

# Effects of Best-Management Practices in Three Agricultural Watersheds in Wisconsin

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# Study Design

- Before vs after BMP implementation water quality evaluation
- Pre-implementation period
  - Garfoot and Brewery Creek Watersheds
    - Water Years 1985-1986
  - Otter Creek Watershed
    - Water years 1991-1993



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# Study Design

- Post-implementation period
  - Garfoot and Brewery Creek Watersheds
    - Water Years 1997-1998
  - Otter Creek Watershed
    - Water years 2000-2002



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# Study Design: Water Quality Evaluation

- Baseflow periods:
  - Suspended sediment/solids, total phosphorus, ammonia-nitrogen
- Runoff event periods: Mass loadings
  - Suspended sediment/solids, total phosphorus, ammonia-nitrogen



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# Data-Collection Methods

- Continuous recording stream gages
- Stage-activated refrigerated water samplers
- Fixed interval sampling
- Continuous recording precipitation gages



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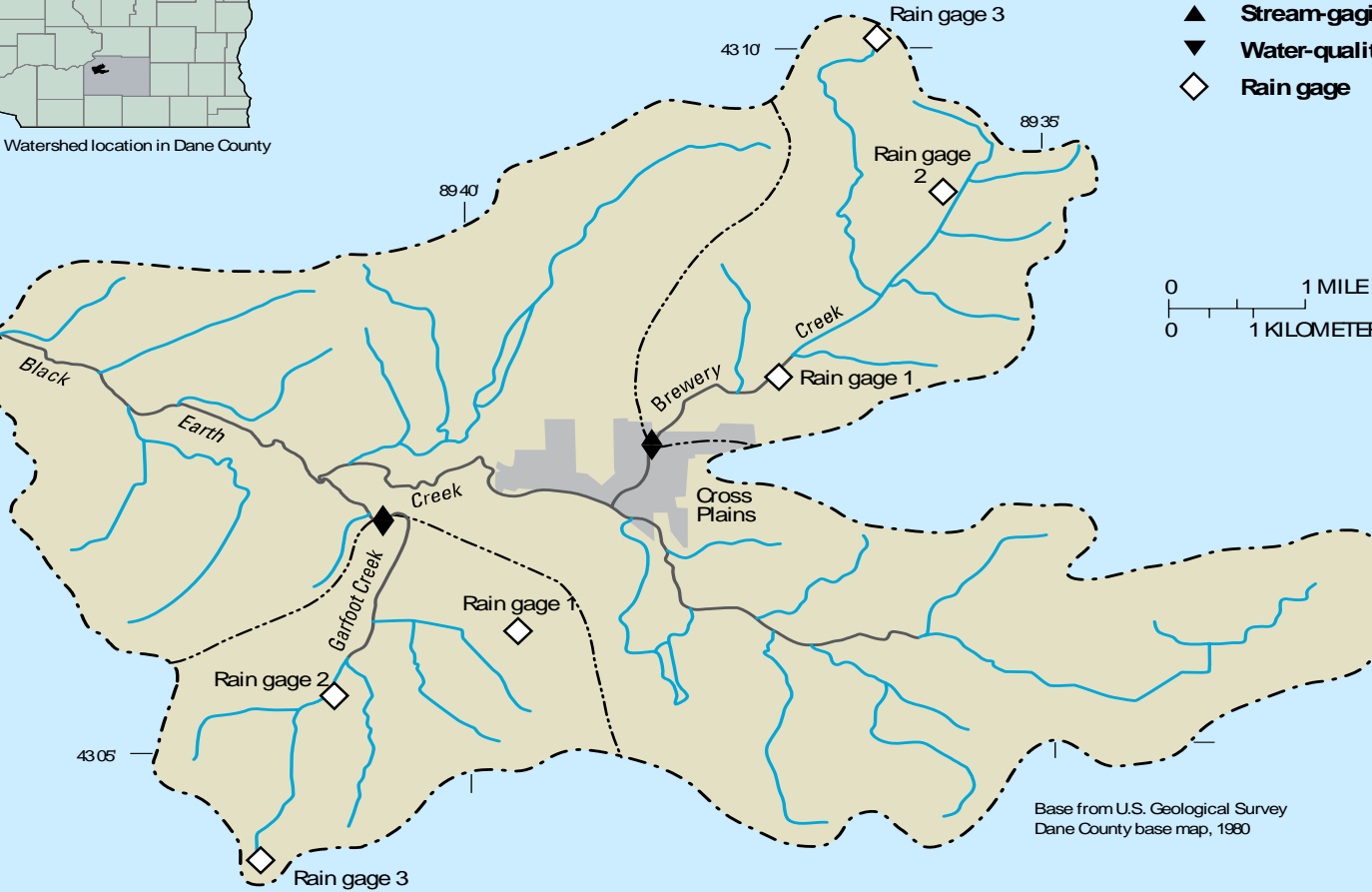


