

An aerial photograph of a large, irregularly shaped reservoir in a rural landscape. The reservoir is a dark, still body of water, surrounded by a mix of green fields and brownish patches, possibly indicating different types of vegetation or soil. The surrounding land is divided into a grid-like pattern of fields. The text "Understanding Wisconsin River Reservoirs: Lakes or Rivers?" is overlaid in white, bold, sans-serif font on the upper left portion of the image.

# Understanding Wisconsin River Reservoirs: Lakes or Rivers?

# Need to recognize Rule #1 (Scott's Rule) Nutrient and Sediment Transport Systems

- Rivers cut and move

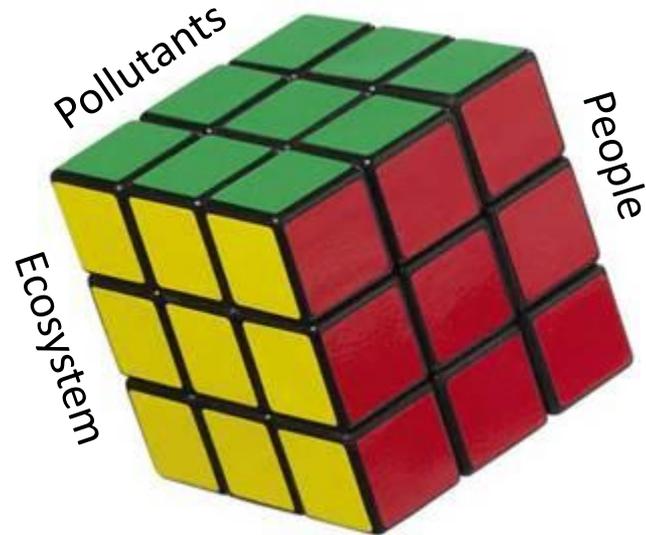


This is natural!  
Always going to  
have some deposition.

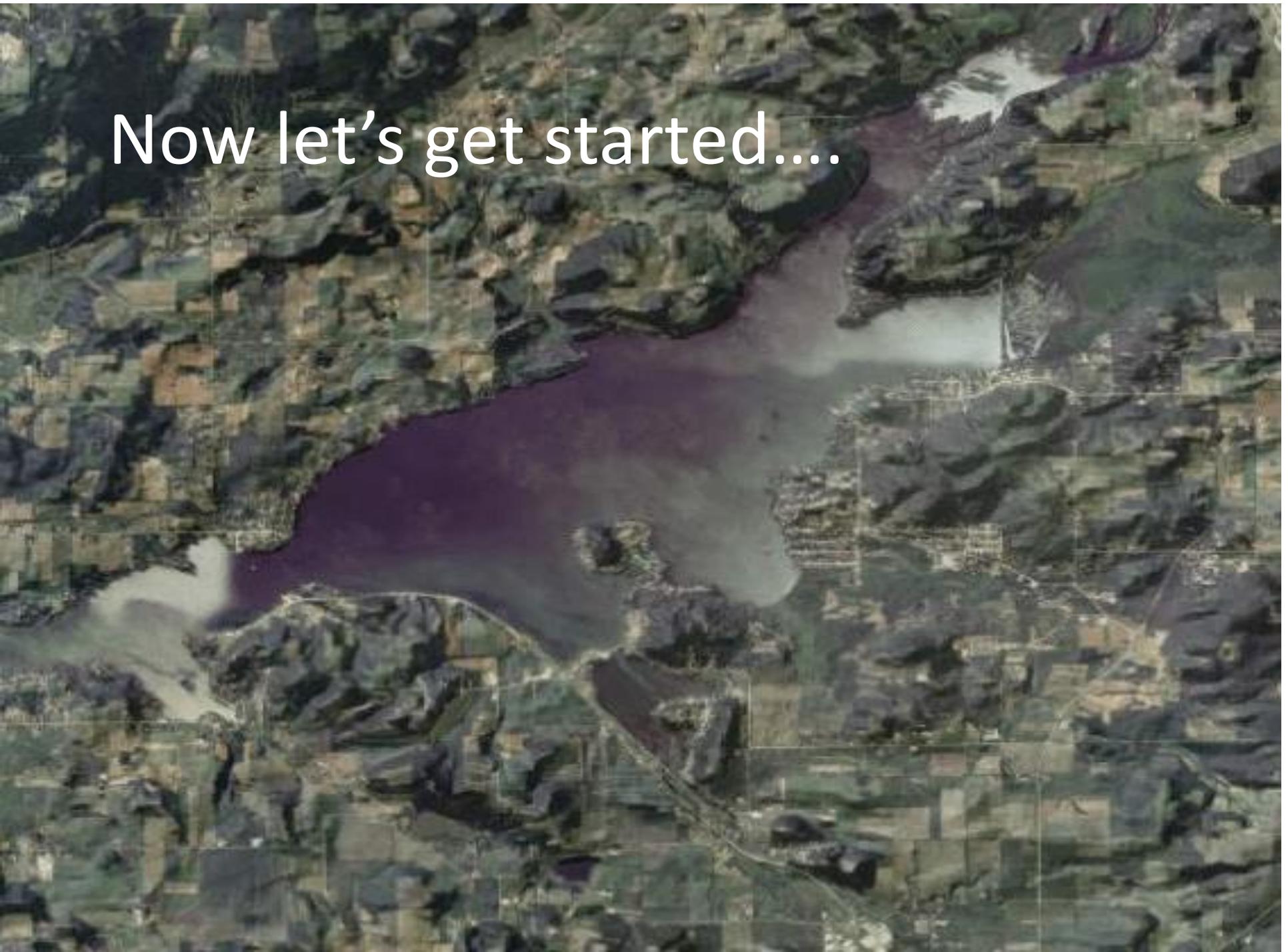
- Material deposit at low energy and erodes at higher energy (we're going to use velocity and energy as the same)

# Rule #2: Need to think in a matrix

- Resource management is NOT,  $A + B = C$
- It's this!  
One action has multiple reactions



Now let's get started....



