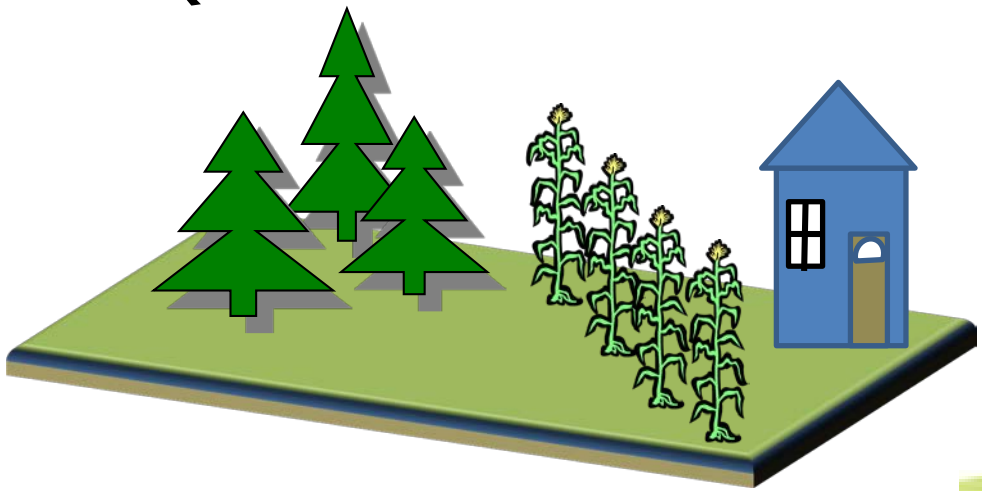

What is the **Water** telling Us about the **Land**?

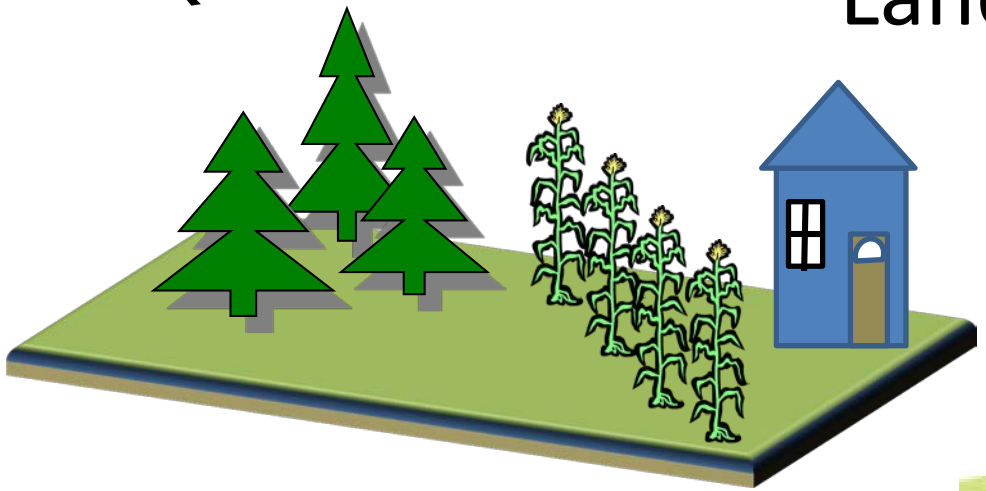


This Morning

Rain

Land

Water



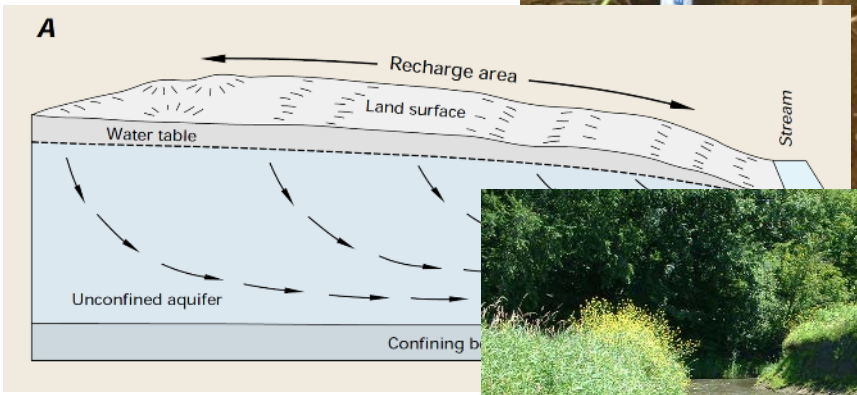
This Morning

The Water

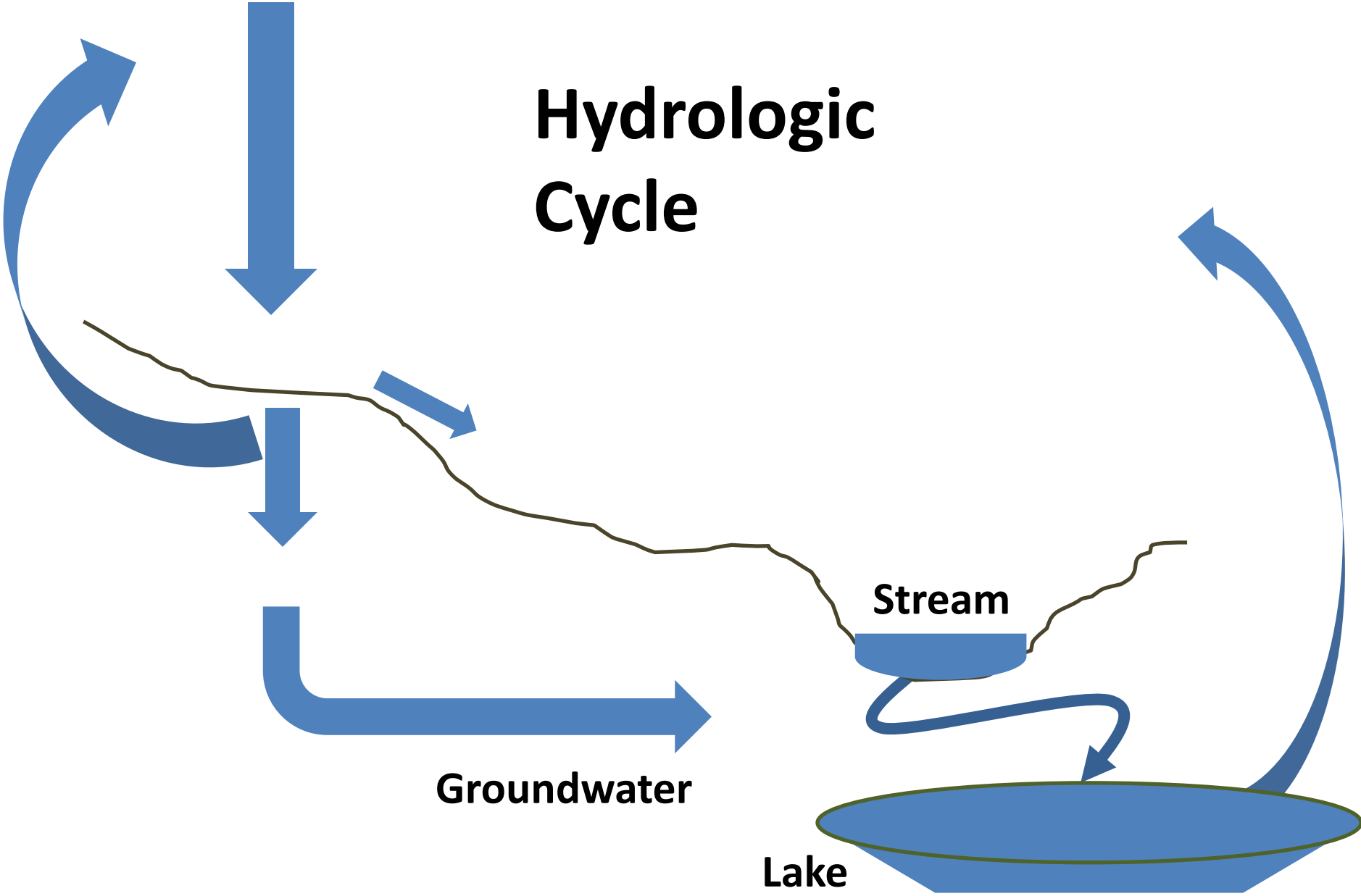
- Precipitation
- Soil Water
- Groundwater
- Streams
- Lakes

The Water

- Let's explore how these are connected!