WISCONSIN

Watershed location in Dane County

- EXPLANATION**
- - - Watershed boundary
  - · - Subwatershed boundary
  - ▲ Stream-gaging station
  - ▼ Water-quality station
  - ◇ Rain gage

Black Earth



Base from U.S. Geological Survey  
Dane County base map, 1980



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# Inventory of Watersheds

- Watersheds were inventoried to provide information on land-use and land-treatment.








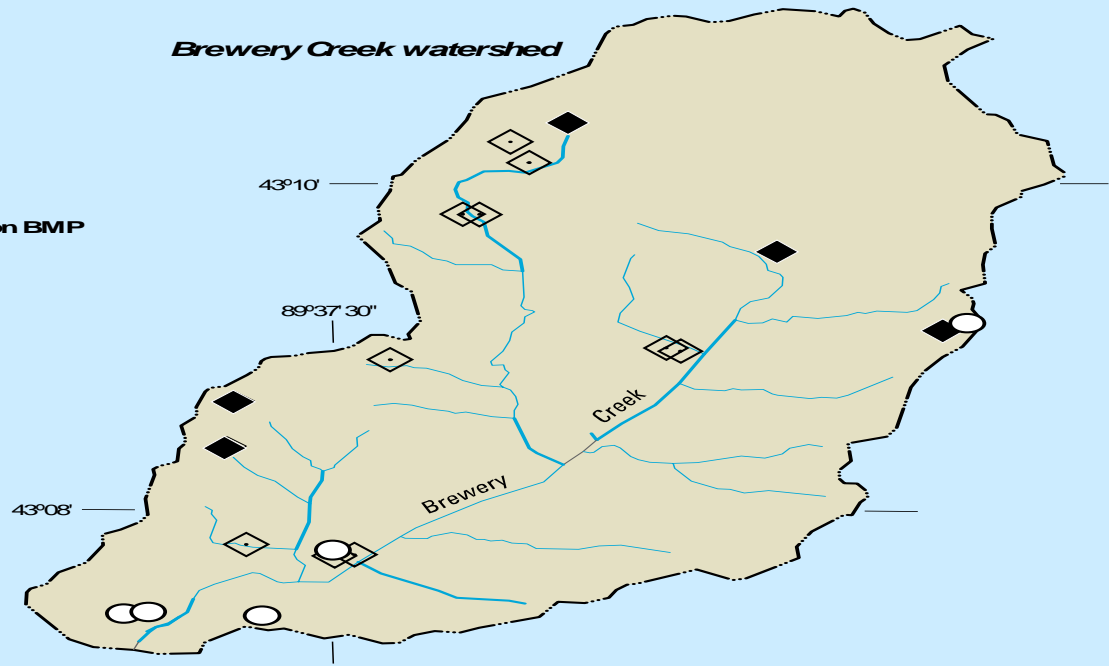
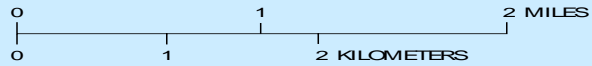
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*Brewery Creek watershed*

