

Constructed Wetlands for Sediment, Nutrient and Runoff Volume Reduction in Northeastern Kansas

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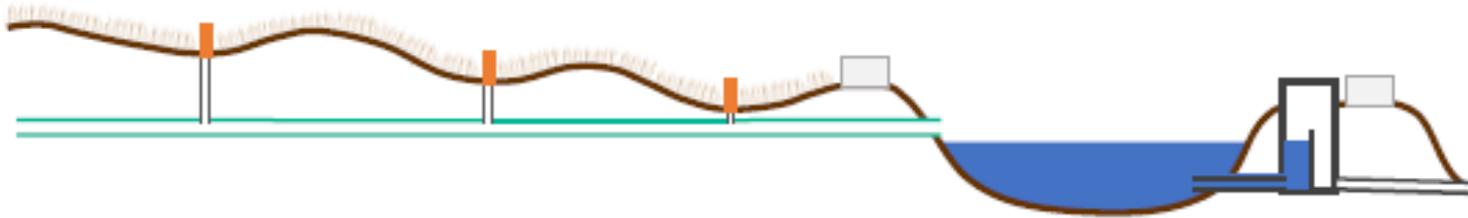
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Tiled Outlet Terrace (TOT) Drainage



- Terracing on sloping land minimizes channelized runoff and reduces soil erosion
 - Conventional terraces drain to grassed waterways that filter sediments and remove nutrients
- Underground tile outlet terrace drains allow for more planting area, but more pollutant transport
- Adding created wetlands at TOT outlet can mitigate drainage impacts on water quality



Project Scope

- **This project examines the water quality impacts of three wetlands constructed to provide on-site collection of storm runoff from tiled outlet terrace (TOT) drainage systems**
 - Wetlands installed to NRCS specifications (Practice Code 658)
- Study Objectives:
 1. Collect field-scale data on water quality benefits provided by constructed wetlands
 2. Examine TOT runoff impact on local waterways

Study Sites

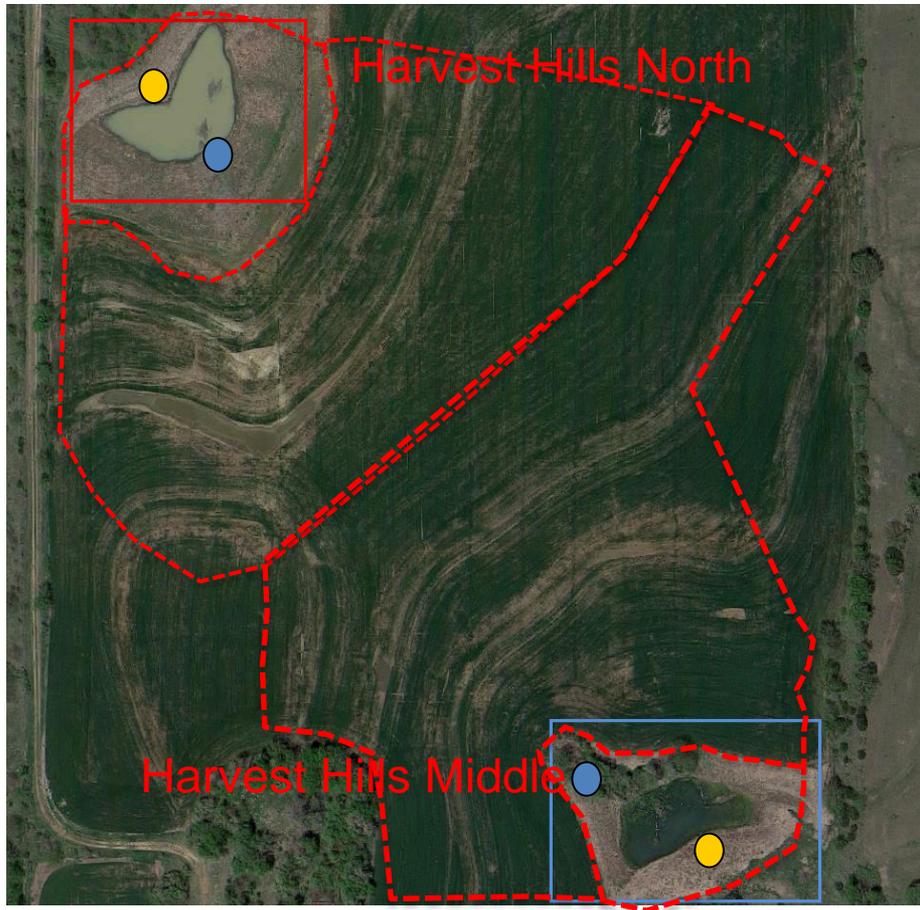
Three wetland ponds in northeastern KS, constructed between 2008 and 2011