Hydrologic Cycle

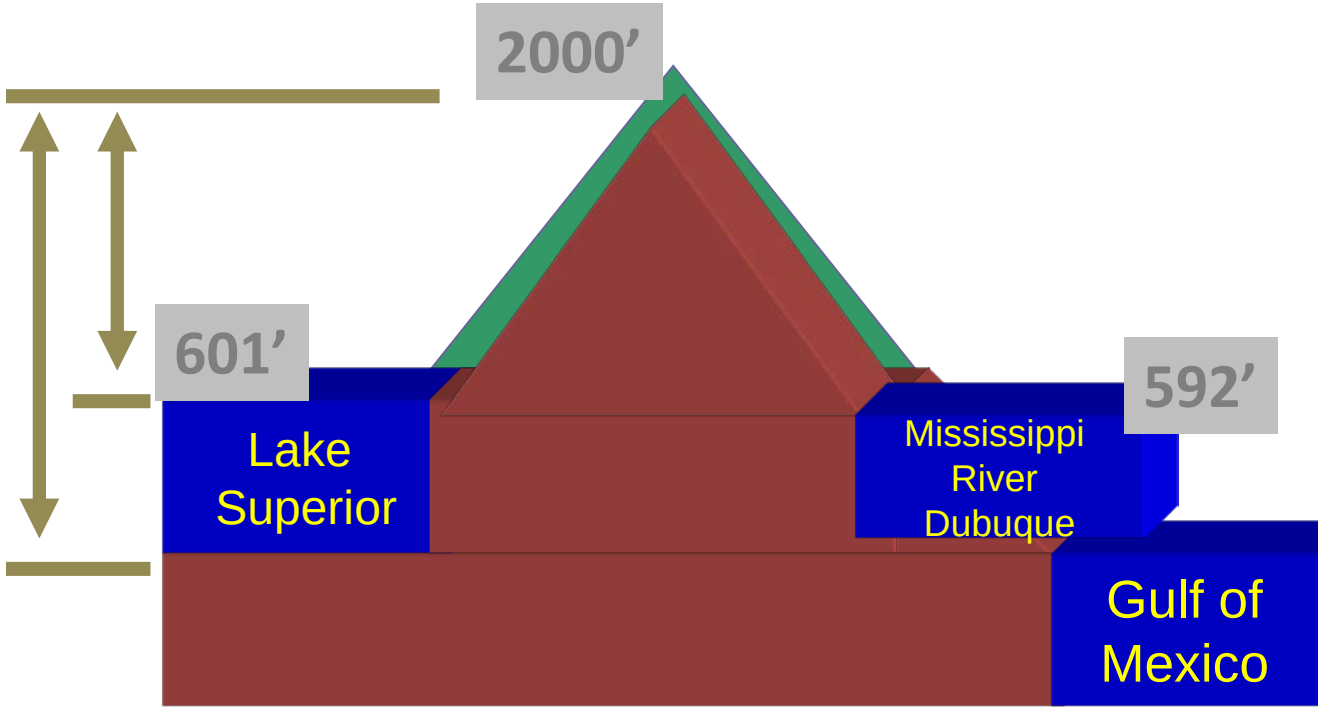


Elevation

- Water goes downhill

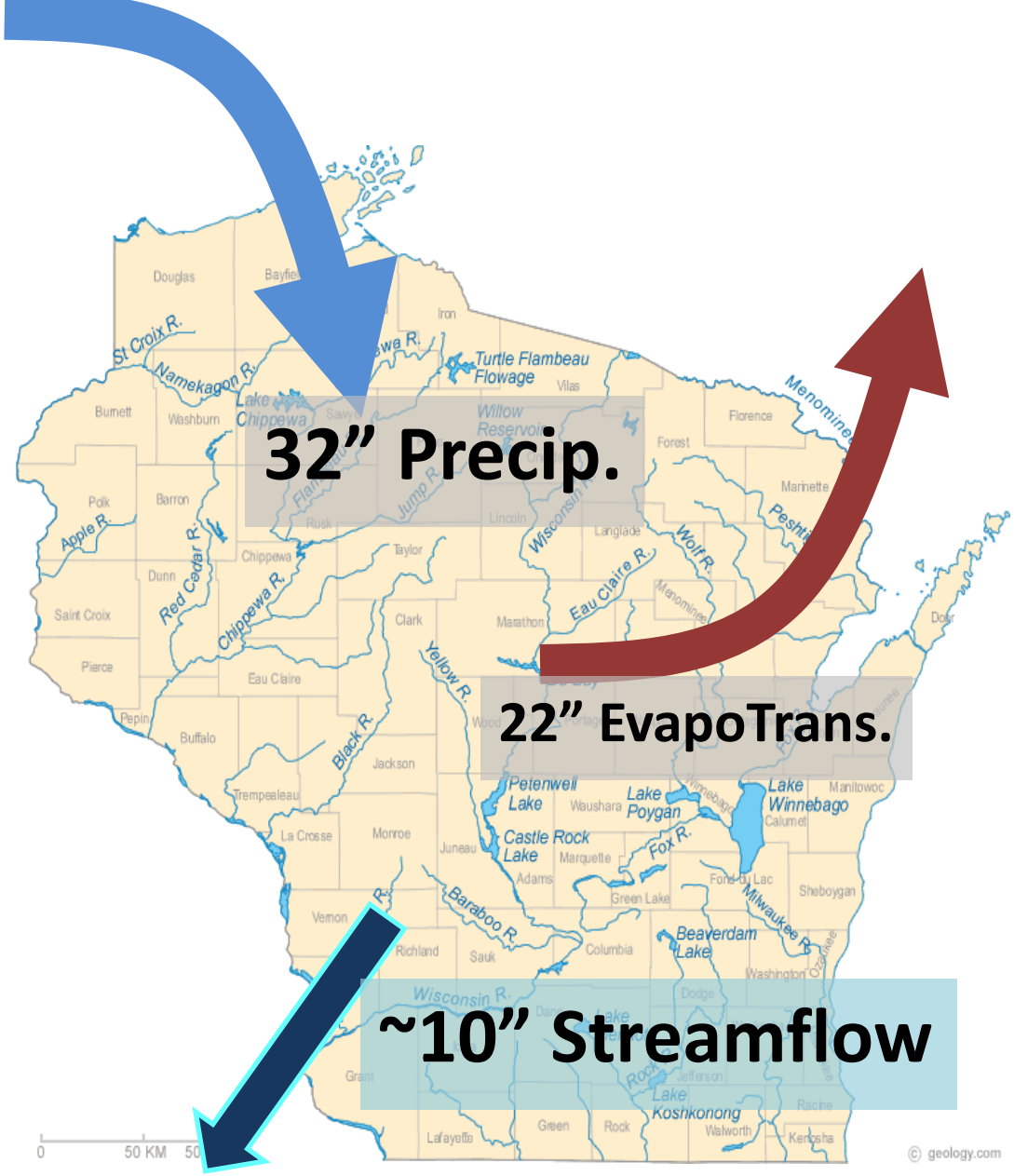
Elevation

- Water goes downhill

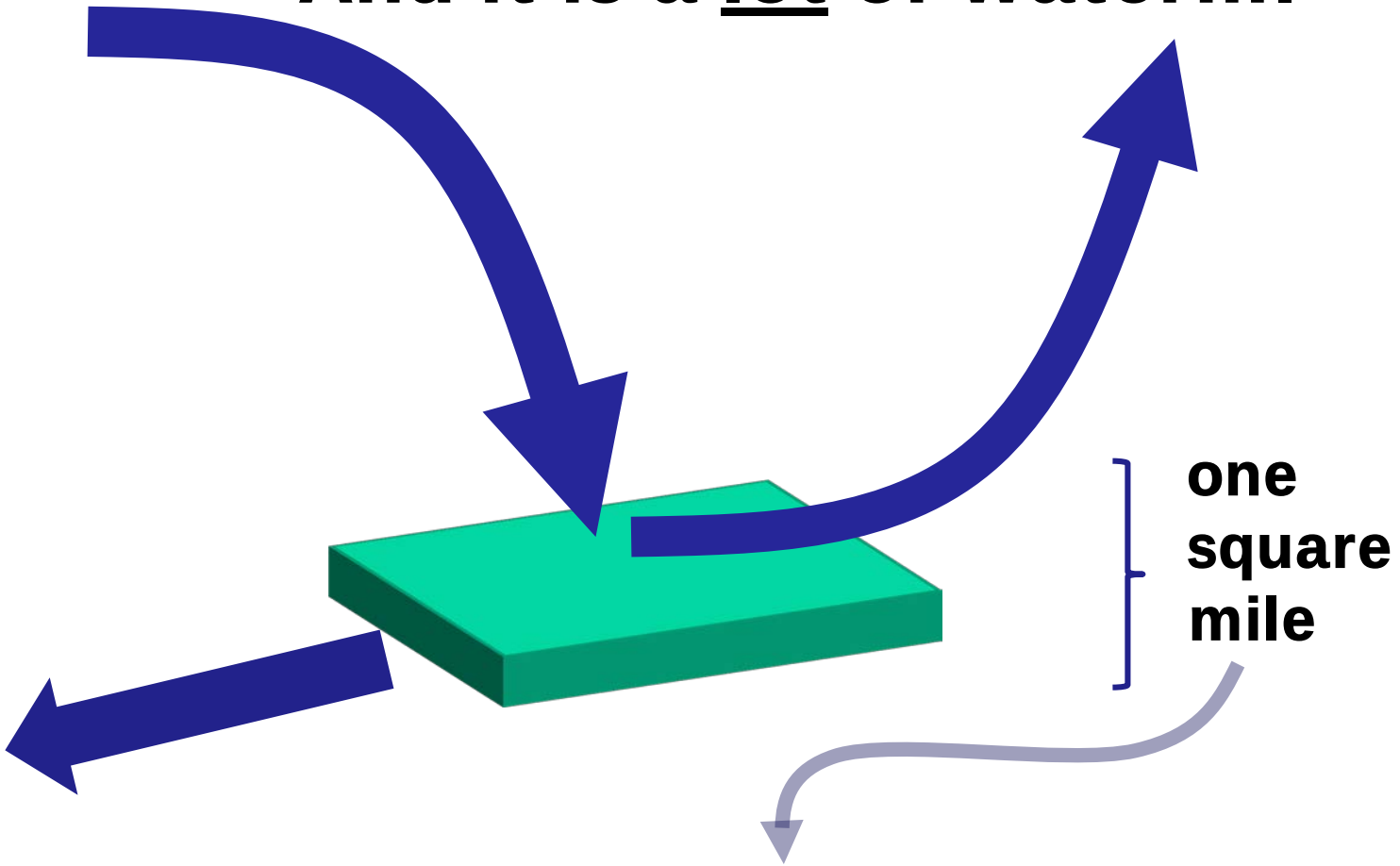


The Water

- Precipitation
- Evapotranspiration
- Streamflow

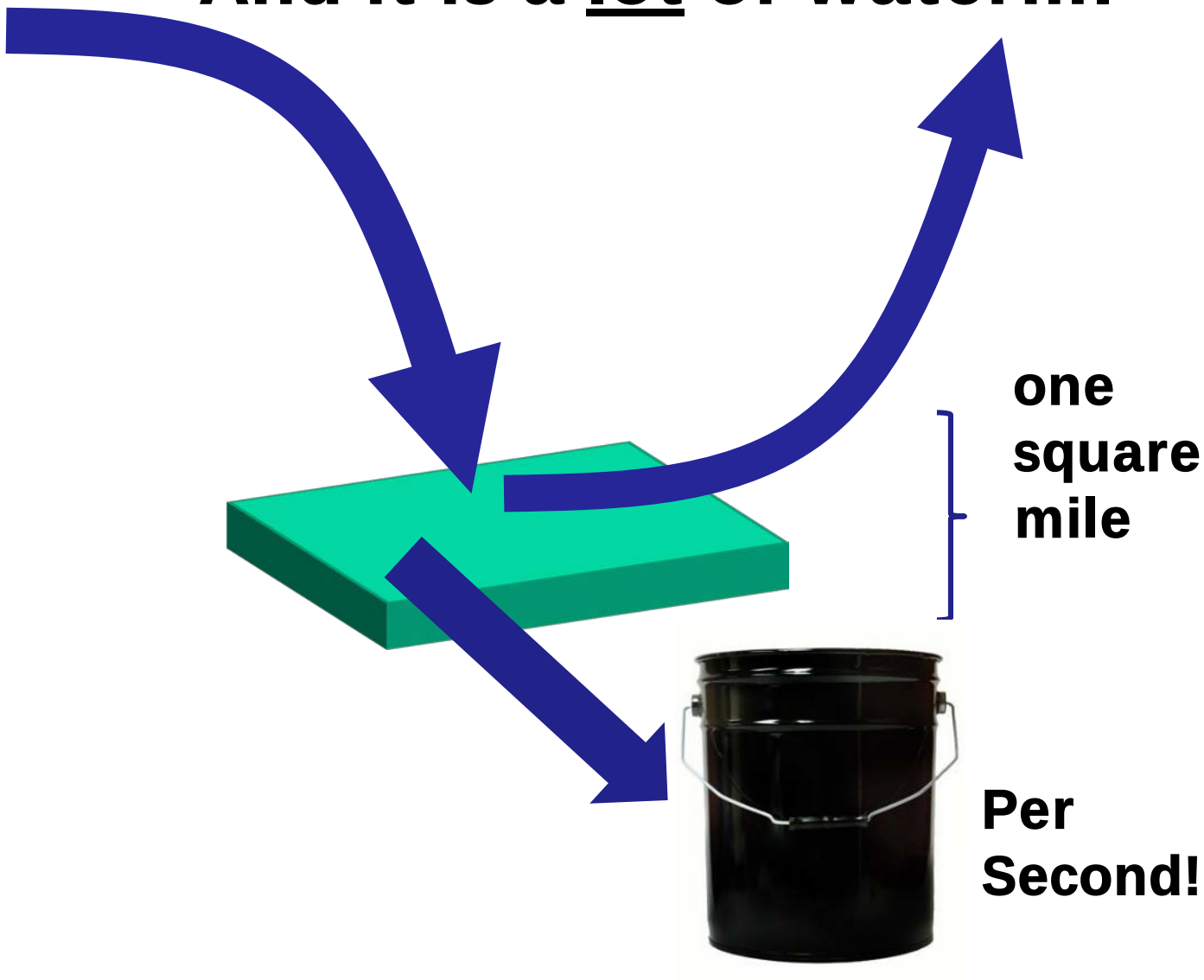


And it is a lot of water….



$$10"/yr = \frac{23\ million\ cubic\ ft/yr}{31\ million\ seconds/yr} = 0.74\ cfs$$

And it is a lot of water….

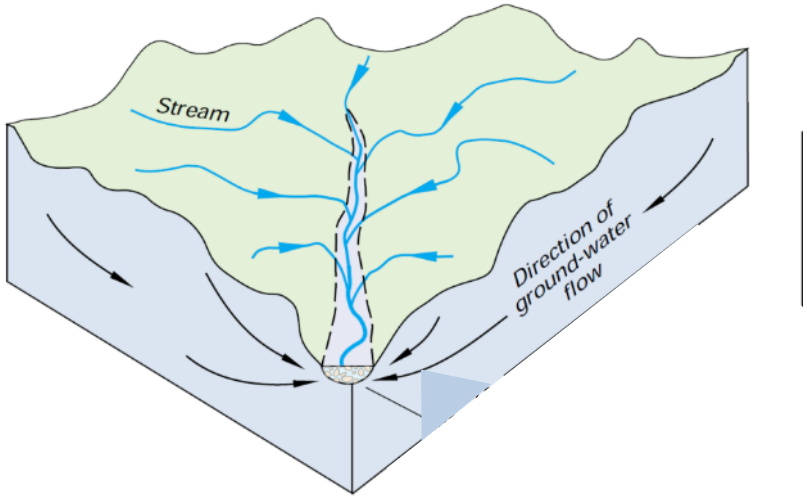


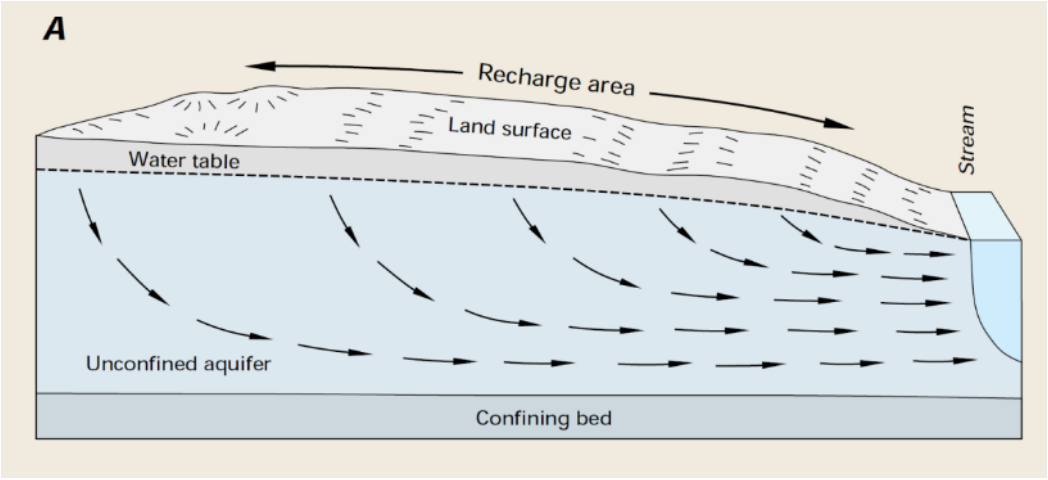
How could we test this?

- Figure out the area that contributes water to a point
  - We'll call this the watershed
- Measure the streamflow and convert that to a depth of water per year
  - This is some math...
  - Volume of water divided by area = depth

The Watershed

- A land area
- Remember, water flows downhill



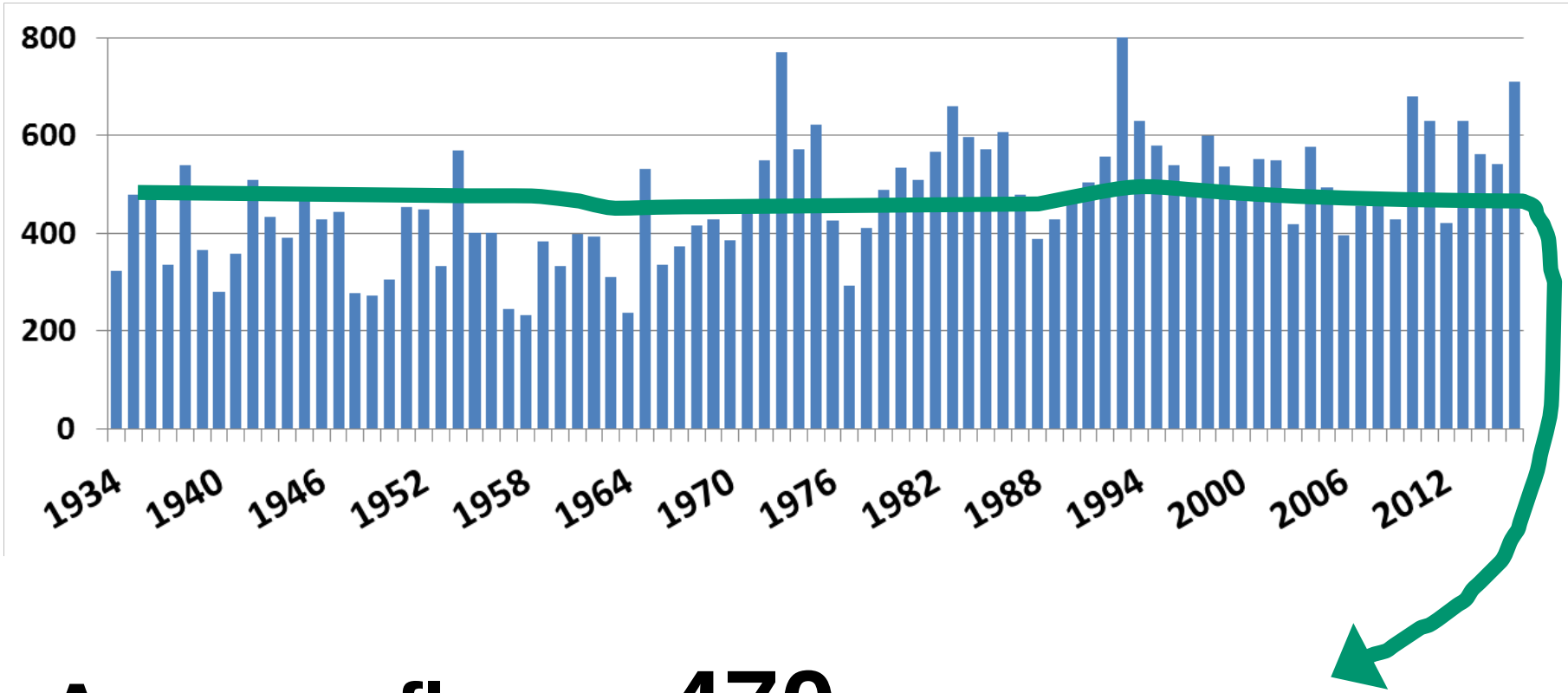


The Watershed

- A land area
- Remember, water flows downhill
- Some clues from a map
- Topography

Really?

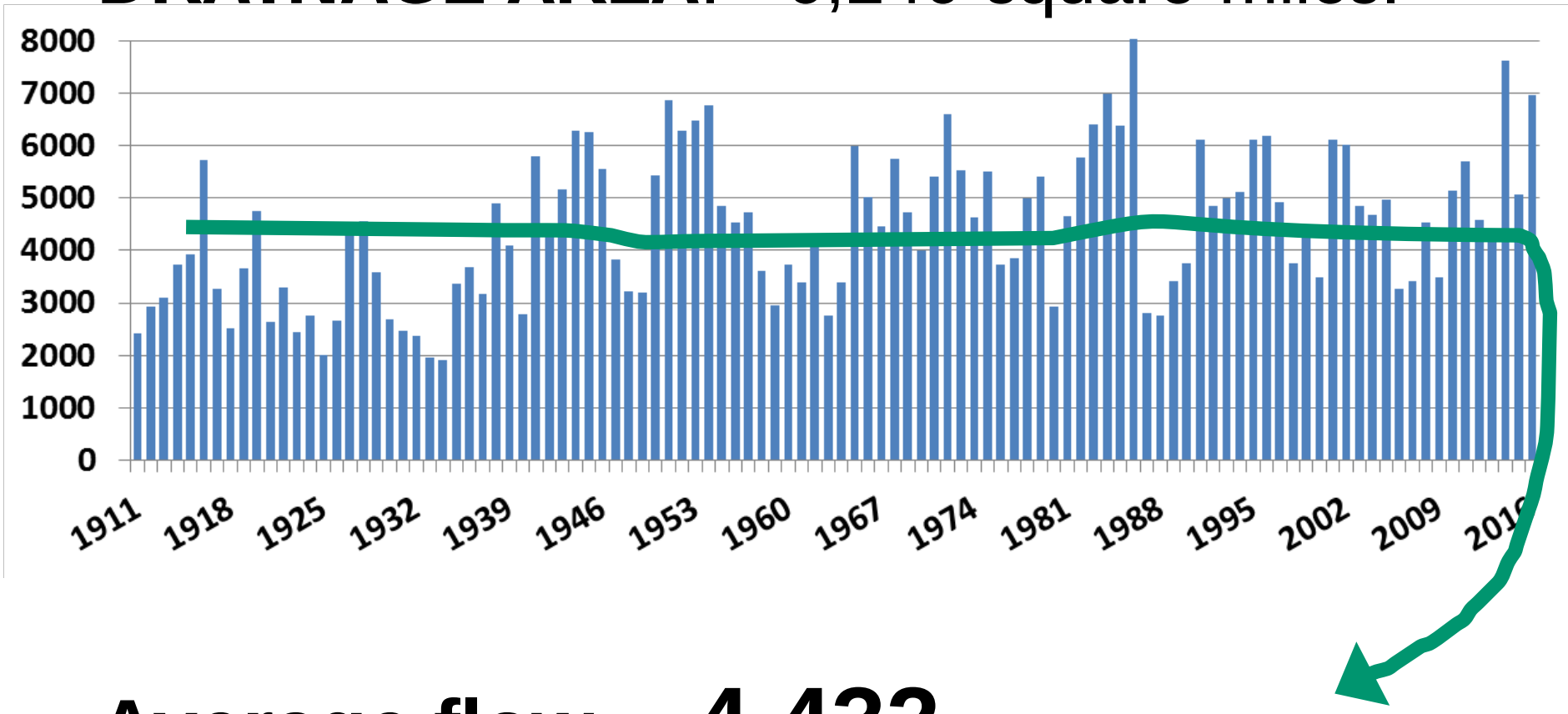
- **USGS 05379500 TREMPEALEAU RIVER AT DODGE, WI**
- **DRAINAGE AREA**.--643 square miles.



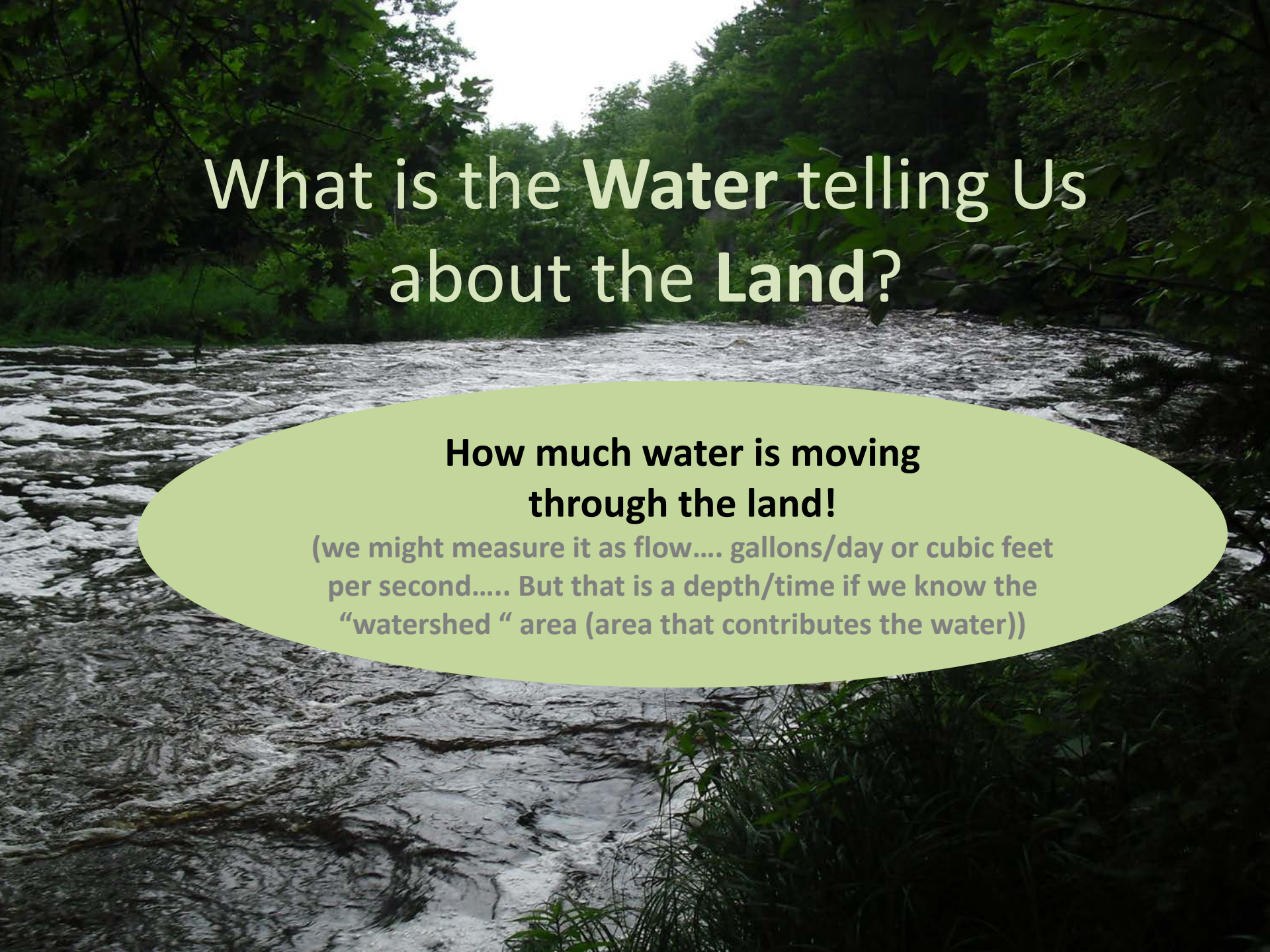
Average flow ~470 cubic feet per second

Really?