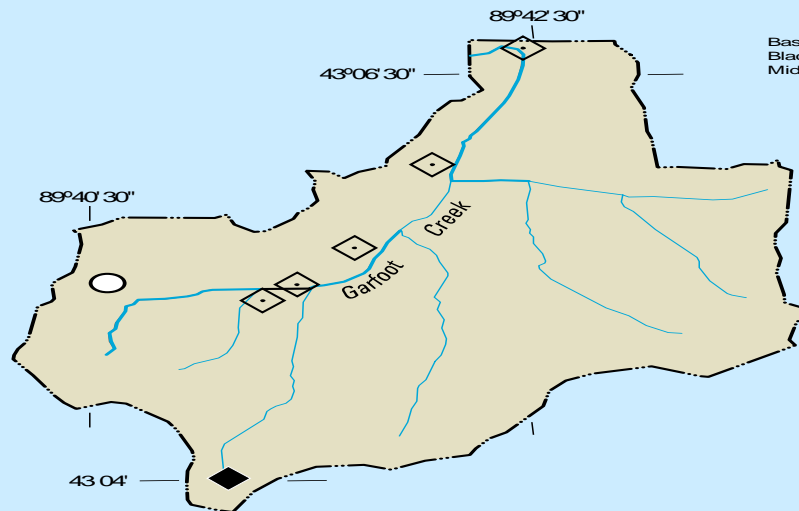
**EXPLANATION**

-  Implemented streambank protection BMP
-  Stream
-  Eligible barnyard runoff BMP
-  Installed barnyard runoff BMP
-  Barnyard no longer has livestock



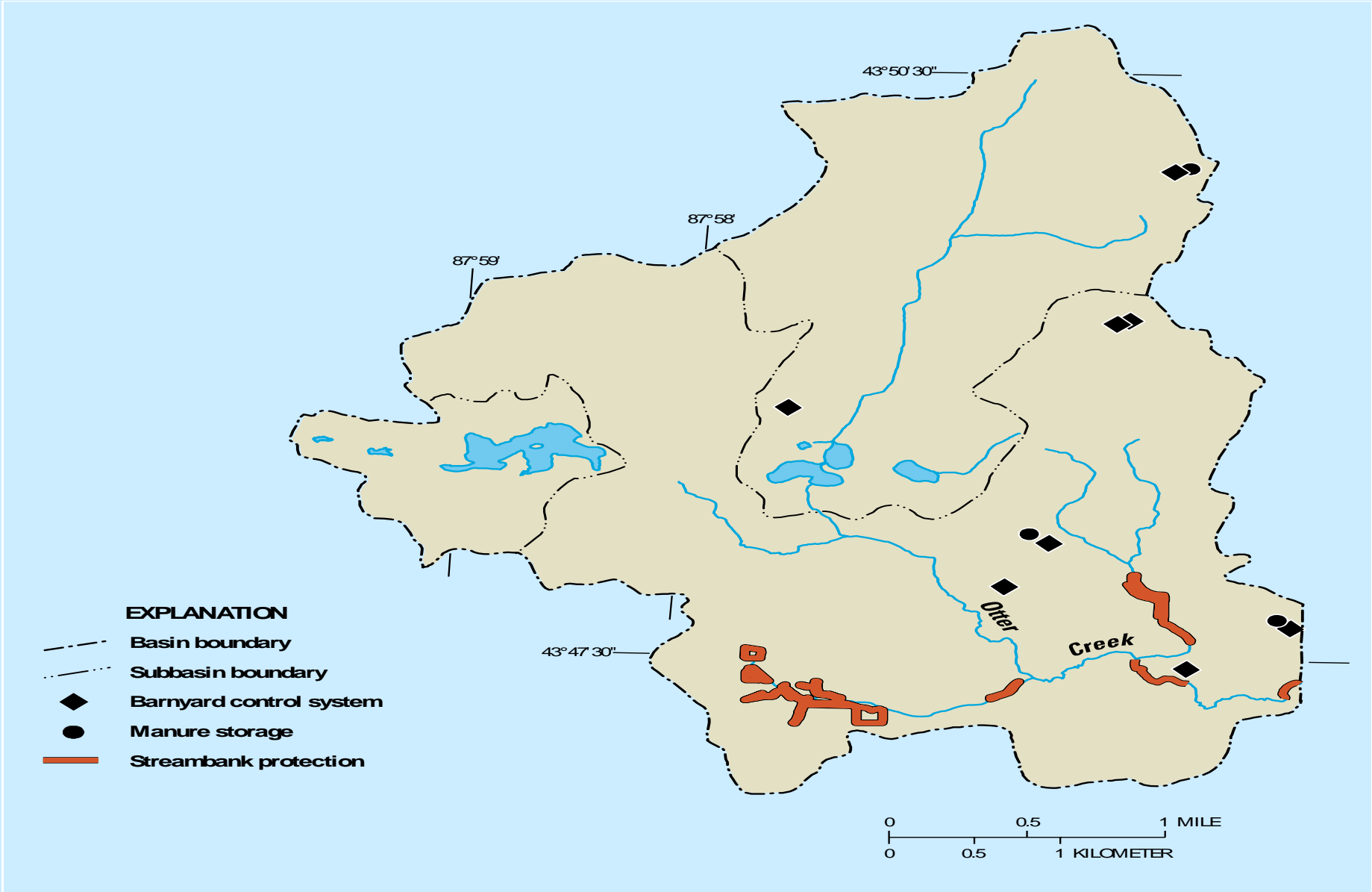
Base from U.S. Geological Survey 1:24,000:  
Black Earth, 1962; Cross Plains, 1962;  
Middleton, 1969; Springfield Corners, 1969