# Fundamentals: Dams Create Reservoirs



So...

So, this:

$$Q = vA \text{ or } v = Q/A$$

- River slows down when it reaches reservoir
- A increase; v decreases; Q stays the same
- Hydraulic Residence Time (HRT) increases
- “stuff” settles out
- Some “stuff” increases algae.

Remember how TP decreased at outlets...

Equation 2.2: Stokes' Law

$$V_s = \frac{g(\rho_s - \rho_w)d^2}{18\mu}$$

where

$V_s$  = terminal settling velocity of the solid particle

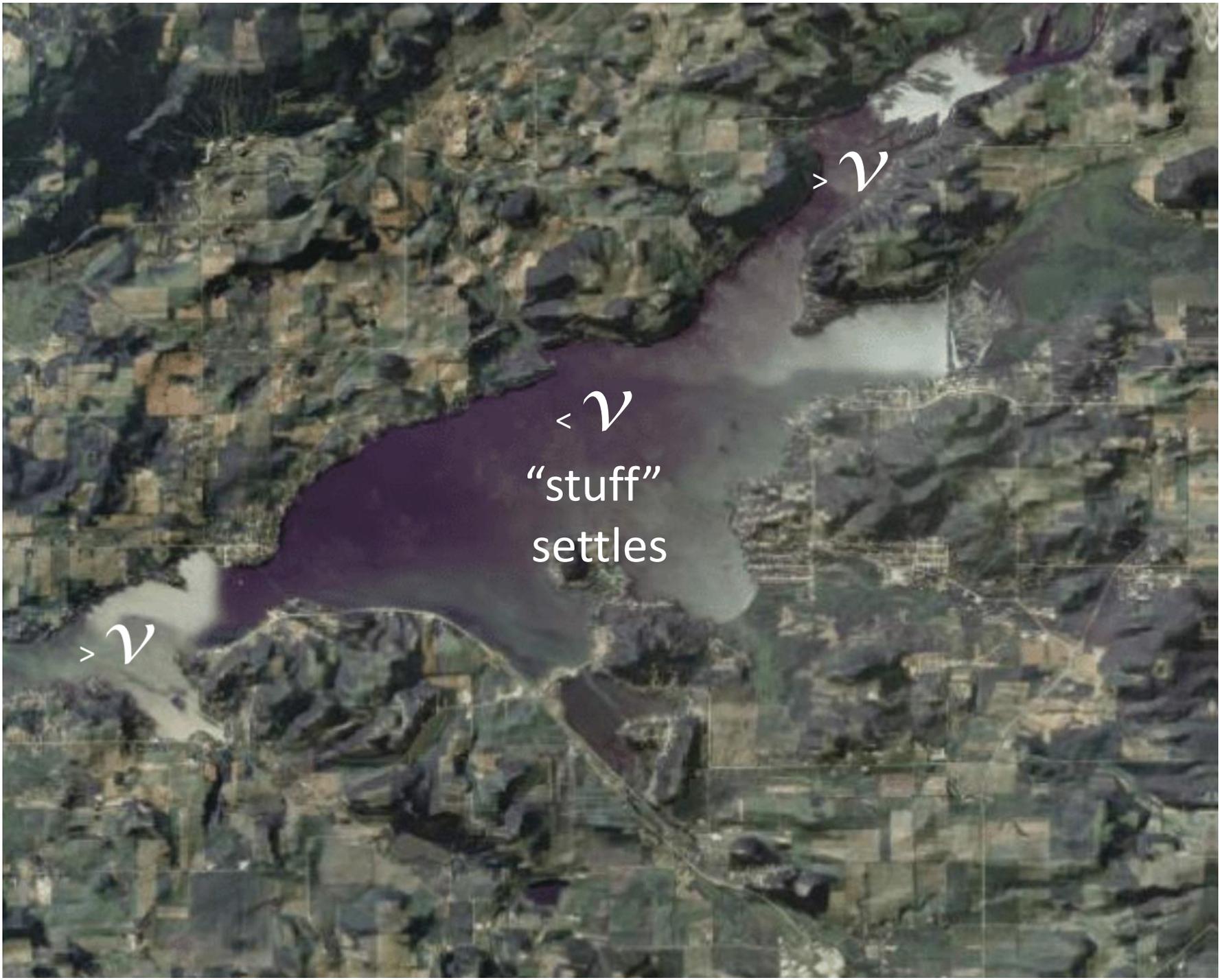
$g$  = gravitational acceleration

$\rho_s$  = density of settling particle

$\rho_w$  = density of water

$d$  = diameter of particle

$\mu$  = dynamic viscosity



*Hold on, it's about to get heavy...*

*- eminem*

As HRT increases, the “stuff” in the water (P & N) has more time to increase algal growth. Add heat and droughty conditions, HAB from BGA can increase even more. This leads to decreased water clarity, which increases habitat preference of some AIS like carp. Carp disturb sediment and release nutrients that destroy habit for native species by disturbance and decreased light penetration.

