Annualized Agricultural Non-Point Source Pollution Model (AnnAGNPS) Phosphorus Components

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AnnAGNPS – Annualized Agricultural Nonpoint Source Pollution Model

- Evaluates the effect of conservation practices for integrated watershed management planning (used in CEAP by ARS & NRCS).
- Uses RUSLE2 science and databases.
- Tracks pollutants from their source (fields, gully, channel, point source, feedlot).
- Linked to channel – lake/reservoir - groundwater models.

AnnAGNPS: the pollutant loading (PL) model

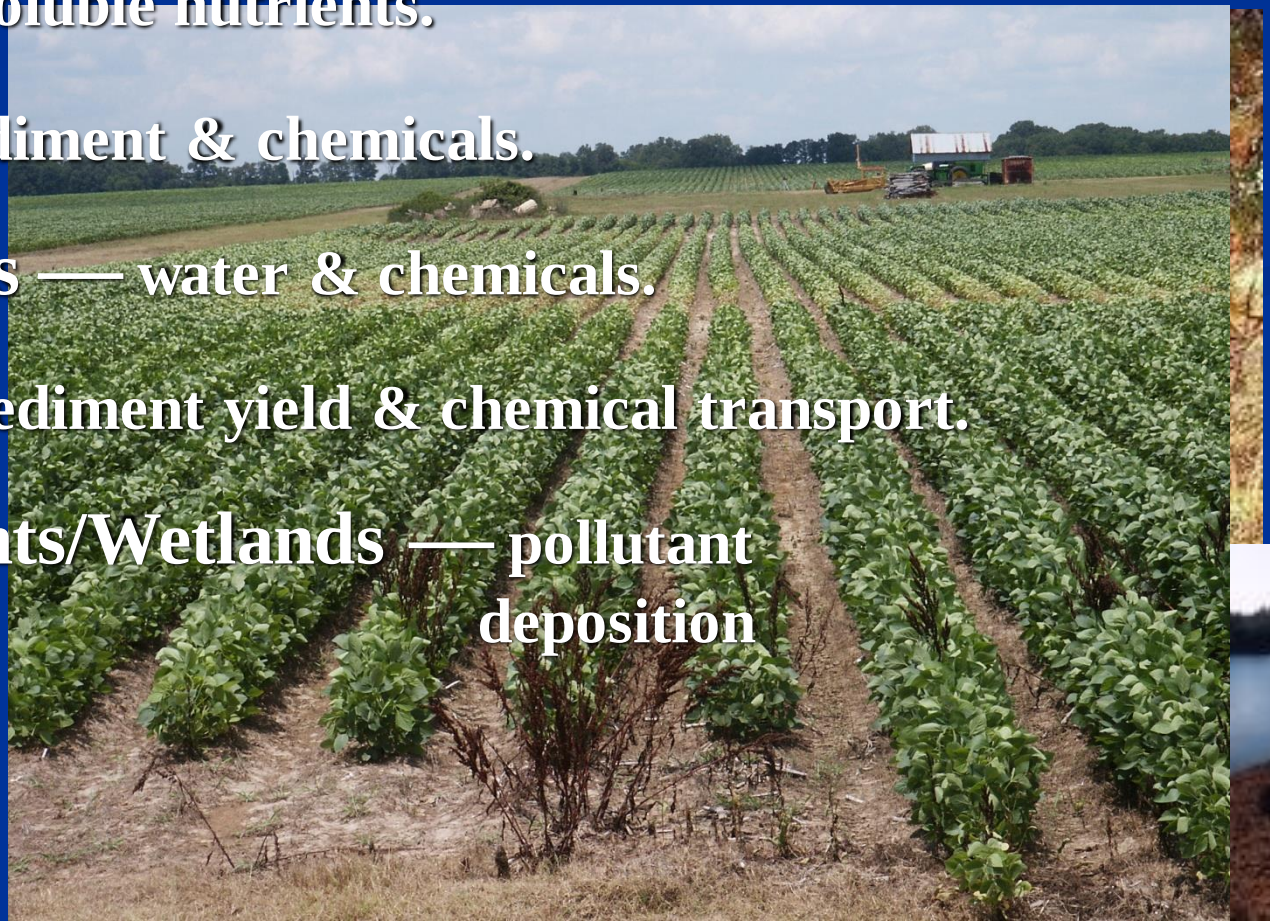
Erosion, yield, & loadings by type of PL:

- **Water**—rainfall, snowmelt, irrigation, & point sources.
- **Sediment by particle size-class and source:**
  - clay;
  - silt;
  - sand;
  - small aggregate; and
  - large aggregate.
- **Chemicals (attached & dissolved):**
  - nutrients—nitrogen, phosphorous, & organic carbon; and
  - pesticides—any number, any kind.

Model Process Components

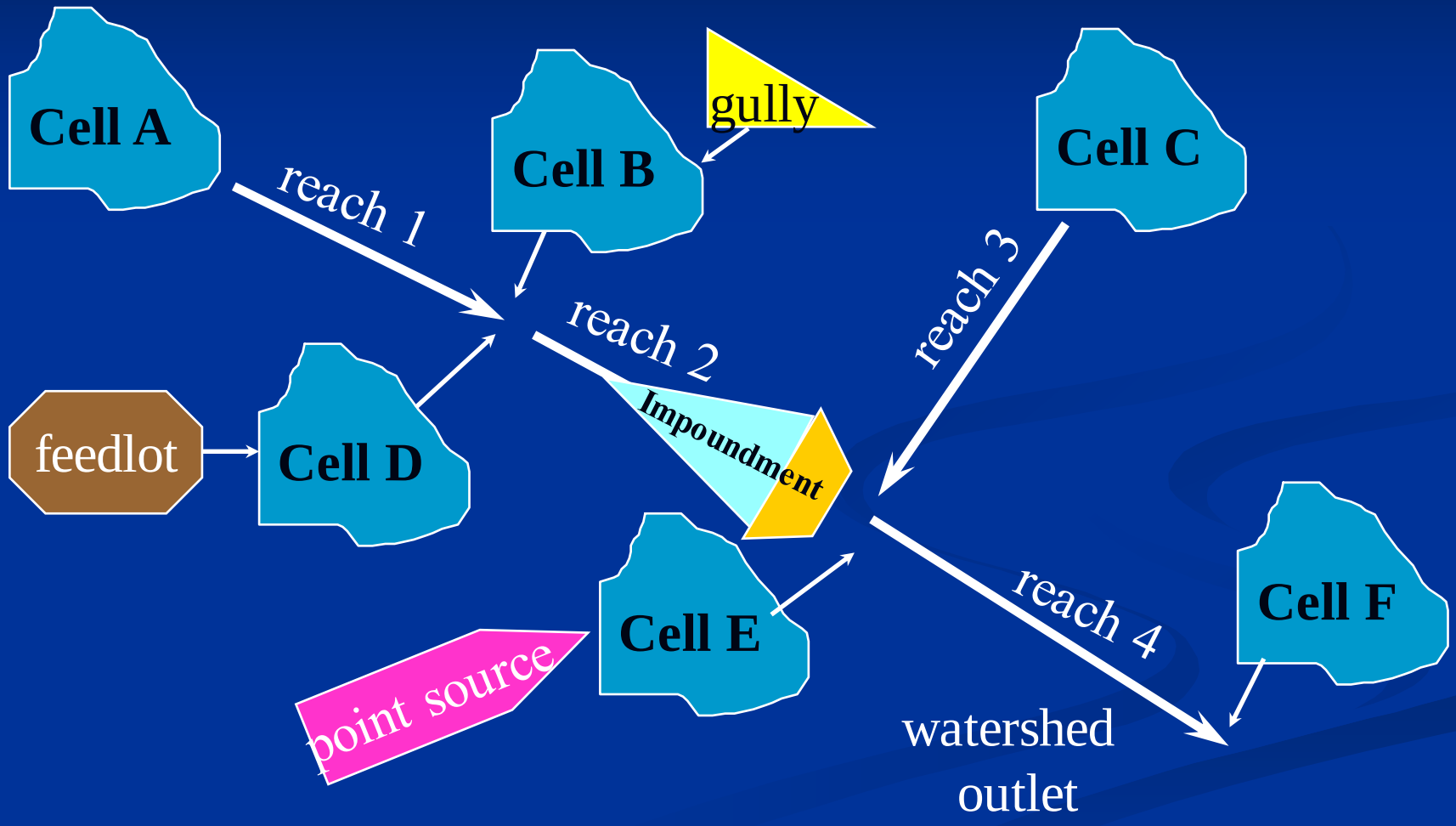
Loadings by source

- **Cells (RUSLE Landscapes) — water, sediment, & chemicals.**
- **Feedlots — soluble nutrients.**
- **Gullies — sediment & chemicals.**
- **Point Sources — water & chemicals.**
- **Reaches — sediment yield & chemical transport.**
- **Impoundments/Wetlands — pollutant deposition**