Two intermittent streams, one receiving wetland effluent, one with direct TOT runoff

All drain to Clinton Lake, which supplies drinking water to the City of Lawrence



Harvest Hills Sites

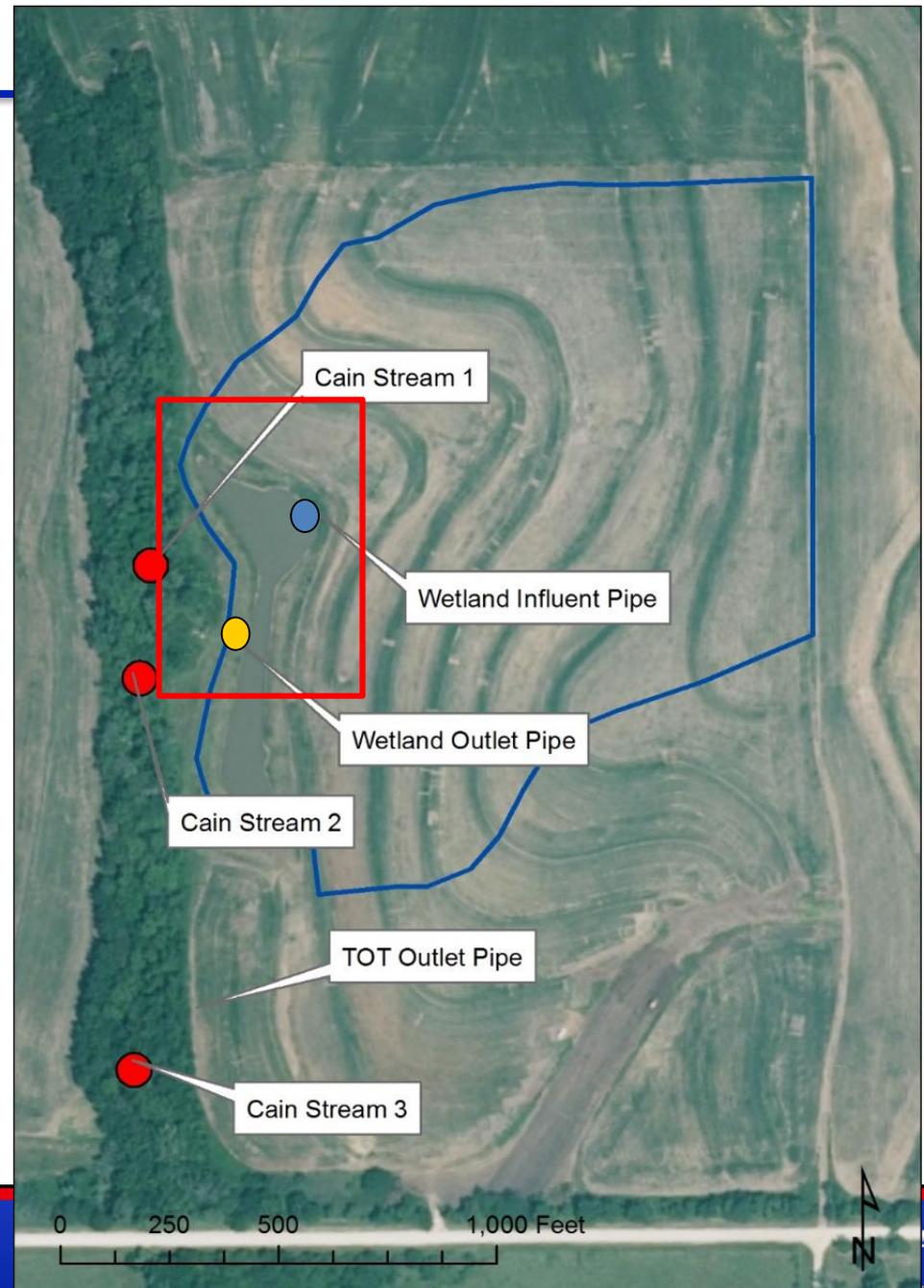


● -Inlet pipe ● -Outlet weir

- Sites drain ~ 10.6 acres each
- Runoff collected at tile drainage outlet to pond, and in pond effluent weir box
- North site has exposed riser on 2nd terrace, leading to increased sediment transport
- Planted with soybeans (2014) and corn (2015)
- Samples collected from June–November, 2014 and May – November, 2015