HRT=Hydraulic Residence Time

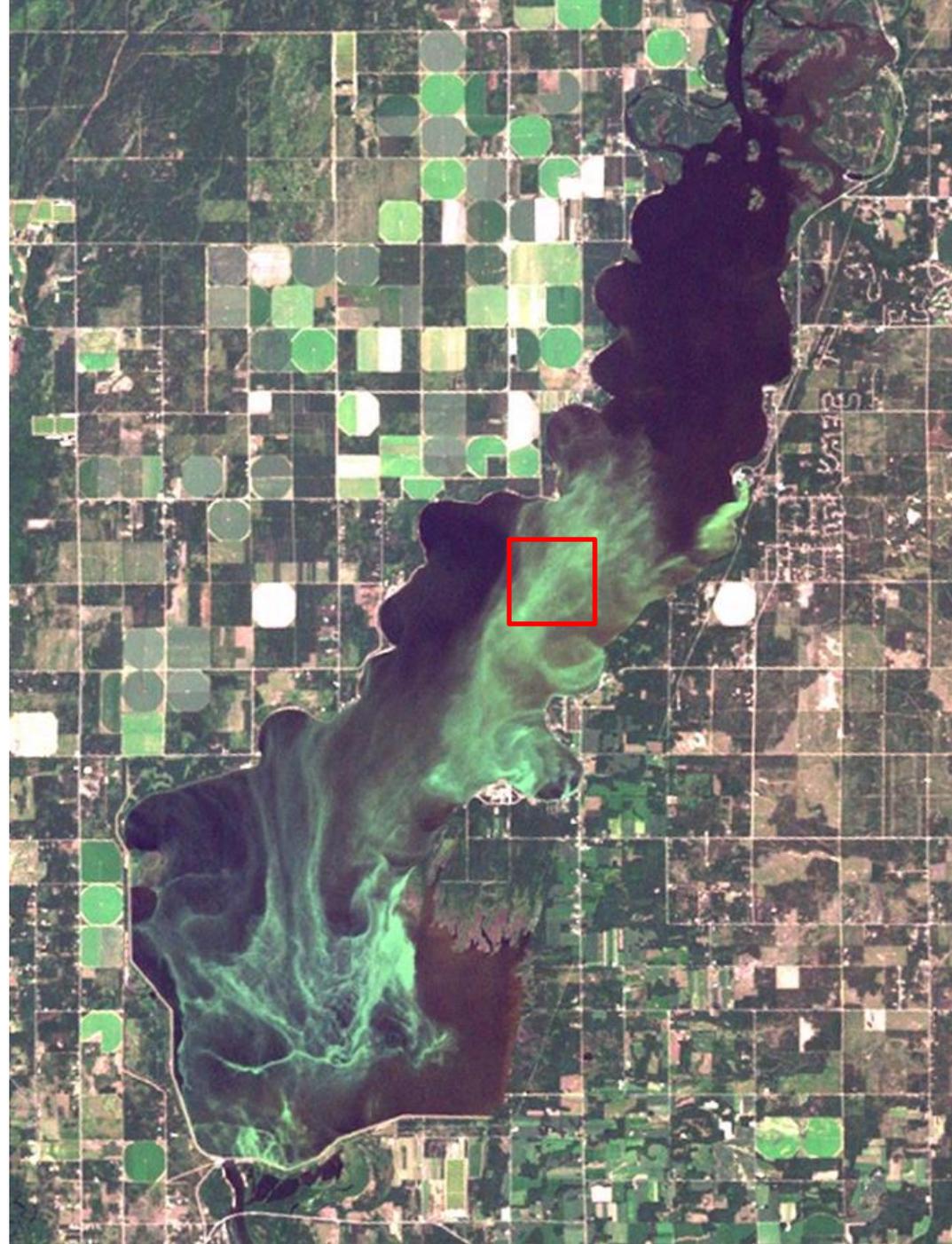
P = Phosphorus

N = Nitrogen

HAB = Harmful Algal Blooms

BGA = Blue Green Algae

AIS = Aquatic Invasive Species



# To complicate things: HRT varies amongst reservoirs and within reservoirs

- As HRT varies, so does behavior
- High HRT, acts like a lake
- Low HRT, acts like a river
- Stuff settles as HRT increases

# Statewide Phosphorus (i.e. stuff) Rule



**Rivers**  
100 µg/L



**Streams**<sup>1</sup>  
75 µg/L



**Reservoirs**

- Not Stratified = 40 µg/L
- Stratified = 30 µg/L



**Inland Lakes**<sup>2</sup>  
Ranges from 15-30 µg/L



**Great Lakes**

- Lake Michigan = 7 µg/L
- Lake Superior = 5 µg/L

Which one is it?



<sup>1</sup>All unidirectional flowing waters not in NR 102.06(3)(a). Excludes Ephemeral Streams.

<sup>2</sup>Excludes wetlands and lakes less than 5 acres

# Lake Wisconsin as an example

- Average summer HRT is <14 days
- Lake Wisconsin is a RIVER
- Acts like a lake sometimes
- As HRT increases; BGA increases



Rivers

100  $\mu\text{g/L}$



# Reservoir Monitoring Results

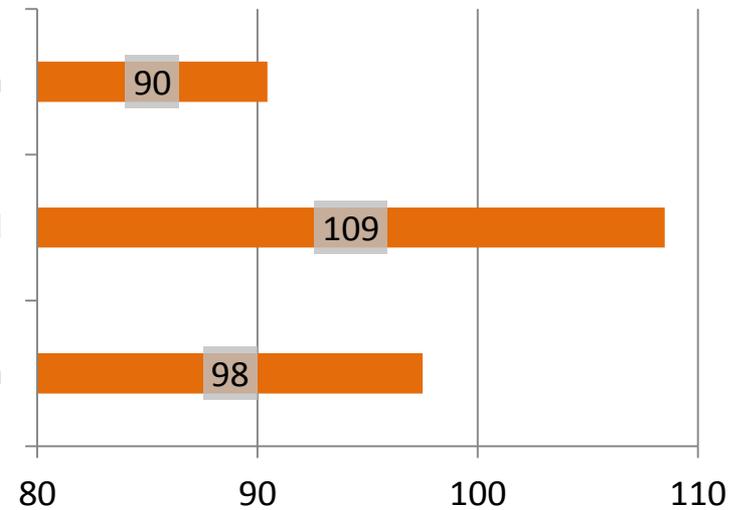
Lake Wisconsin

Northern

Central

Southern

Total Phosphorus Concentration



2010-2013 Mid-June – Mid Sept (µg/L)