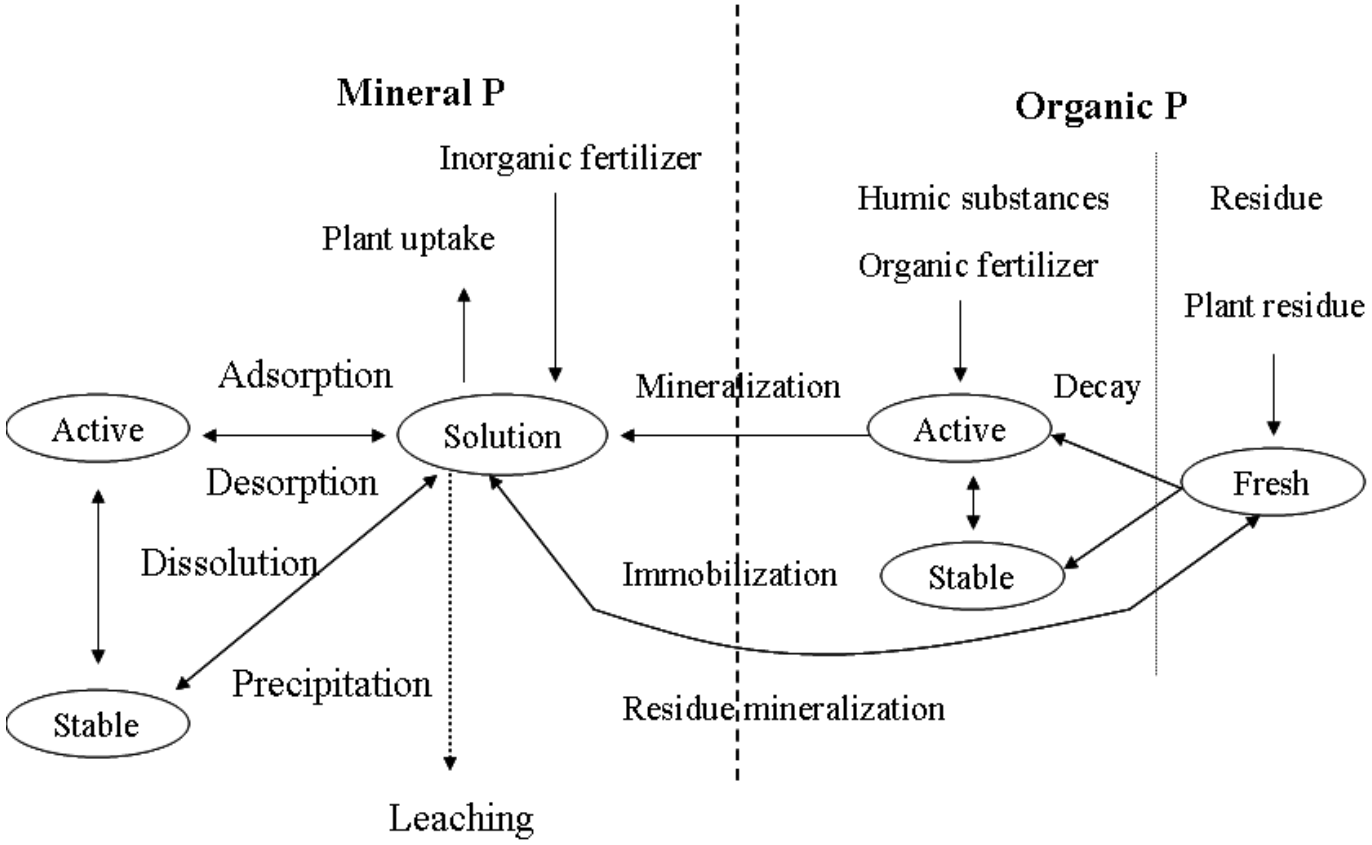
Watershed Water, Sediment, & Chemical Sources

Tracks loadings by source throughout the transport process



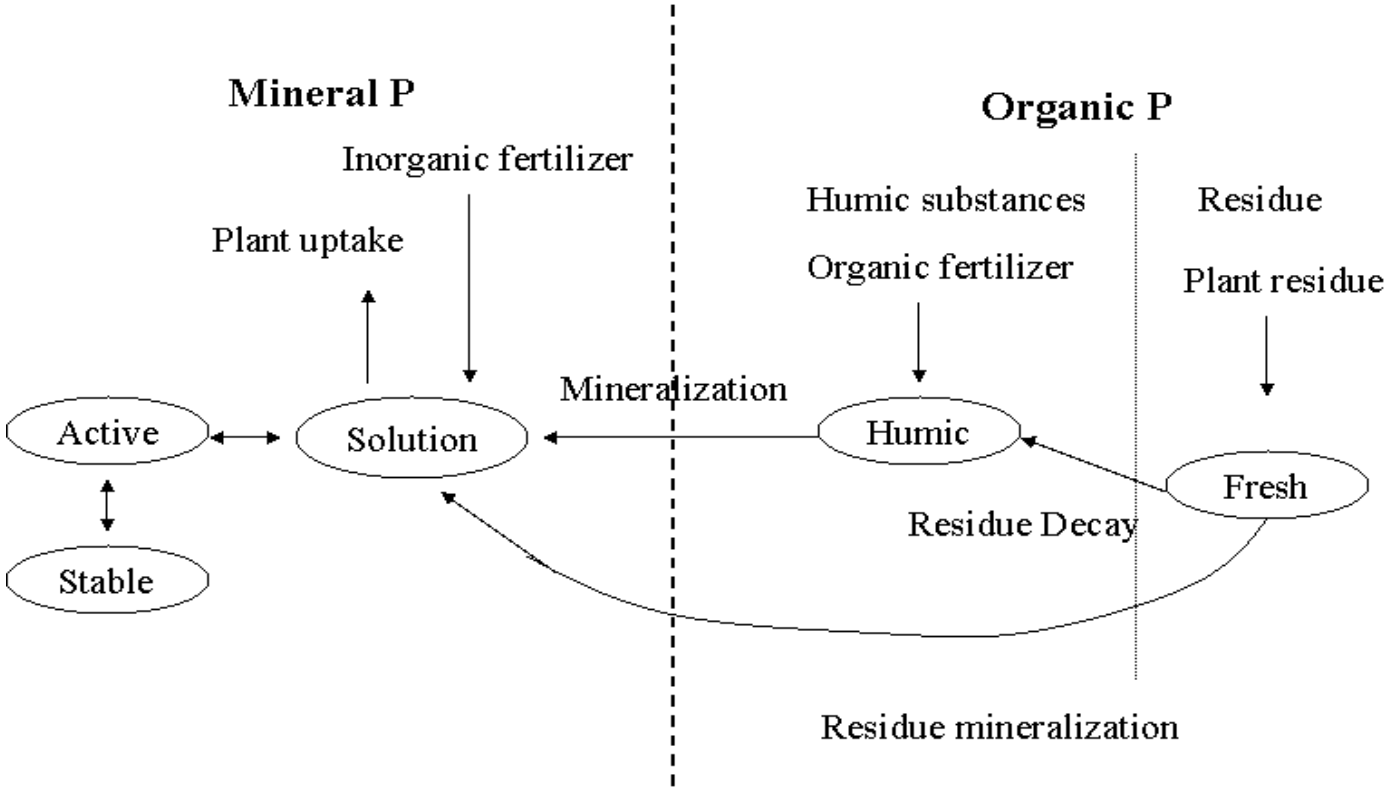
AnnAGNPS: Phosphorus Components

A simplification of phosphorus processes (Havlin et al., 1999)