- **USGS 05340500 ST. CROIX RIVER AT ST. CROIX FALLS, WI**
- **DRAINAGE AREA**.—6,240 square miles.



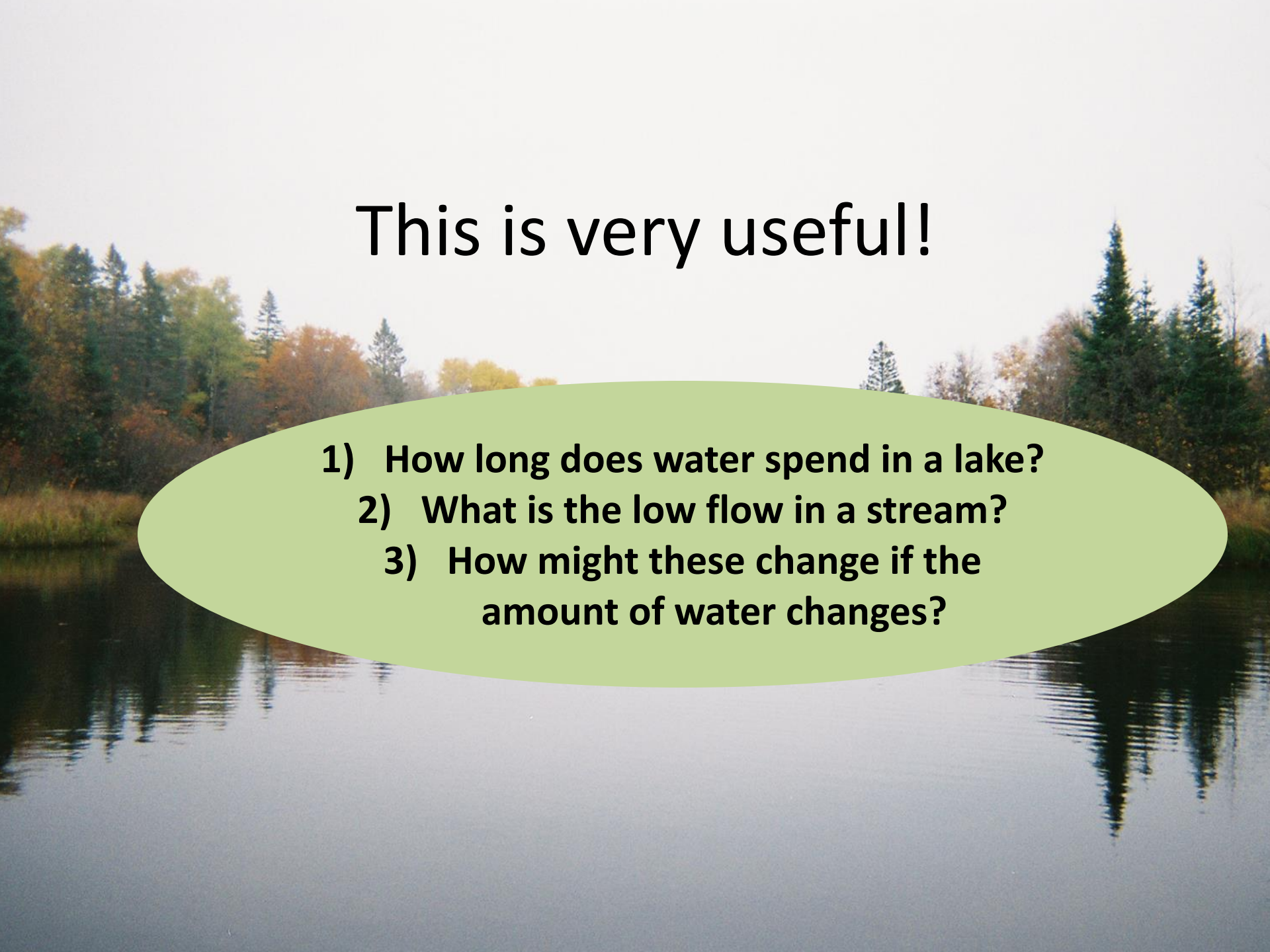
Average flow ~4,432 cubic feet per second



What is the **Water** telling Us about the **Land**?

How much water is moving through the land!

(we might measure it as flow…. gallons/day or cubic feet per second….. But that is a depth/time if we know the "watershed " area (area that contributes the water))



This is very useful!

1) How long does water spend in a lake?
2) What is the low flow in a stream?
3) How might these change if the amount of water changes?

Part 2.

- ***What can we learn in a single storm?***

Part 2.

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R. Mentz Photo, Pioneer Farm

Part 2.

The Rain

__ Inches per Year +/-

↓

- ***What can we learn in a single storm?***

___ storms per year +/-

↓

____ hours of precipitation (>trace) per year +/-

Part 2.

The Rain

32 Inches per Year +/-

↓

100 storms per year +/-

↓

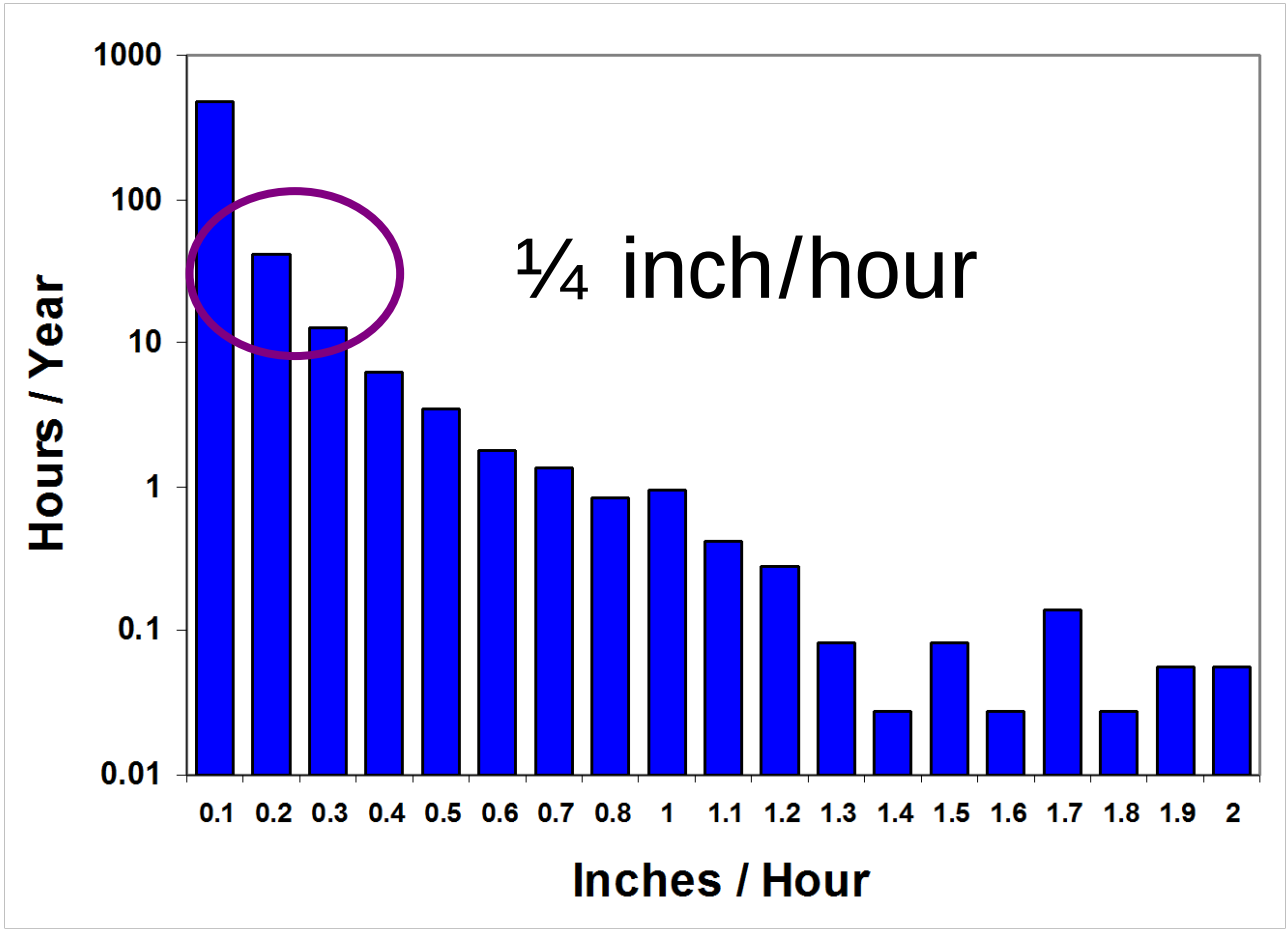
500 hours of precipitation (>trace) per year +/-

- ***What can we learn in a single storm?***

Part 2.

How much rain do we get in these hours?

- ***What can we learn in a single storm?***

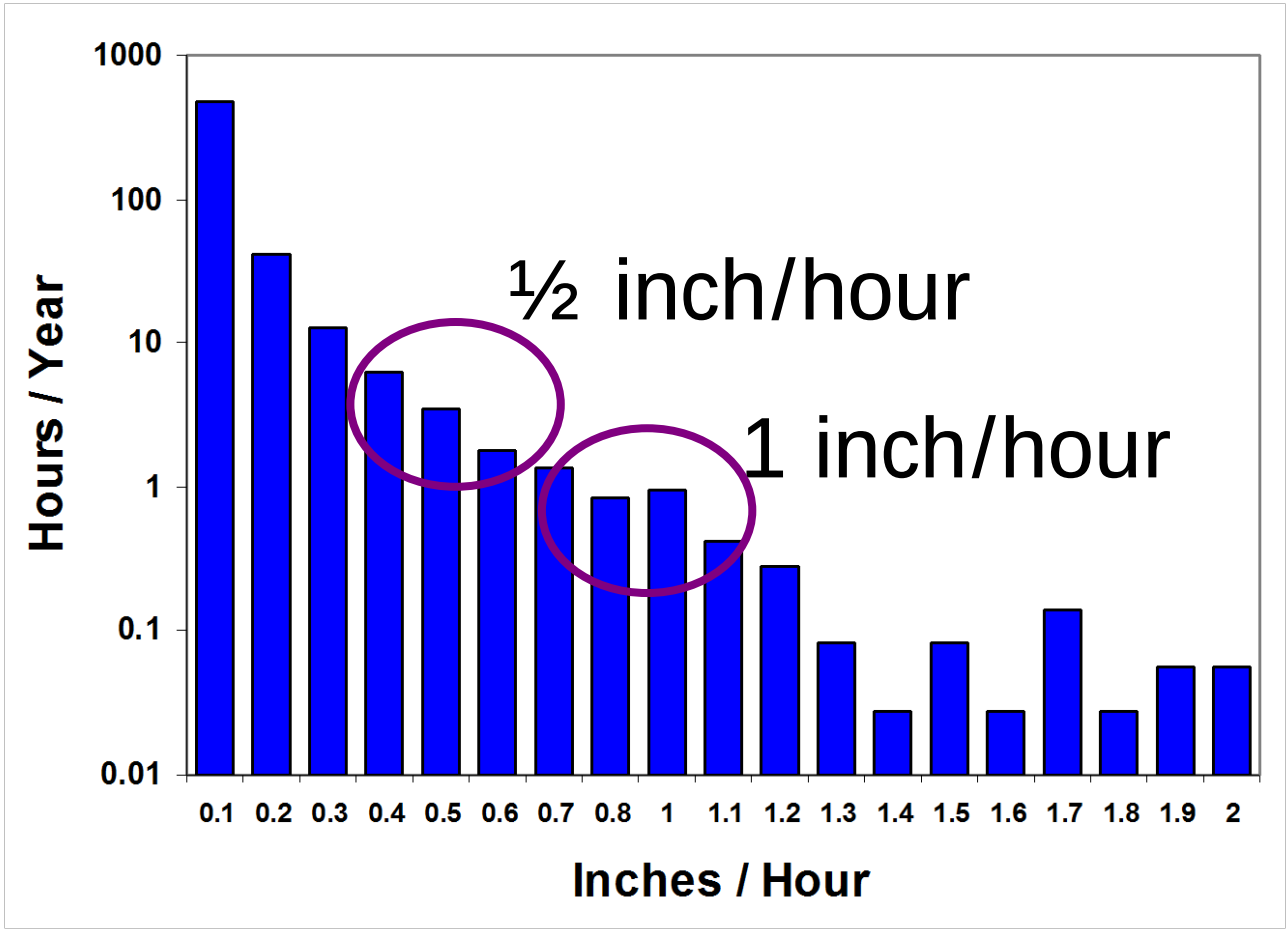


Based on P8 hourly rainfall
File for 36 years, Madison

Part 2.

How much rain do we get in these hours?

- ***What can we learn in a single storm?***



Based on P8 hourly rainfall
File for 36 years, Madison

Part 2.

- ***What can we learn in a single storm?***

What's going on here?

R. Mentz Photo, Pioneer Farm

Part 2.

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What's going on here?

Part 2.

- ***What can we learn in a single storm?***

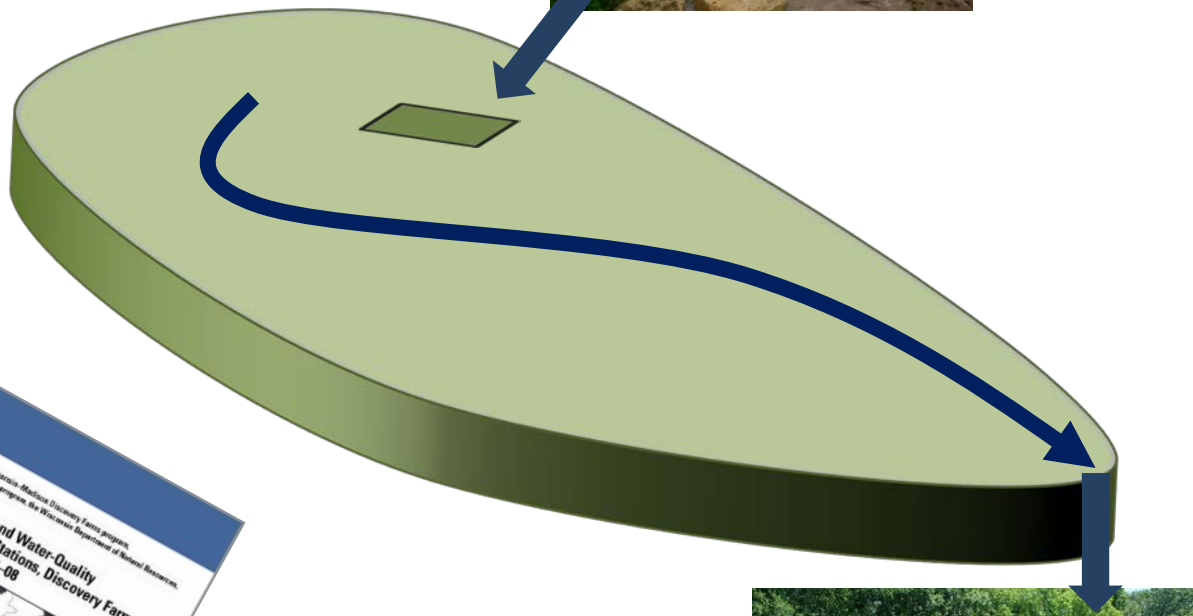
What's going on here?

R. Mentz Photo, Pioneer Farm

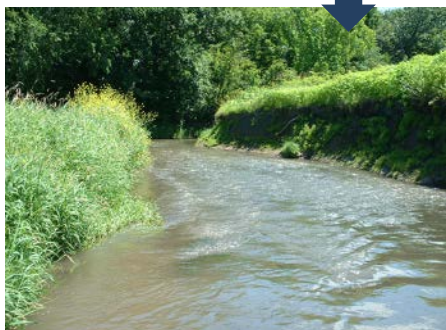
1) ***Raining faster than it can infiltrate***
2) ***Raining on saturated ground***

What if we could monitor some small areas and the stream !