# What to do:

## Site Specific Criteria

## Wisconsin River Basin Phosphorus Criteria - Central/South

### Stream / River Phosphorus Criteria

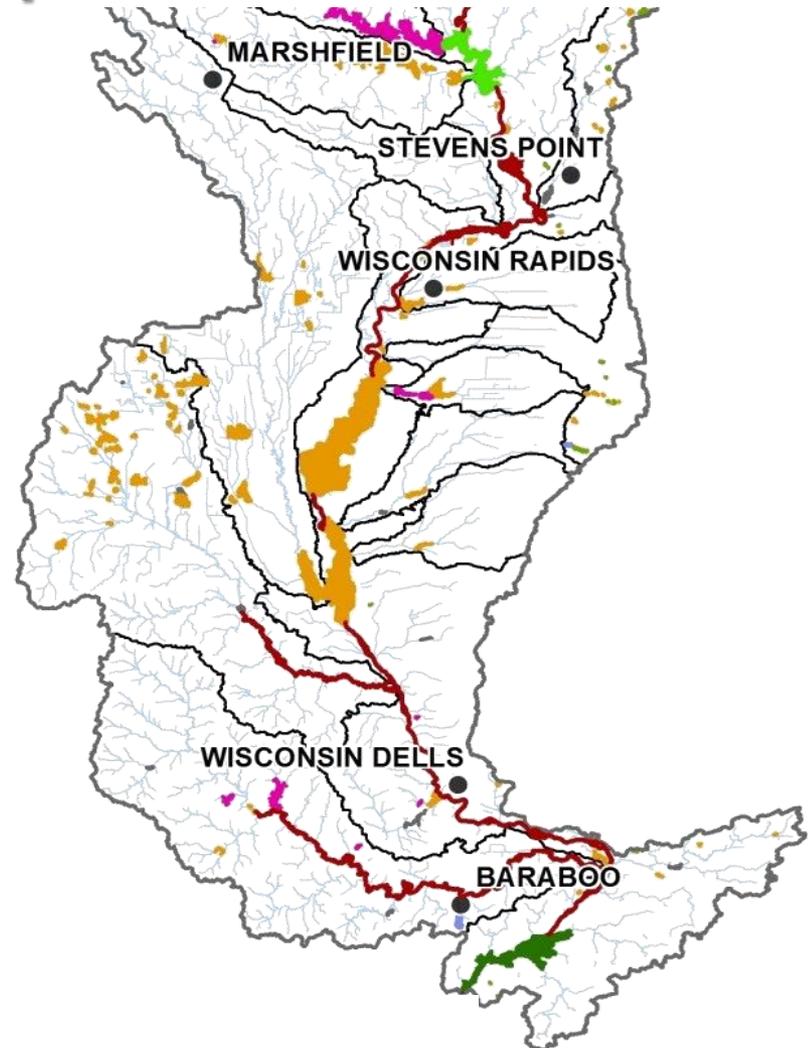
-  75 ug/L
-  100 ug/L

### Reservoir Phosphorus Criteria

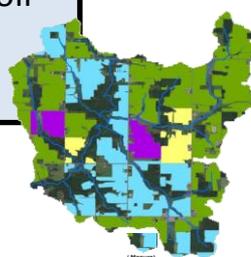
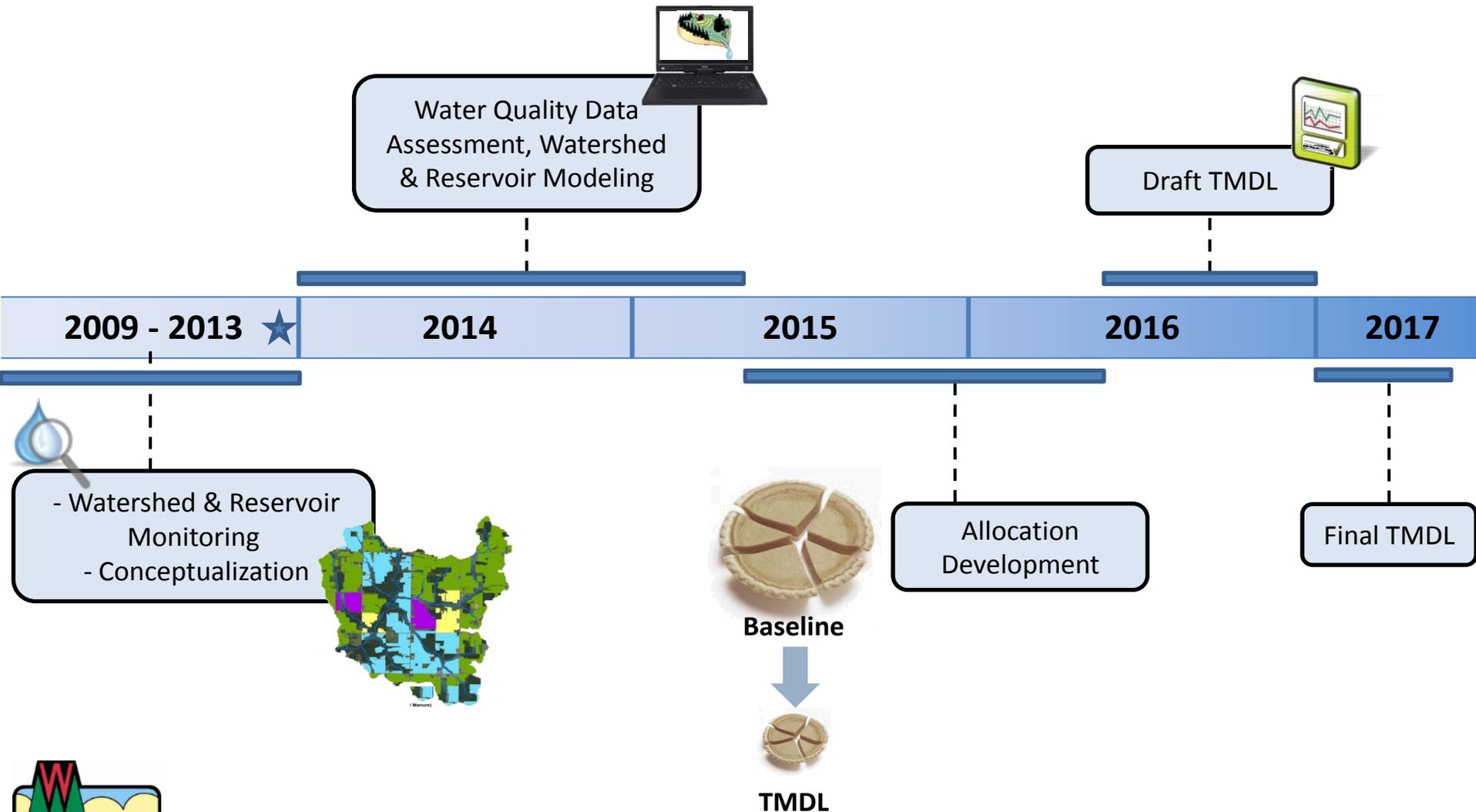
- |  |   |
|--|---|
|  Requires SSC |  40 ug/L                       |
|  15 ug/L      |  40 ug/L or SSC (Undetermined) |
