National Water Quality Initiative (NWQI) Monitoring in the Black Hawk Lake Watershed: Paired catchment study

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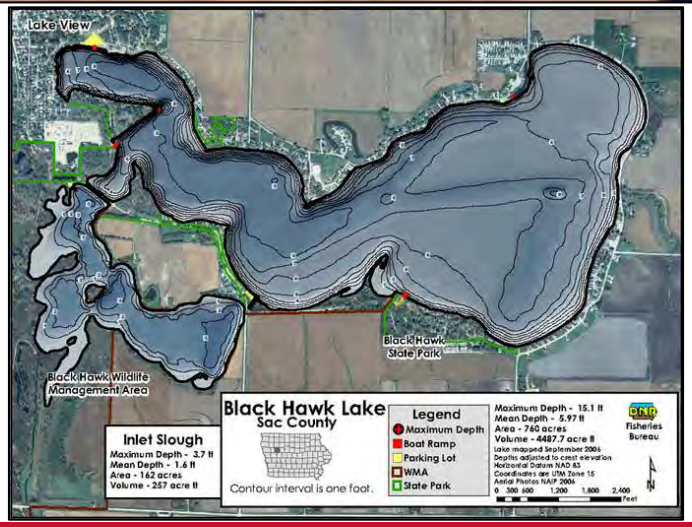
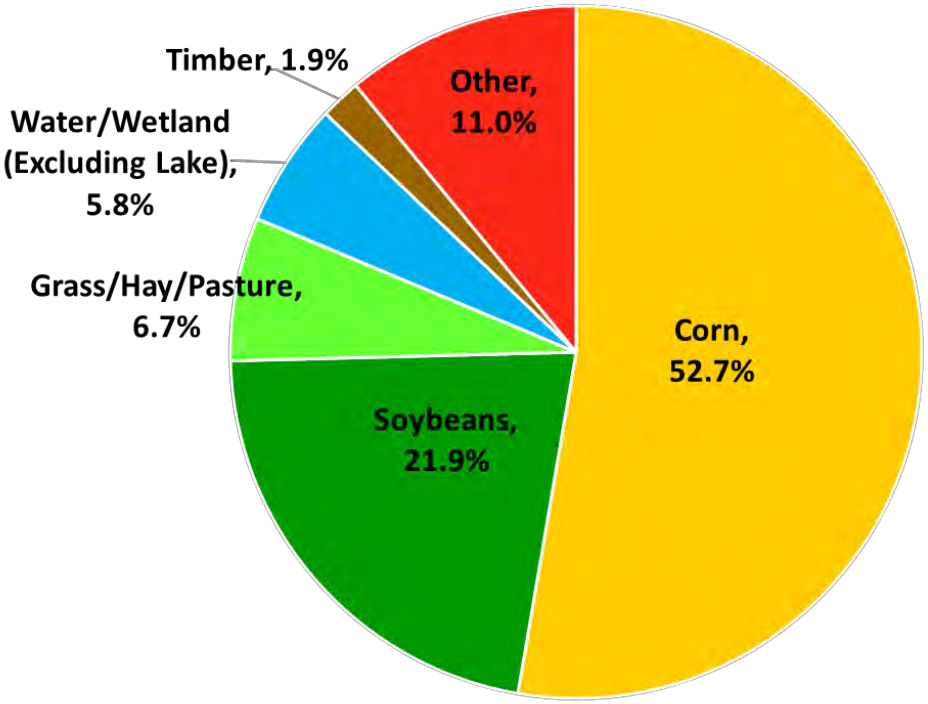
Background: Black Hawk Lake

Image: www.lakeviewlifestyle.com



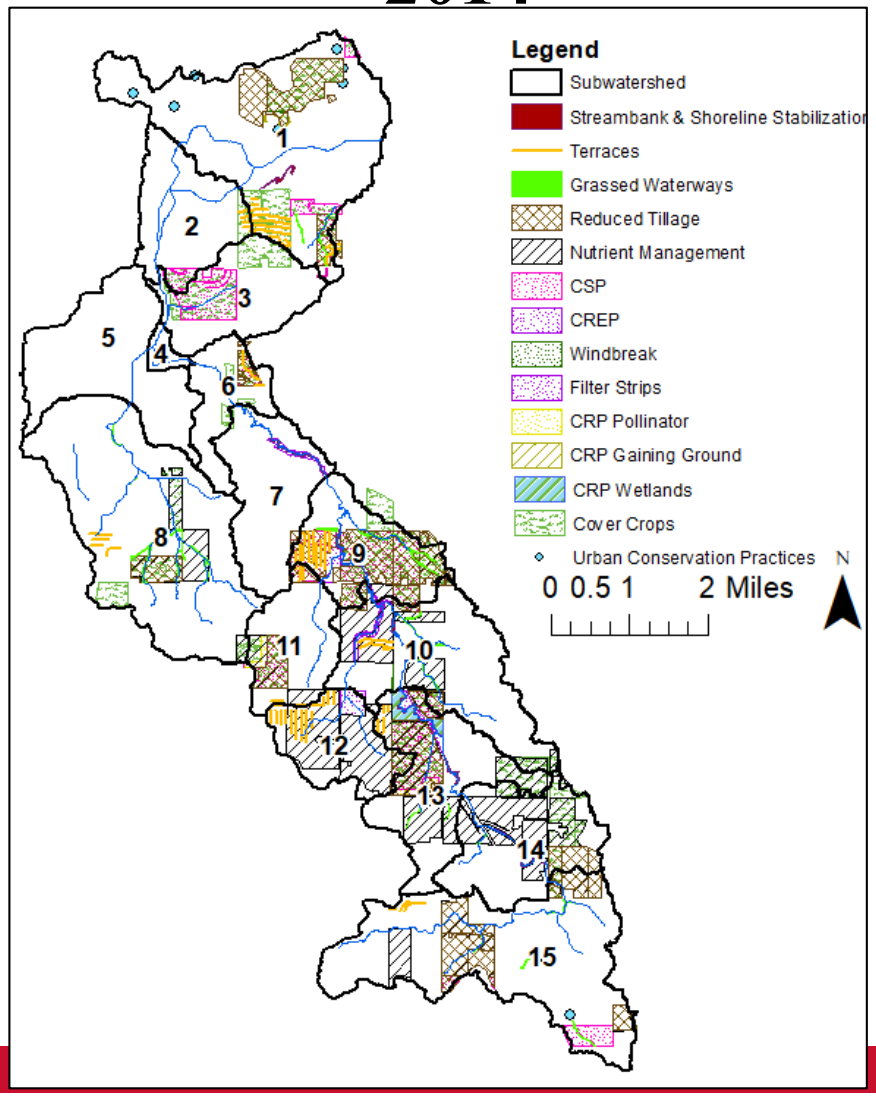
Background: Black Hawk Lake watershed

- Watershed area = 5,324 ha (13,156 acres)
- Watershed:lake ratio = 14:1
  - Ratio < 20:1 has potential for lake restoration through BMPs
- Land uses:

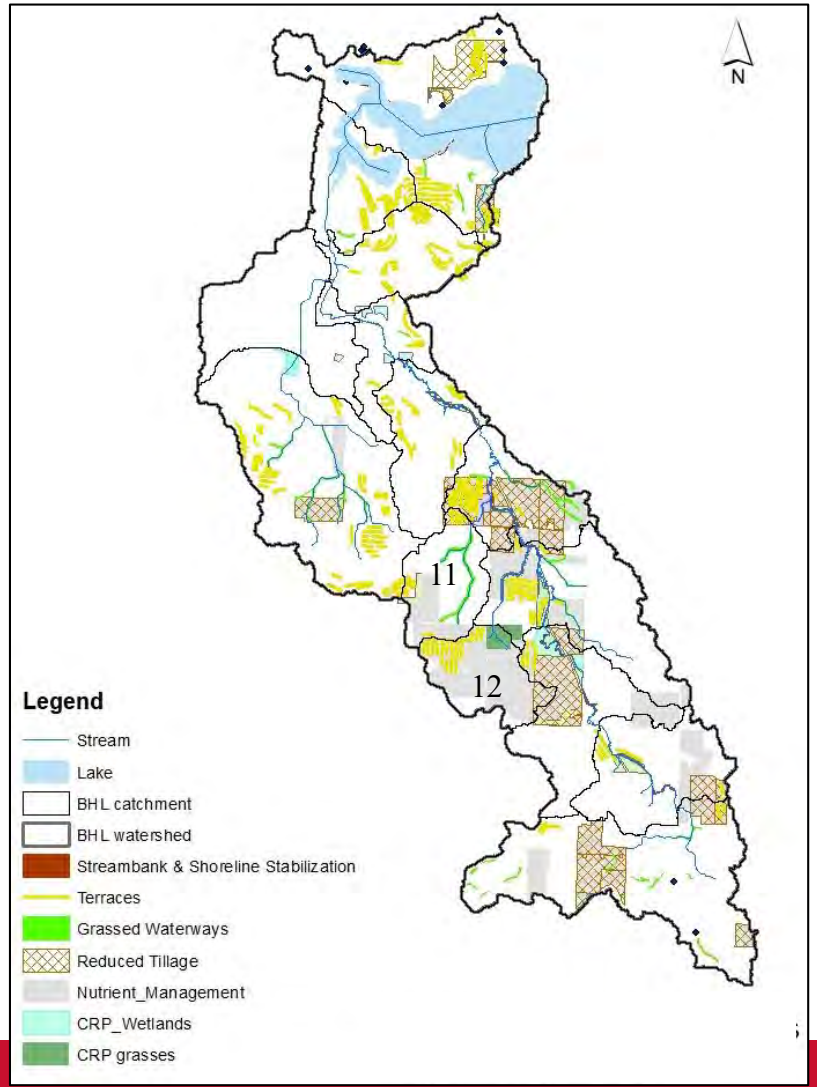


Black Hawk Lake BMPs

2014



2019

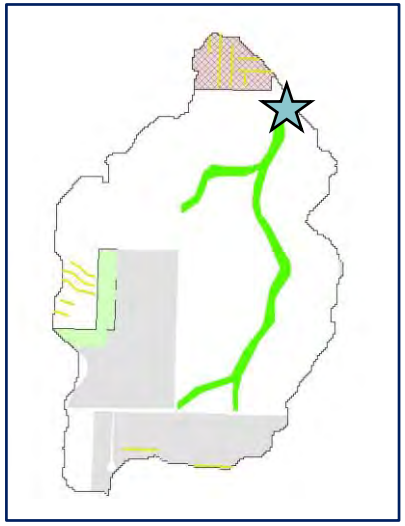


Only minor changes in BMP implementation levels during the study period.

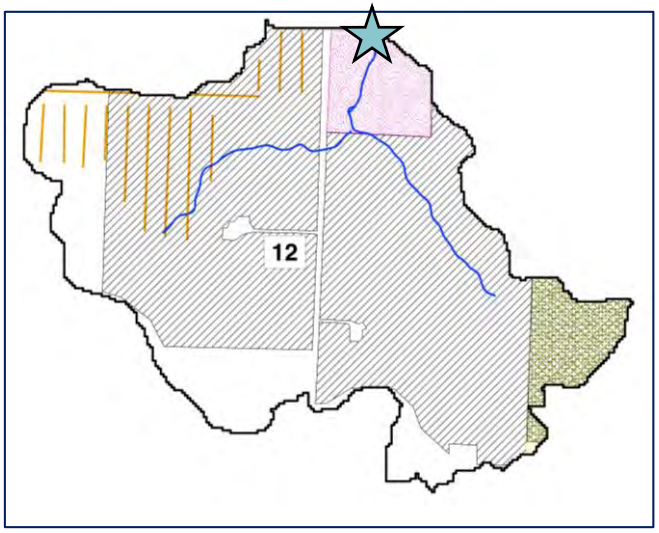
Objectives

- **To compare nutrients and sediment loading from subwatersheds with high and low BMP implementation**

- Complements DNR existing/historical monitoring data to quantify long-term water quality and quantity trends for Black Hawk Lake



Subwatershed 11: Low BMPs

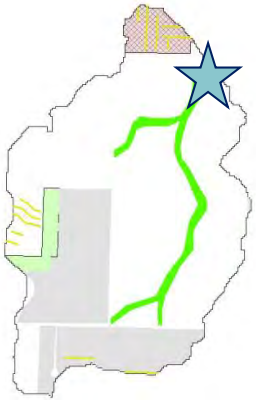


Subwatershed 12: High BMPs

Methods: Monitoring locations

Subwatershed 11:

- Size: 567 acres
- Some BMP implementation (~30% of area), but not near the stream
- No-till (3.7%), nutrient management (27.3%), cover crops
- 1 Monitoring Location: 1st order stream (site S11)
  - Tile outlet upstream

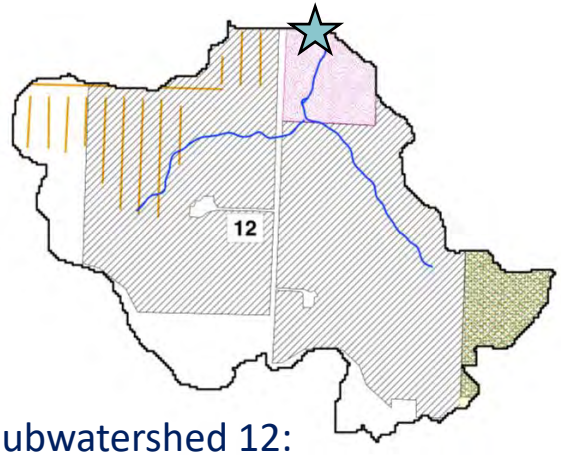


Subwatershed 11:

Methods: Monitoring locations

Subwatershed 12:

- Size: 547 acres
  - Similar to subwatershed 11
- BMP implementation over majority of area (87.5%)
  - Terraces (0.2%), no-till, nutrient management plans (80.5%), CRP at surface monitoring point (7.1%)
- 2 Monitoring Locations:
  - One 15” tile (site T12),
  - One 1st order stream (site S12)