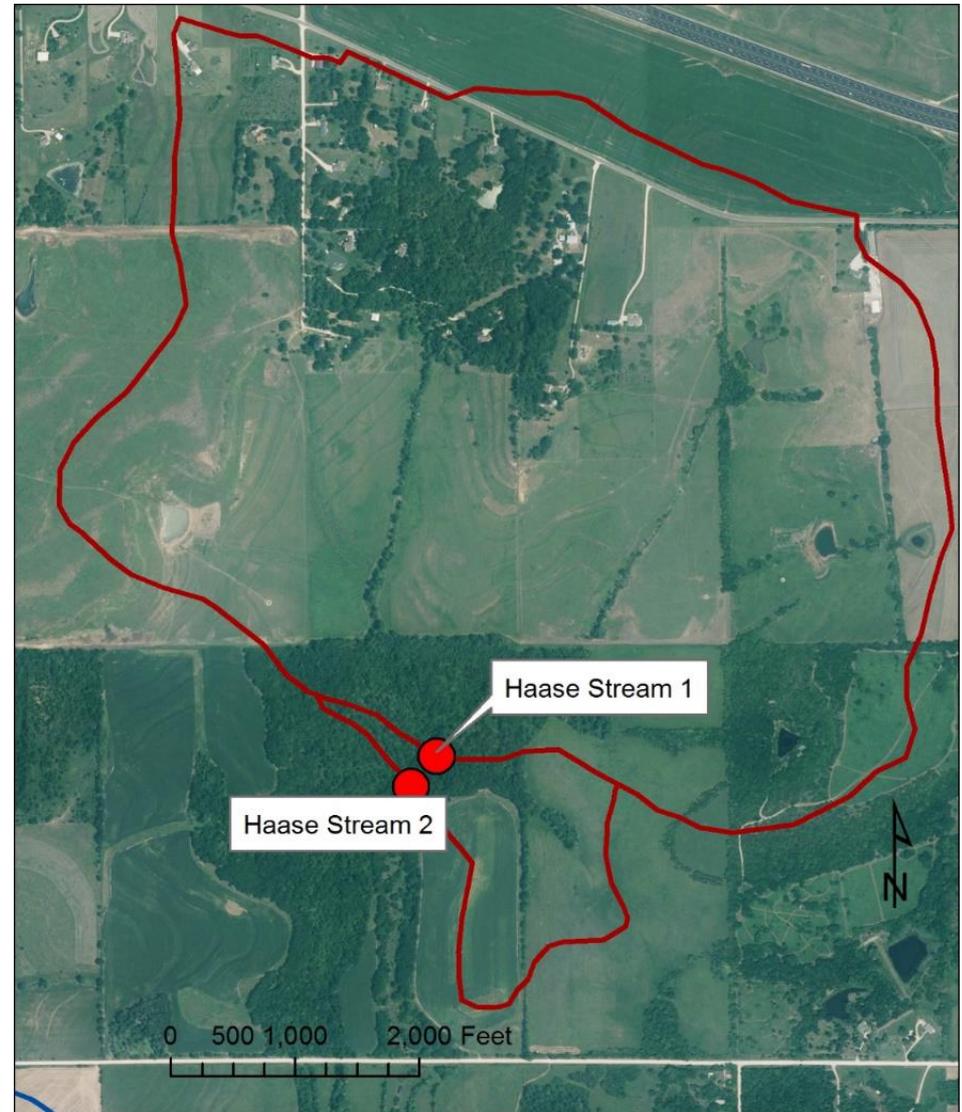
Cain Site

- Drains 29 acres (6 terraces plus small area near wetlands)
- Submerged pond inlet, with standing water and sediments in pipe at lower two terraces
 - Influent sampled from upper four terraces only
- Effluent exits through steep pipe
- Planted with soybeans in both 2014 and 2015
- Automated sample collection began in September, 2014