*Garfoot Creek watershed*








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**EXPLANATION**

-  Basin boundary
-  Subbasin boundary
-  Barnyard control system
-  Manure storage
-  Streambank protection



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# Baseflow Water Quality

- Fixed interval samples were collected during the pre and post-BMP periods.
- Determined if samples collected were during baseflow periods.
- A nonparametric Wilcoxon rank-sum test was used.



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# Summary Baseflow Water Quality

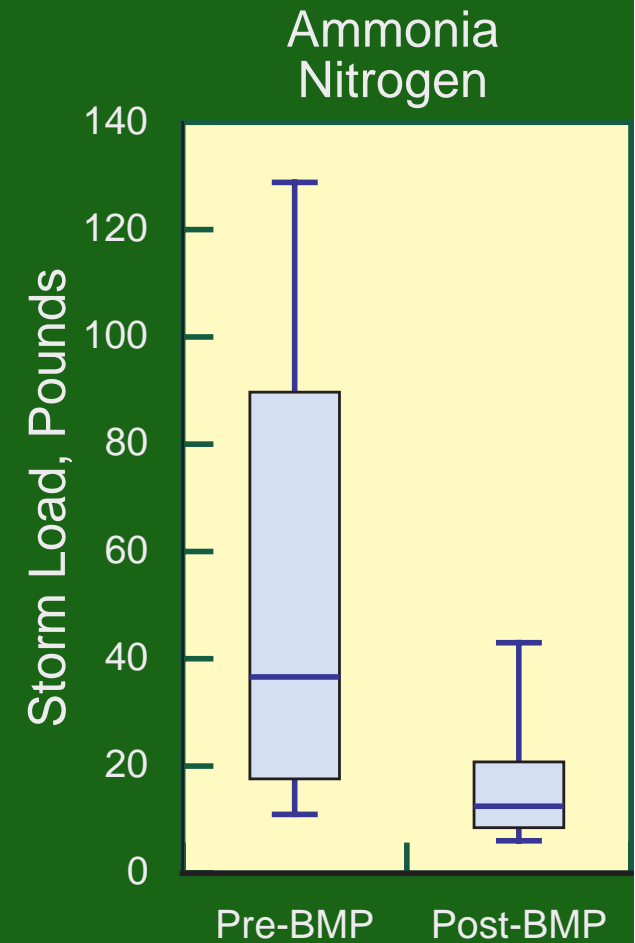