|  20 ug/L      |  75 ug/L                       |
|  30 ug/L      |  100 ug/L                      |

### Notes:

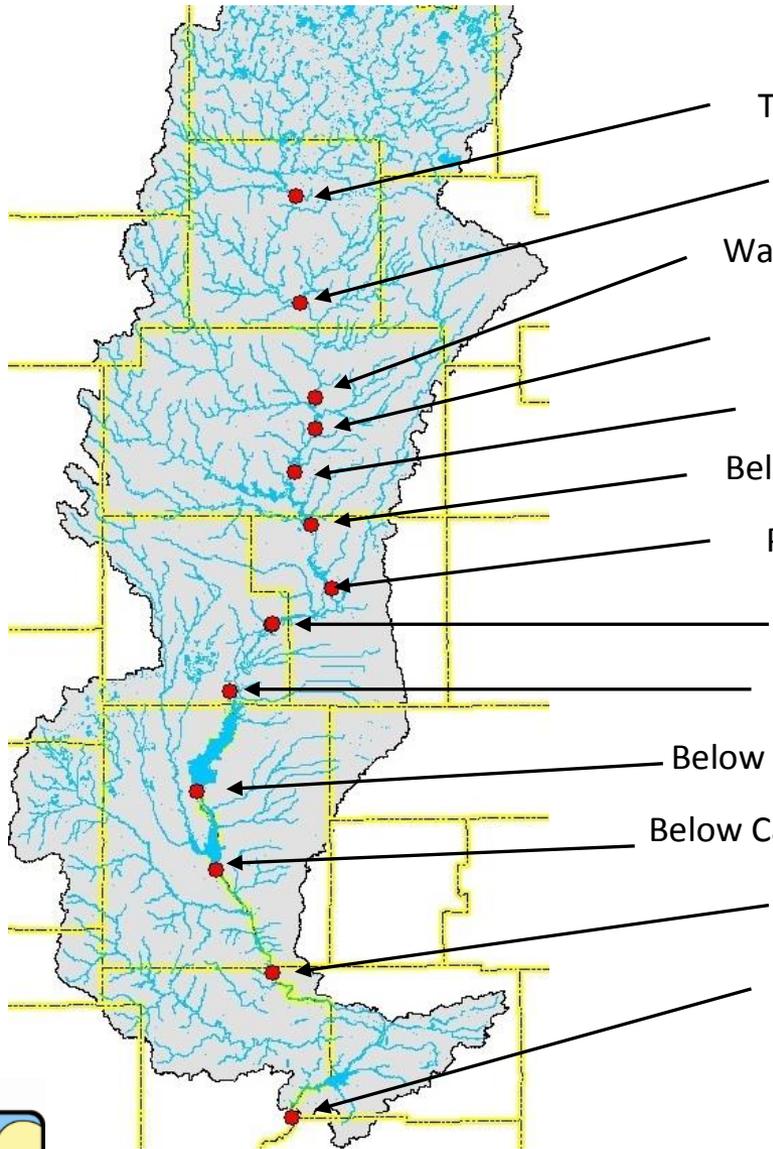
1. Phosphorus criteria delineated using the 24K Hydro layer and the 100 ug/L river extent narrative from administrative code NR 102.06
2. Streams with a stream order of two or greater are shown. All smaller tributaries stream are assumed to have a phosphorus criteria of 75 ug/L.



