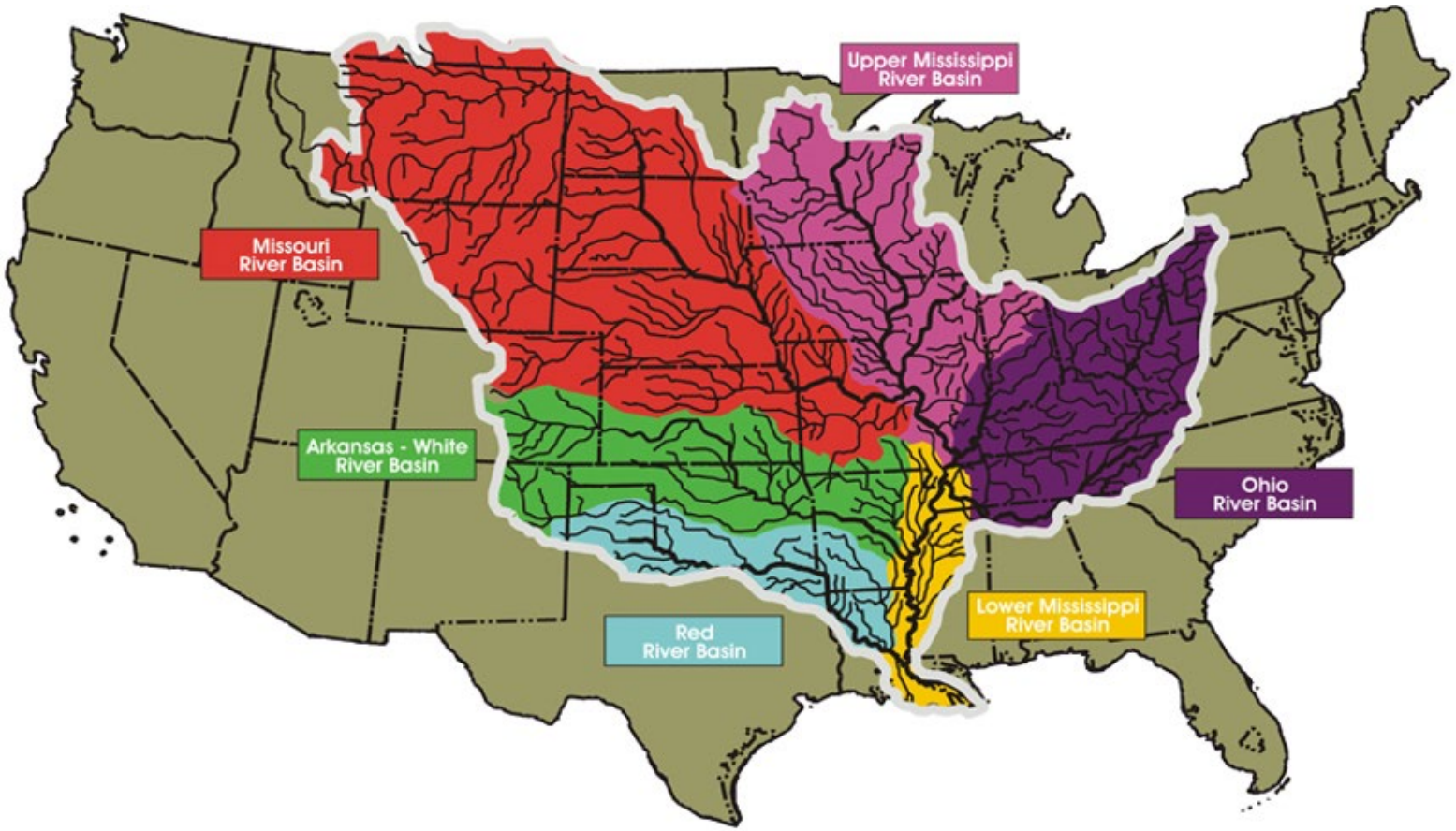


Image from: Restore the Mississippi River Delta

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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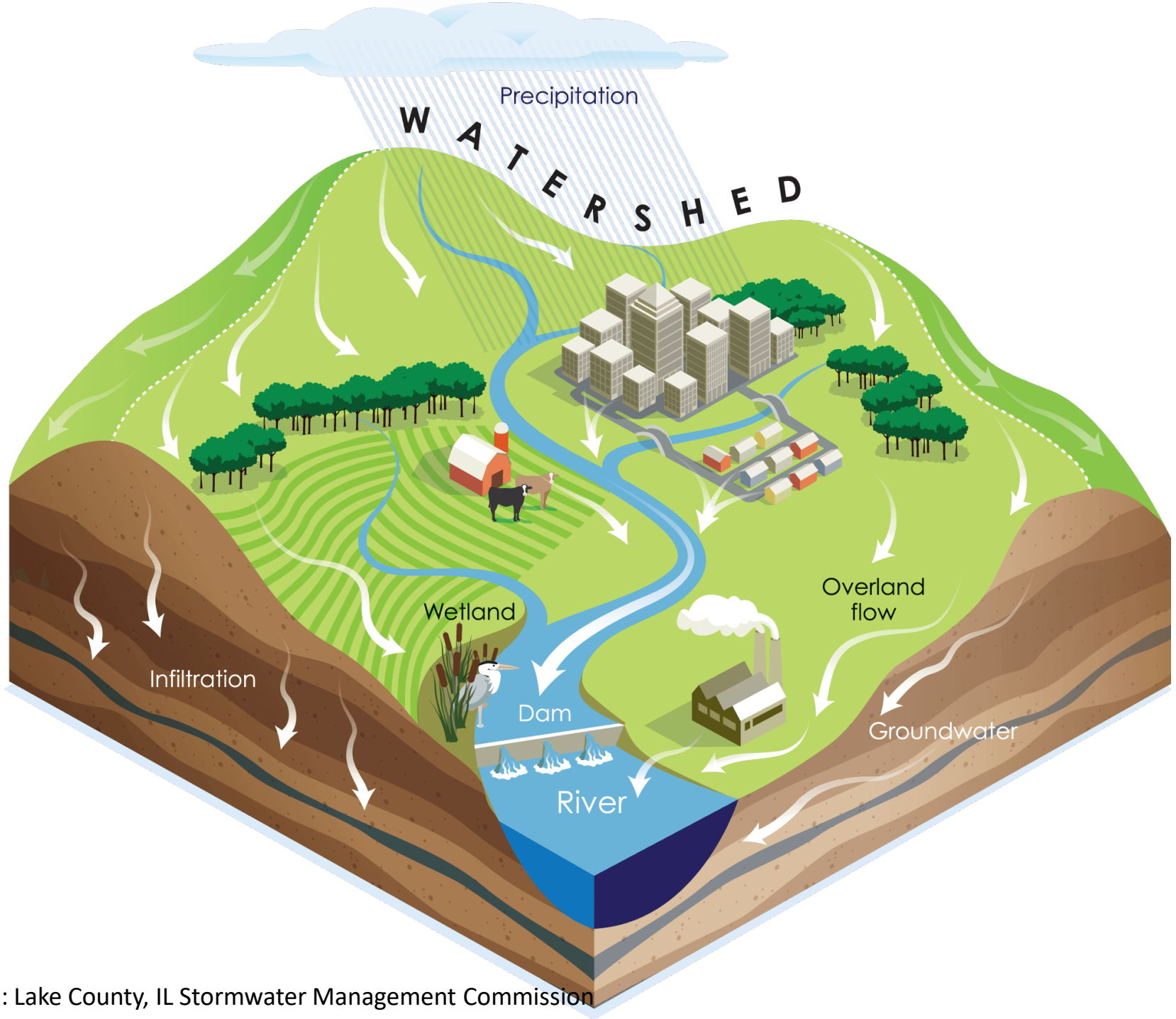
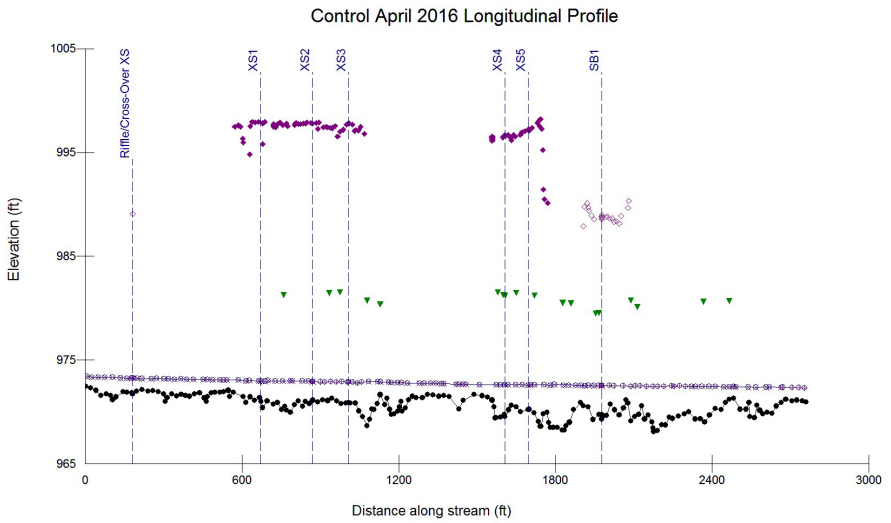
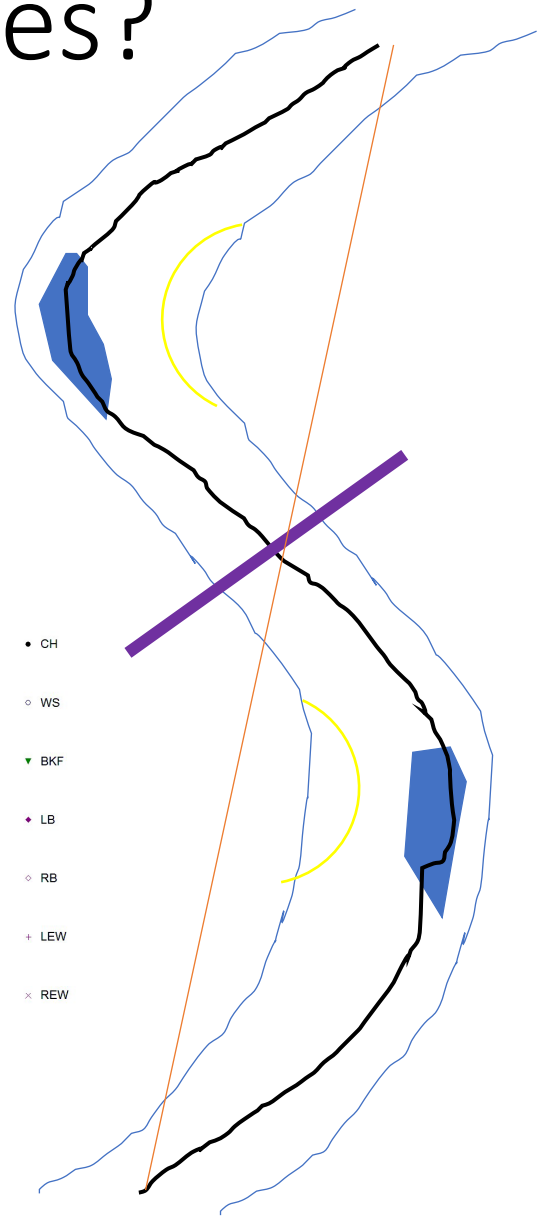