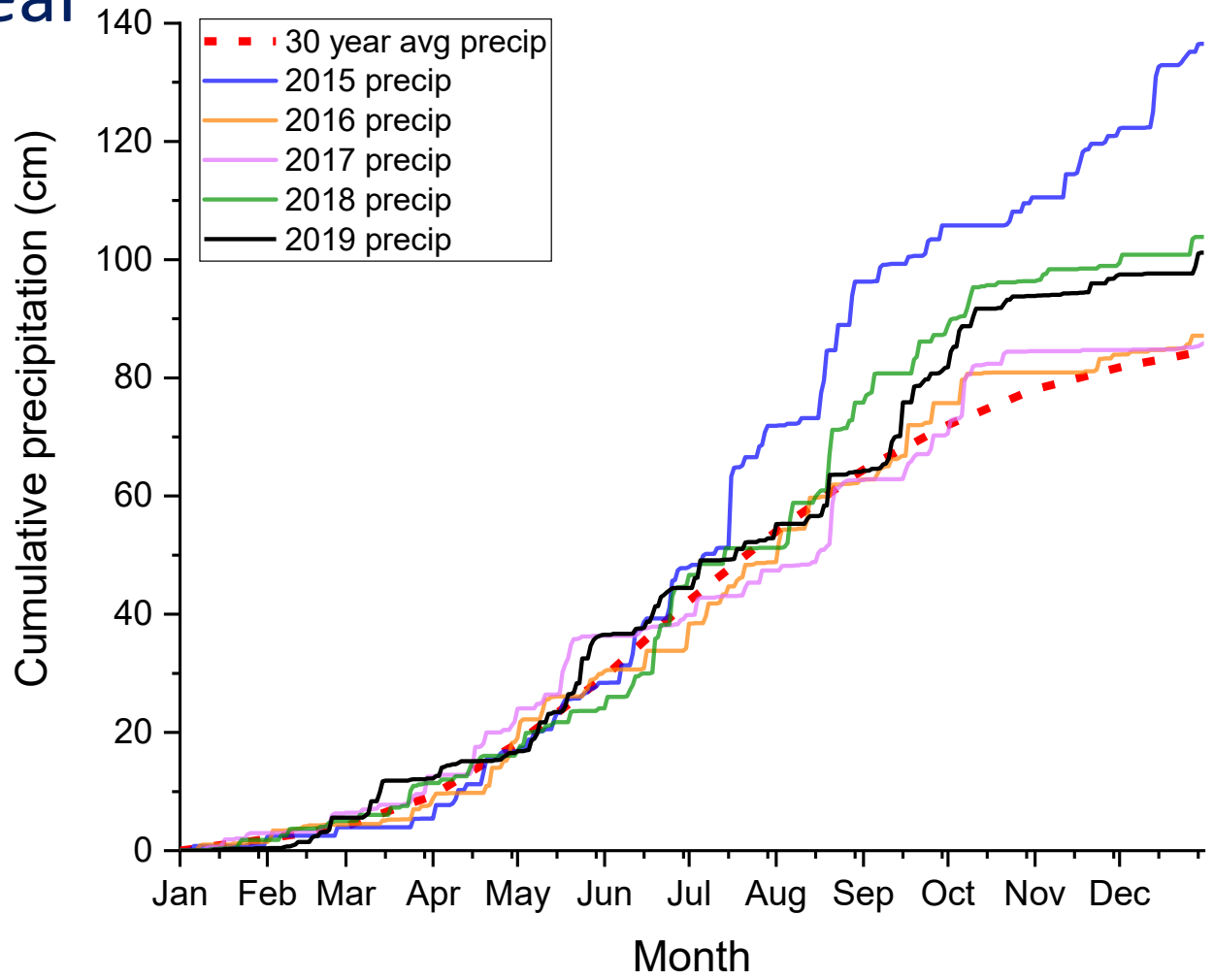


Subwatershed 12:

Methods: Sample collection and analysis

- Sites visited every two weeks from March-November to collect data and samples
- Flow-weighted (both base and storm flow) composite samples collected using ISCO 6712 automated samplers
- Water level and velocity, and precipitation data collected at 5-min intervals
- Samples analyzed for:
  - **Nitrate+ Nitrite (NO_3-N + NO_2-N)**
  - Ammonia (NH3-N)
  - Total Nitrogen (TN)
  - **Total Phosphorus (TP)**
  - Dissolved Reactive Phosphorus (DRP)
  - **Total Suspended Solids (TSS)**
  - Volatile Suspended Solids (VSS)

2015-2019 Annual Precipitation patterns included the wettest year on record, 3 normal years, and 1 wet year