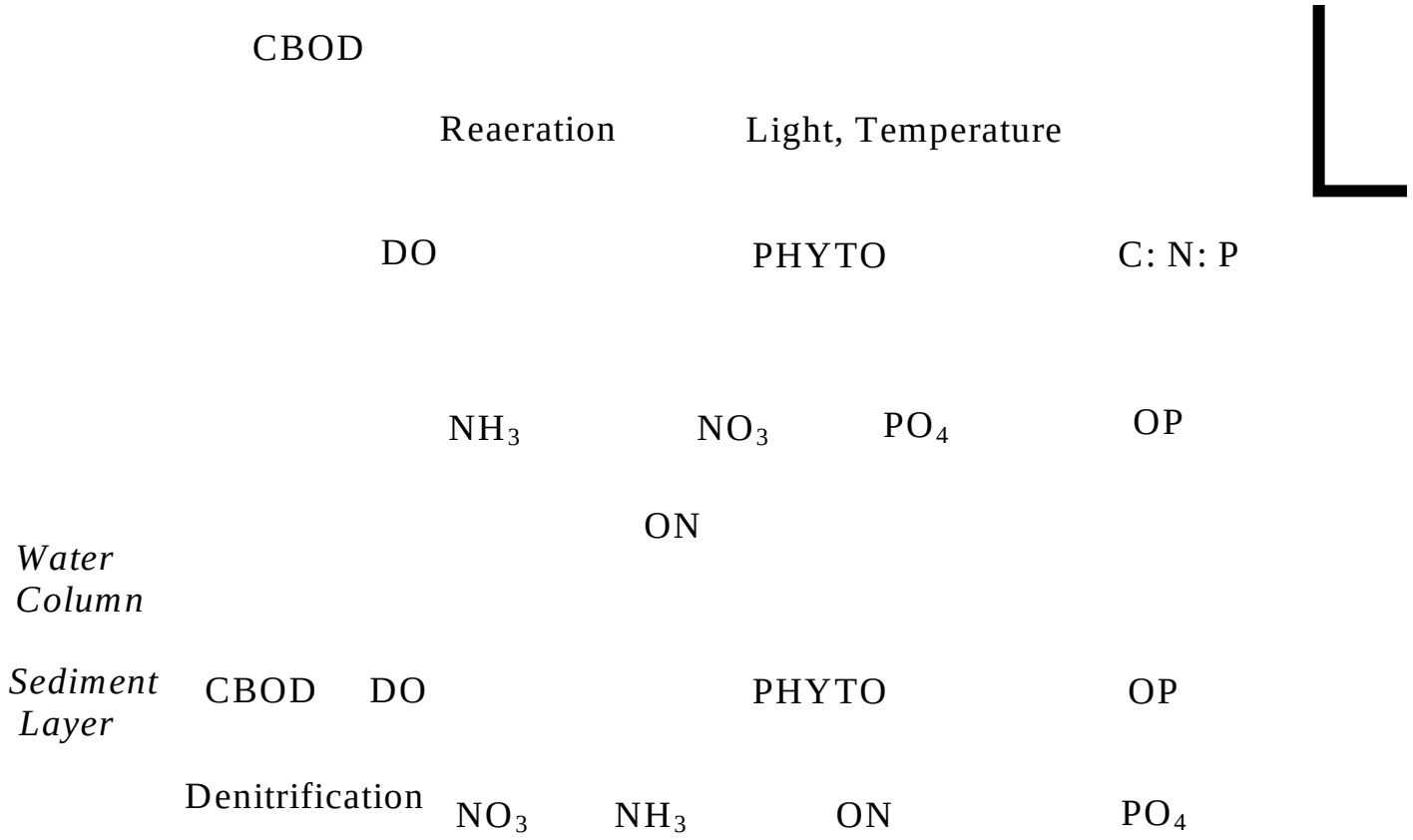
AnnAGNPS: Phosphorus Components

Phosphorus processes simulated within AnnAGNPS



AnnAGNPS: Phosphorus Components

Phosphorus processes linked to the lake model CCHE-WQ



AnnAGNPS: Phosphorus Components

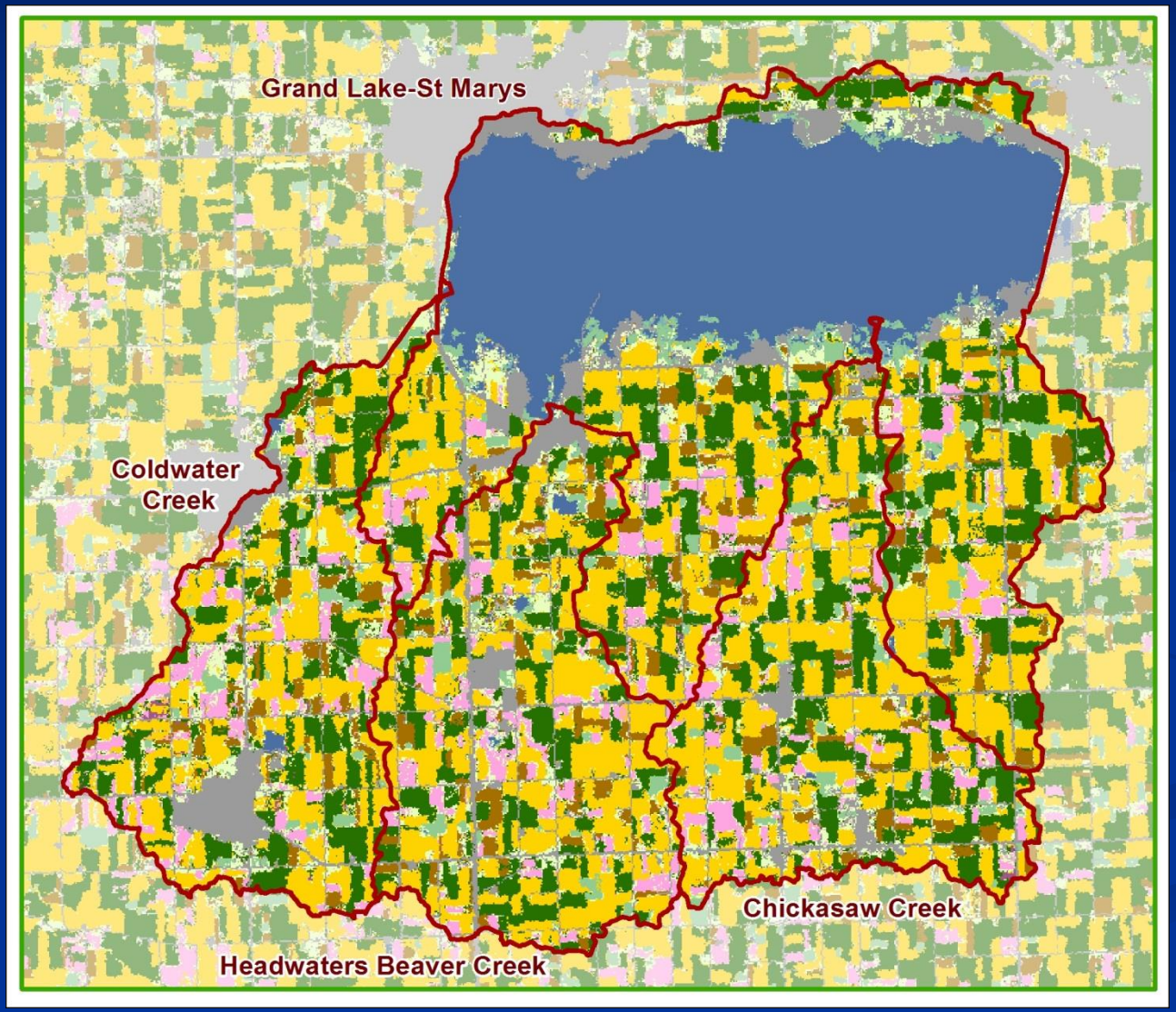
- **Top soil layer - 203.2 mm tillage surface soil layer**
- **Second soil layer - depth to an impervious layer or user supplied**
- **Simplification of the EPIC P model.**
- **Sediment-bound P is determined from the clay-sized fraction of soil erosion, which is also part of eroded aggregates.**
- **Adapts surface and subsurface residue decomposition routines from RUSLE2**
- **Users enter initial soil P levels or defaults of 1.5% OM for orgP and 0.75% for inorgP are used**
- **P saturation uncertainty impacting long term simulations**