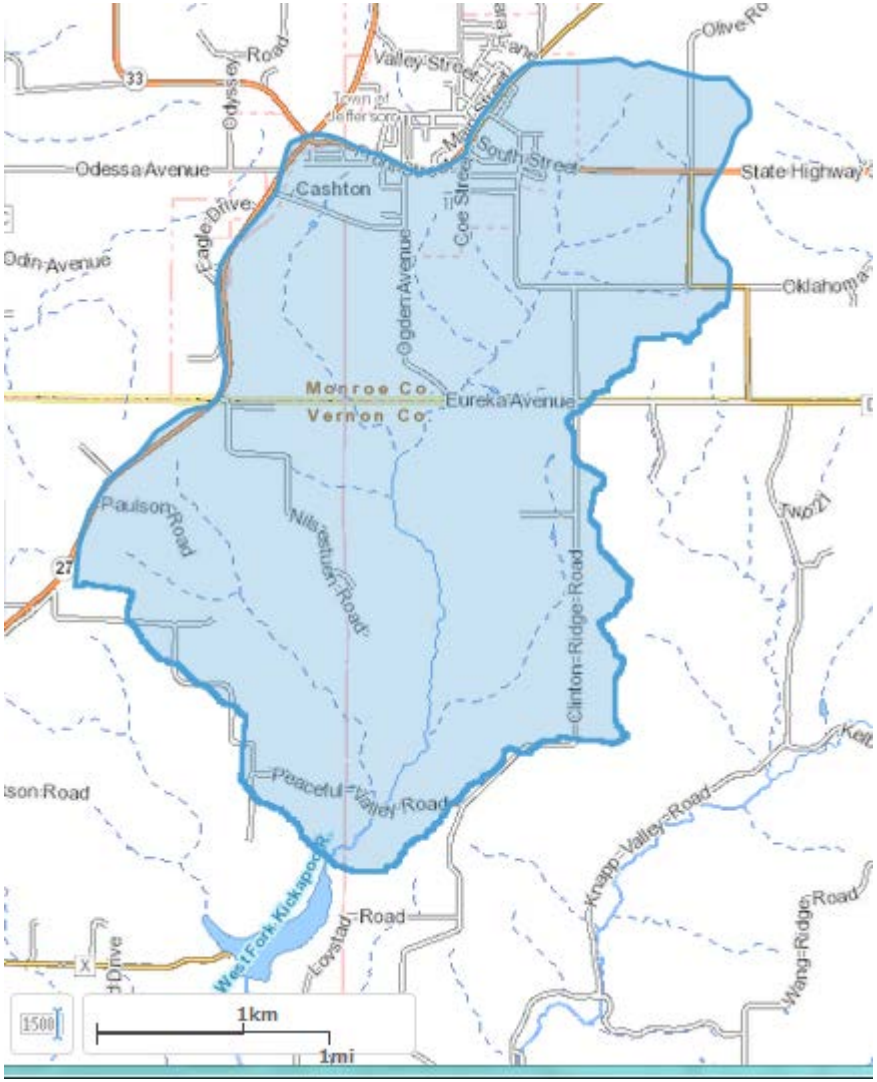
Small Area



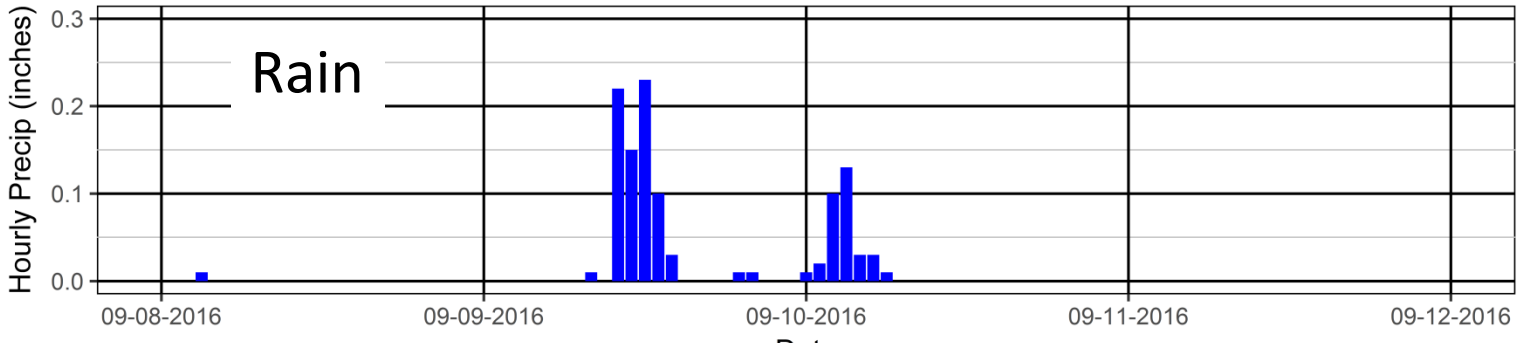
Stream

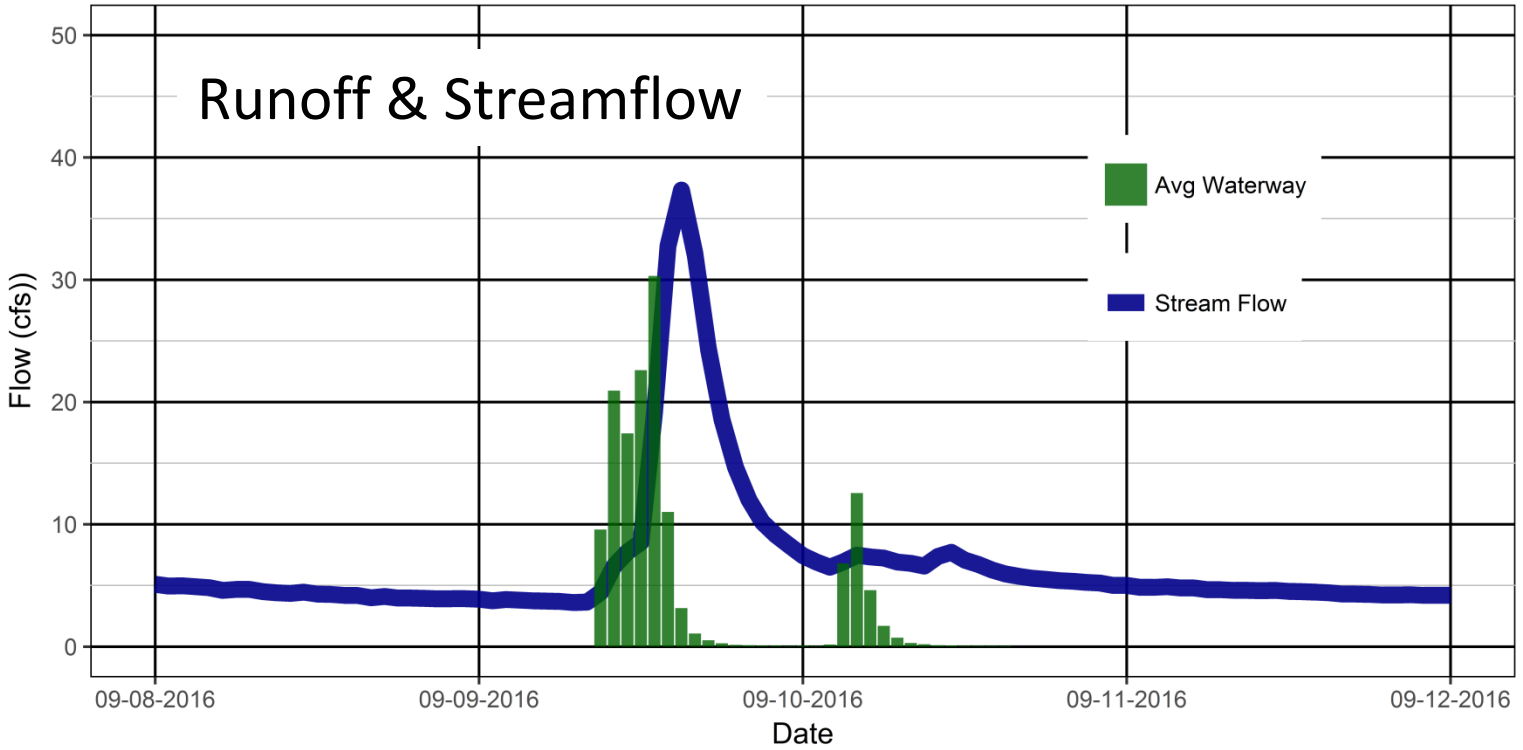


- ***Let's look at one of those projects***



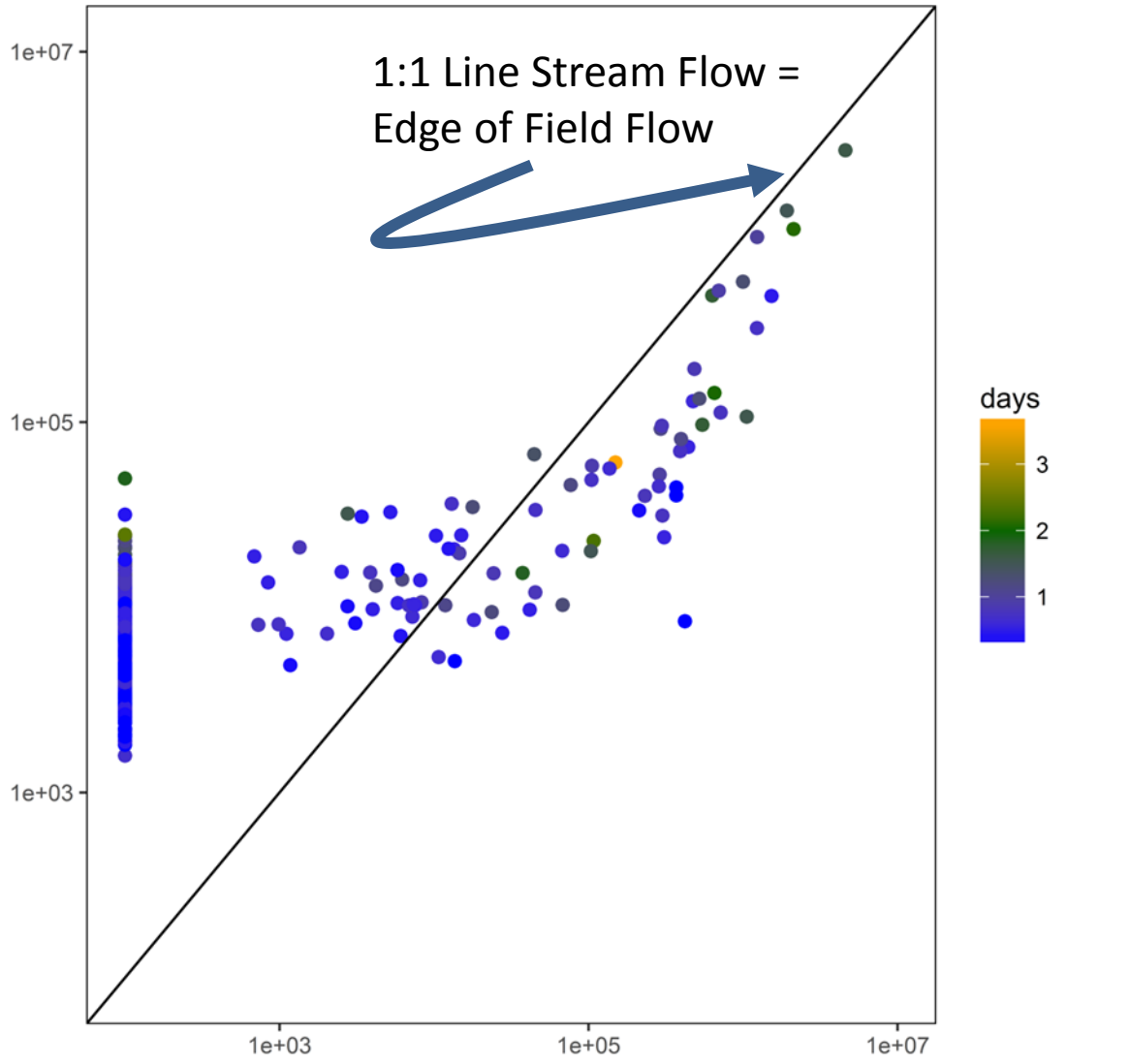
Edge-of-field to Stream





- Jersey Valley 5000 acre watershed
- Discovery Farms
- USGS

Stream Flow vs Runoff Flow

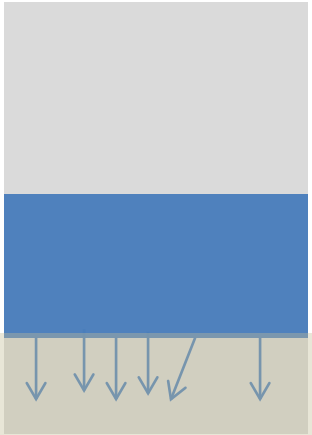


Stream Flow Volume During Event (ft3/mi2)

Edge of Field Runoff Volume During Event (ft3/mi2)

What do we learn?

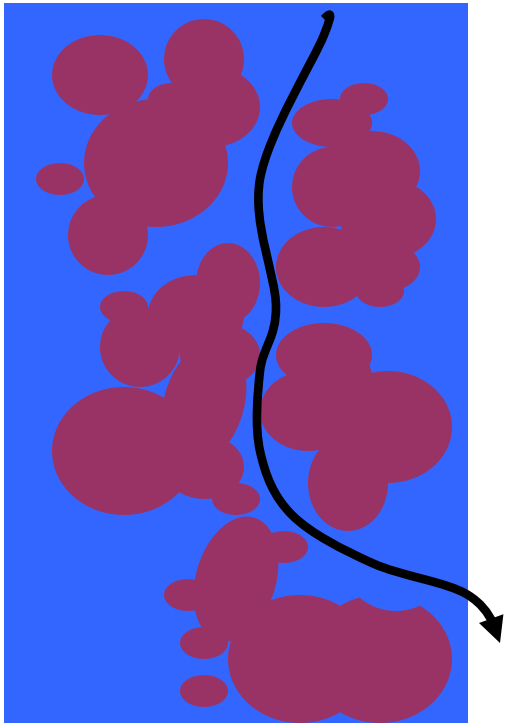
- 0 to 4 inches/yr of water across the surface
- 6 to 14 inches/yr of infiltration
- Streamflow combines sources of runoff
- What separates runoff from infiltration?
  - Infiltration rates are important!



Example Infiltration Rates

Type of Soil

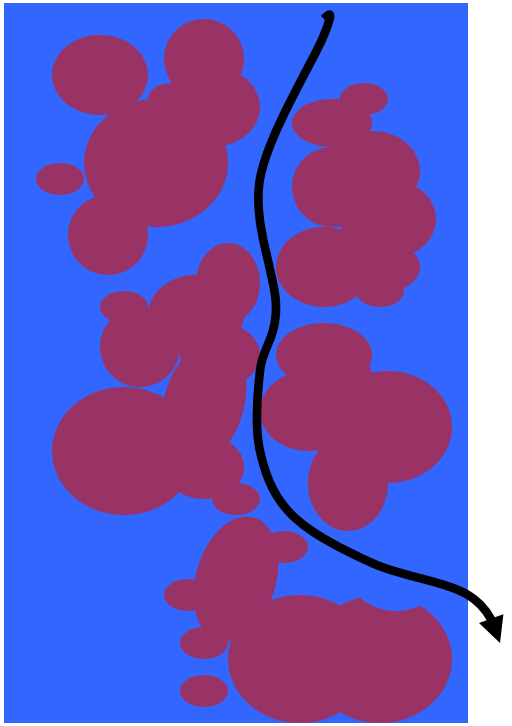
Soil Texture	Ponded Infiltration Rate (in/hr)
Sand	2 to 10
Silt Loam	0.2 to 1
Clay	0.03 to 0.3



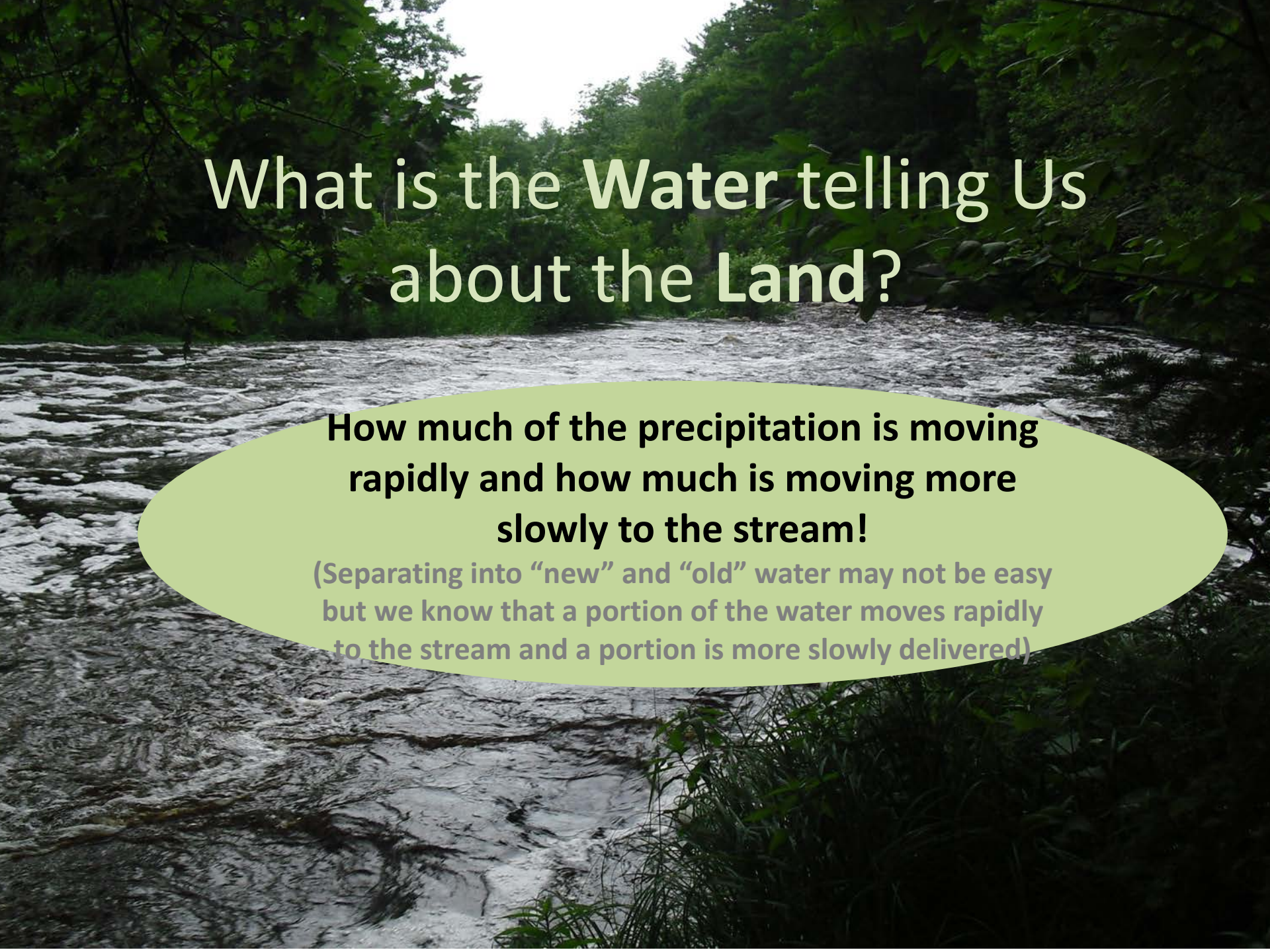
Example Infiltration Rates

Condition *(compaction/structure)*

Condition	Ponded Infiltration Rate (in/hr)
Vegetated	3.4
Open Soil	0.7
Traffic	0.1



Silt loam soil described by Vervoort, R.W., S.M. Dabney and M.J.M. Romkens. 2001. Tillage and Row Position Effects on Water and Solute Infiltration Characteristics, Soil Science Society of America Journal 65:1227-1234.