Image from: Lake County, IL Stormwater Management Commission

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

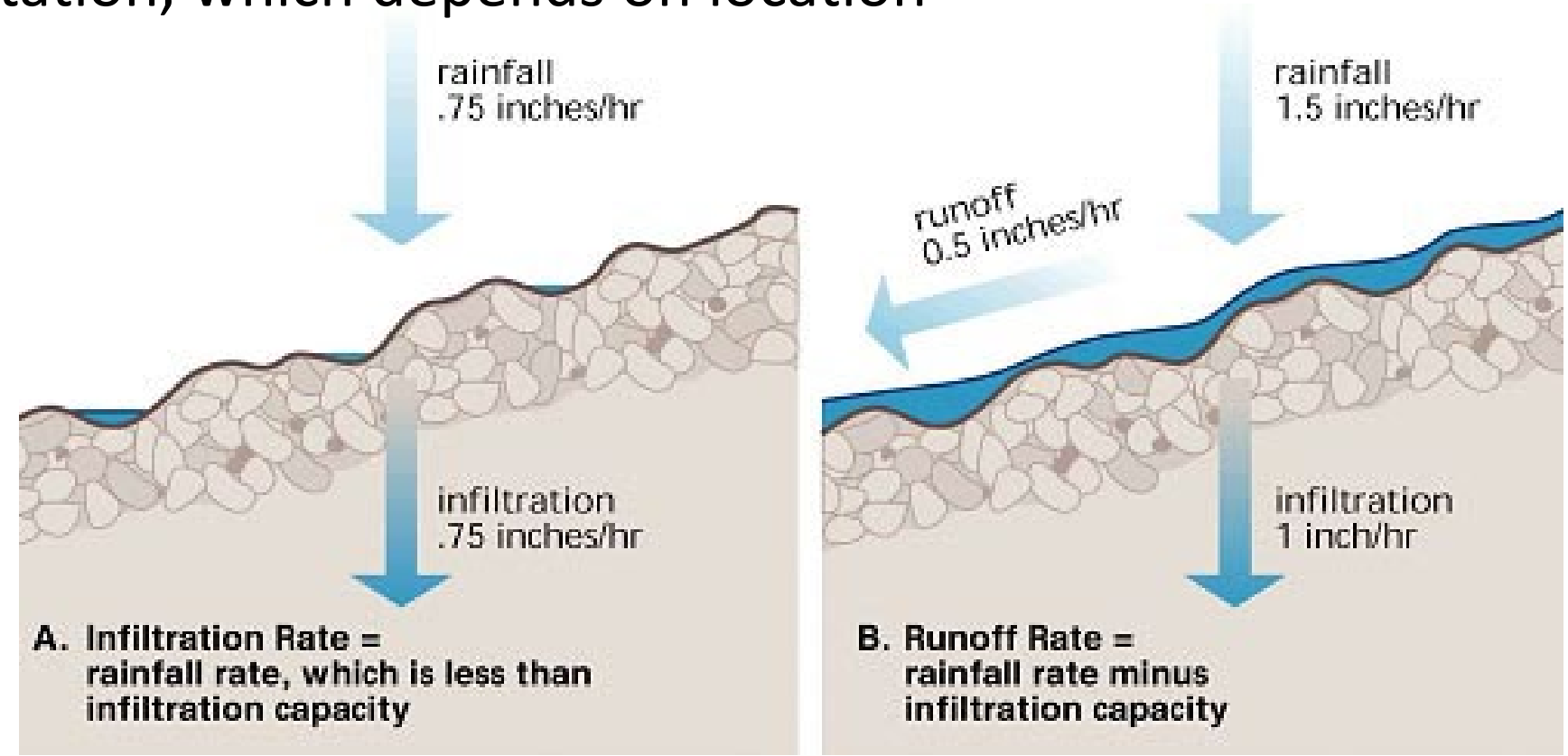
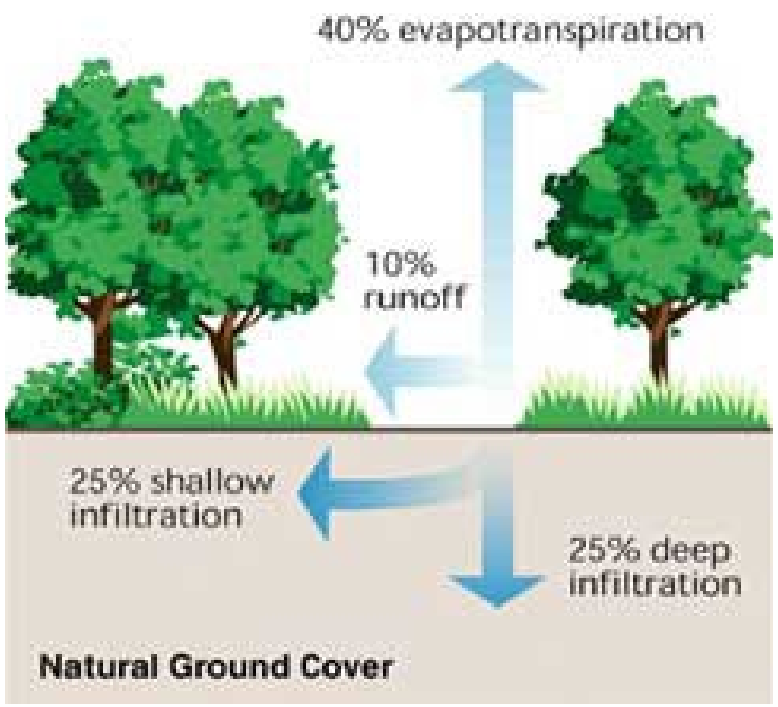
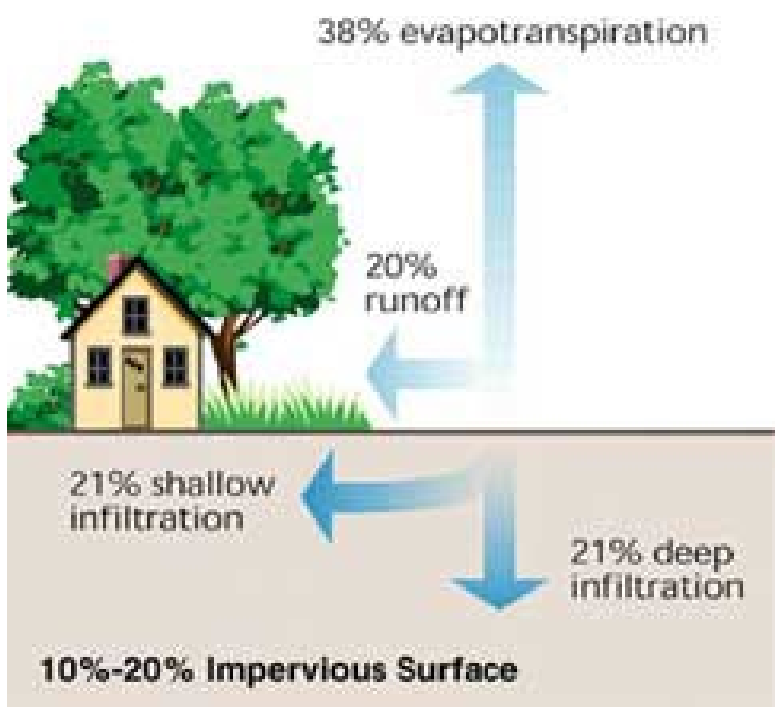
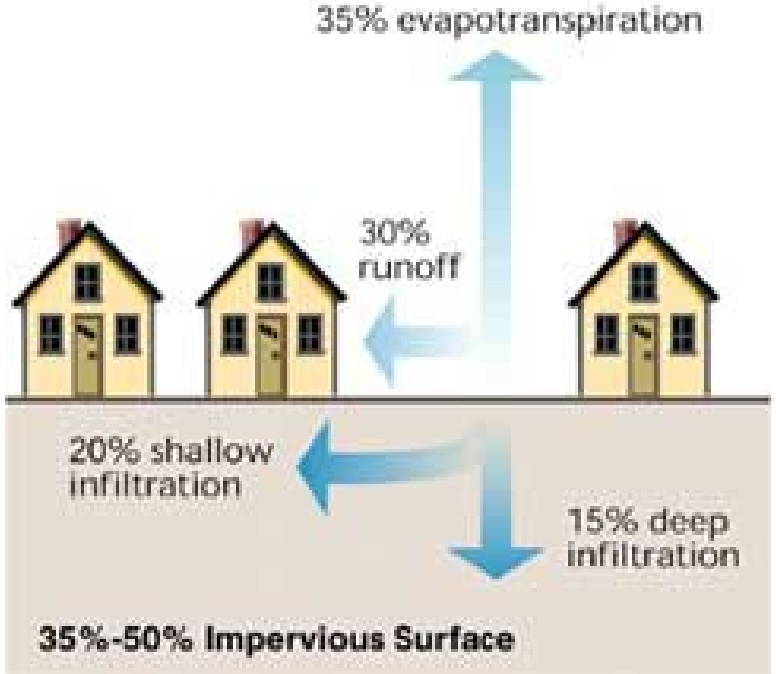


Image from University of Arizona Extension







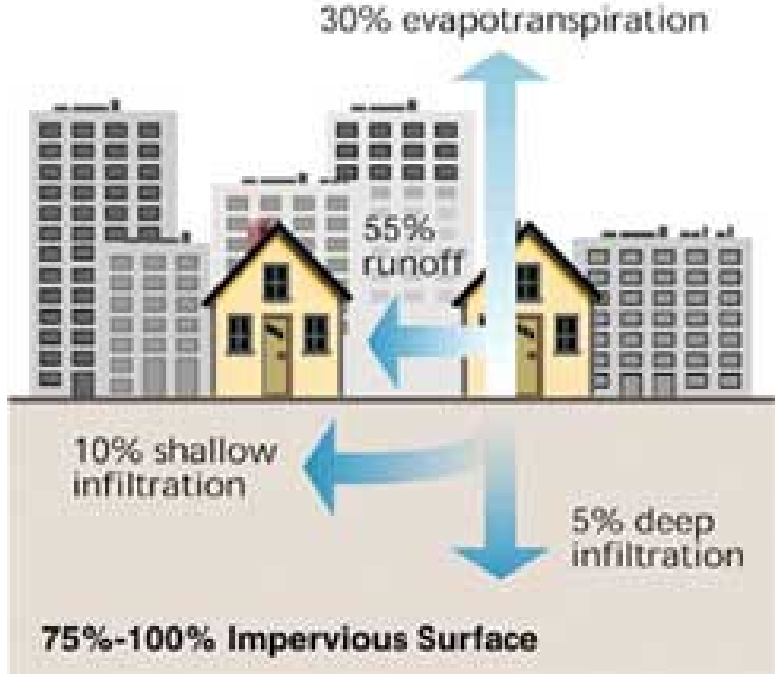


Image from Federal Interagency Stream Restoration Working Group (FISRWG)

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

Land cover has the largest effect on infiltration.

We will revisit this later.

Why does a stream look the way it does?