Assessment of Conservation Practice Effects on Phosphorus Loads from Grand Lake St. Marys Watershed, Ohio using AnnAGNPS

Objective

To determine where and if conservation practices can be placed and/or adopted to reduce phosphorus loadings to Grand Lake St Marys.

LANDUSE



Crops ~ 68%

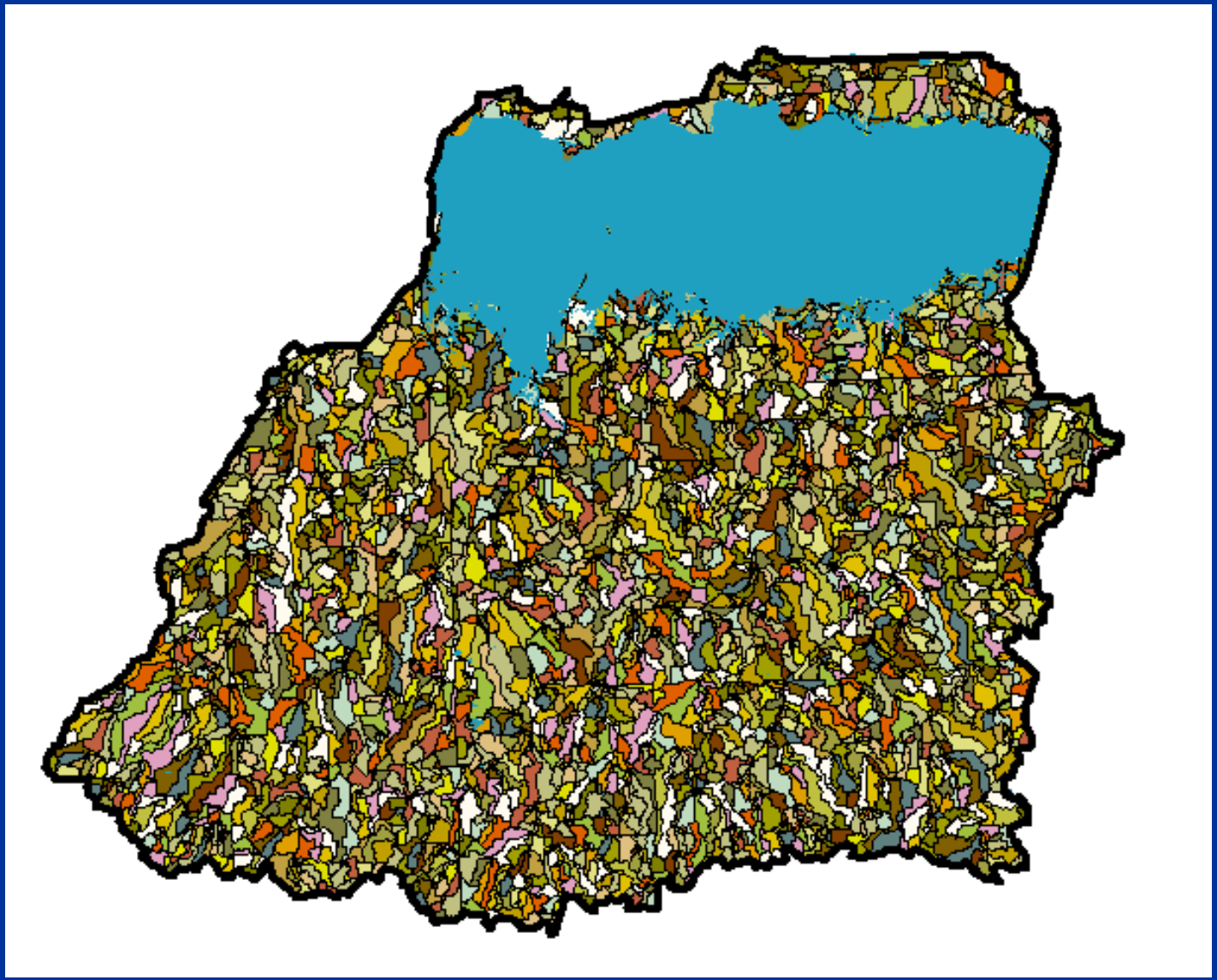
Pasture ~ 7%

Forest ~ 6%

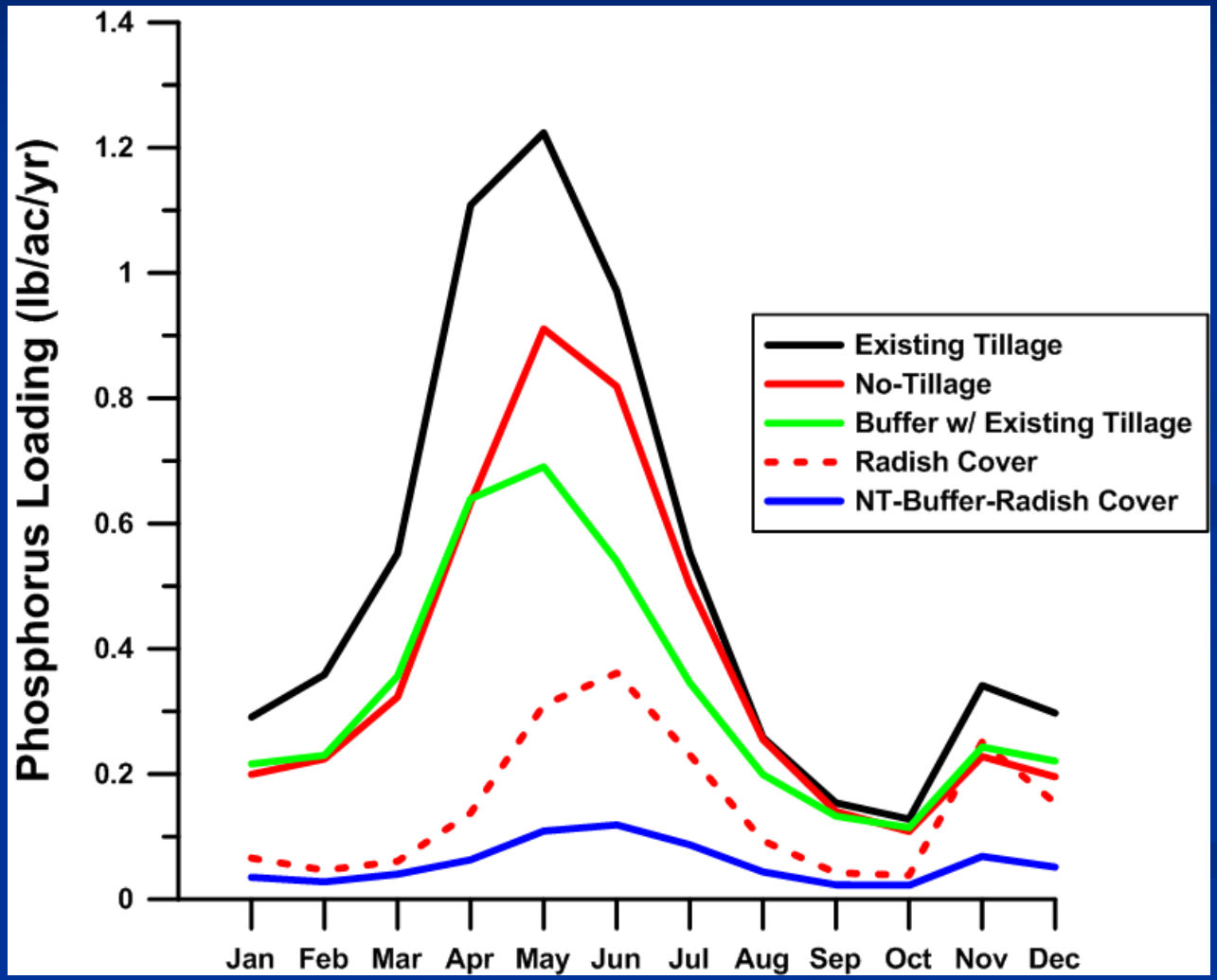
Developed ~ 16%

Other ~ 3%

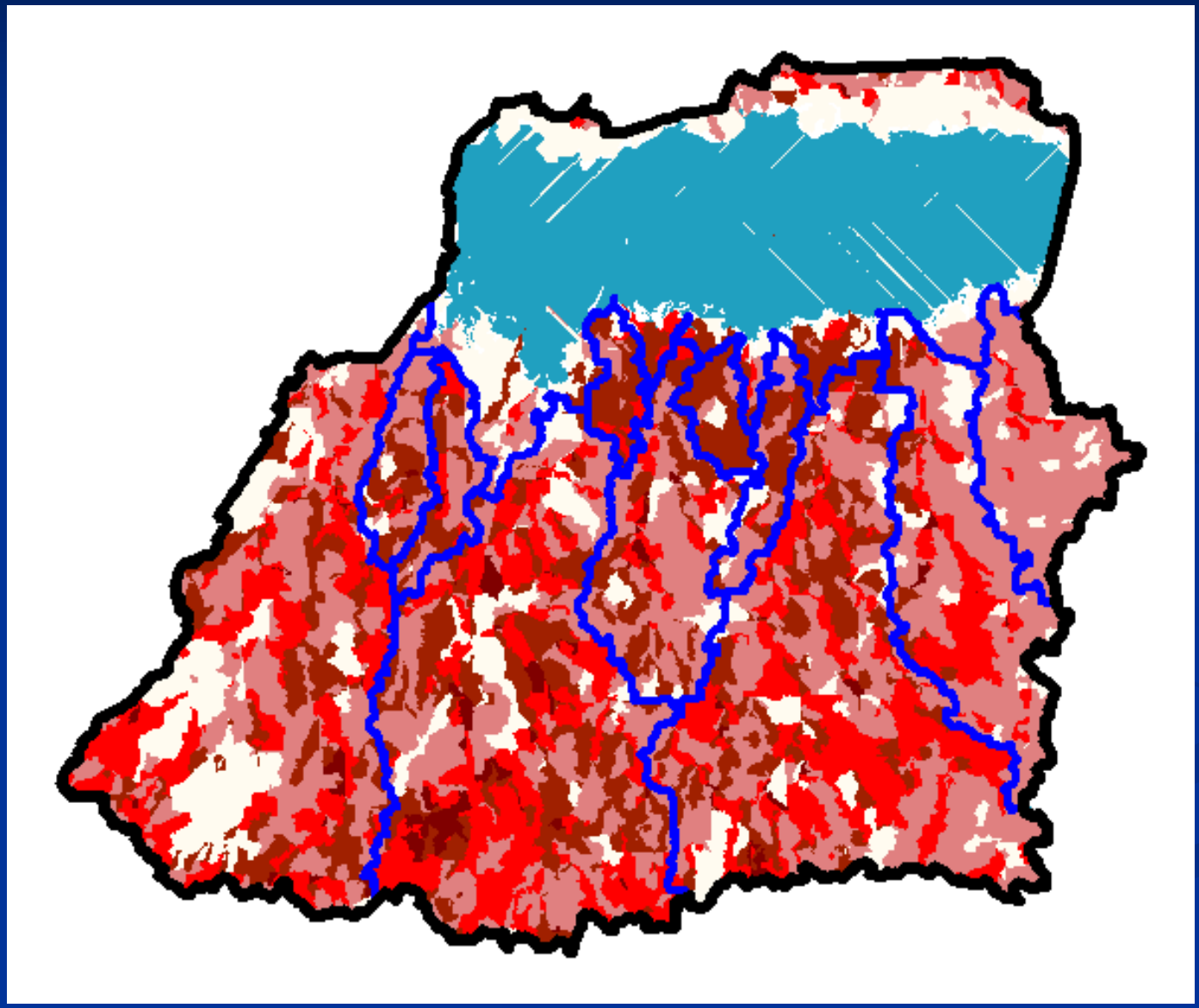
3214 AnnAGNPS Cell Subdivision for GLSM



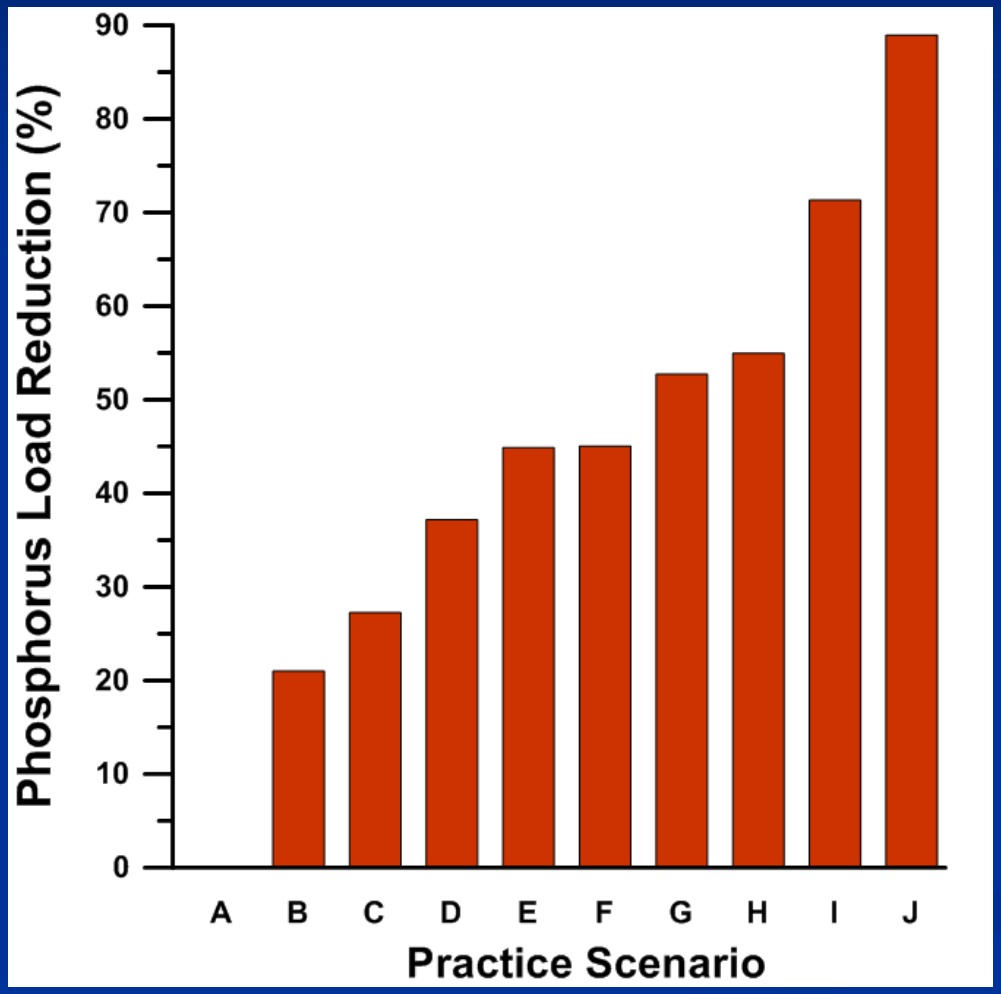
Average Annual Monthly Phosphorus Loading Various Scenarios