Site characteristics and flow patterns are similar between the two catchments

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Estimate							
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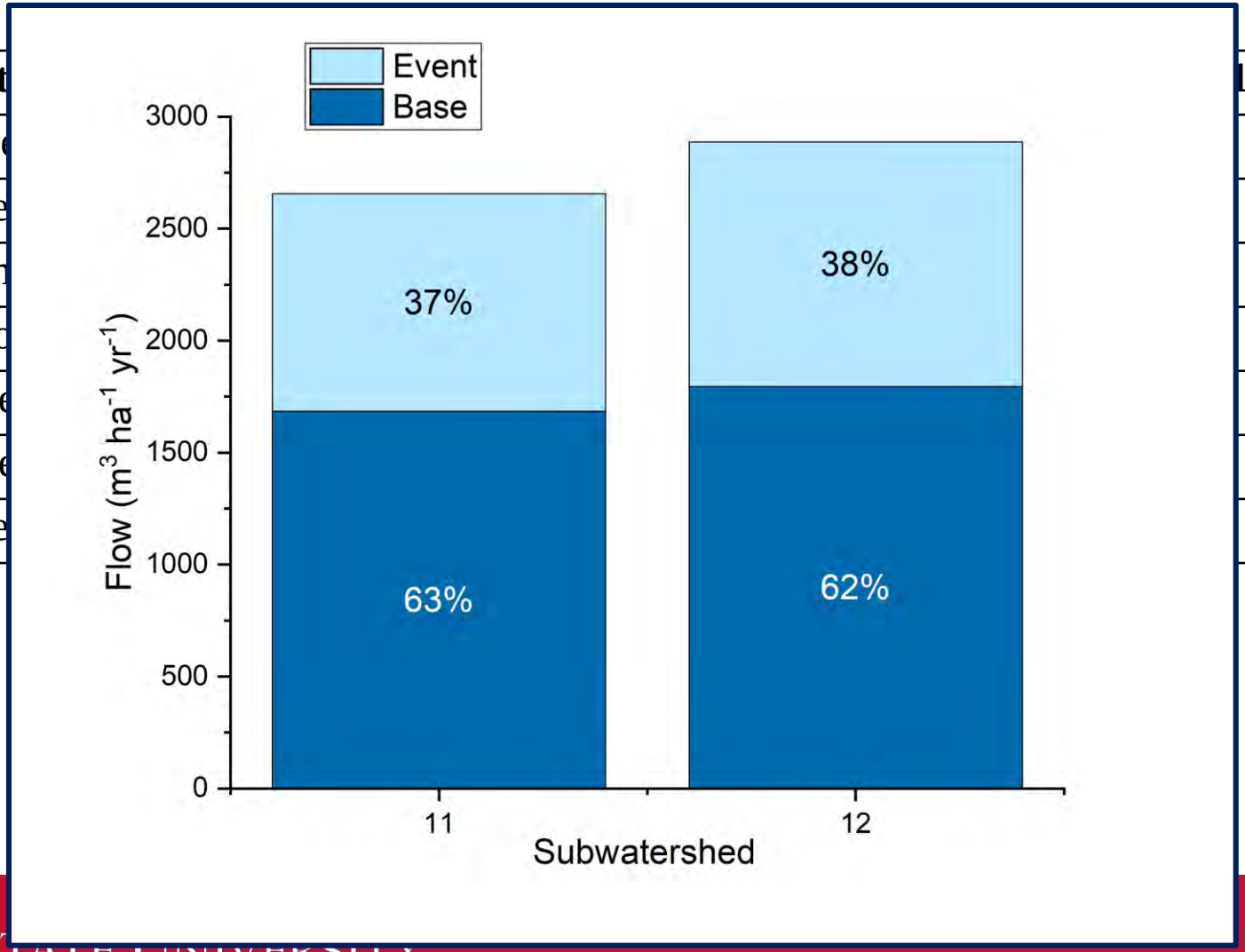
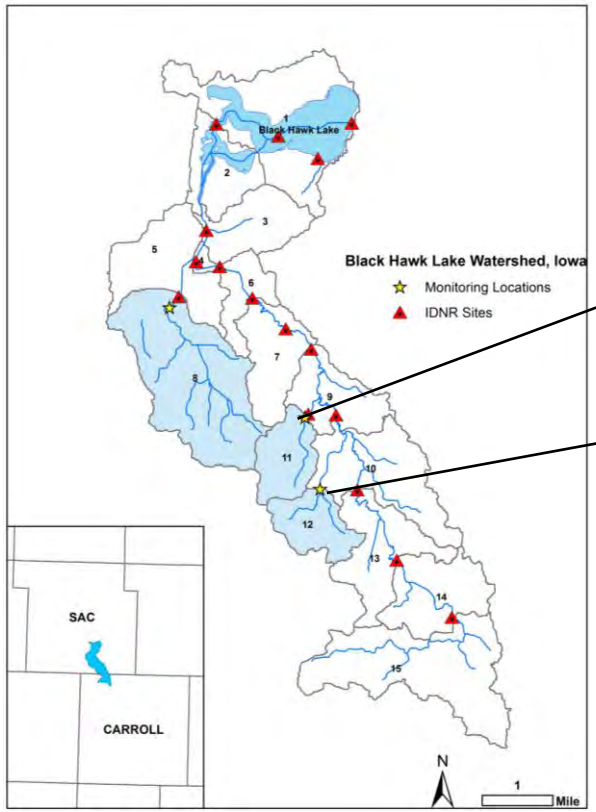
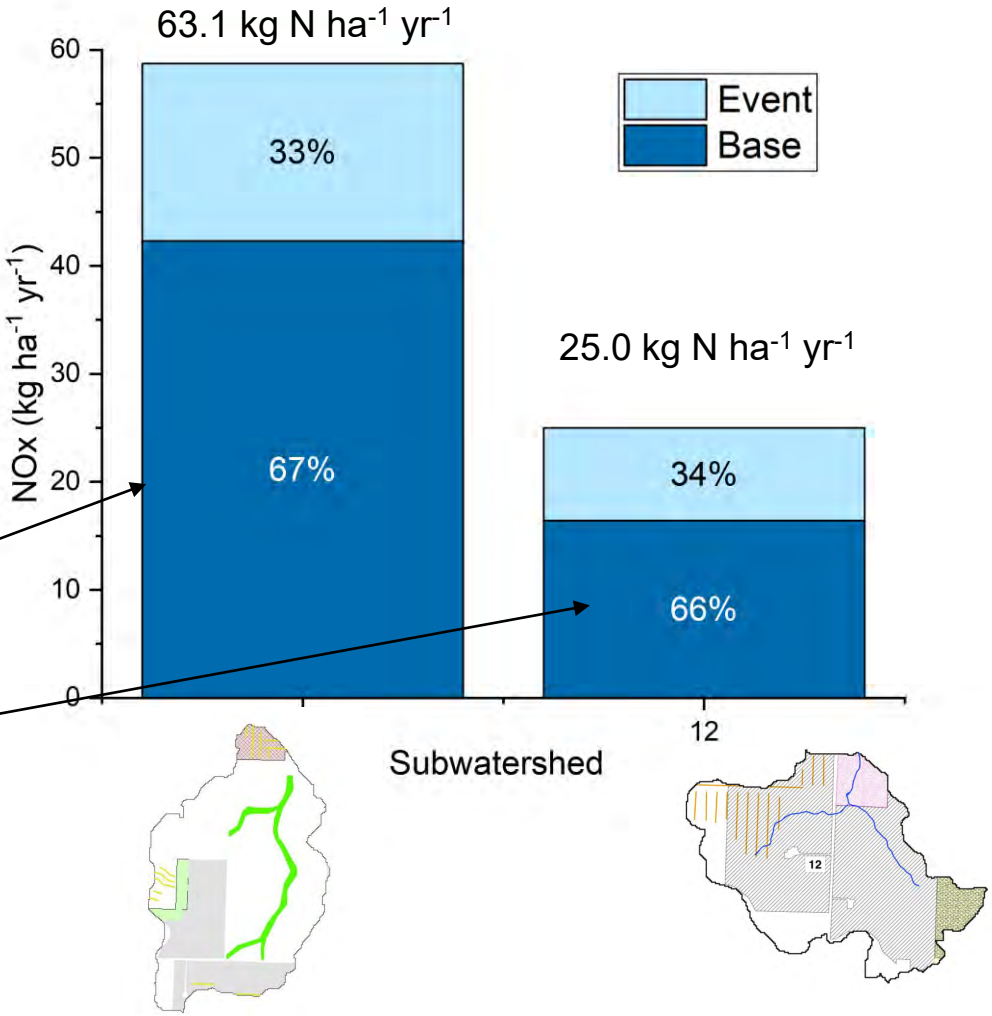


N export (2016-18) was greater from low BMP watershed, mostly during base flow

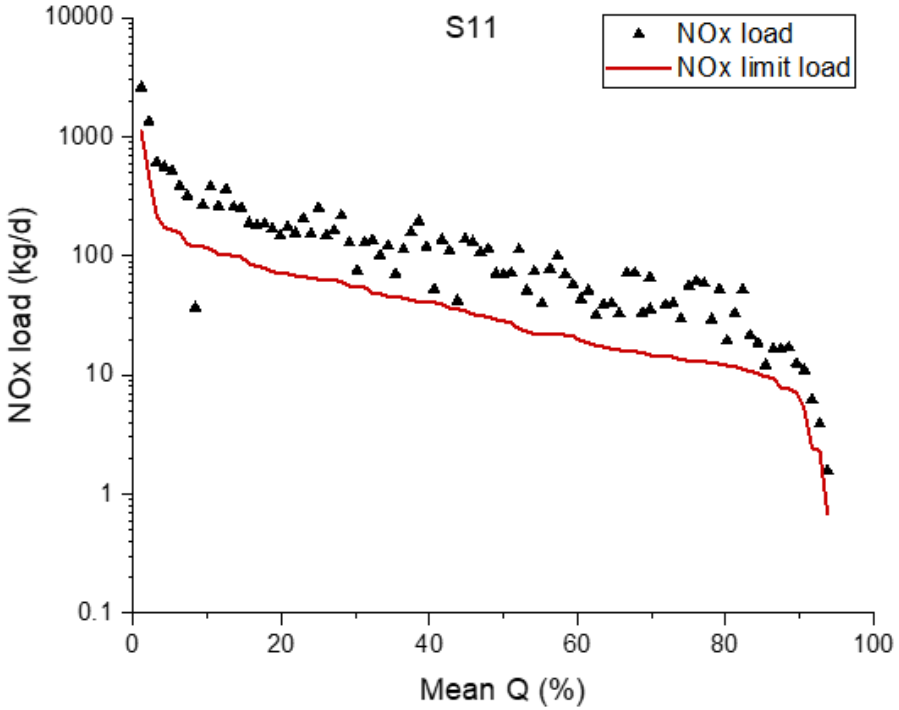
Typical annual N input:
170-220 kg N ha^{-1} yr^{-1}