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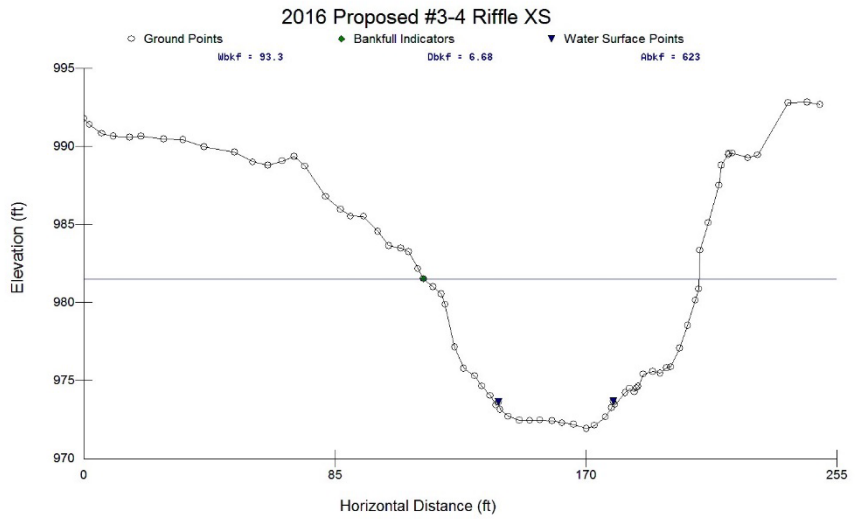
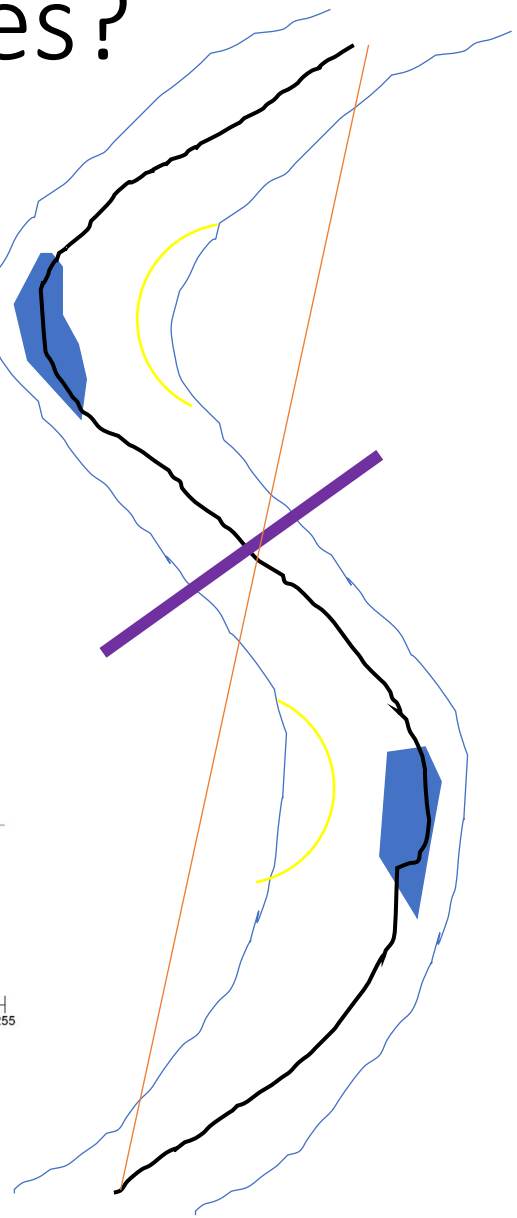
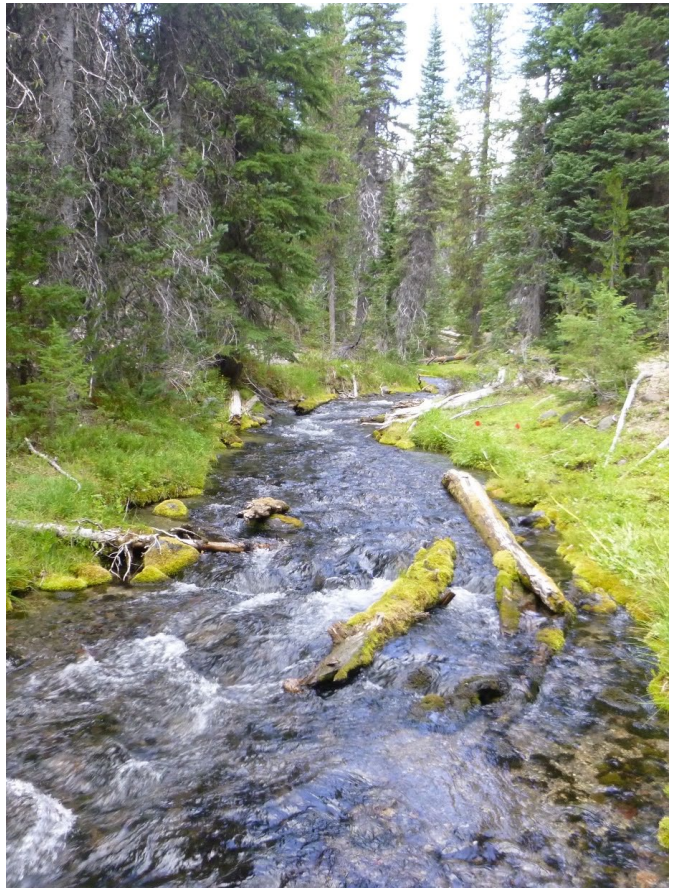




Sediment Load

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



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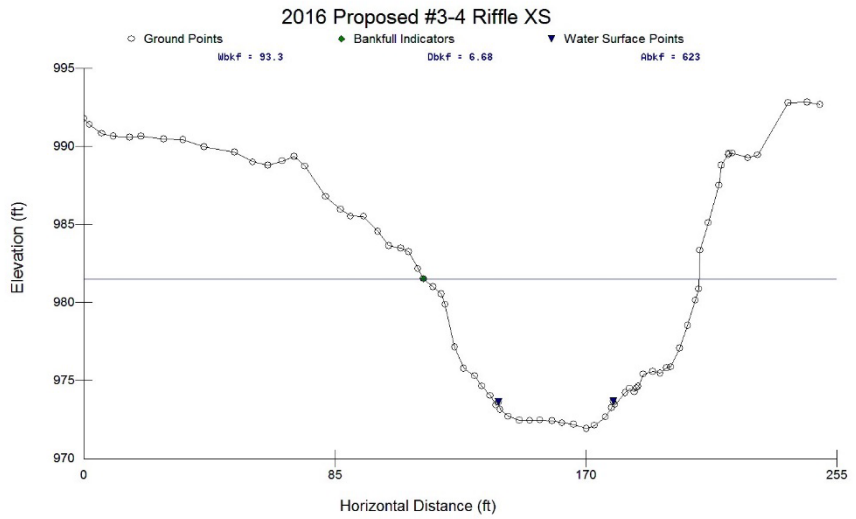