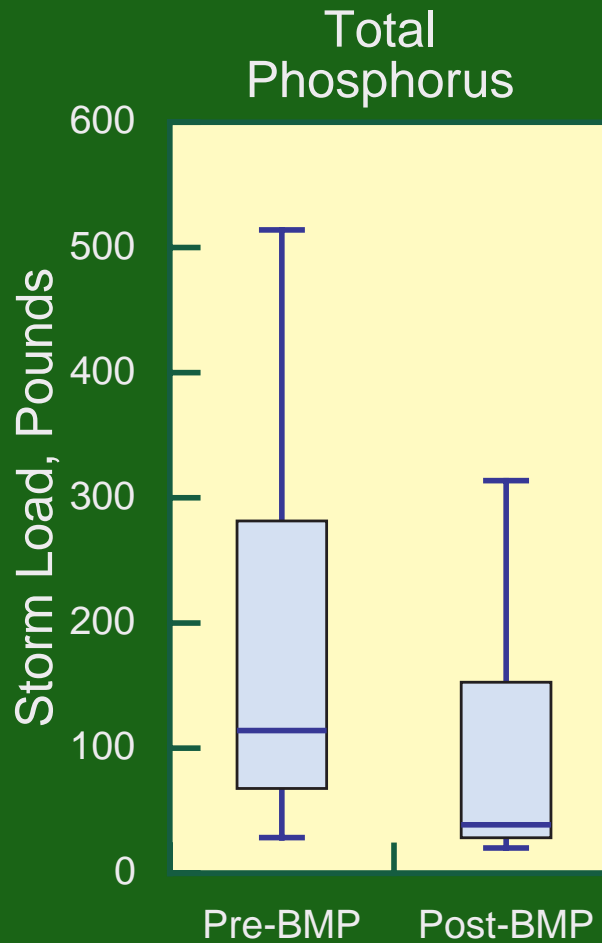
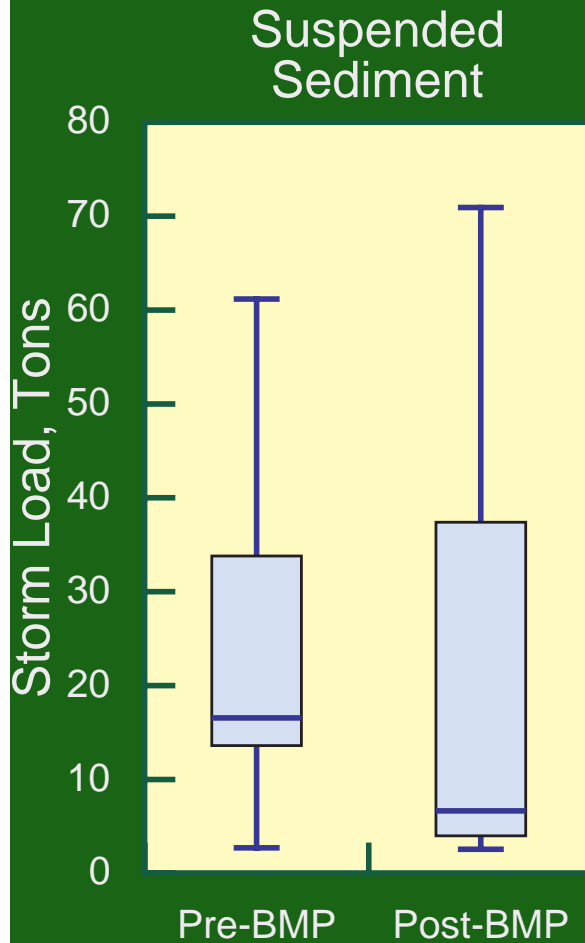
	Suspended Sediment/Solids	Total Phosphorus	Ammonia Nitrogen
Brewery Creek	NSD	NSD	NSD
Garfoot Creek	↓	NSD	↓
Otter Creek	↓	NSD	NSD



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# Garfoot Creek



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# Statistical Analysis

- Compute individual storm loads
- Correlate with:
  - rainfall values: depth, intensity, antecedent
  - Seasonal values
- Regressions with these variables reduces influence of natural variability
- Statistical analysis computed on regression residuals