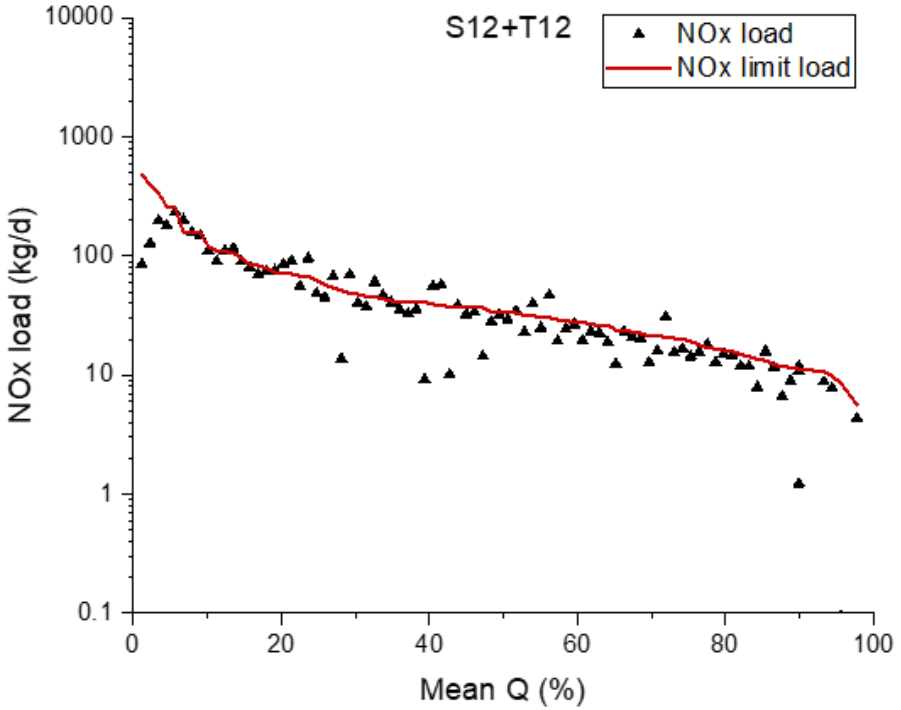
Annual N loss:
Sub 11: 63.1 kg N ha^{-1} yr^{-1} (32.3% of input)
Sub 12: 25.0 kg N ha^{-1} yr^{-1} (12.8% of input)

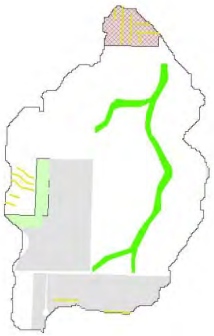




When BMP implementation is low, NOx daily loads were higher over all flow conditions

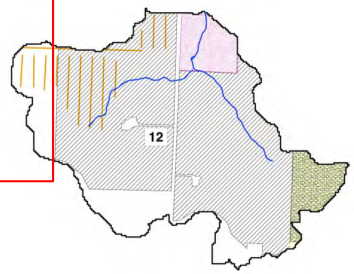




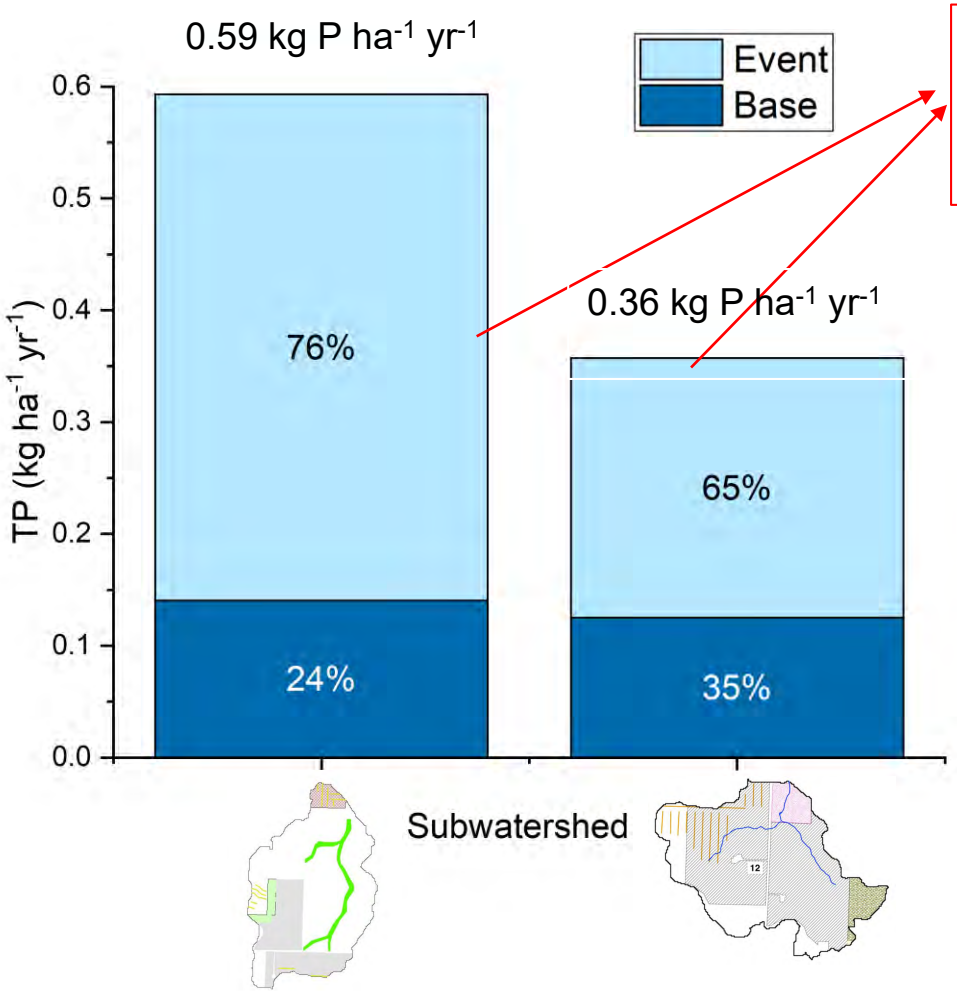


99% samples exceeded standard
46% export occurs when Q>90%
88% export occurs when Q>50%

25% samples exceeded standard
33% export occurs when Q>90%
82% export occurs when Q>50%



Total Phosphorus export was greater from low BMP subwatershed at the catchment outlet