Haase Stream Site

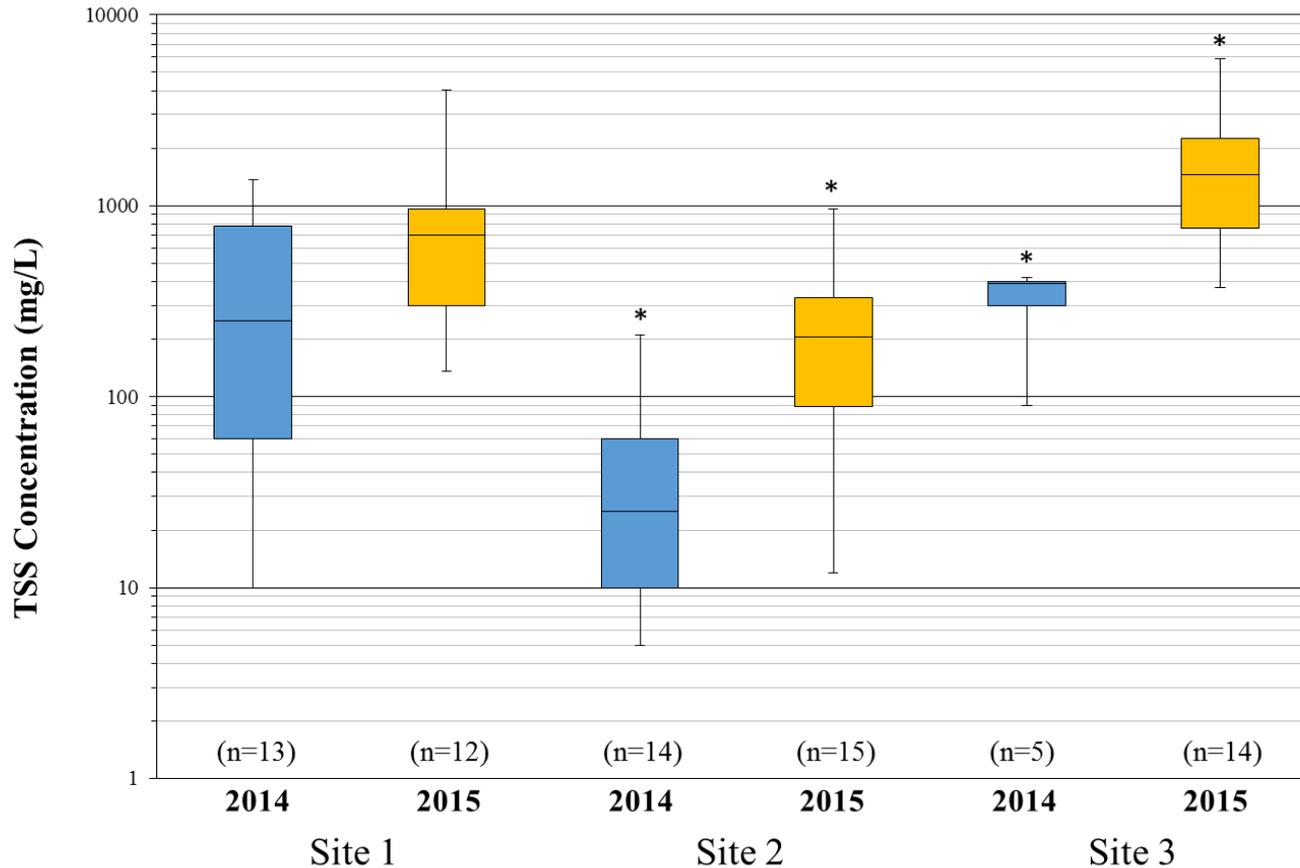
- Comparative site with stream sampling only
- Farmed in same manner as Harvest Hills site, but no wetland
 - Effluent discharges from TOT system into stream
- Planted with corn in 2014, soybeans in 2015
- Stream samples upstream and downstream of TOT discharge
- Stream also sampled at TOT outfall