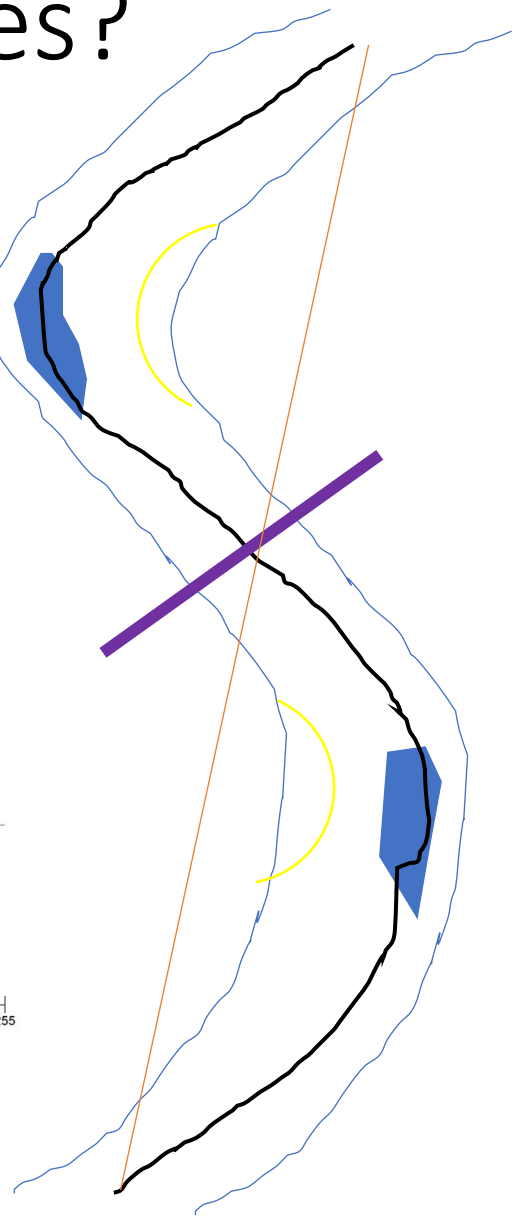

Boundary Conditions

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

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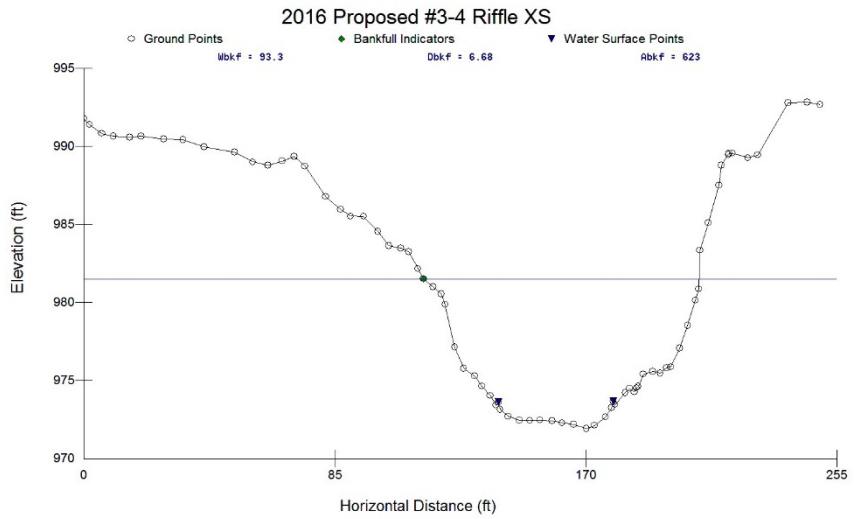
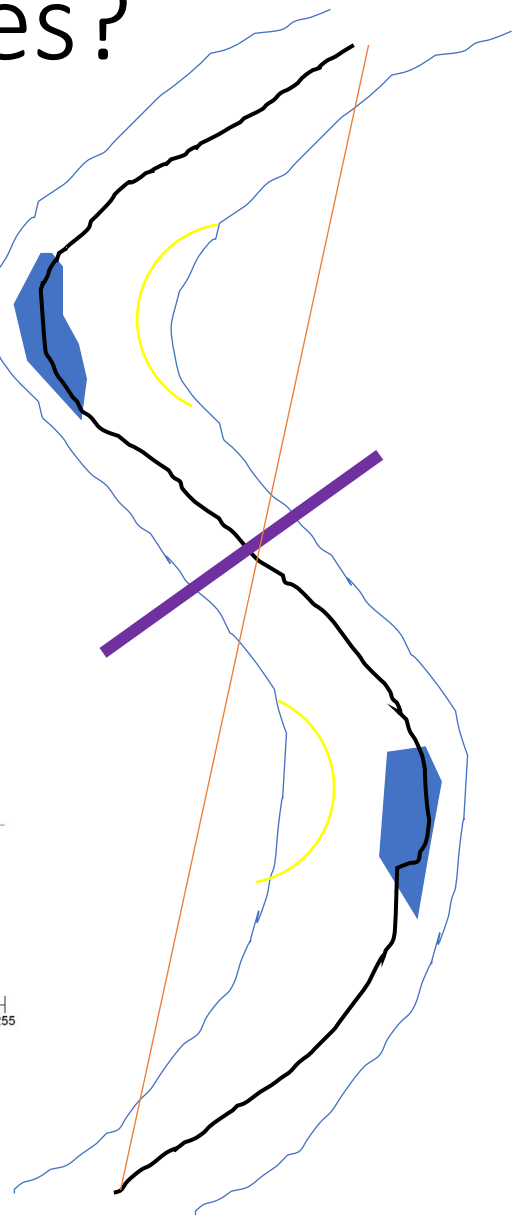
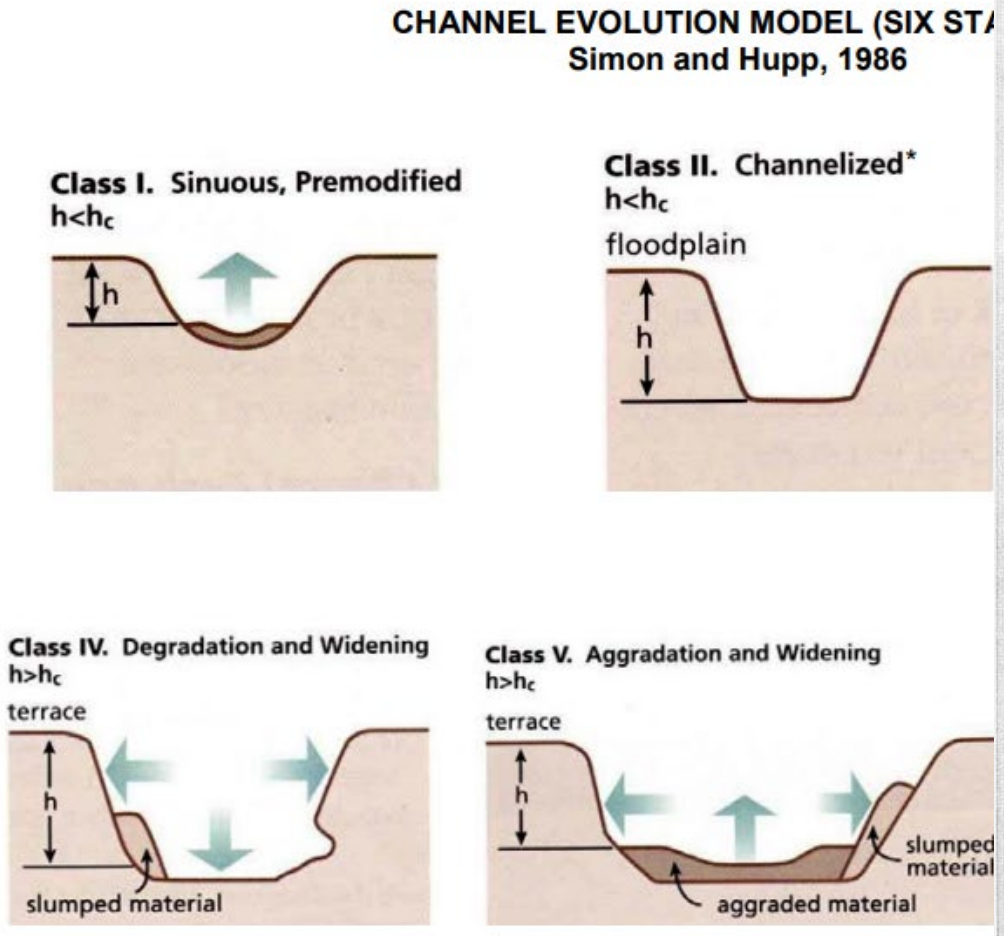