Primarily carried by event flow – TP concentration increased during storm events

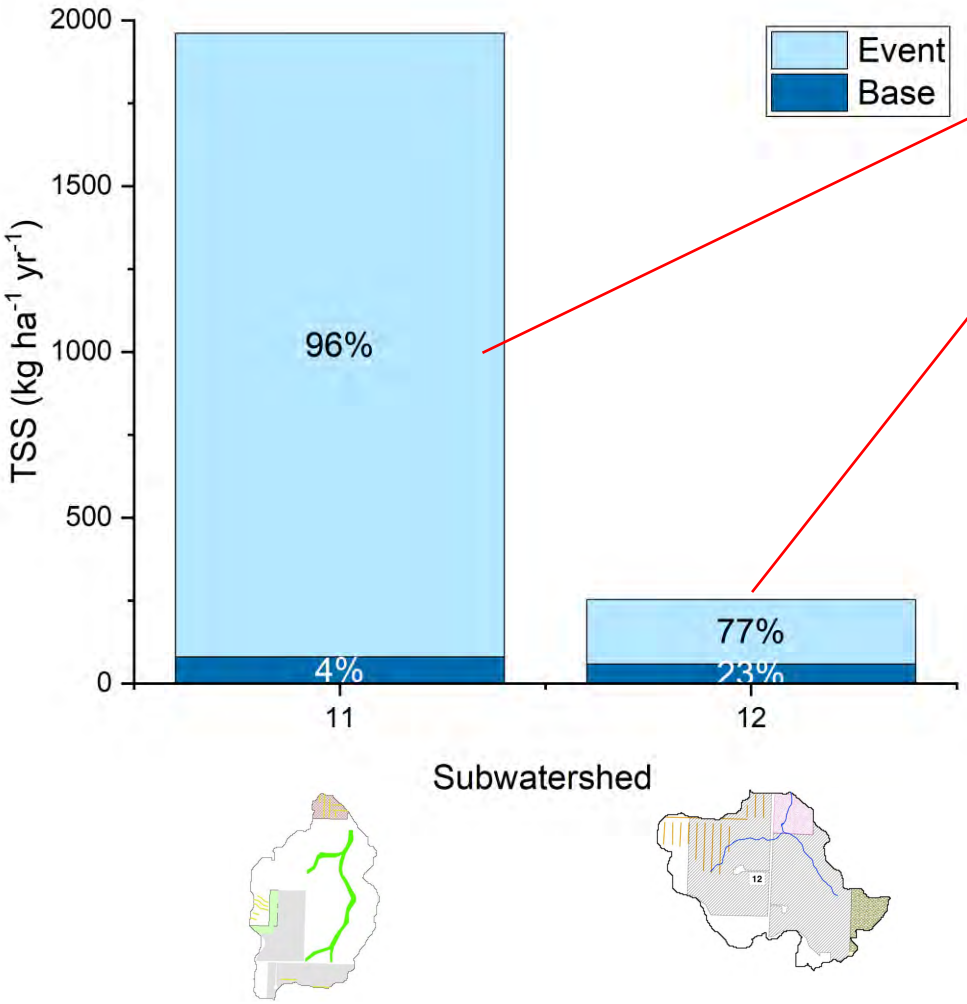
No statistically sig difference in base flow median concentration
(~0.035-0.037 mg/L)

Sig differences in event flow median concentrations
Low BMP: 0.29 mg/L
High BMP: 0.069 mg/L

Sub 11: Low BMPs - surface

Sub 12: High BMPs – tile and surface

Total Suspended Solids export was greater from low BMP subwatershed at the catchment outlet



Primarily carried by event flow – TSS concentration increased during storm events

Sig difference in base flow median concentration
Low BMP: 13.3 mg/L
High BMP: 6.9 mg/L

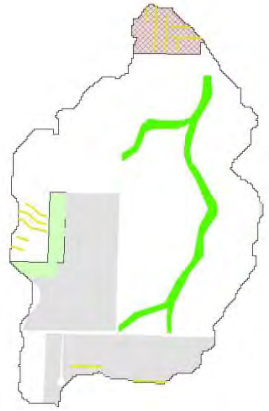
Sig differences in event flow median concentrations
Low BMP: 148 mg/L
High BMP: 18.6 mg/L

Sub 11: Low BMPs - surface

Sub 12: High BMPs – tile and surface

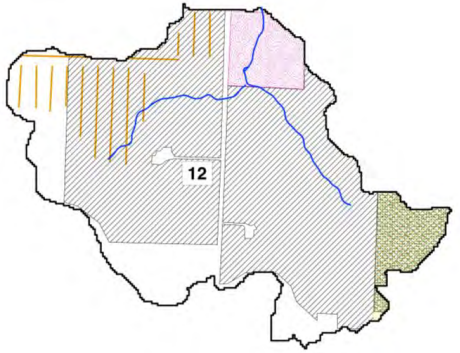
"Paired subwatersheds" comparison: Nutrients and sediment loss were lower in the subwatershed with higher BMP implementation

Subwatershed 11: Low BMPs



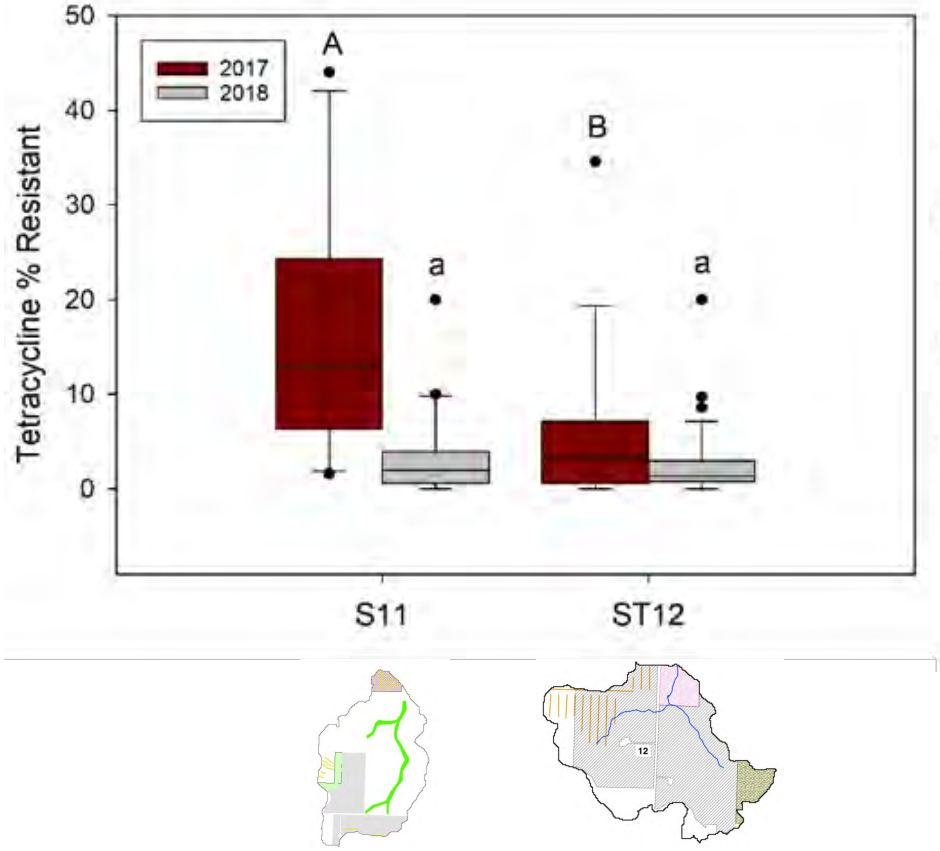
- Nitrate loss = 63.1 kg ha^{-1} yr^{-1}
- TP loss = 0.59 kg ha^{-1} yr^{-1}
- TSS (Soil loss) = 1961 kg ha^{-1} yr^{-1}