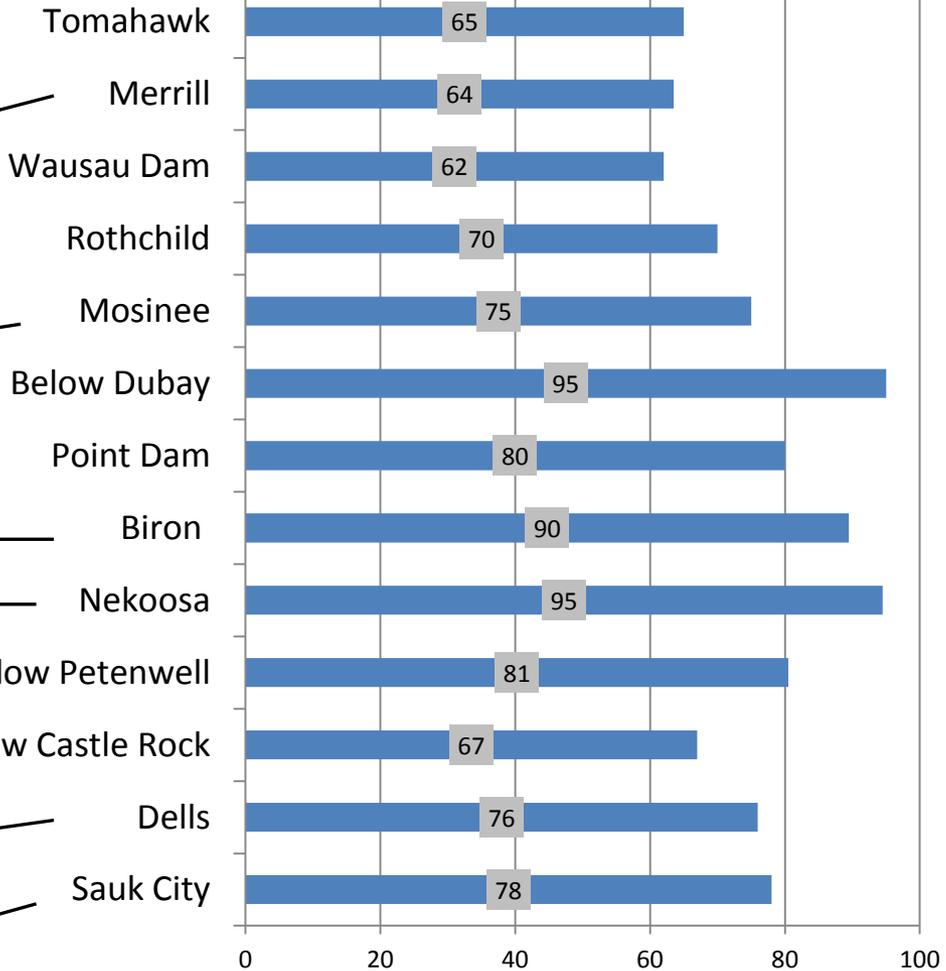
# Brings us to the Wisconsin River TMDL



# Main Stem Monitoring Results



## Total Phosphorus Concentration



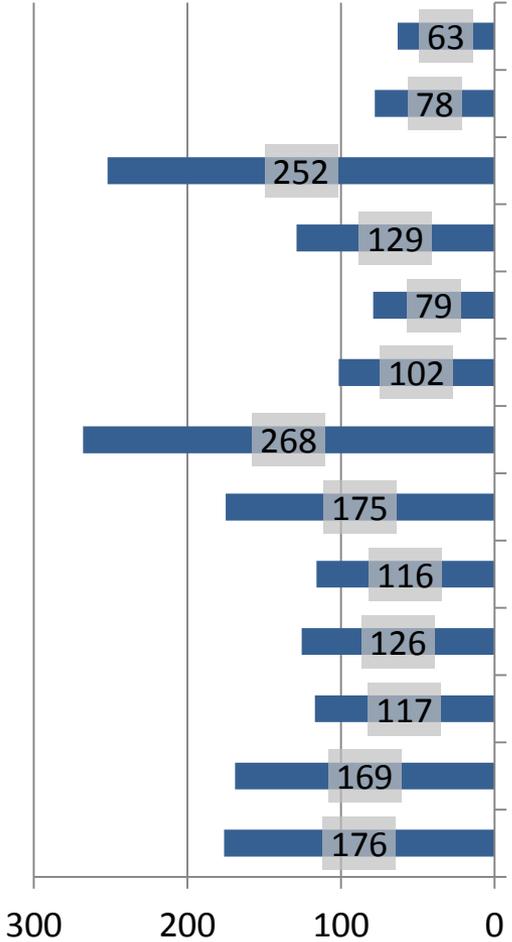
2010-2013 May-Oct Median TP (µg/L)