Phosphorus Loads to GLSM
Existing Conditions – 30 Year Simulation



Phosphorus Load Reduction From Conservation Practices



A. Conventional Tillage

B. Minimum Tillage

C. No-Tillage

D. Buffers w/ Conv. Till.

E. Rye Cover w/ Conv. Till.

F. Clover Cover w/ Conv. Till.

G. Wheat Cover w/ Conv. Till.

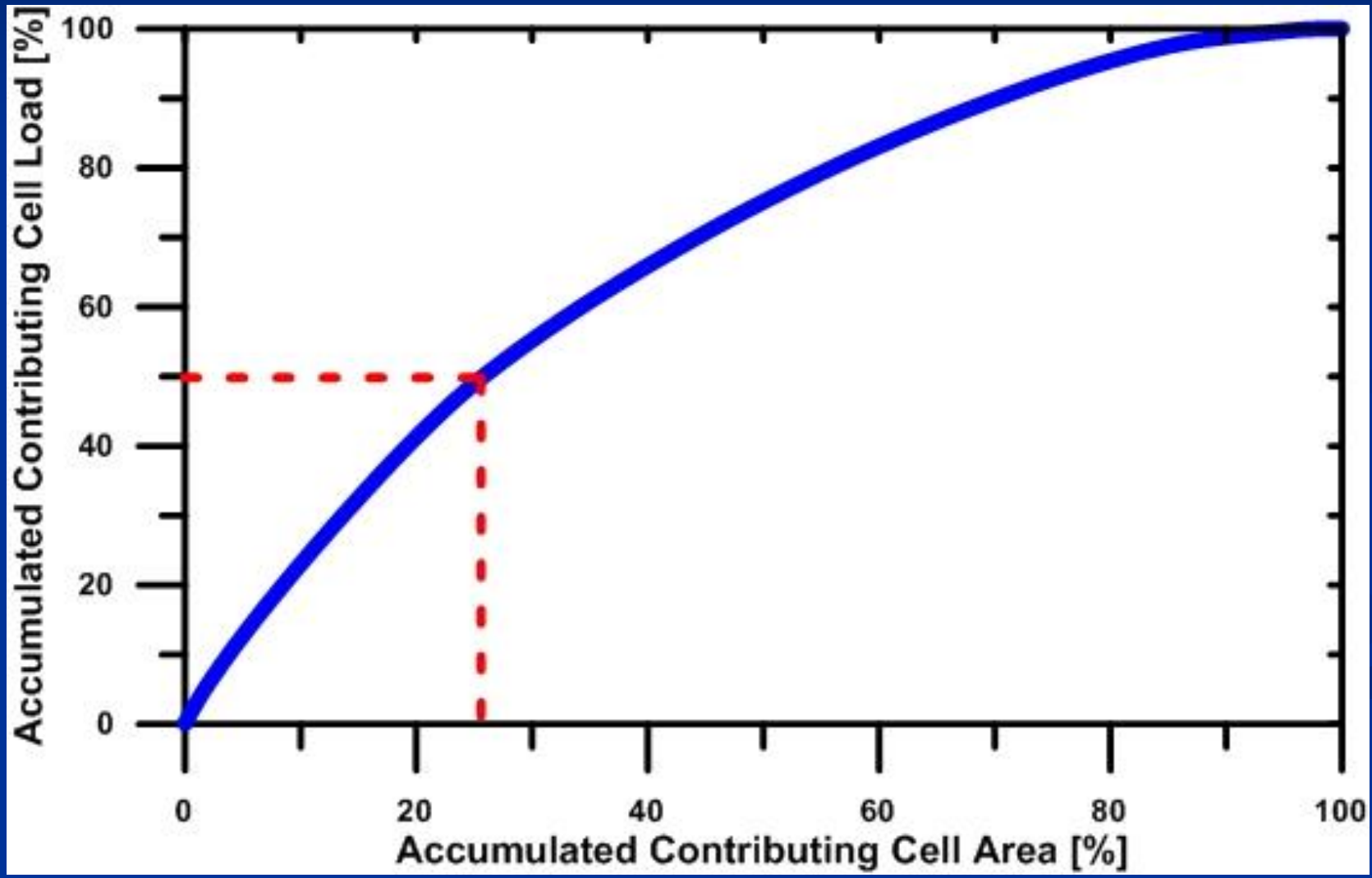
H. Vetch Cover w/ Conv. Till.