Wetland Sampling Results

Influent Water Quality

Influent TSS Concentration



All influent concentrations higher in 2015

Similar patterns for N and P

Influenced by rainfall pattern and sampling period

Nitrogen increased more at HH sites, where crop switched to corn

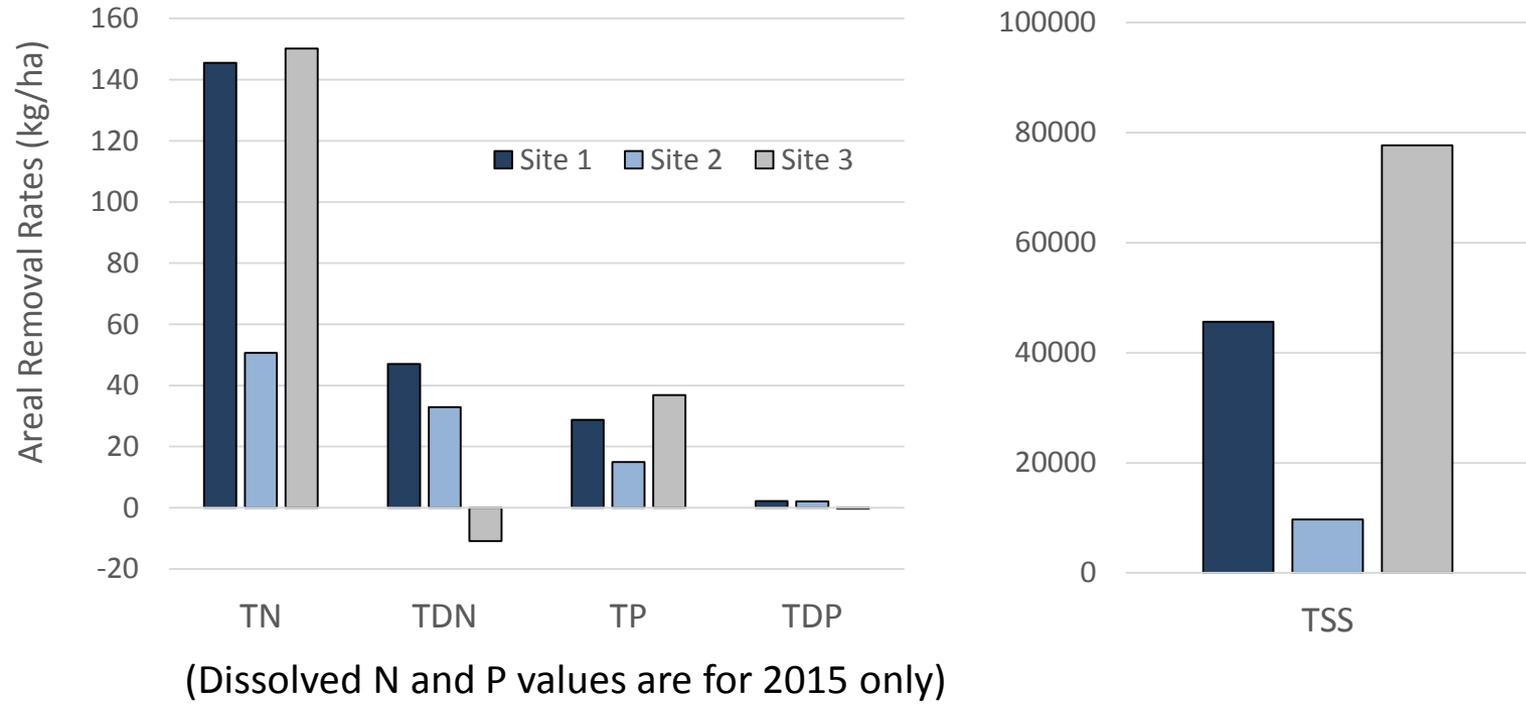
Water Quality Improvements:

- **Mass-based removal efficiencies at each site**

	TSS		TN		TP	
	%	Mass (kg)	%	Mass (kg)	%	Mass (kg)
Site 1 (HHN)	67%	9969	32%	31.8	38%	6.3
Site 2 (HHM)	57%	2275	17%	11.9	40%	3.5
Site 3 (Cain)	83%	53,748	53%	103.9	56%	25.5

- **These results weight concentration changes in runoff by total volume entering and leaving the wetland**
 - Outflow/Inflow Ratios at each site
Site 1: 86%, Site 2: 71%, Site 3: 92%

Wetland Performance on Areal Basis

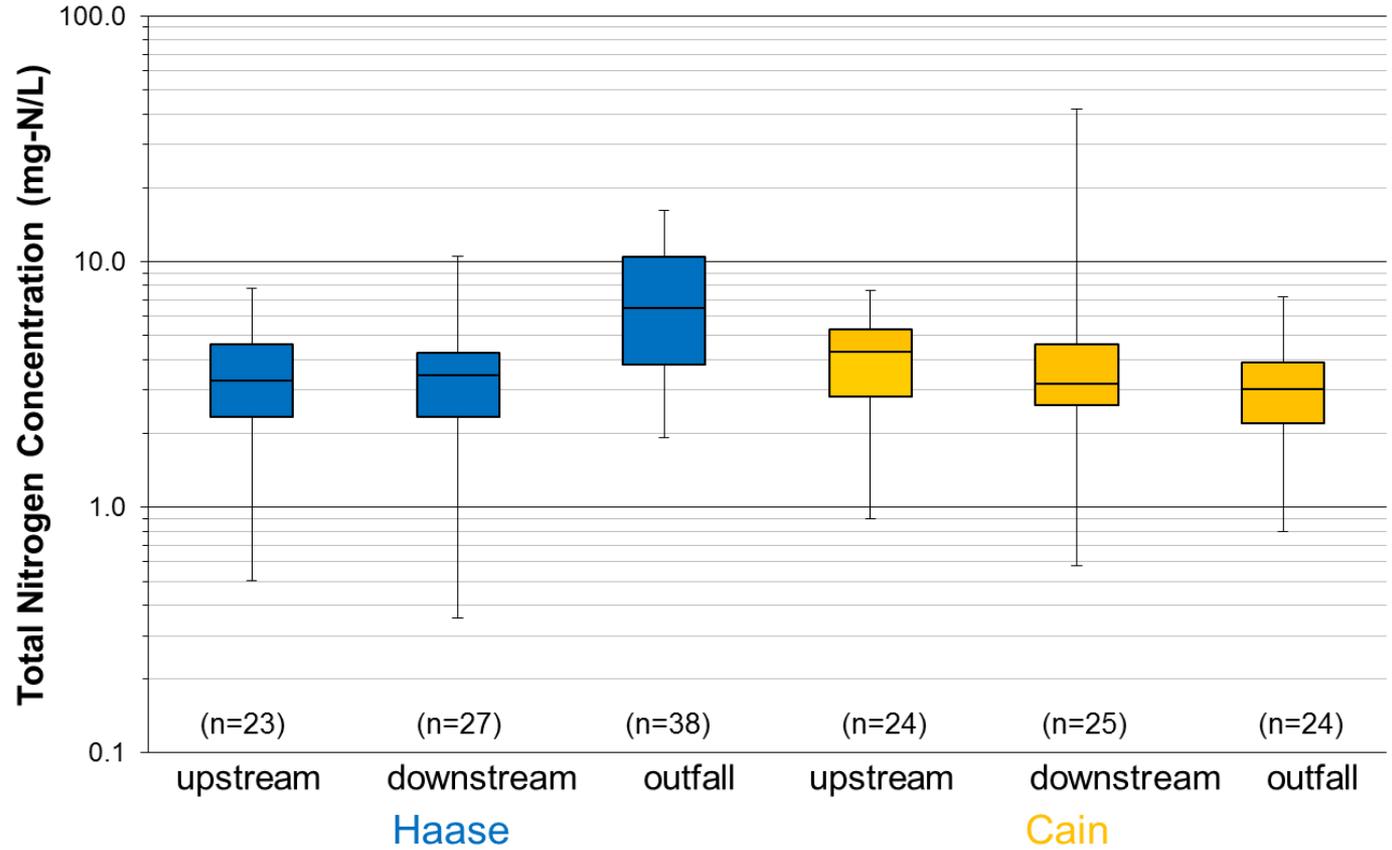


Site 3 (Cain) had much lower influent concentrations of TDN and TDP, along with lower removal rates in the wetland