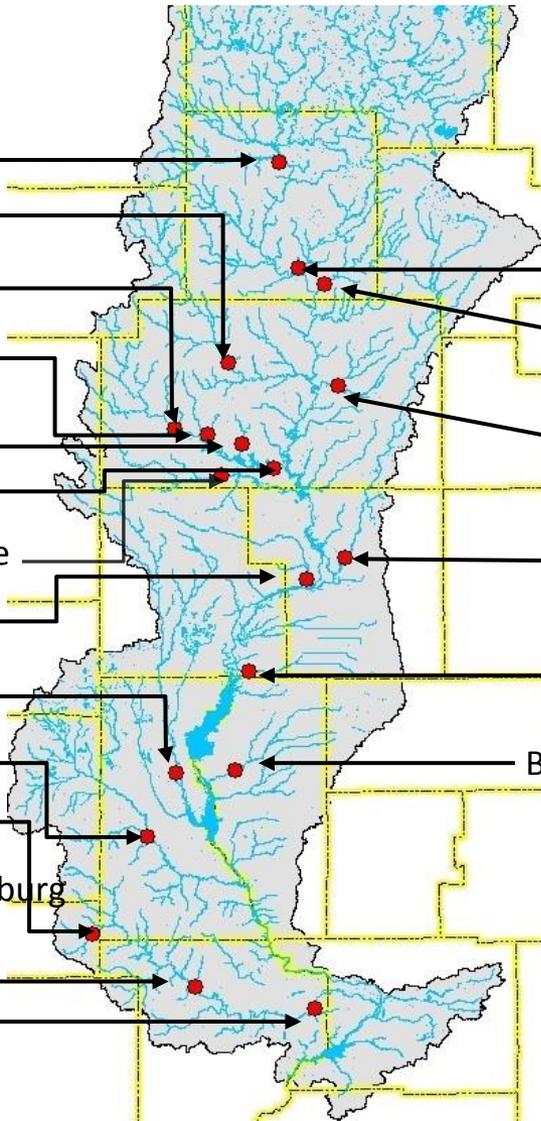
# Tributary Monitoring Results

## Total Phosphorus Concentration

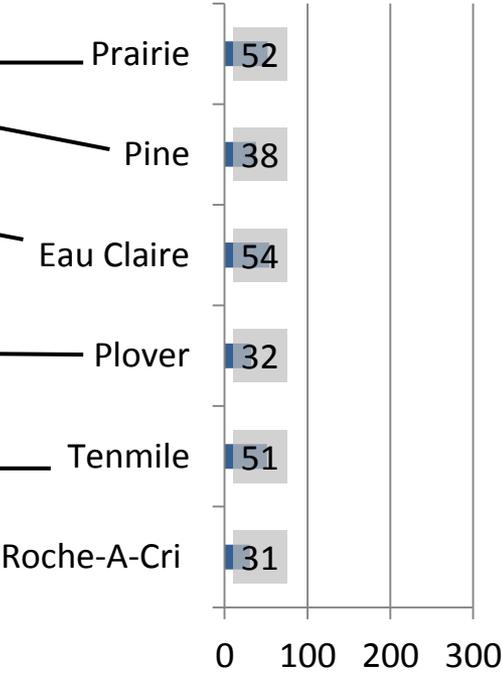
### West Tributaries



2010-2013 May-Oct Median TP (µg/L)



### East Tributaries

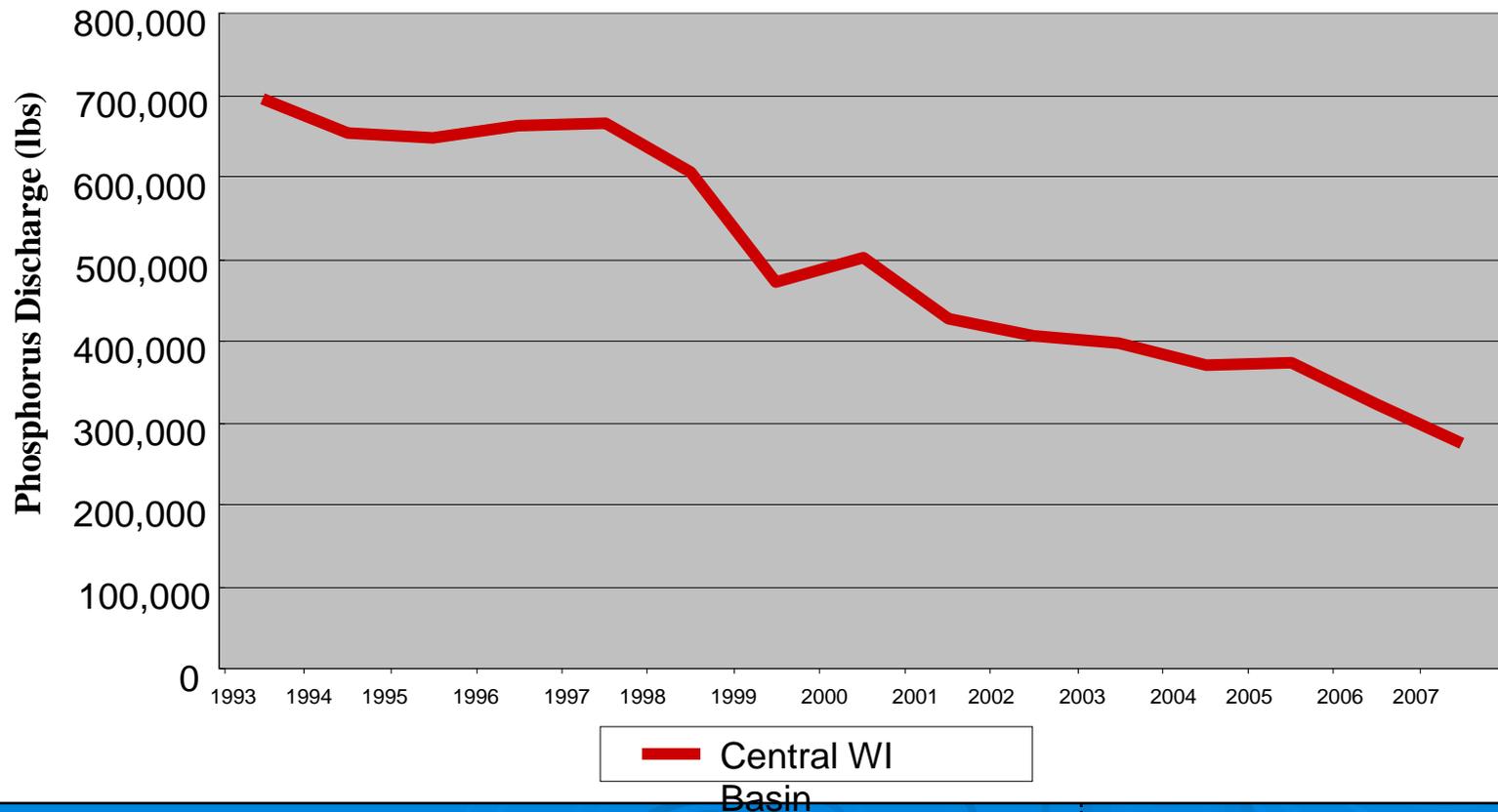


2010-2013 May-Oct Median TP (µg/L)