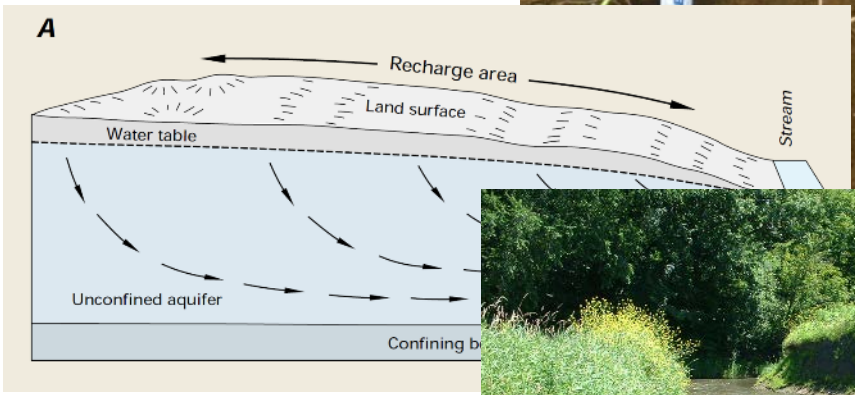
What is the **Water** telling Us about the **Land**?

How much of the precipitation is moving rapidly and how much is moving more slowly to the stream!

(Separating into "new" and "old" water may not be easy but we know that a portion of the water moves rapidly to the stream and a portion is more slowly delivered)

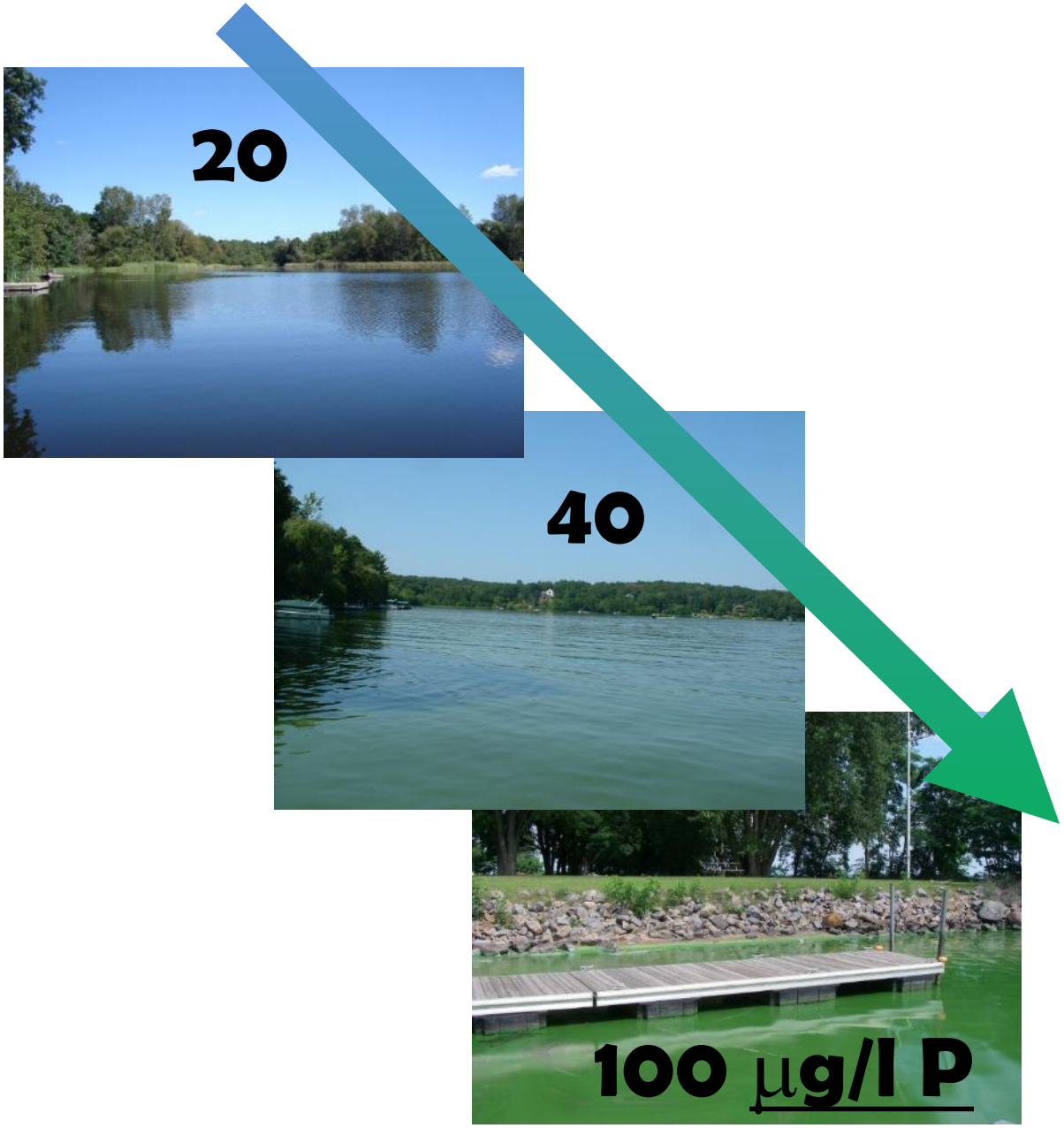
Part 3.

- ***Let's do some chemistry***



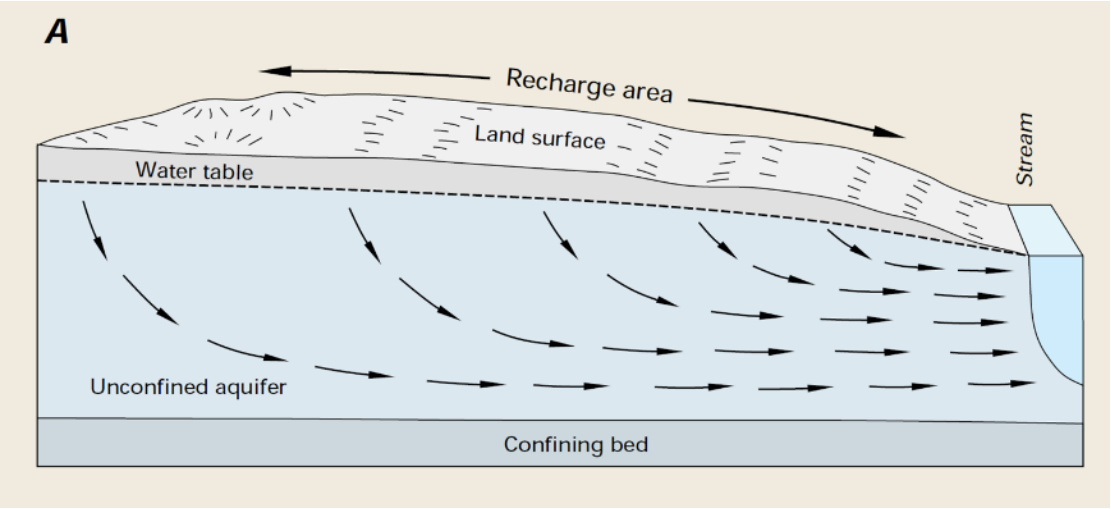
Part 3.

- *Let's do some chemistry*
- *Why is this important?*
- *Remember, it doesn't explain everything*



Part 3.

- ***Let's look at two important examples***

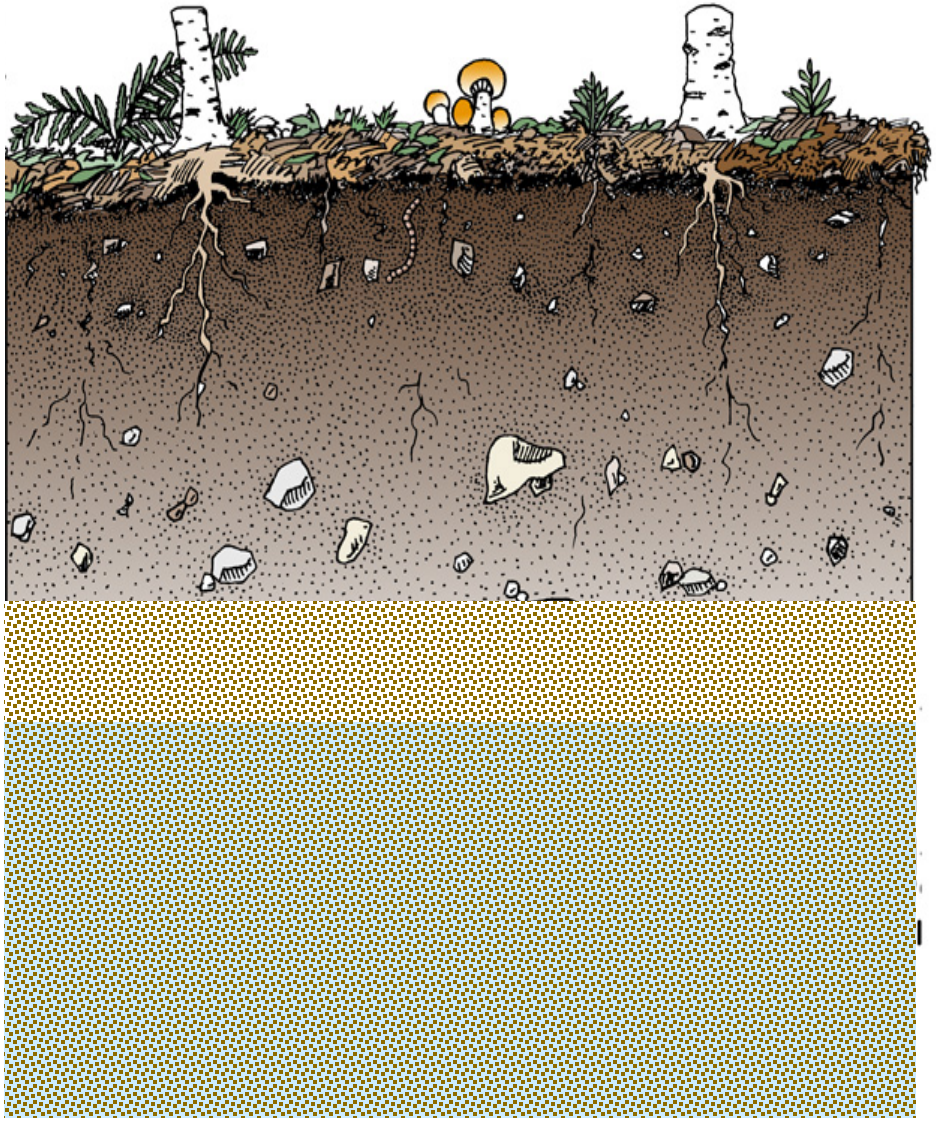


- **Groundwater**
- **Runoff (…lake and stream)**

Remember, this distinction is a little tricky

Part 3.

- ***Groundwater***
- ***Water percolating through soil profile***
- ***Rain becomes groundwater!***



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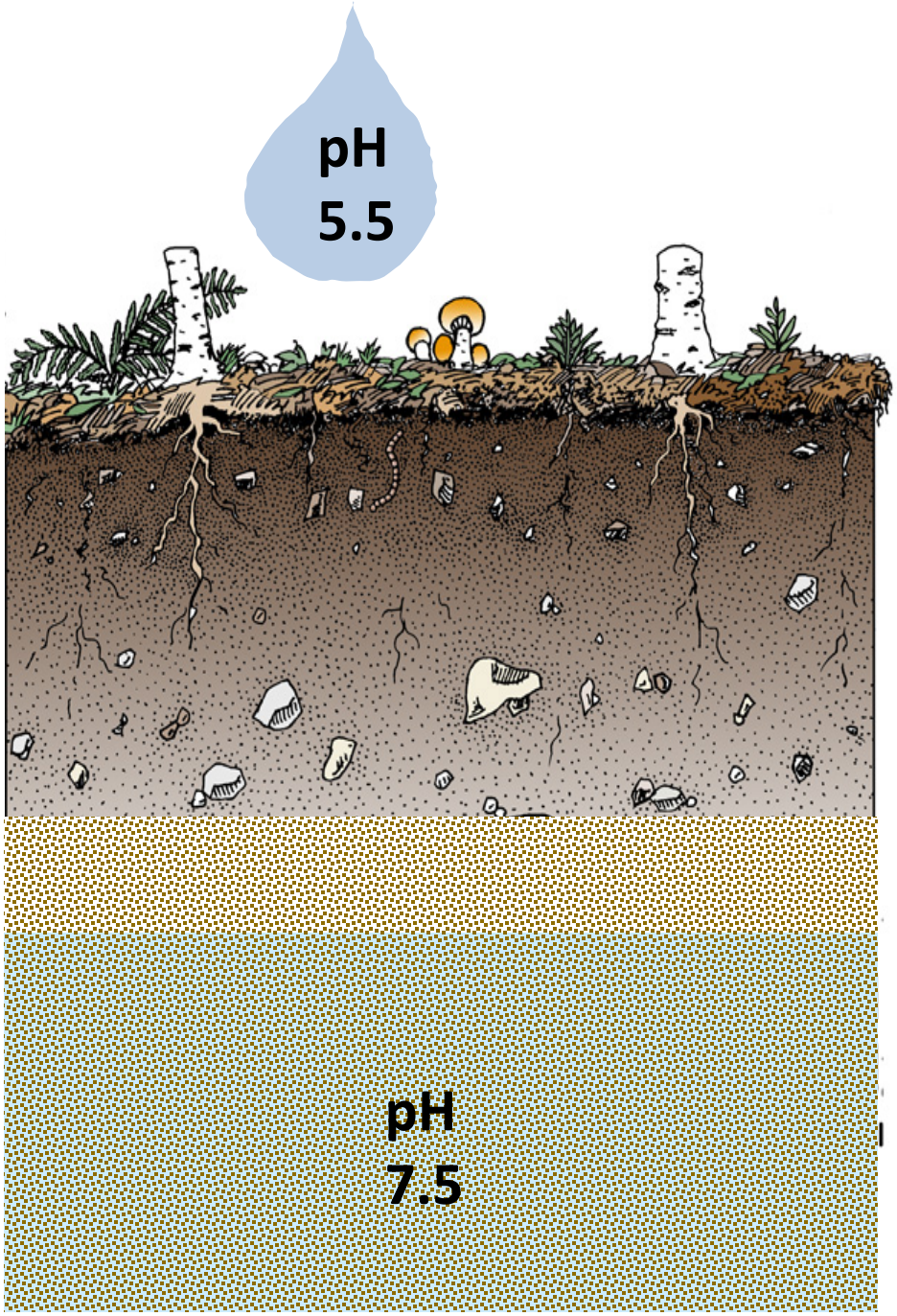

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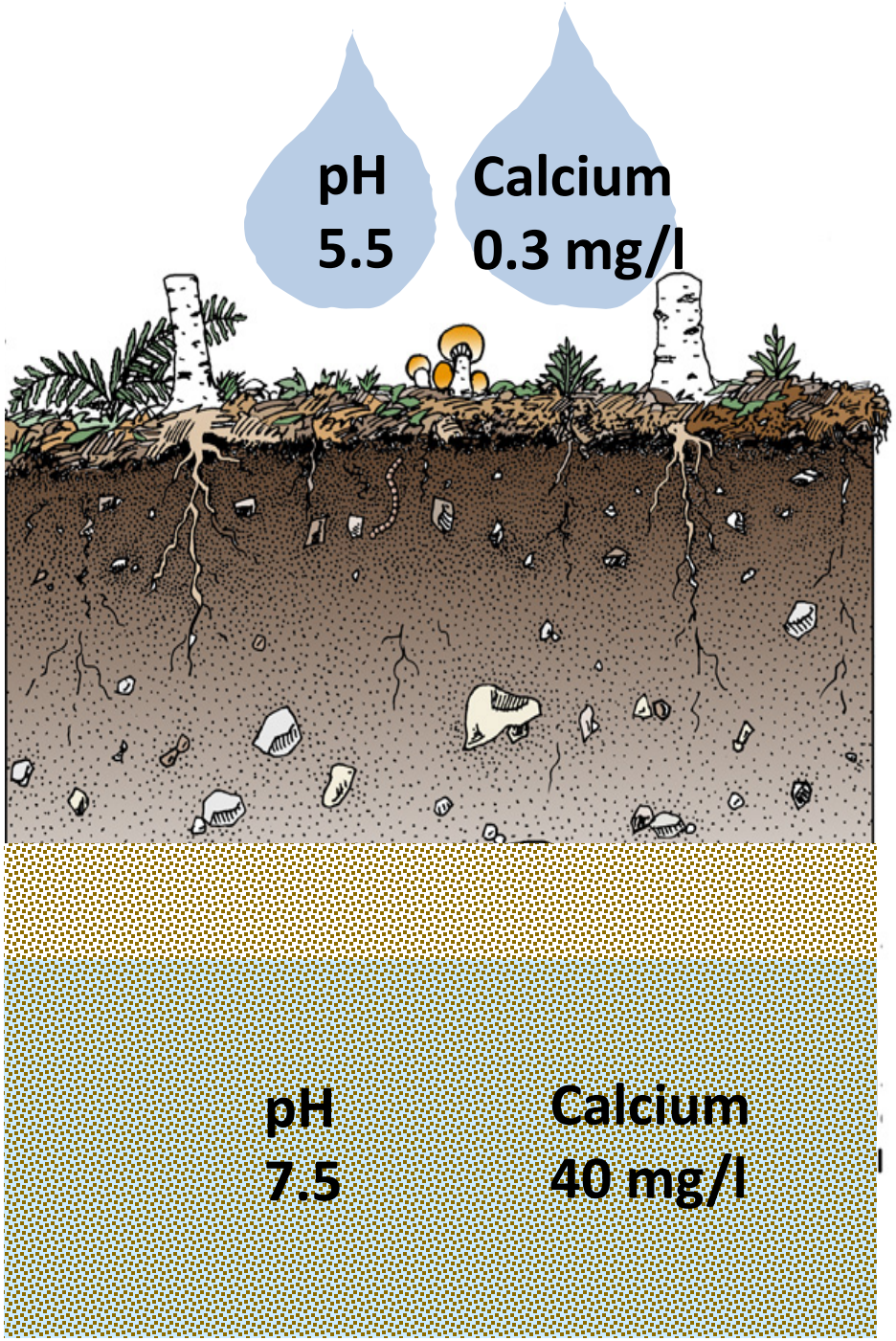