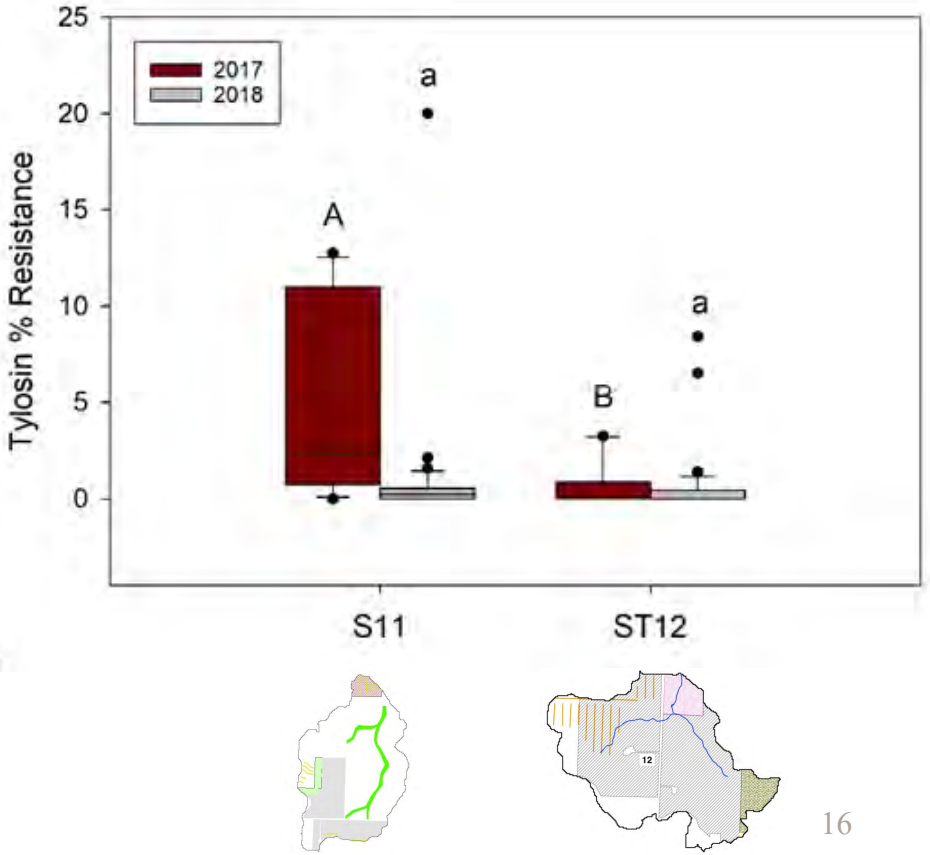
Subwatershed 12: High BMPs



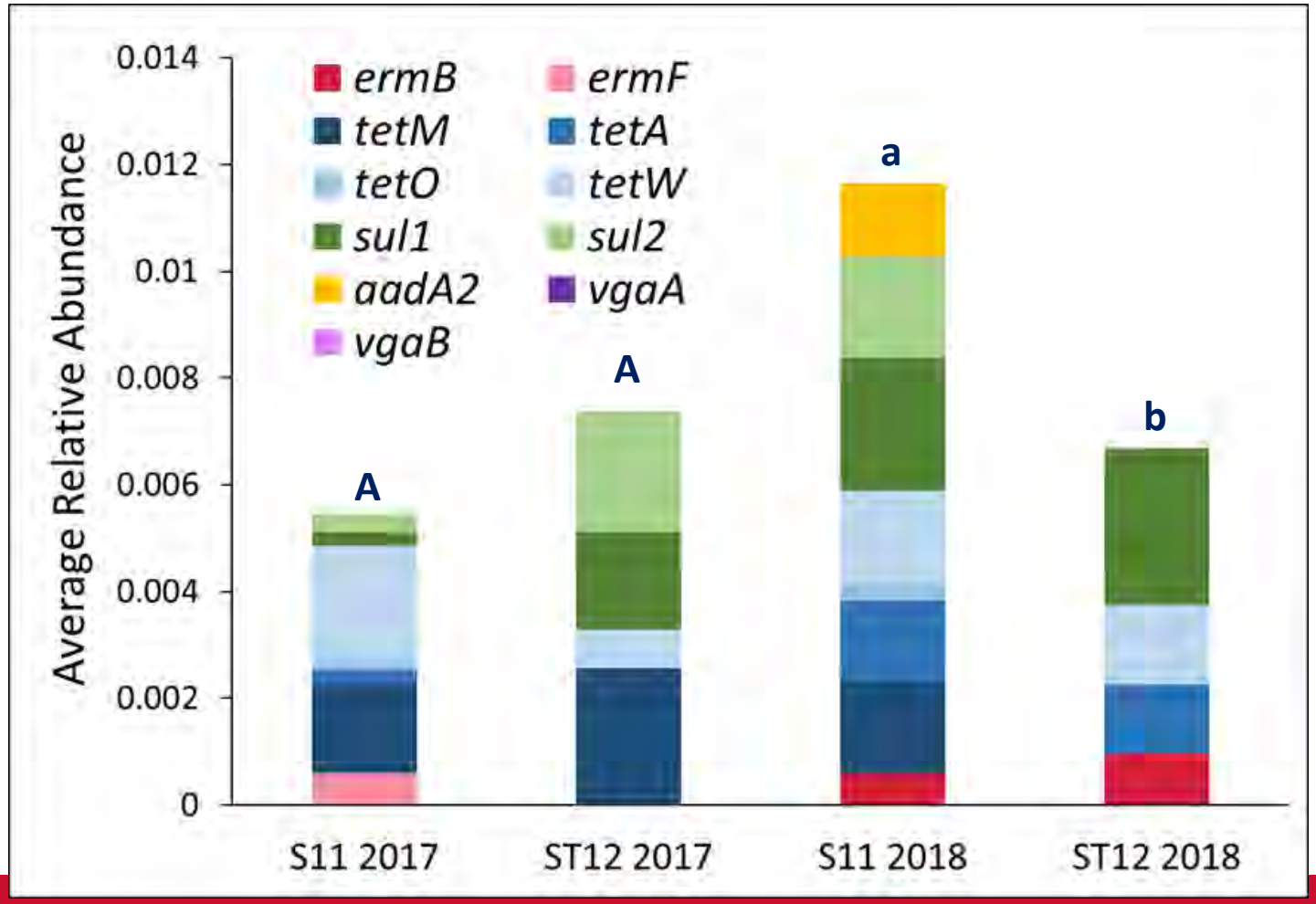
- Nitrate loss = 25 kg ha^{-1} yr^{-1} **(60% less)**
- TP loss = 0.36 kg ha^{-1} yr^{-1} **(39% less)**
- TSS (Soil loss) = 253 kg ha^{-1} yr^{-1} **(87% less)**

The low BMP catchment is manure amended and had higher export of antibiotic resistant bacteria





The low BMP catchment is manure amended and had higher export of resistant genes in 2018