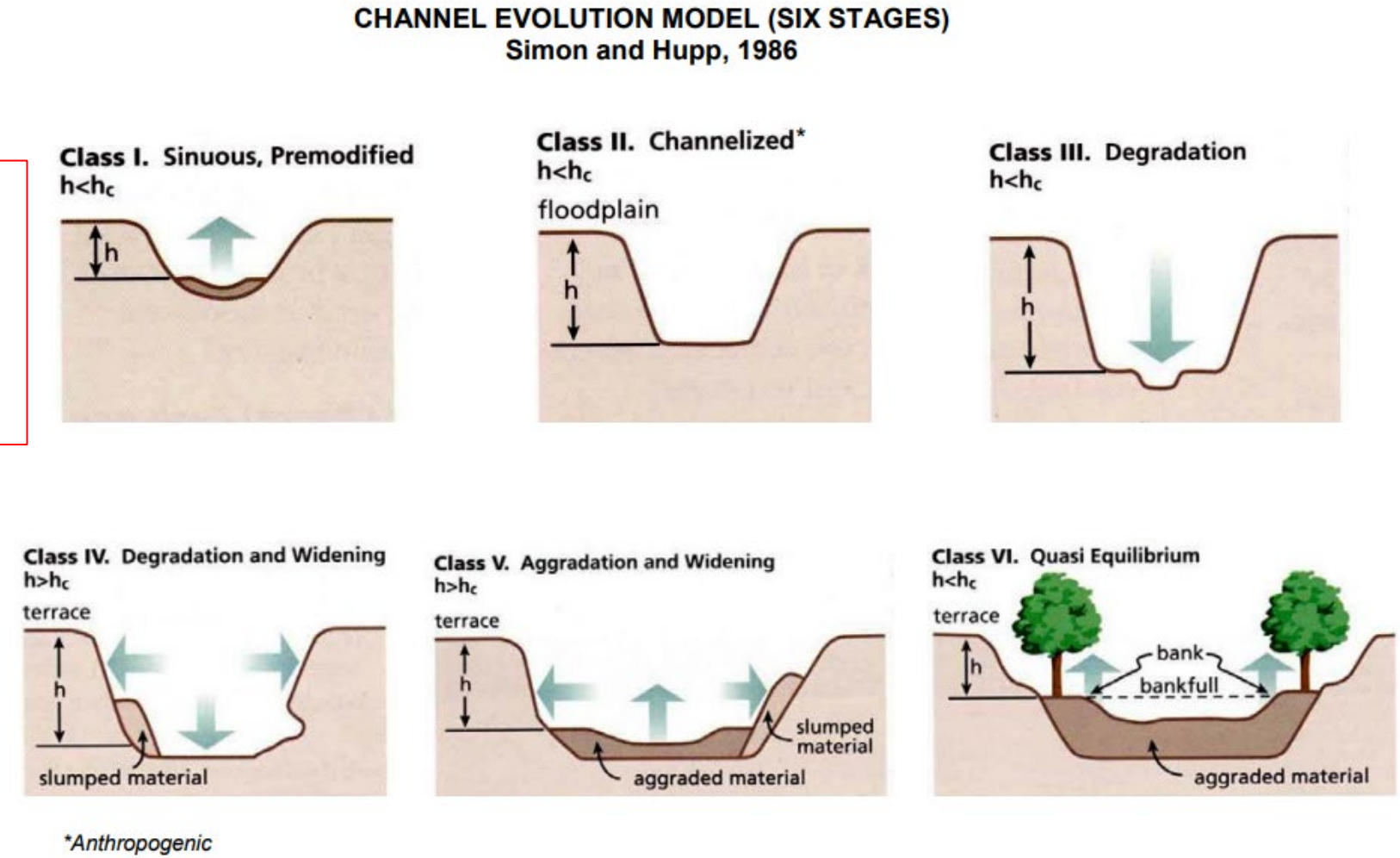


Why does a stream act the



Why does a stream act the way it does?

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