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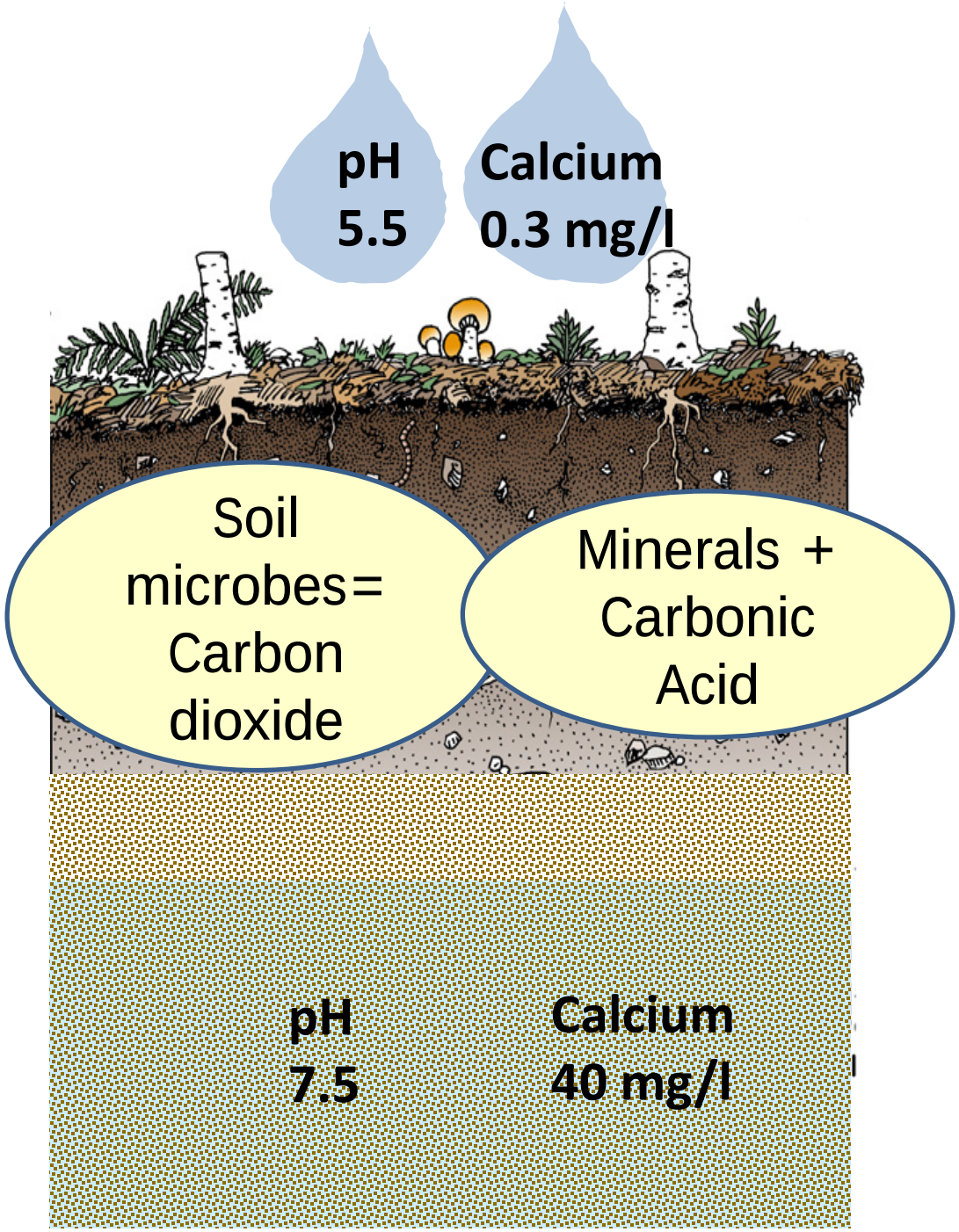
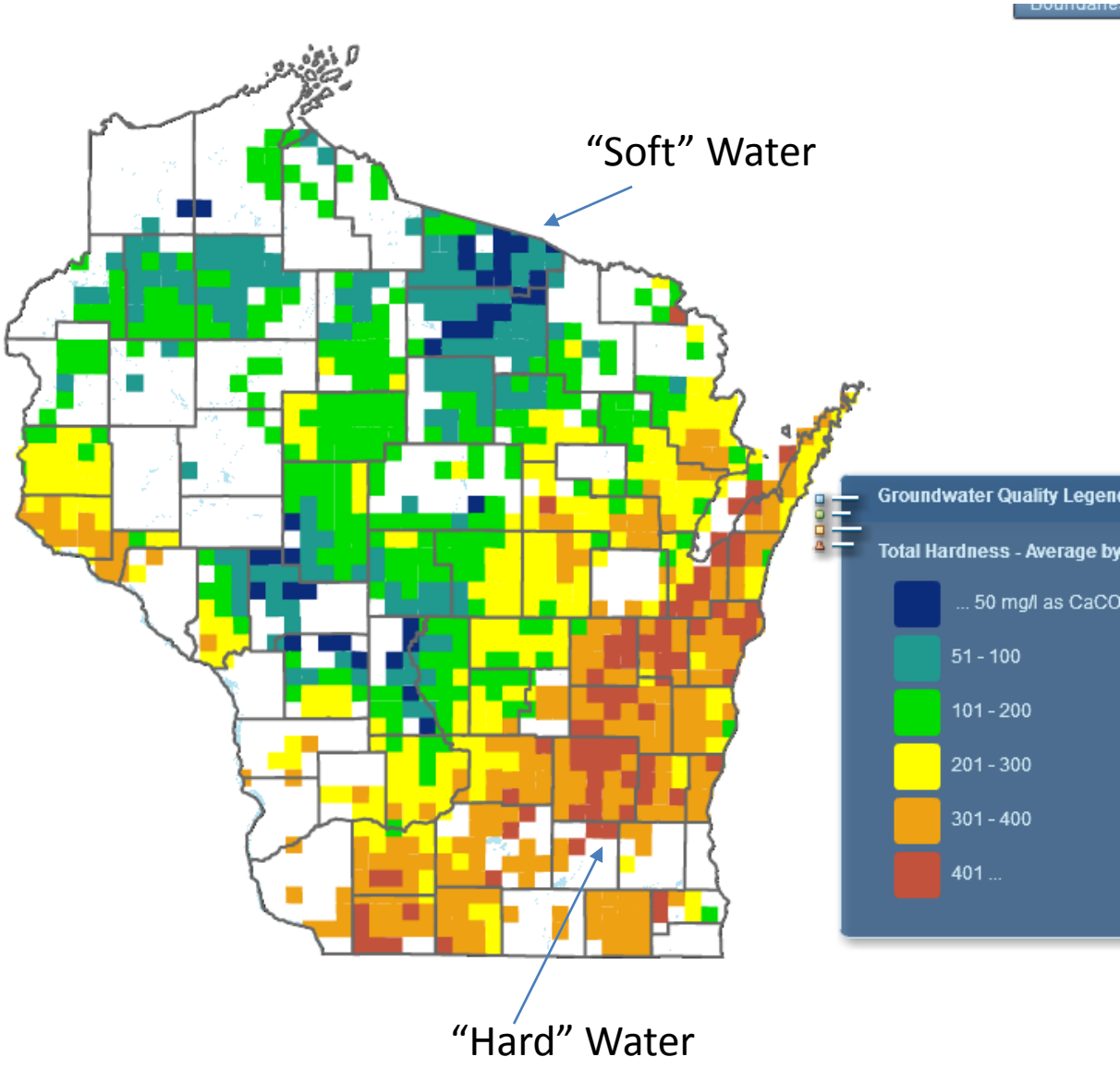


Part 3.

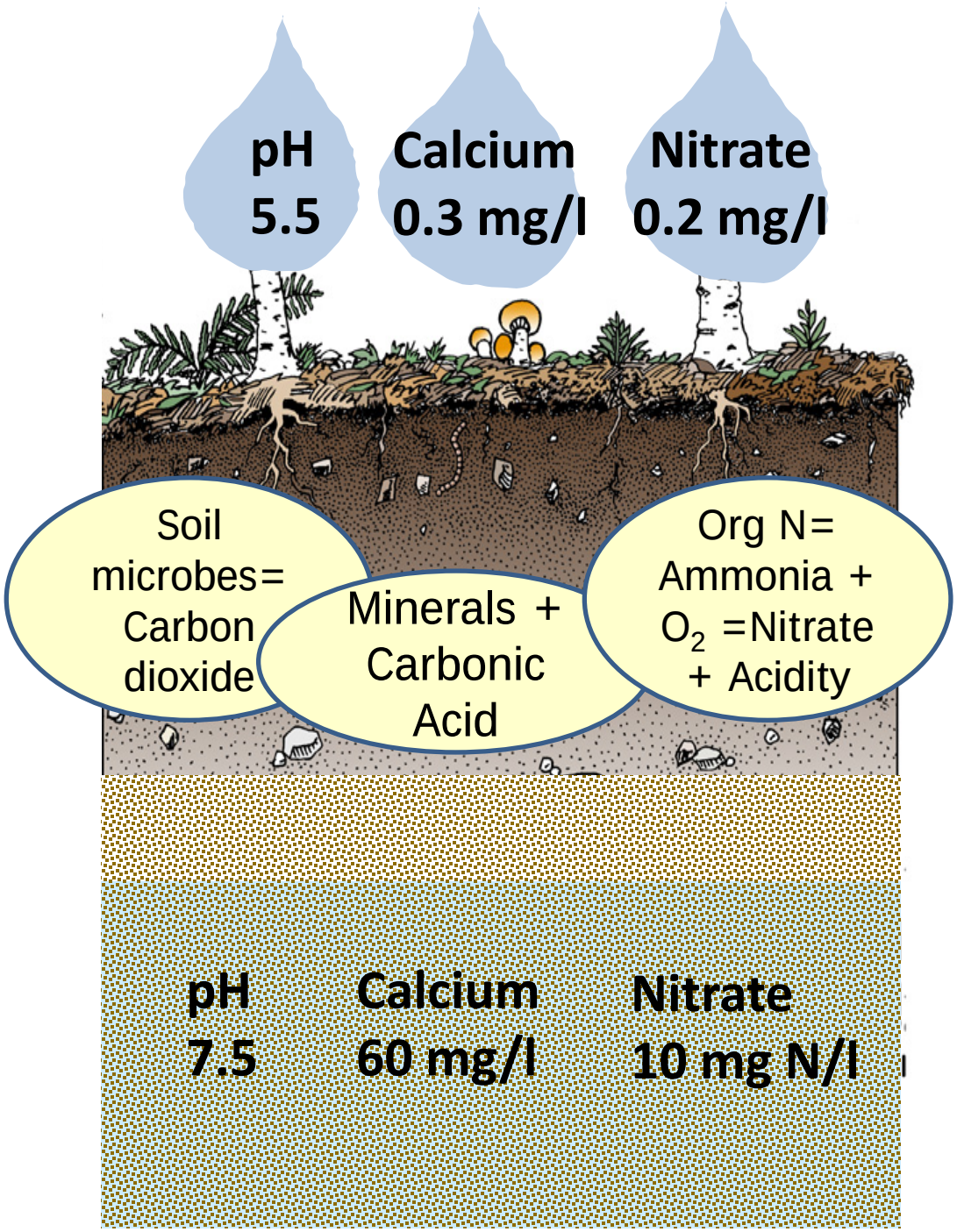
- ***Calcium and Magnesium ("hardness") varies across Wisconsin… Why?***



Part 3.

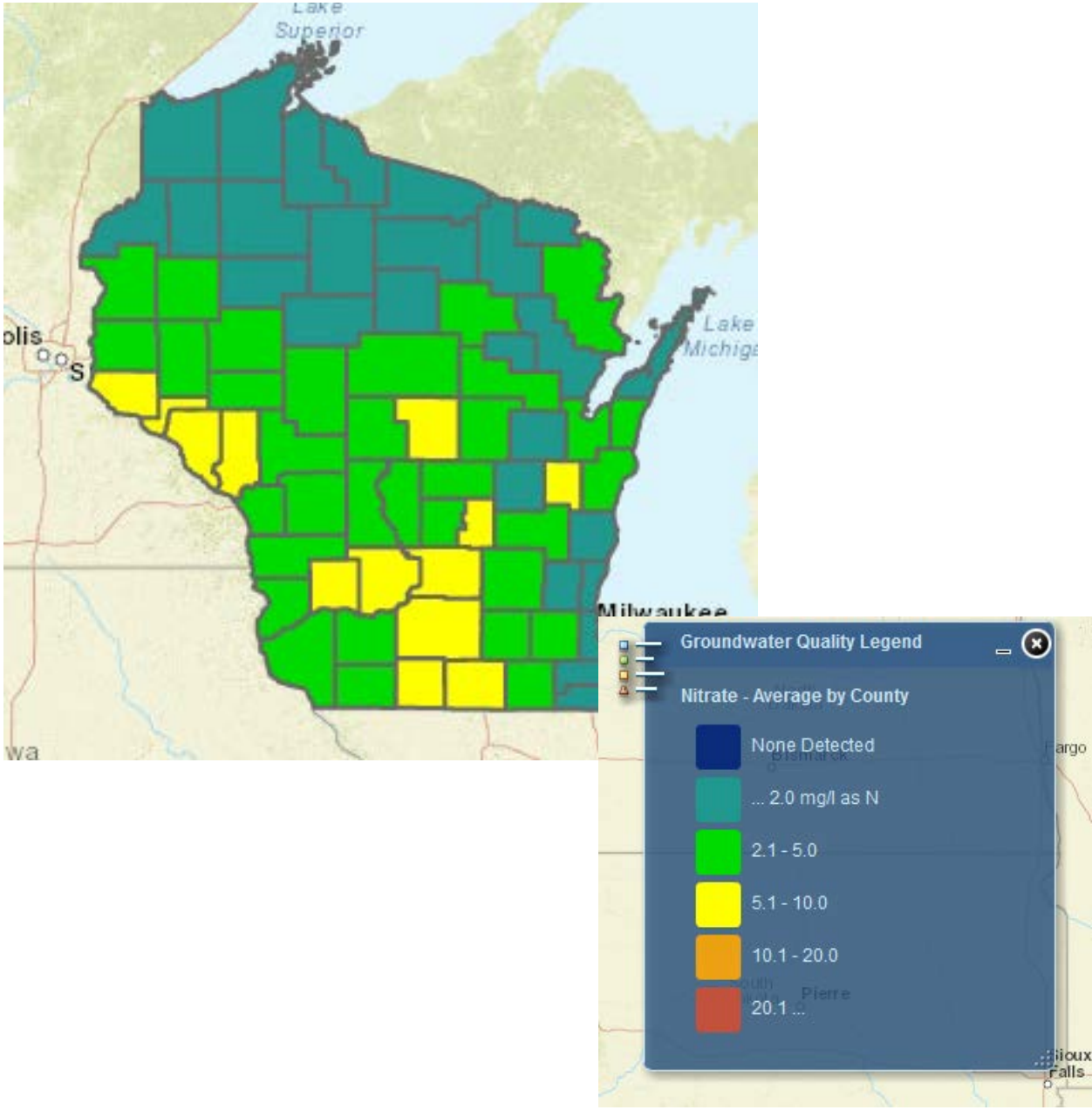
- ***Groundwater***
- ***Large amounts of nitrogen in the soil profile increase groundwater nitrate***

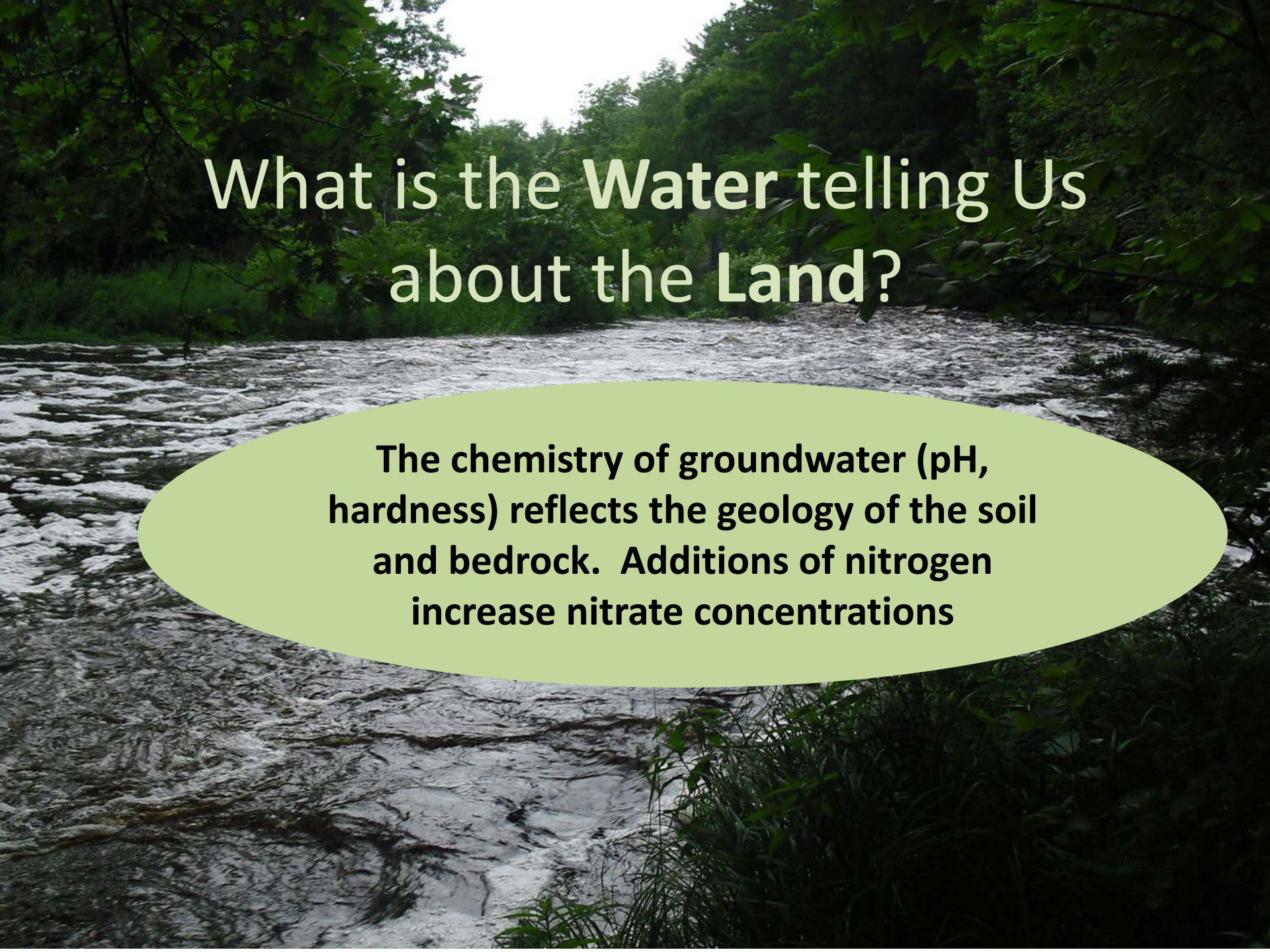
(and hardness)



Part 3.