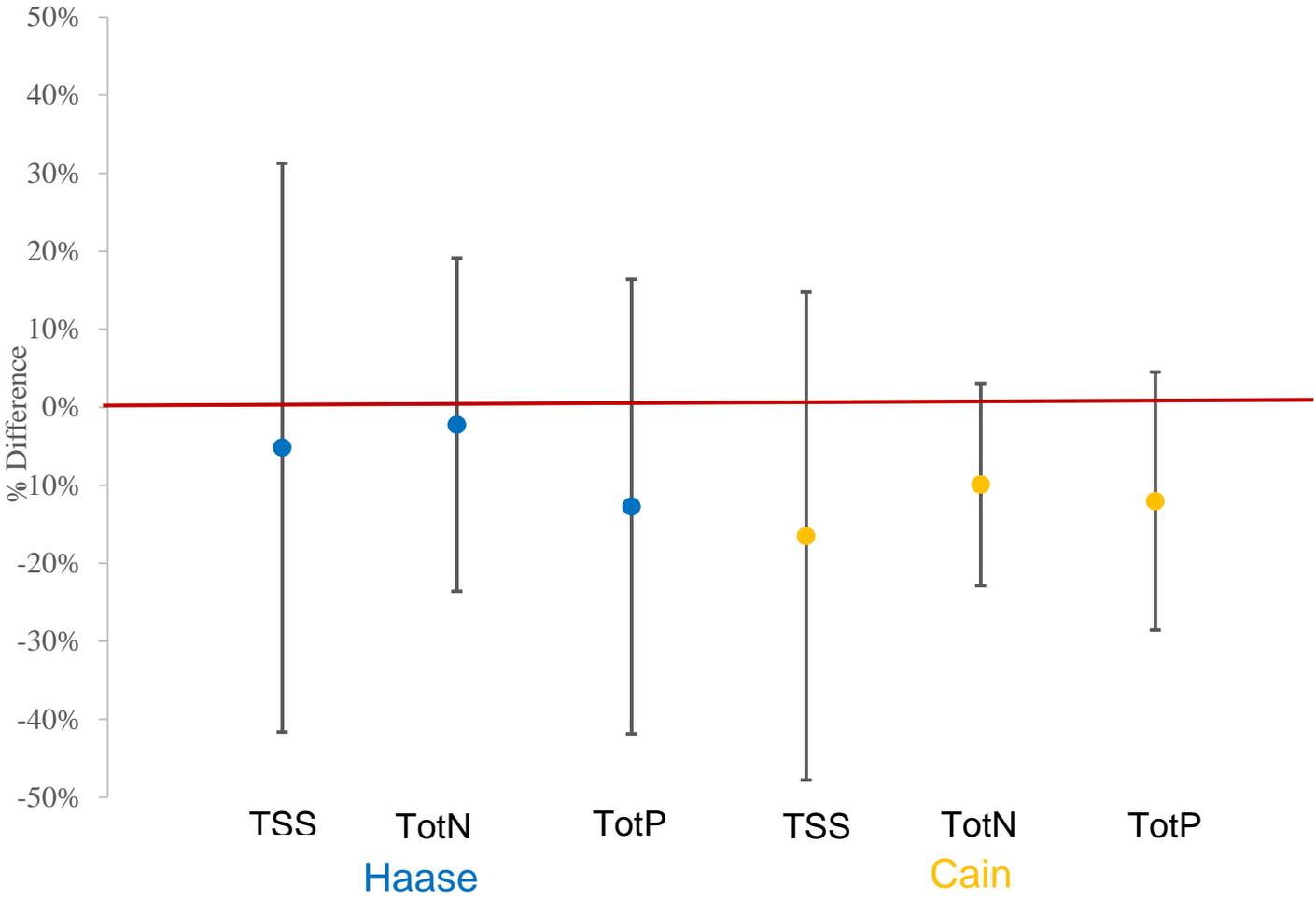
Results Part 2: Stream Sampling

Stream Nitrogen Results

- Similar patterns observed for TP
- TSS much higher at the Cain site
- No differences between outfall and other samples



Impact of TOT Runoff: Upstream/Downstream Comparison



No direct impact of runoff on stream quality was observed in our study

Stream Quality Compared

- However, even upstream nutrient concentrations are elevated at both sites
- TP Concentrations are in the upper 15% of agricultural watersheds measured by USGS
- Median values in Upper and Middle Kansas River tributaries are 0.4-1.25 mg/l for TN, and < 0.1-0.25 mg/l for TP (Banner, 2008)

	HAASE		CAIN		Benchmark
	Upstream	Downstream	Upstream	Downstream	
TN	3.3	3.4	4.3	3.2	0.9
TP	0.57	.57	0.75	0.51	.075

Major Findings

1. TOT runoff contains elevated concentrations of nitrogen, phosphorus and total suspended solids
2. The treatment wetlands were effective at suspended solids removal
3. The treatment wetlands had some success at nutrient removal, with substantial variation between sites
4. Wetland design impacted treatment capabilities
 - The Cain site had deeper water, steeper slopes, and more areas. It was the most effective at removing solids and solid-associated particles, but weakest at dissolved nutrient removal
5. TOT runoff likely impacts stream quality, but a direct impact was not observed in the adjacent streams

Recommendations for Future Research

- Further study of treatment wetland effectiveness is recommended
 - Need to optimize design and construction to maximize environmental benefit at minimal cost to landowner
- Hydrologic model of wetland storage to assist in predicting long-term pollutant retention
 - Better describe dry season behavior
 - Estimate water quality during winter storm events
- Look at potential impact of larger-scale wetland implementation on stream water quality

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