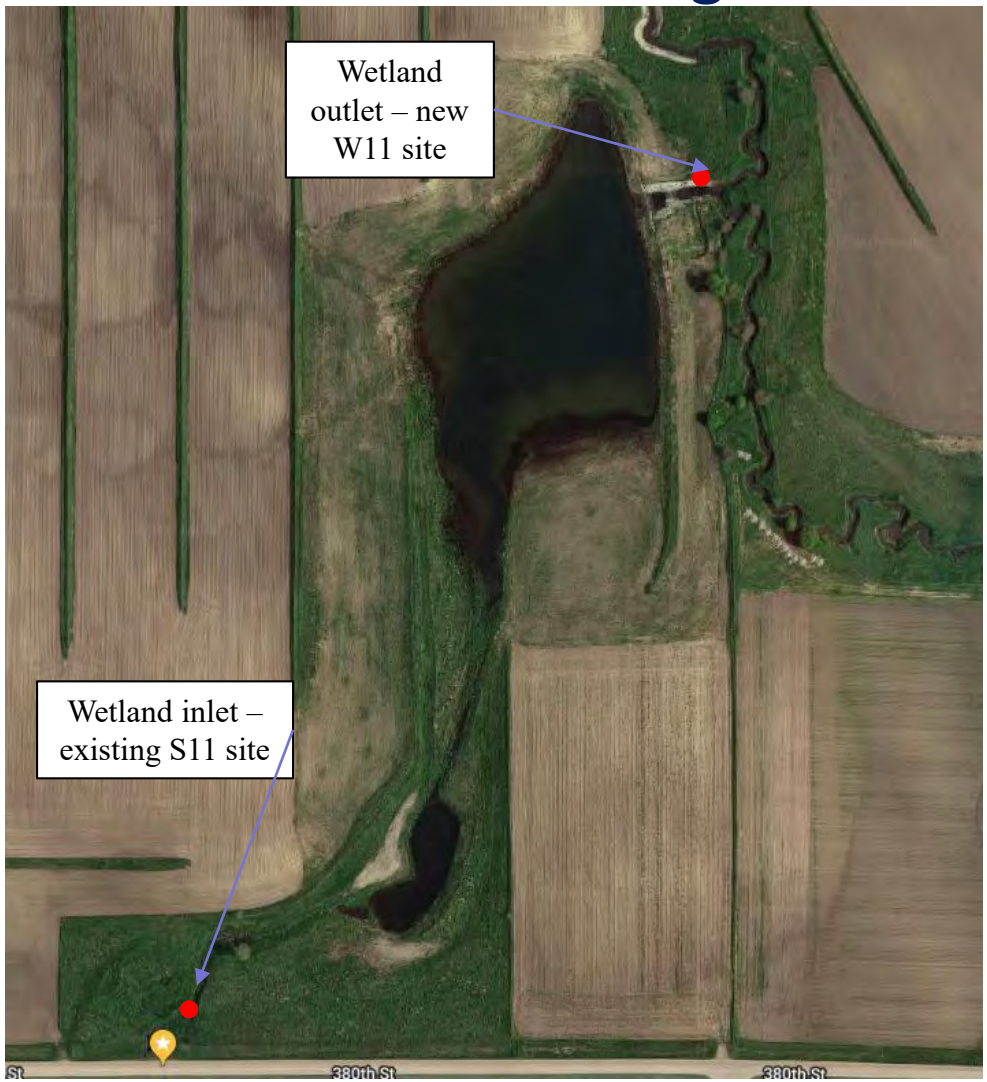
As we continue to monitor this site, changes mean new opportunities:

- To compare relative benefits of downstream CREP wetland in subwatersheds with high (sub 12) and low (sub 11) BMPs
- Track changes in BMPs in subwatersheds and the impact on water quality
  - Potential increased BMPs implementation in sub 12
  - Potential decreased BMPs implementation in sub 11

Outcomes

- Evaluate the environmental benefits of wetland and upstream stacked practices
- Long term data collected over a potentially wide range of weather conditions (8 years)
- Continued engagement with stakeholders and science community

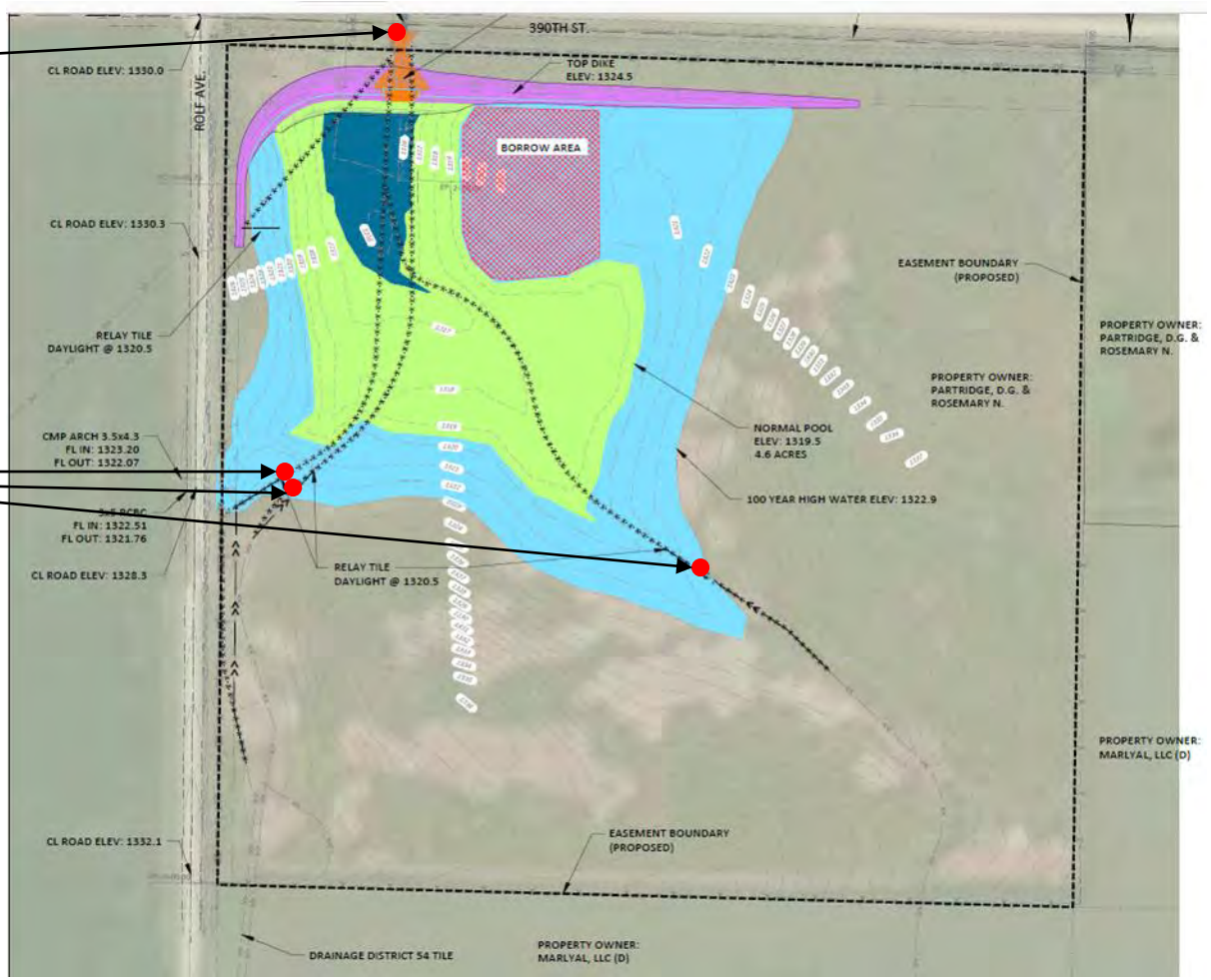
Downstream of the low BMP Subwatershed 11 we will monitor an existing wetland.



In the high BMP Subwatershed 12 a new wetland was installed in 2019

Wetland outlet

Wetland inlets excluding surface runoff



Acknowledgments

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USDA NIFA (AMR monitoring)

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