- ***Groundwater Nitrate Concentrations (County Averages)***





What is the **Water** telling Us about the **Land**?

The chemistry of groundwater (pH, hardness) reflects the geology of the soil and bedrock. Additions of nitrogen increase nitrate concentrations

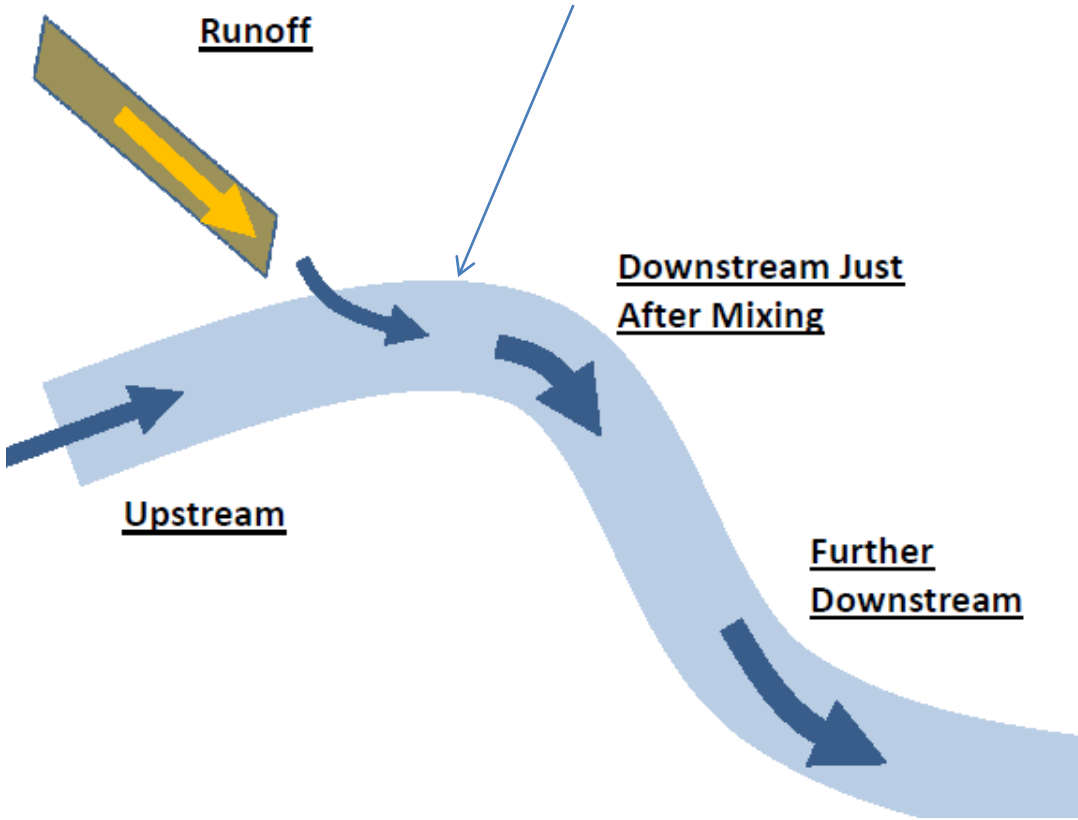
Part 3.

- ***Chemistry… Continued***
- ***What about "Runoff"?***

Part 3.

- ***Chemistry… Continued***
- ***What about "Runoff"?***

A "mass balance"
Concentration =
Total Mass / Total Volume



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- ***What about "Runoff"?***

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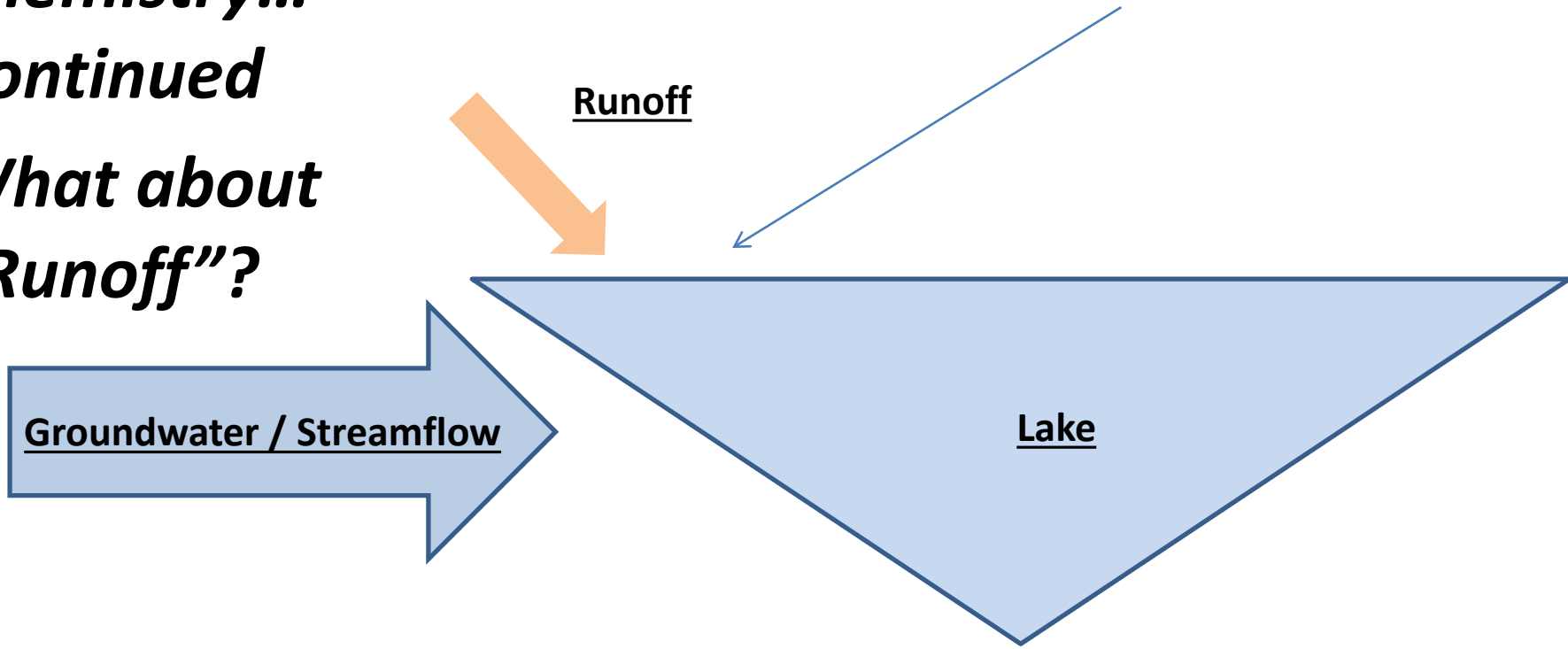
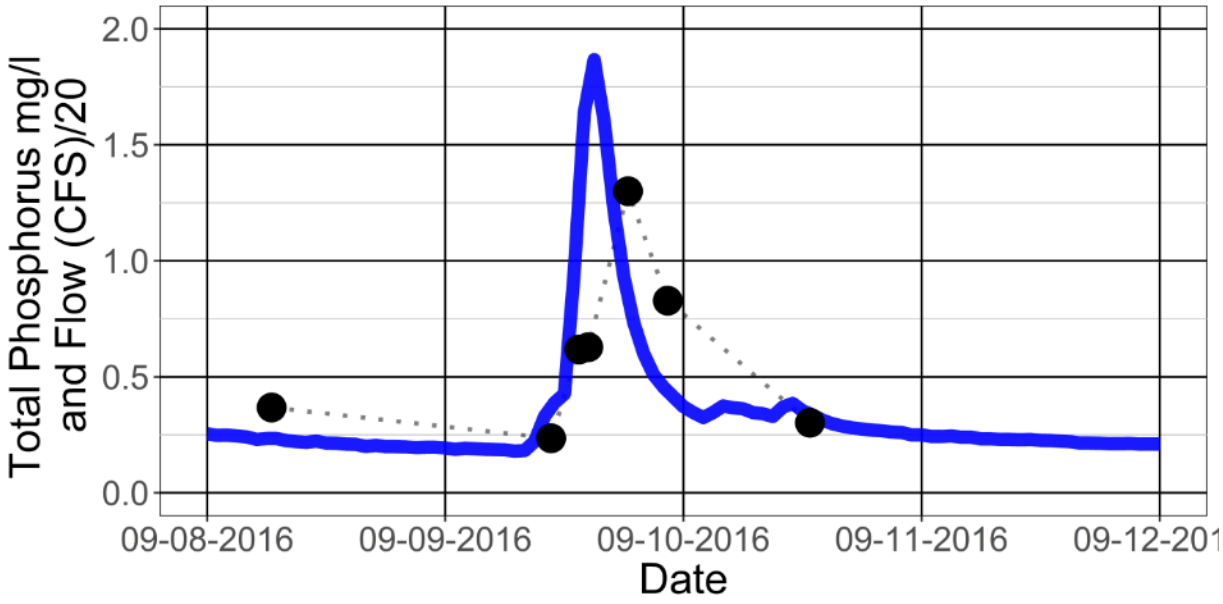


Part 3.

- ***Chemistry… Continued***
- ***What about "Runoff"?***

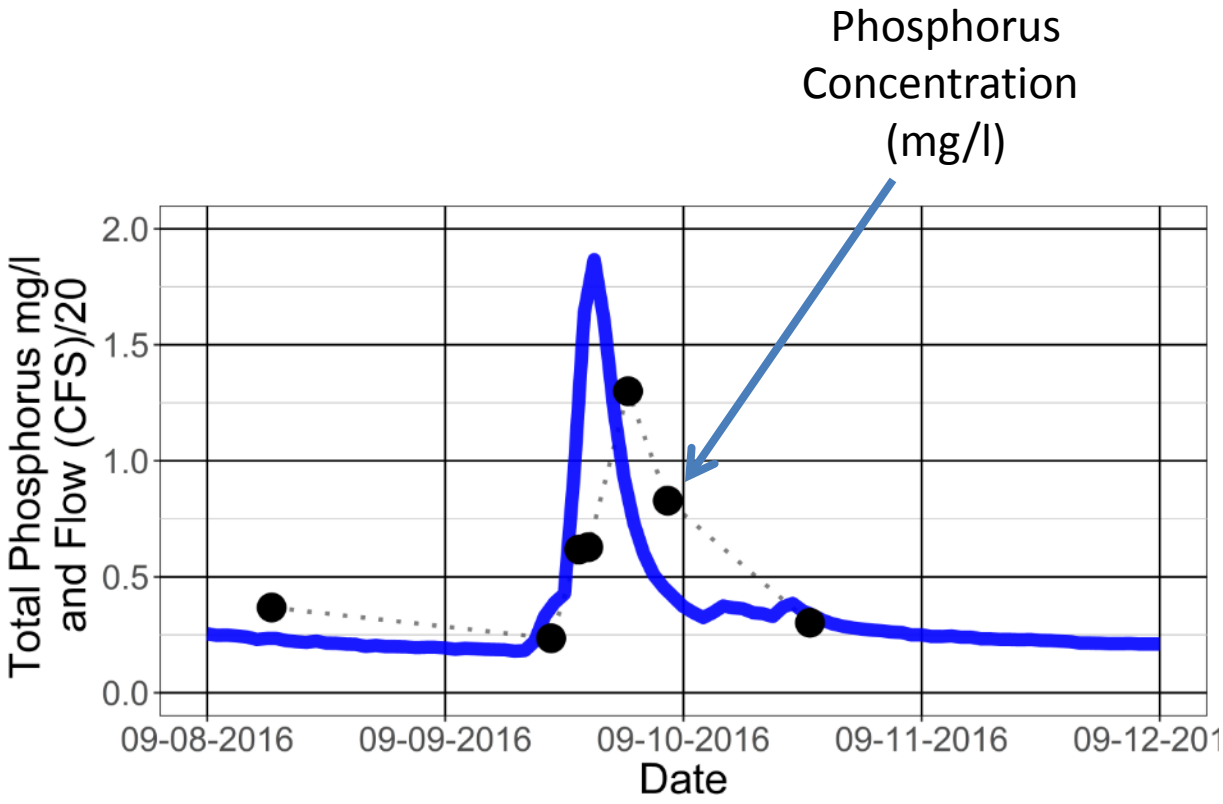
Phosphorus Concentration & Streamflow



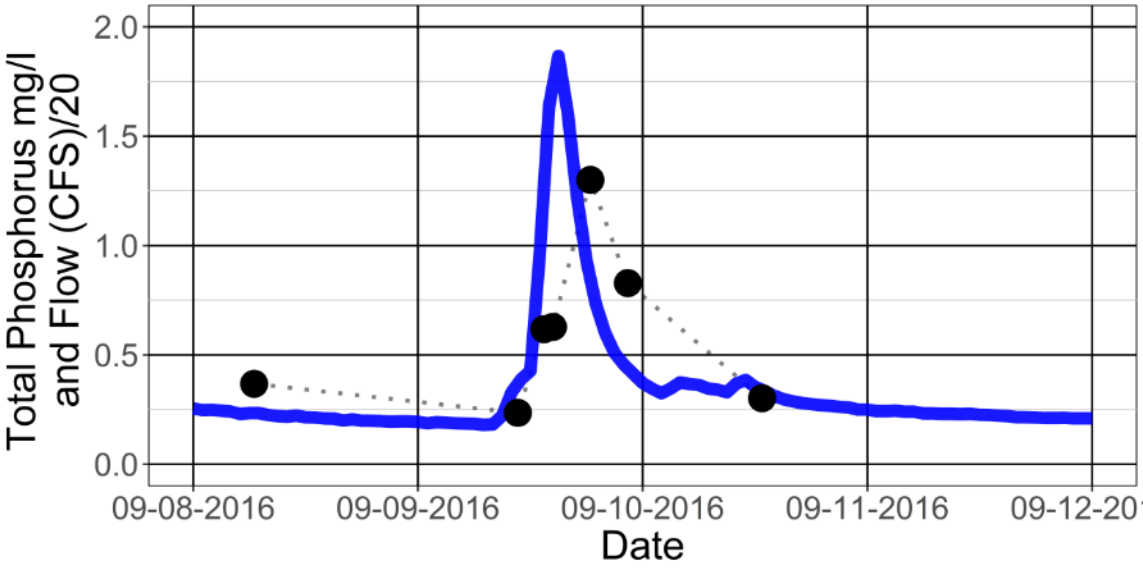
The "hydrograph" & The "chemograph"

Part 3.

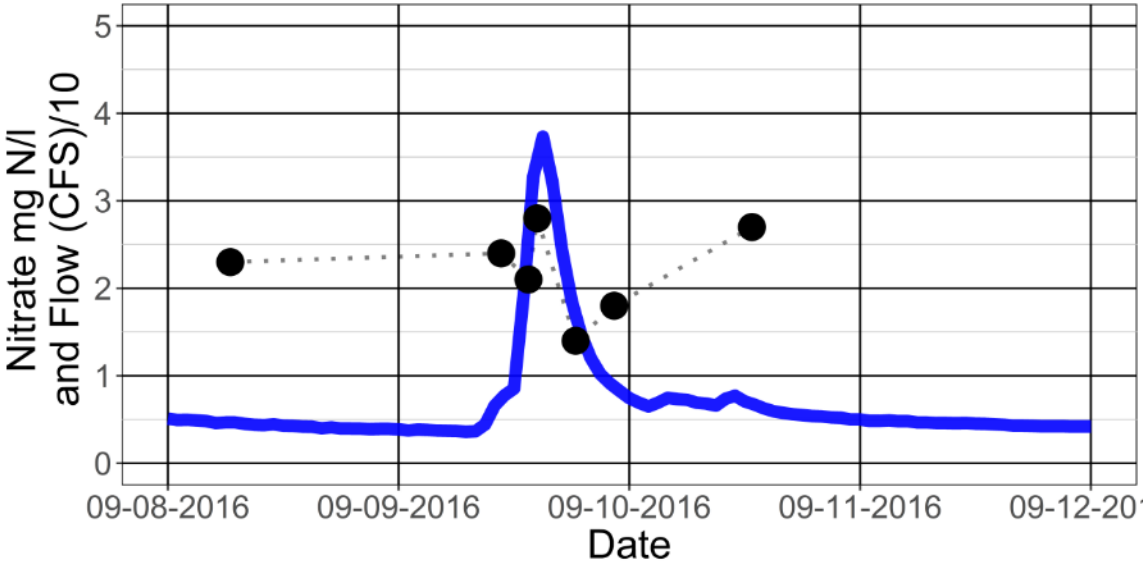
- ***Chemistry… Continued***
- ***What about "Runoff"?***