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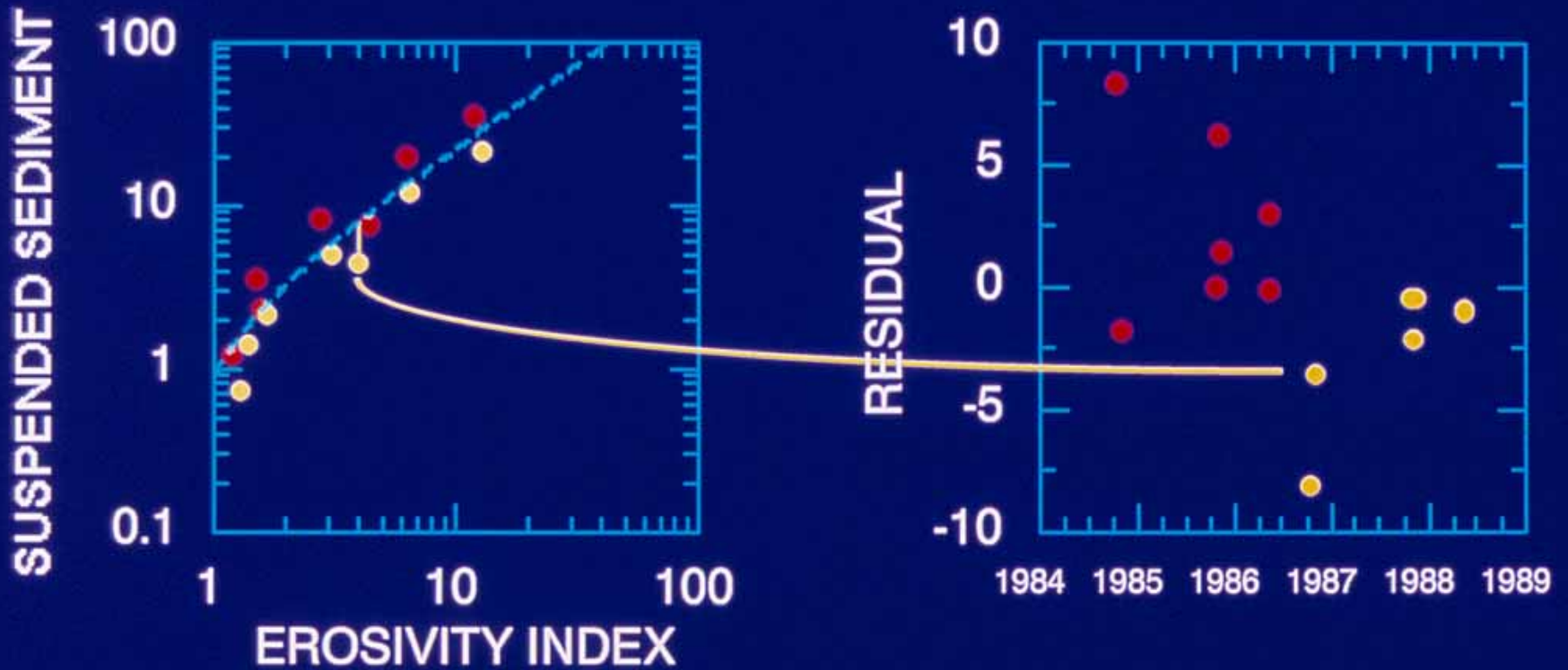
# Regression Analysis

- Separate regressions for each water chemistry parameter (SS or TSS, TP, Ammonia)
- Independent variables:
  - Total ppt, 15- and 30-min max intensities
  - Erosivity index
  - Antecedent ppt (1, 3, 5 days)
  - Seasonal terms [ $\sin(T)$ ,  $\cos(T)$ ]



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Example regression (left panel) for before (red) and after (yellow) data, and resulting residuals (right panel)



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# Storm Load Residuals

	Suspended Sediment		Total Phosphorus		Ammonia Nitrogen	
	Direction of Change	Significance Level	Direction of Change	Significance Level	Direction of Change	Significance Level
Brewery Creek	NSD	0.93	NSD	0.959	↓	0.026
Garfoot Creek	NSD	0.26	↓	0.044	↓	0.005
Otter Creek	↓	0.031	NSD	0.186	↓	0.037



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# Influence of BMPs on Water Quality

- Baseflow
  - Brewery Creek- No significant differences in median baseflow concentrations.
  - Garfoot Creek-Median suspended sediment and ammonia nitrogen concentrations decreased.
  - Otter Creek-Median suspended sediment concentrations decreased.



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# Influence of BMPs on Water Quality

- Storm Load Residuals
  - Brewery Creek— Ammonia Nitrogen regression residuals decreased significantly.
  - Garfoot Creek—Total phosphorus and ammonia nitrogen regression residuals decreased significantly.
  - Otter Creek—Suspended solids and ammonia nitrogen regression residuals decreased significantly.



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# Take Home Points

- Overall effectiveness of BMPs at the watershed scale is mixed.
- Effectiveness of BMP's will depend on type, number and location.



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Questions?



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