I. Radish Cover w/ Conv. Till.

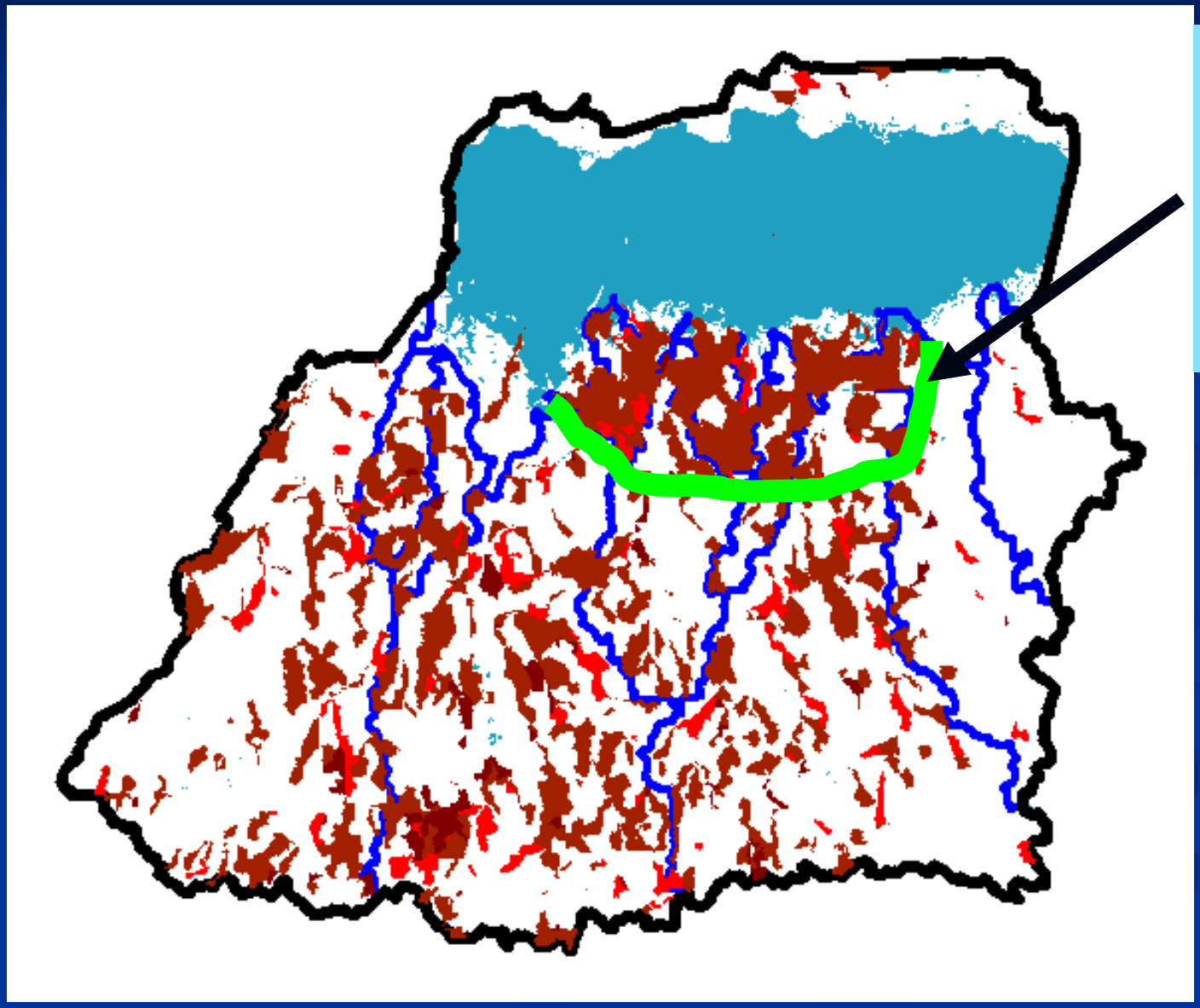
J. No-Till w/ Radish Cover w/ Buffers

Contributed Phosphorus Load vs. Contributing Drainage Area

26% of the GLSM Watershed Contributes 50% of the Phosphorus Load

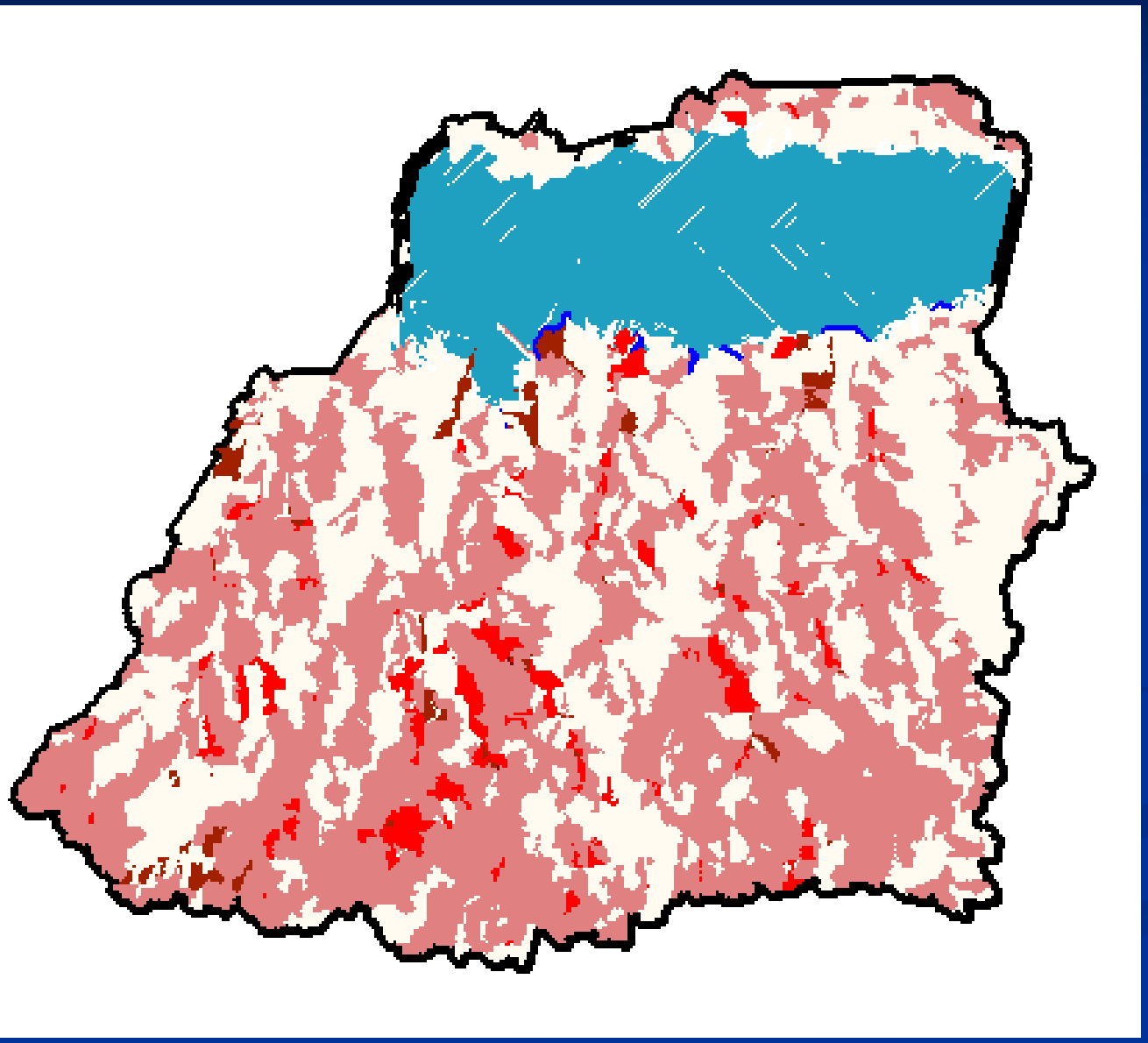


26% of the Area Contributes 50% of the Phosphorus Load to GLSM
Existing Conditions – 30 Year Simulation