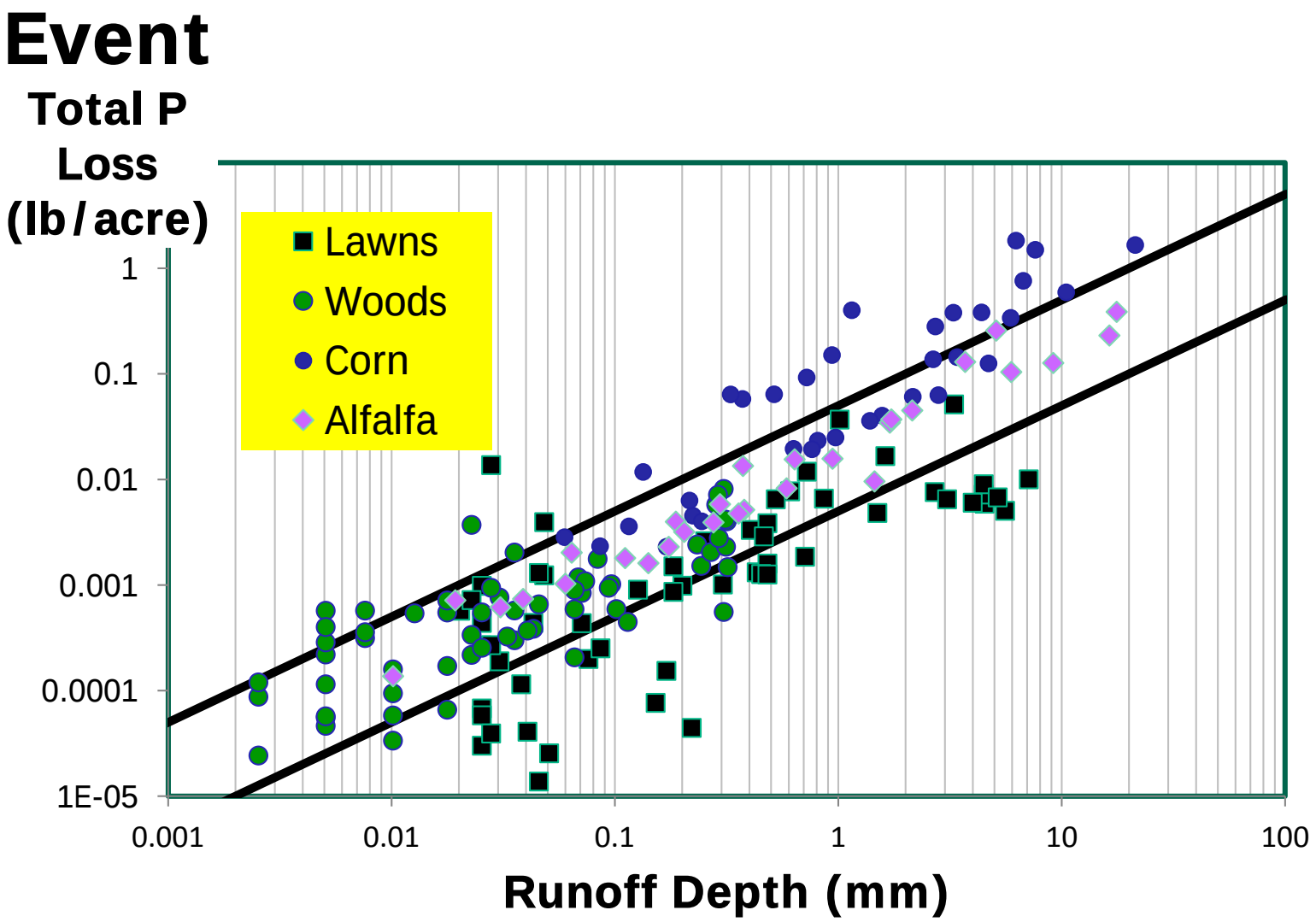
Phosphorus Concentration Increases During the Event



Nitrate Concentration Decreases During the Event

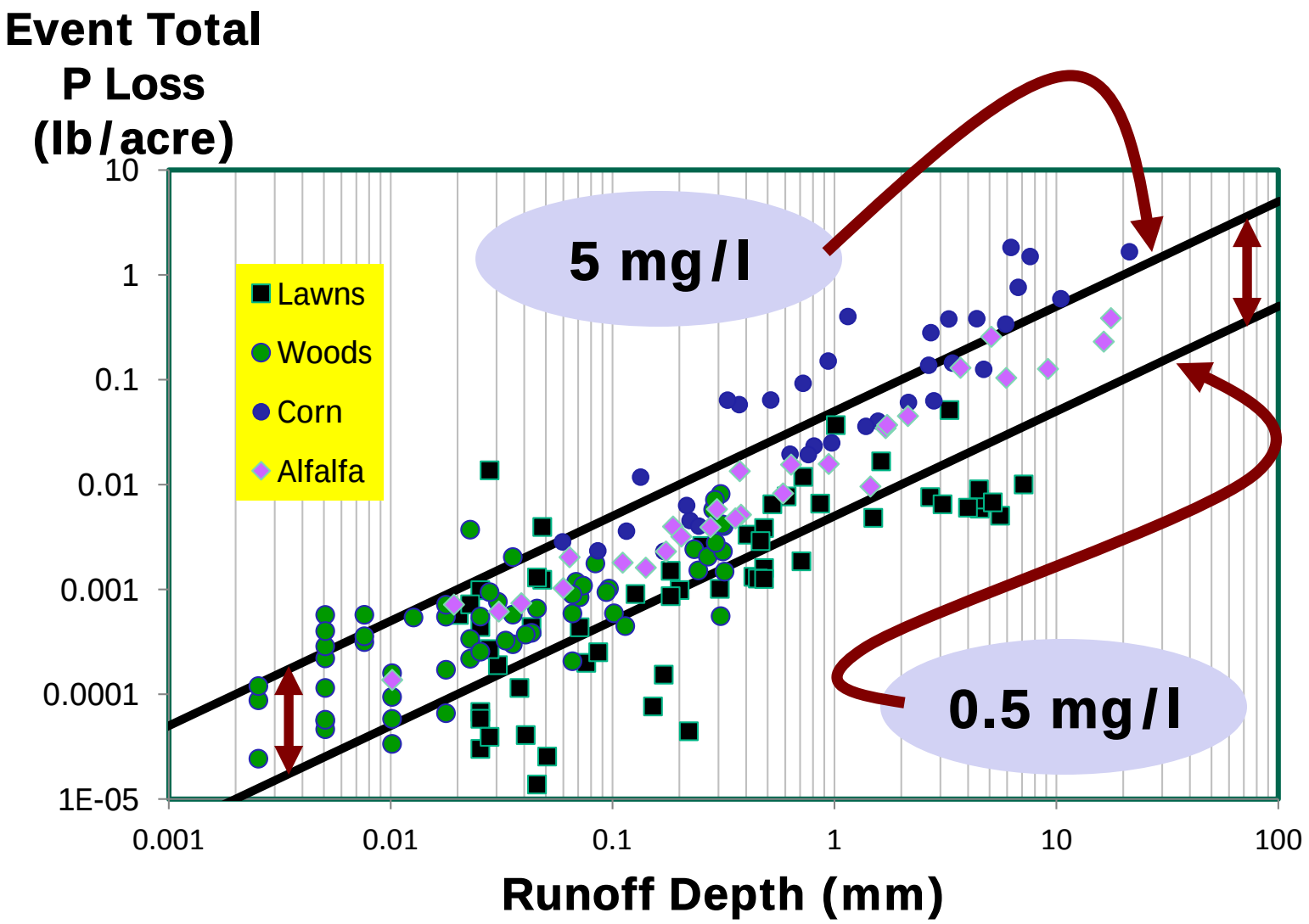


Let's take one last look at phosphorus in different runoff studies

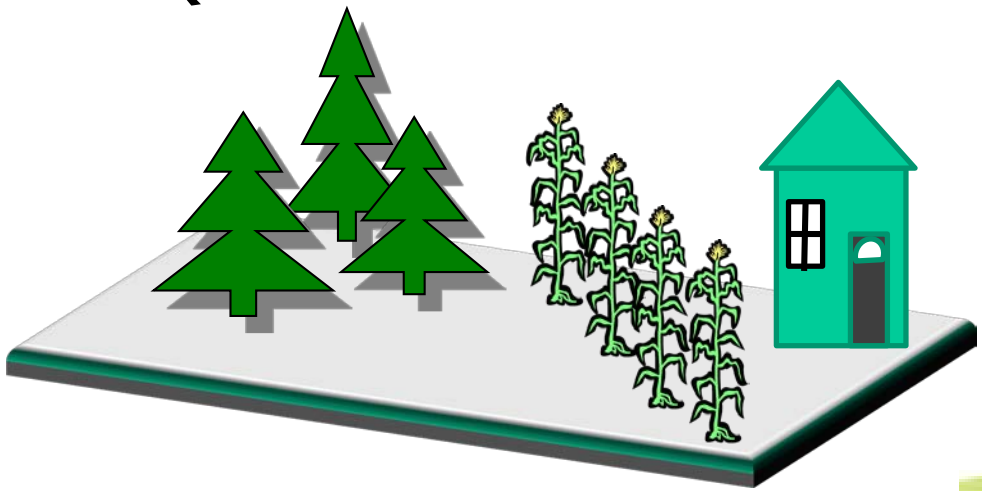


10 fold concentration difference!

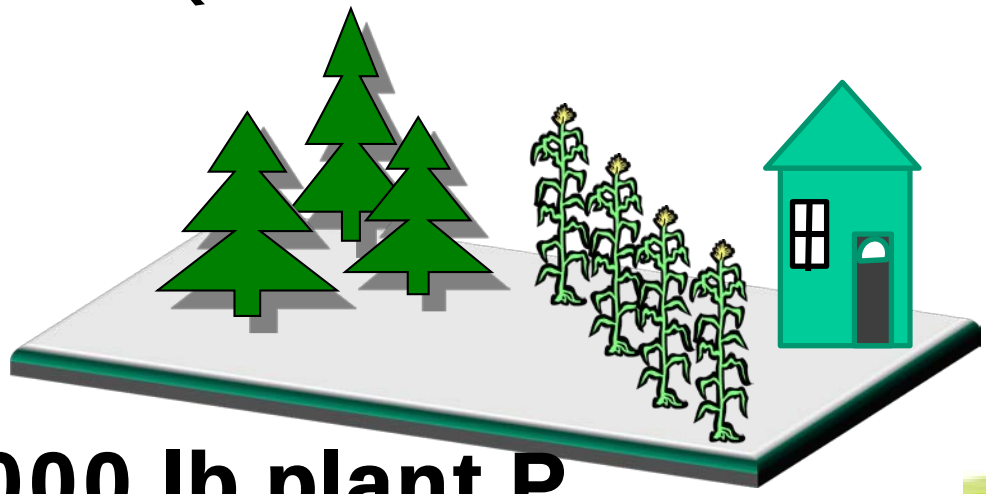
10000 fold runoff volume difference



WHY?



WHY?



350,000 lb P / sq mile

45,000 lb plant P
50,000 lb organic matter P
250,000 lbs soil P (top 6”)

Adapted from Yanai, R.D., 1992. Phosphorus Budget of a 70-year-old northern hardwood forest Biogeochemistry 17:1-22

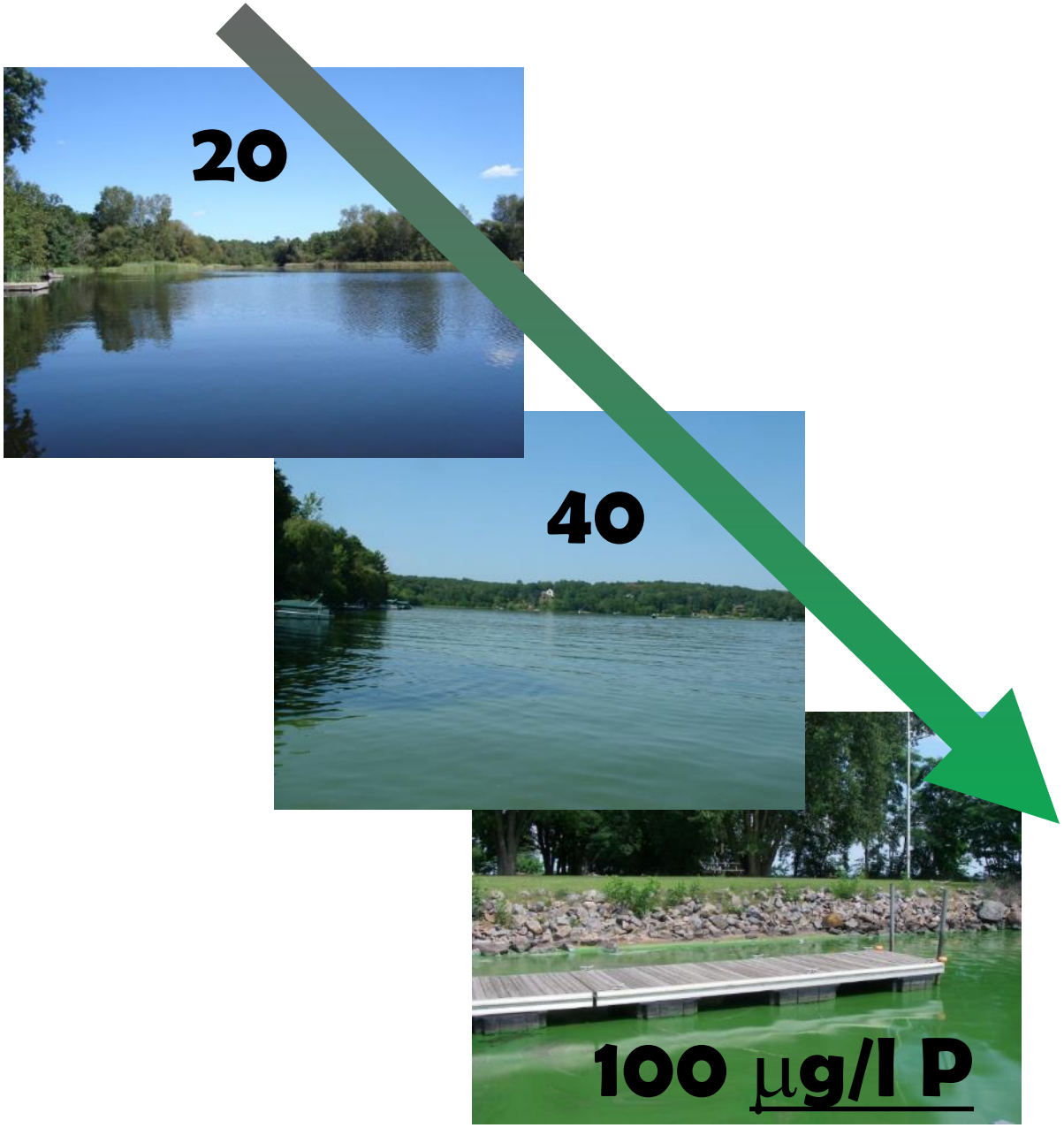
A Tale of Two Pathways

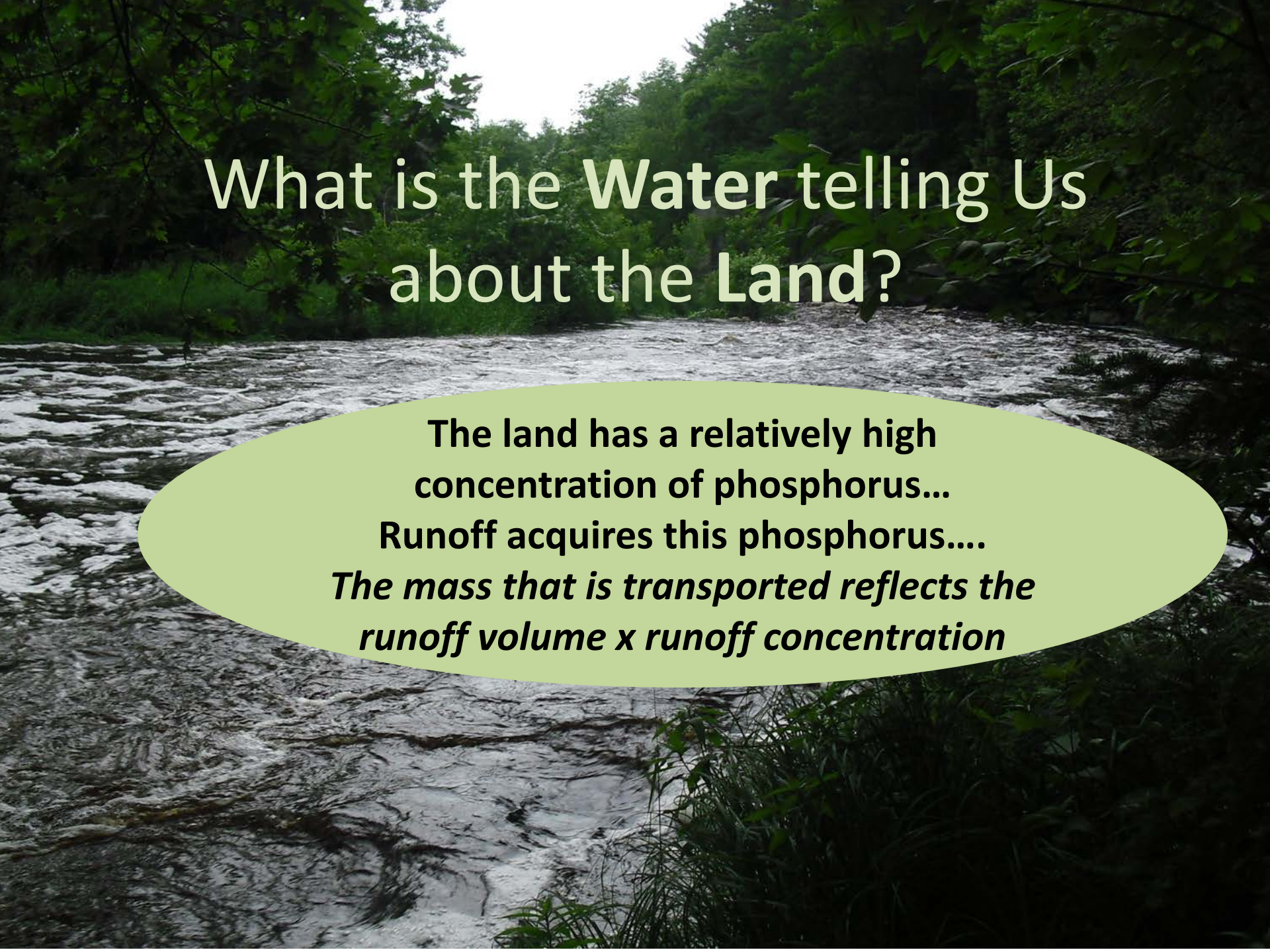
- 10 inches of infiltration at 0.02 mg P/liter
  = 0.05 pounds of Phosphorus from 1 acre

- 2 inches of runoff at 2 mg P / liter
  = 0.90 pounds of Phosphorus from 1 acre

Part 3.

- *The concentration we see reflects the mixing of these pathways*





What is the **Water** telling Us about the **Land**?

The land has a relatively high concentration of phosphorus…
Runoff acquires this phosphorus….
The mass that is transported reflects the runoff volume x runoff concentration

What is the Water Telling Us About the Land?

- **The water moves through land first!**

- The pathways it takes
  - The **amount** of water
  - The **timing** of the water
  - The **mineralization** of our water
  - The **nutrient** content of our water

- Good Luck with your Watershed Connections!


22/6/2013