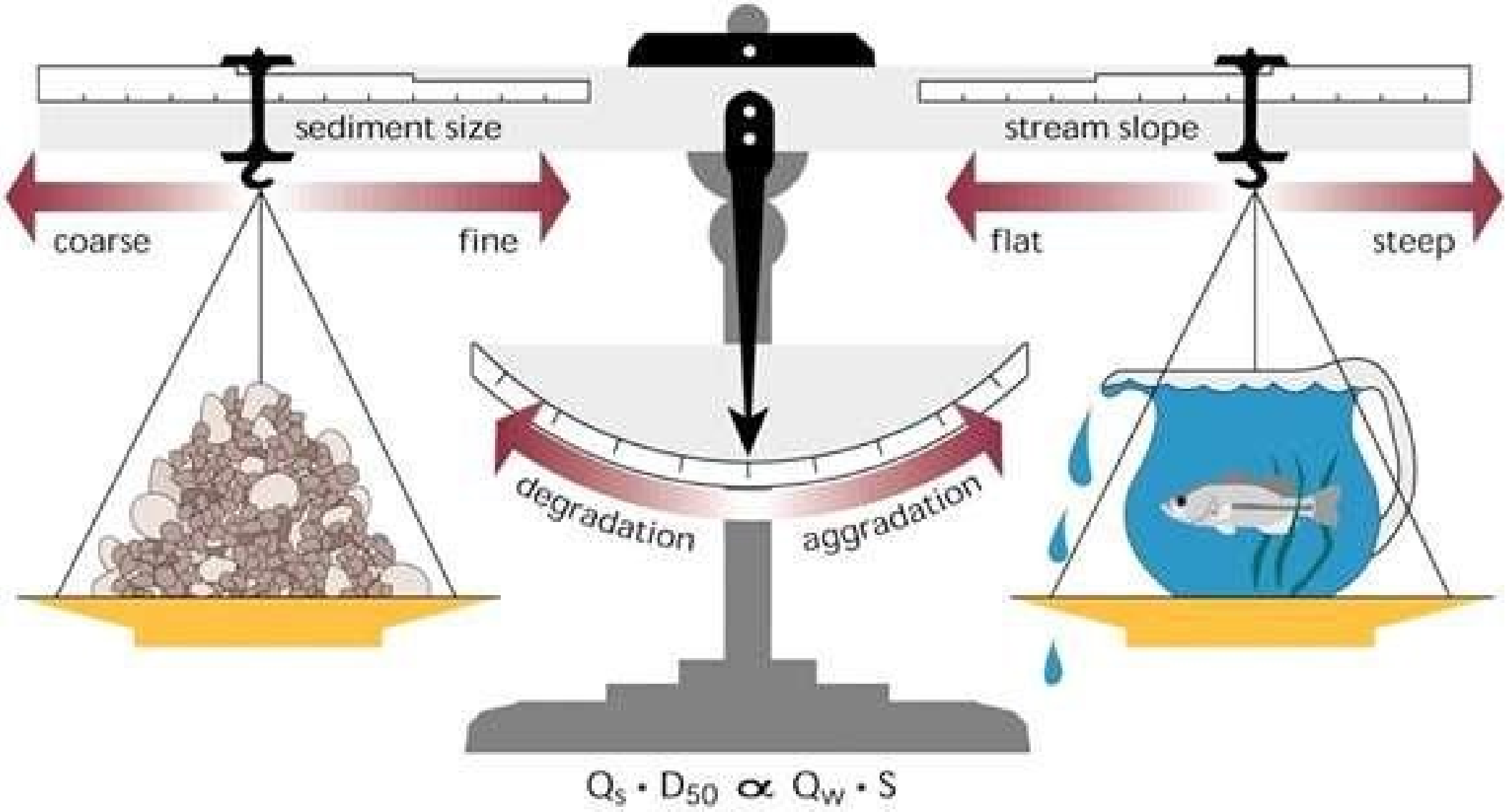


Image from Rosgen (1996)

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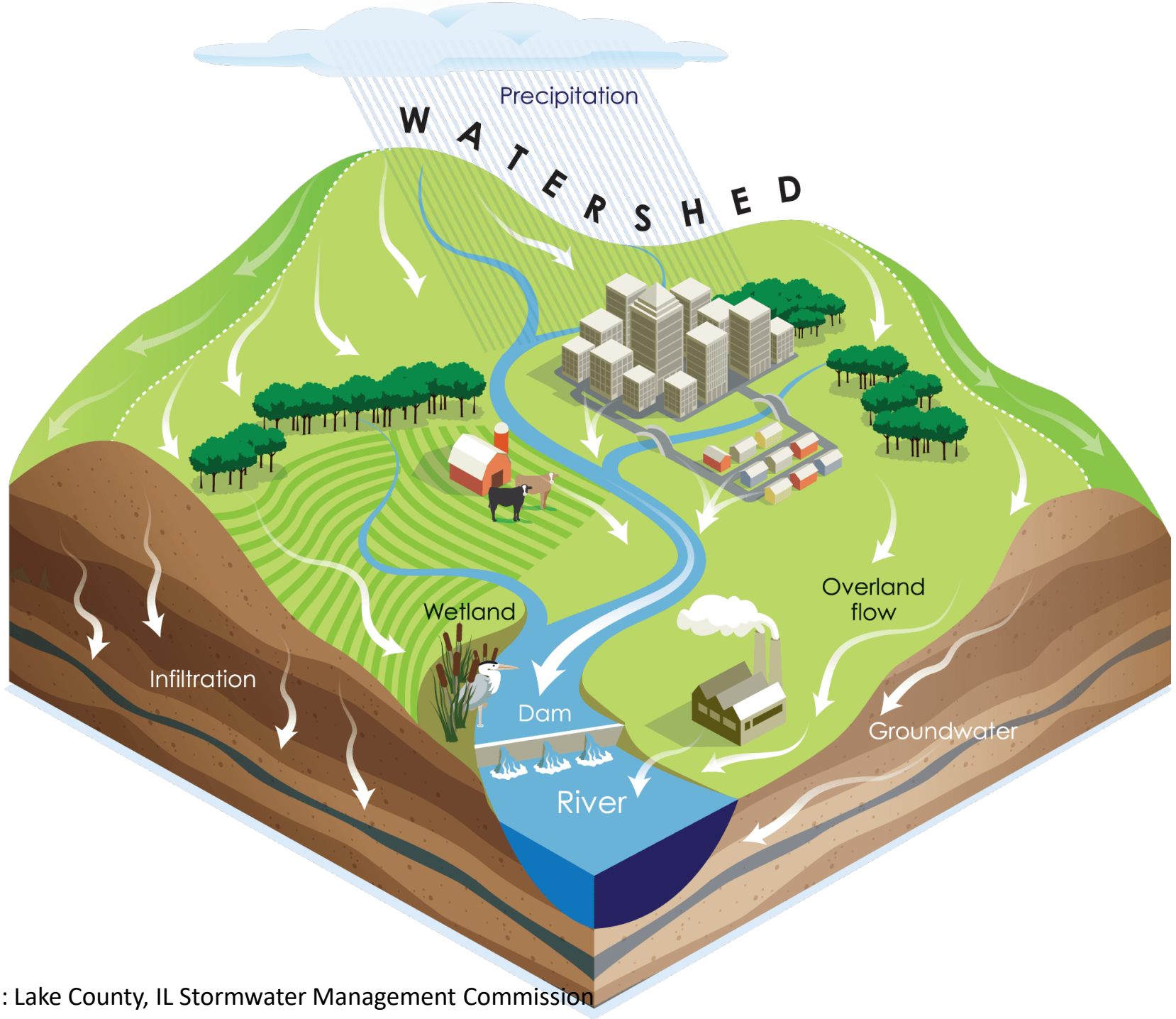