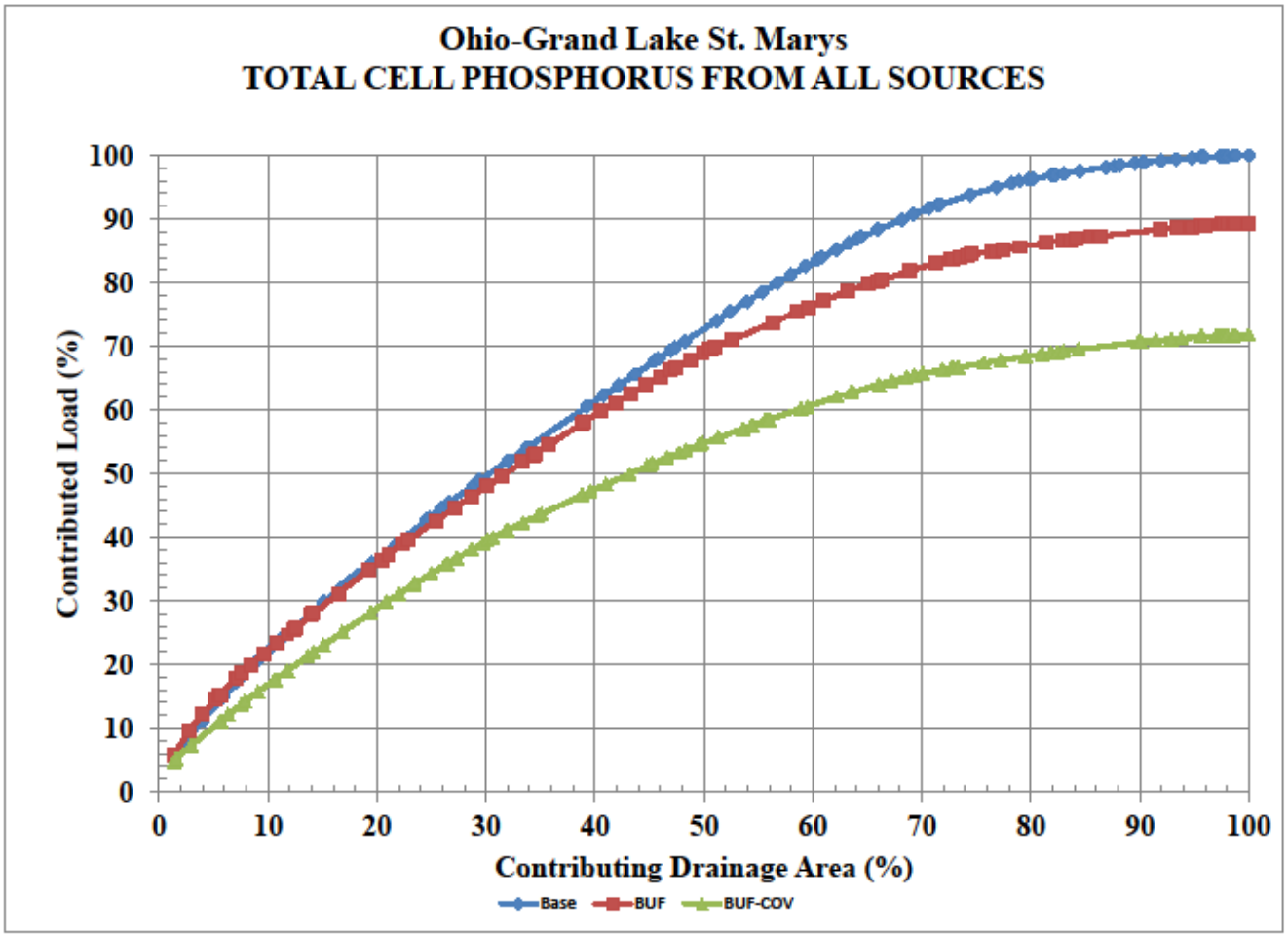


5% of the GLSM watershed contributes 10% of the total P load - (~3.5 km from the lake)

Phosphorus Loads to GLSM
Winter Wheat Cover – 30 Year Simulation



53% Phosphorus Load Reduction to GLSM with Winter Wheat Cover



Base

Buffer

Buffer/ Cover

Summary

- **26% of the watershed contributes 50% of the P loads to GLSM.**
- **10% of the P loads entering GLSM originate near the lake boundary (within 3.5 km).**
- **Cover crops can reduce P loads by over 50% and up to 70%.**
- **Riparian buffers can reduce P loads to the lake by up to 37%.**

General performance ratings for recommended statistics for a monthly time step.

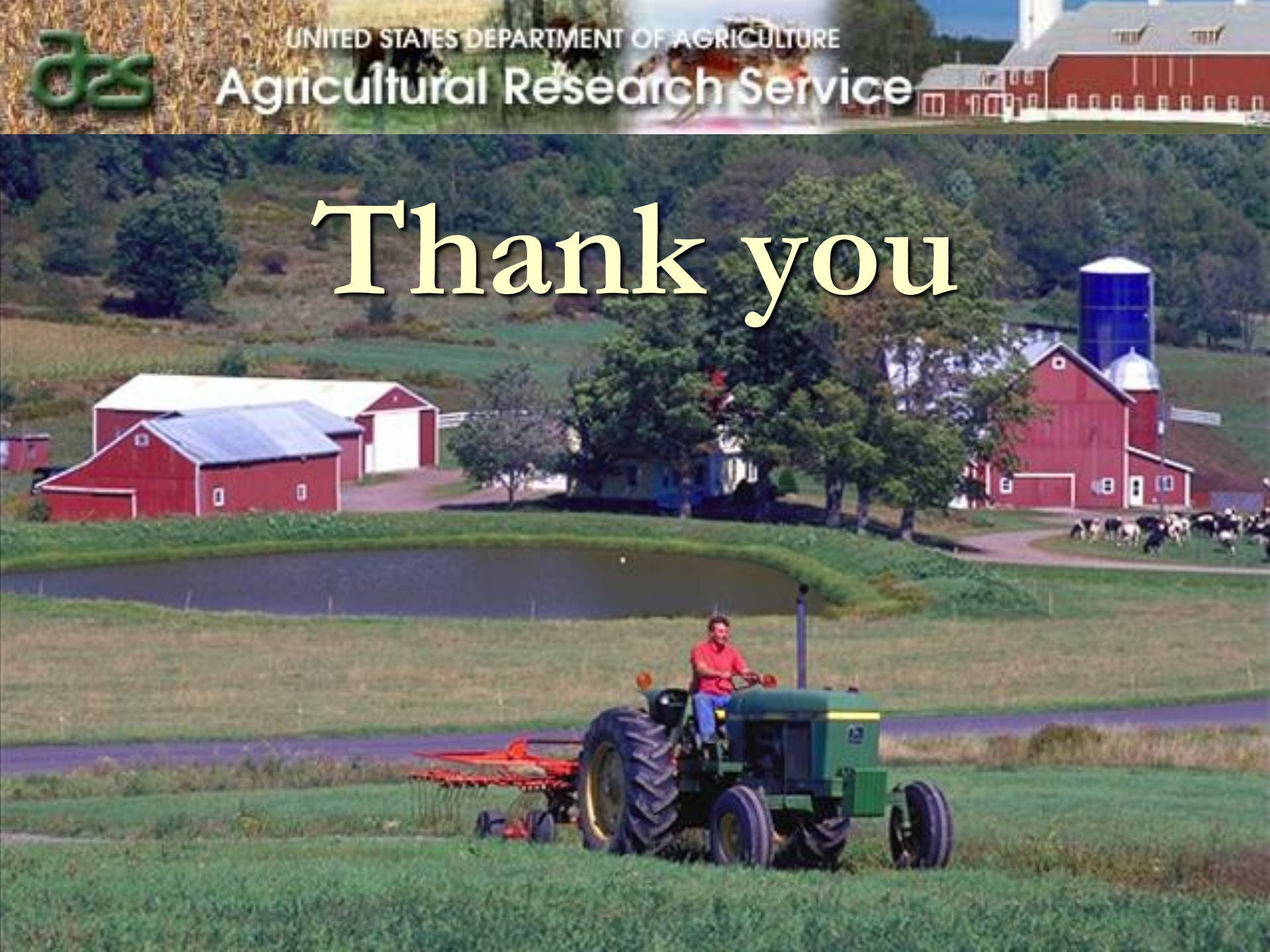
Performance Rating	RSR	NSE	PBIAS (%)		
			Streamflow	Sediment	N, P
Very good	0.00 < RSR < 0.50	0.75 < NSE < 1.00	PBIAS < ±10	PBIAS < ±15	PBIAS< ±25
Good	0.50 < RSR < 0.60	0.65 < NSE < 0.75	±10 < PBIAS < ±15	±15 < PBIAS < ±30	±25 < PBIAS < ±40
Satisfactory	0.60 < RSR < 0.70	0.50 < NSE < 0.65	±15 < PBIAS < ±25	±30 < PBIAS < ±55	±40 < PBIAS < ±70
Unsatisfactory	RSR > 0.70	NSE < 0.50	PBIAS > ±25	PBIAS > ±55	PBIAS > ±70

(Moriasi, D.N., Arnold, J.G., Van Liew, M.W., Bingner, R.L., Harmel, R.D. and Veith, T. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Trans. of the ASABE. 50(3): 885-900. 2007.)

RMSE-observations standard deviation ratio (RSR) - incorporates the benefits of error index statistics and includes a scaling/normalization factor (Legates and McCabe, 1999).

Nash-Sutcliffe Efficiency (NSE) - indicates how well the plot of observed versus simulated data fits the 1:1 line (Nash and Sutcliffe, 1970).

Percent bias (PBIAS) - measures the average tendency of the simulated data to be larger or smaller than their observed counterparts (Gupta et al., 1999).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