# We ARE Making Progress

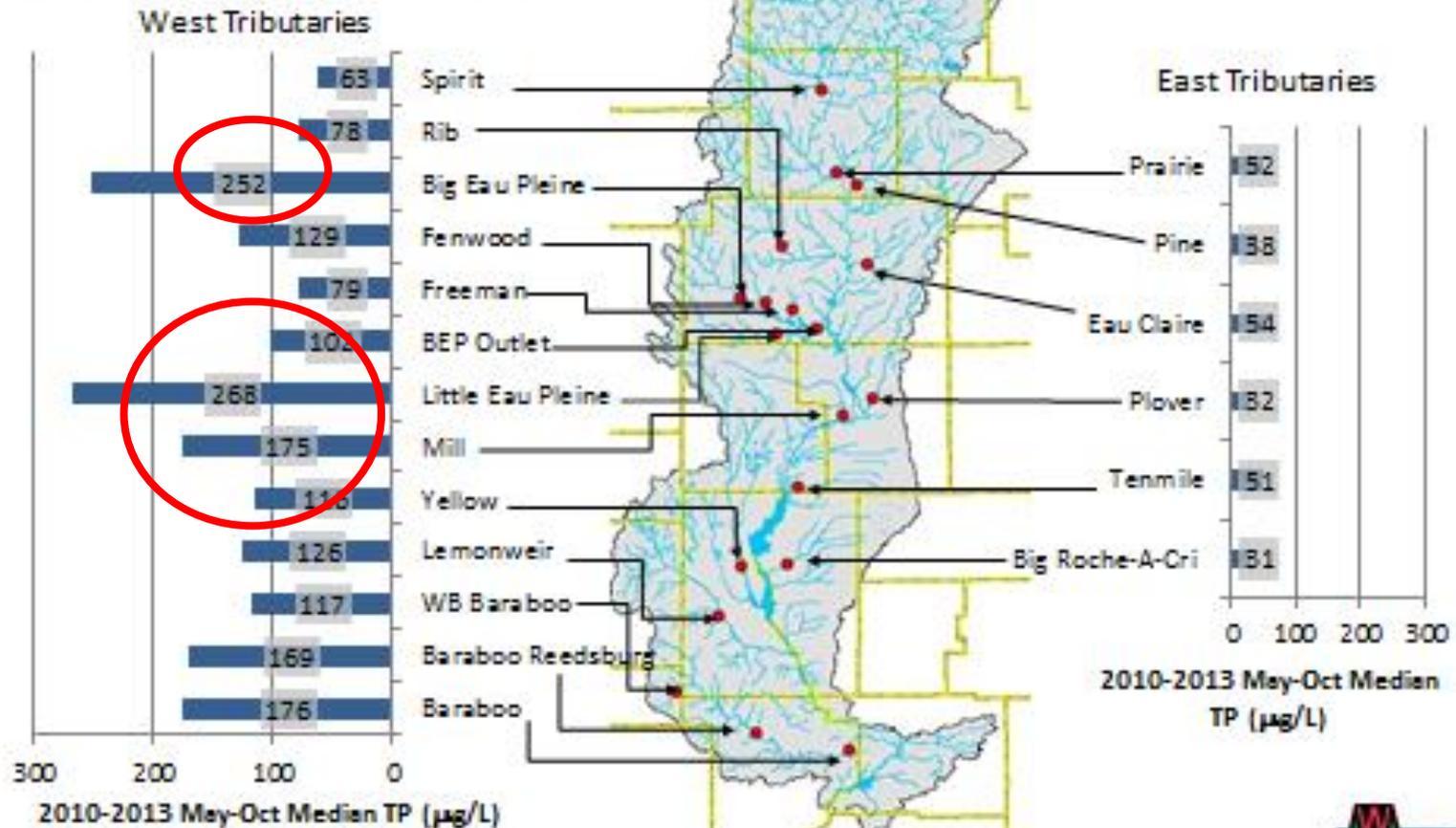
## Estimated Annual Phosphorous Point Source Loading



# Need to Address NPS!

## Tributary Monitoring Results

### Total Phosphorus Concentration



# One Basin; Two Personalities

- East side, tends to be sandy
- Lower runoff potential
- Different management
- Wind erosion



# One Basin; Two Personalities

- West side, tends to be heavier soils
- Higher runoff potential
- Different management



# Difficulty of NPS Management

- Hard to pinpoint source
- Lack of incentives (i.e. rules, \$\$\$, etc.)
- Land use patterns
  - Generational ethos
  - Local demands
  - Perceptions

# Summary

- A river we want to be a lake
- “stuff” (nutrients and sediment) settles
- Fuels algae, decrease water quality, alters bio
- Active TMDL – need implementation
- Progress has been made
- Work on NPS
- Prevent AIS



**Thank You!**

**Yep, Yep, Yep**

# What can we do together?

## Open Discussion

- Show successes
  - NPS control projects
  - PS success
  - AIS prevention model
- Don't ignore problems
- I and E
  - Political
- Bigger picture (i.e. watershed to river valley to continental basin)