Image from: Lake County, IL Stormwater Management Commission

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

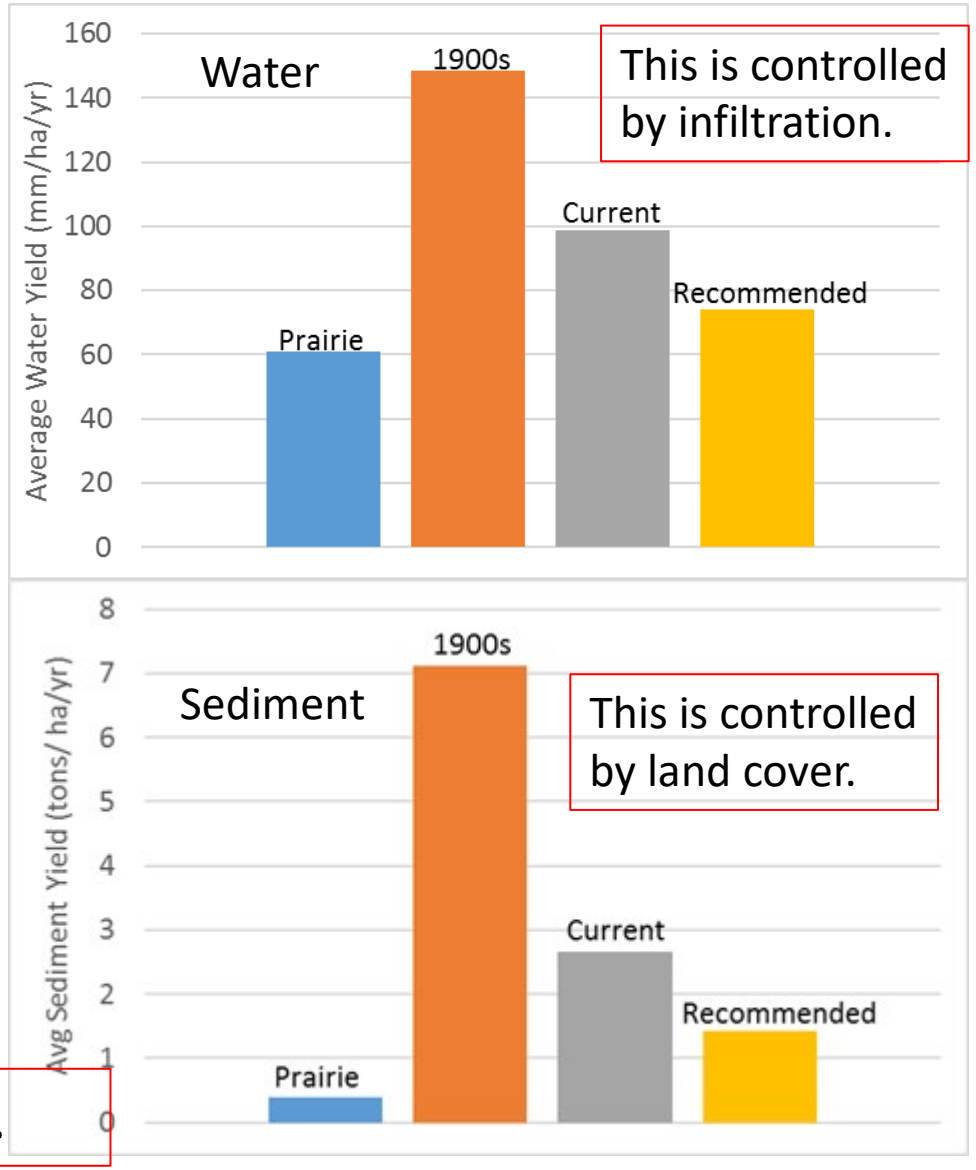
Basin

Reach

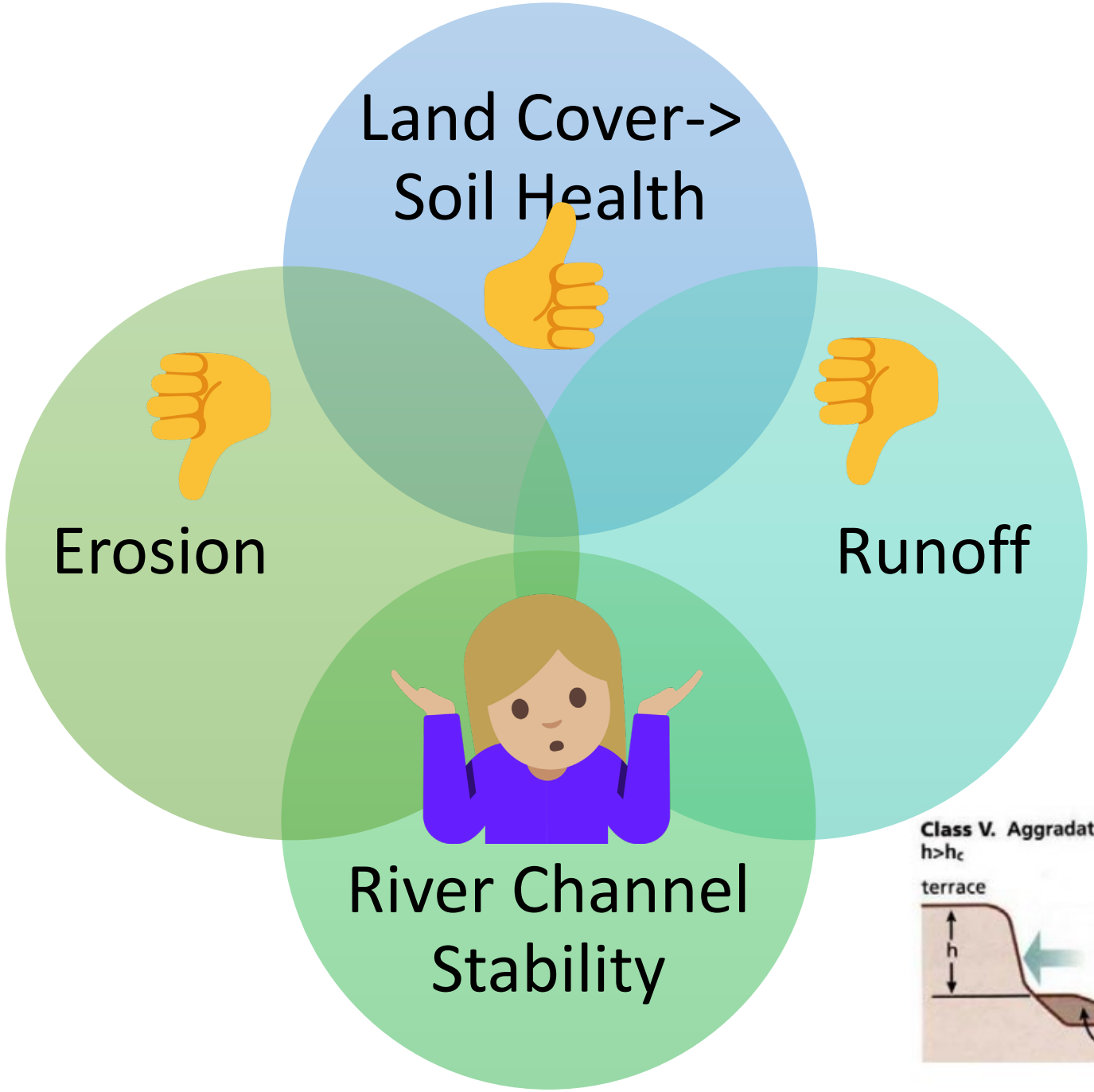
N

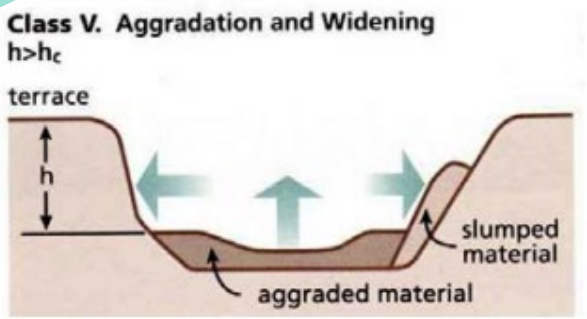
Prairie to Ag Land Example

- 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.


Land Cover->
Soil Health
Erosion
Runoff
River Channel
Stability


Class V. Aggradation and Widening
h>hc
terrace
h
slumped
material
aggraded material


Class VI. Quasi Equilibrium
h<hc
terrace
h
bank
bankfull
aggraded material

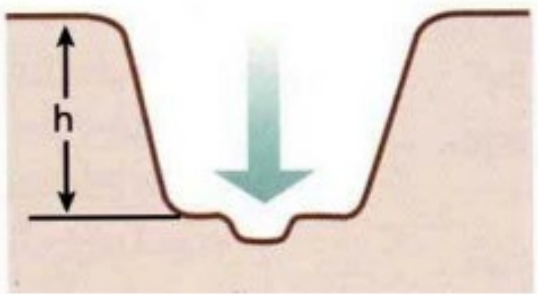
Land Cover->
Soil Health

Erosion

Runoff

River Channel
Stability

Class III. Degradation
$h<h_c$



Changing behavior has cumulative impacts.

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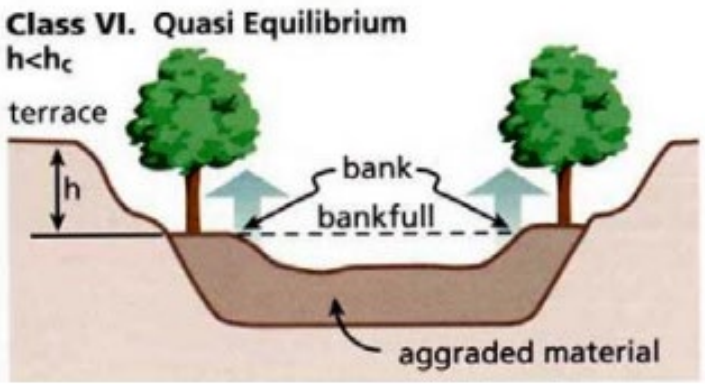
Stream Restoration

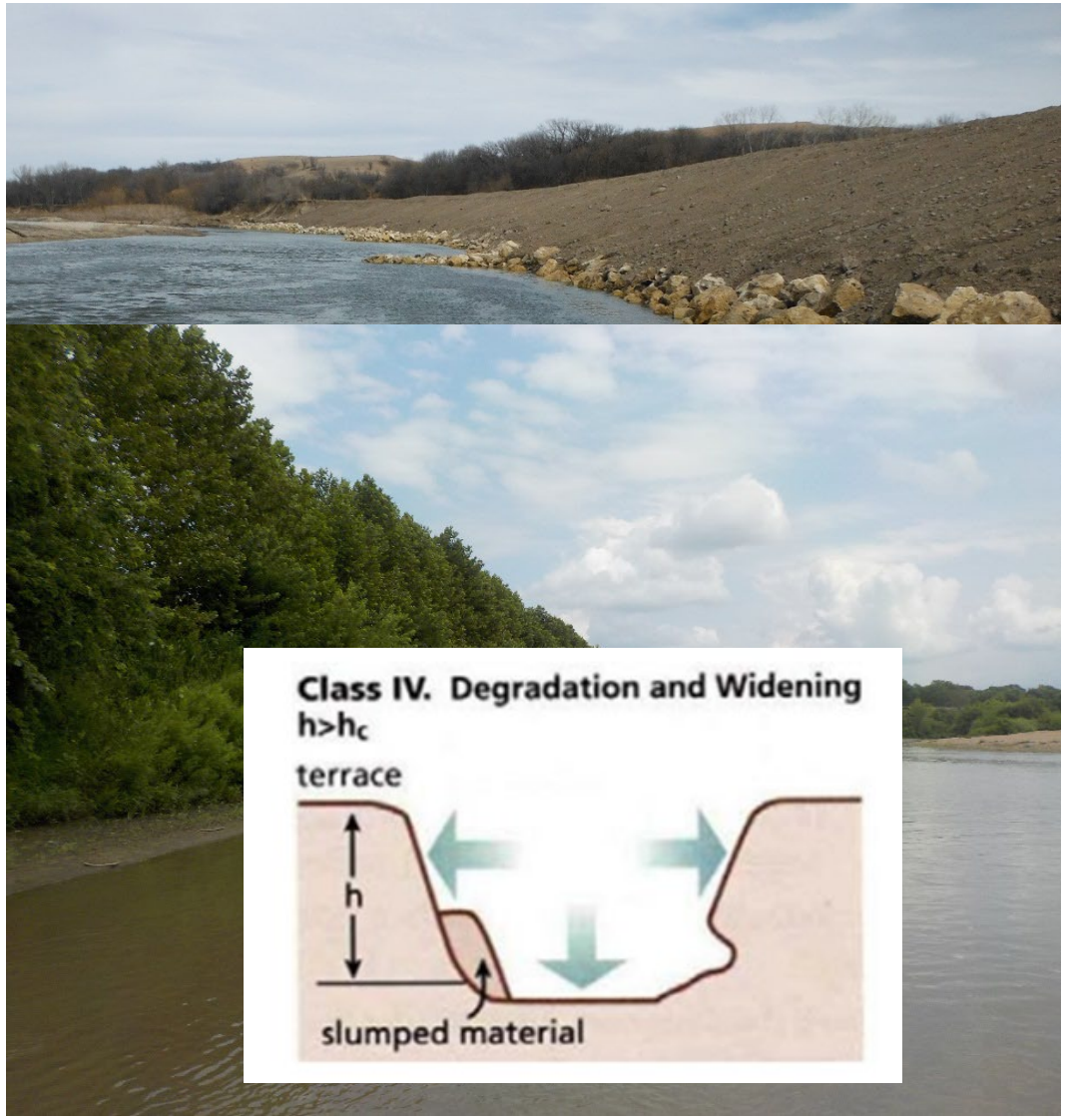
- Design and construction of a vertically- and laterally-stable, floodplain-connected channel that is capable of carrying the bankfull flow and its produced sediment load
- *Recall*: “Floodplain” floods every 1-2 years



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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