

Edge-of-Field Nitrogen and Phosphorus Export in Tile-Drained Fields Managed as Corn for Silage

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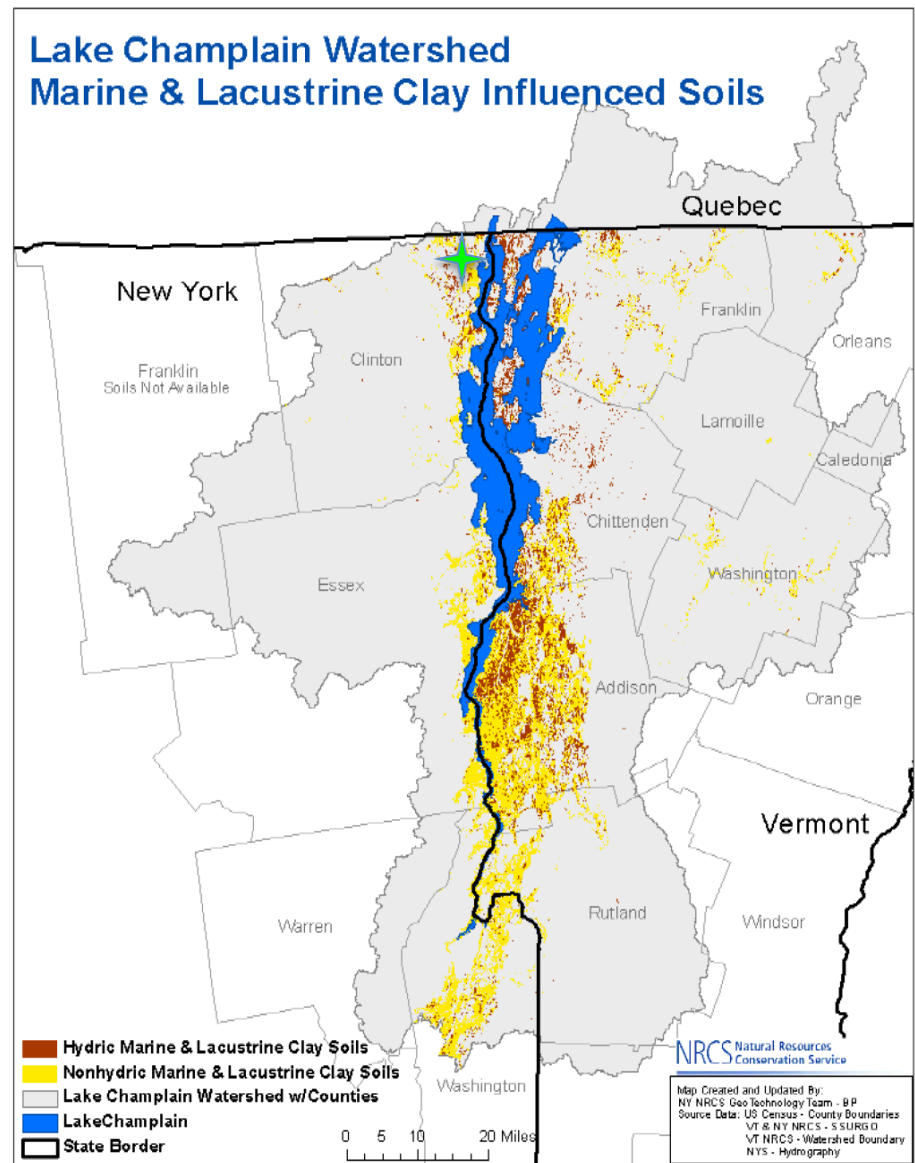
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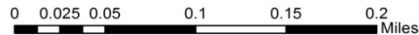
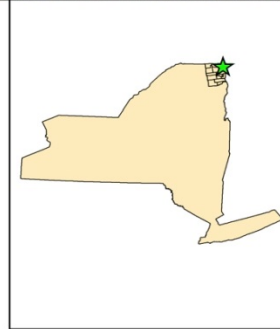
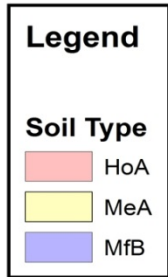
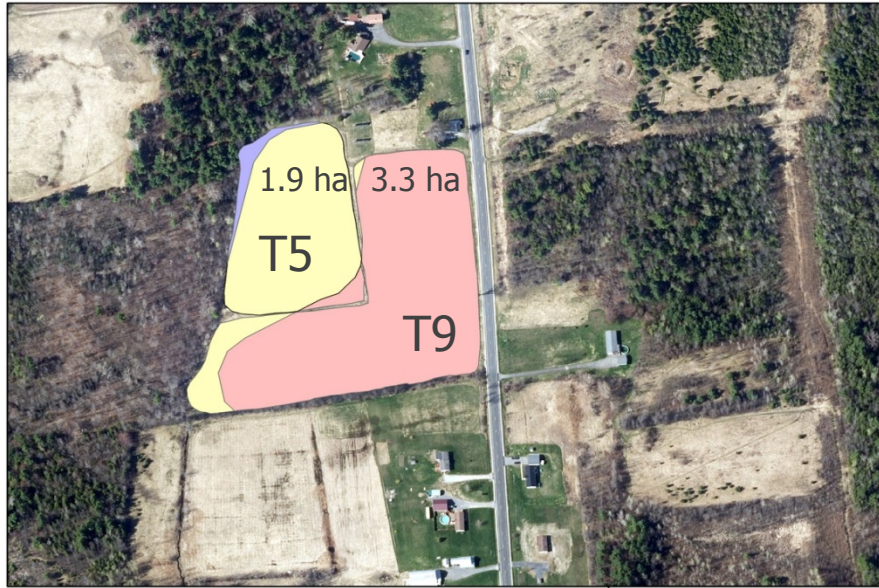
DAIRY

Need for tile

- Higher yields on poorly drained soils
- Less ponding and surface runoff/lower compaction potential (Gilliam et al., 1999)
- Pathway for N & P loss to surface water (Jaynes et al., 2001; King et al., 2015)



Edge of Field Site Map



Charles Hacker

Objective:

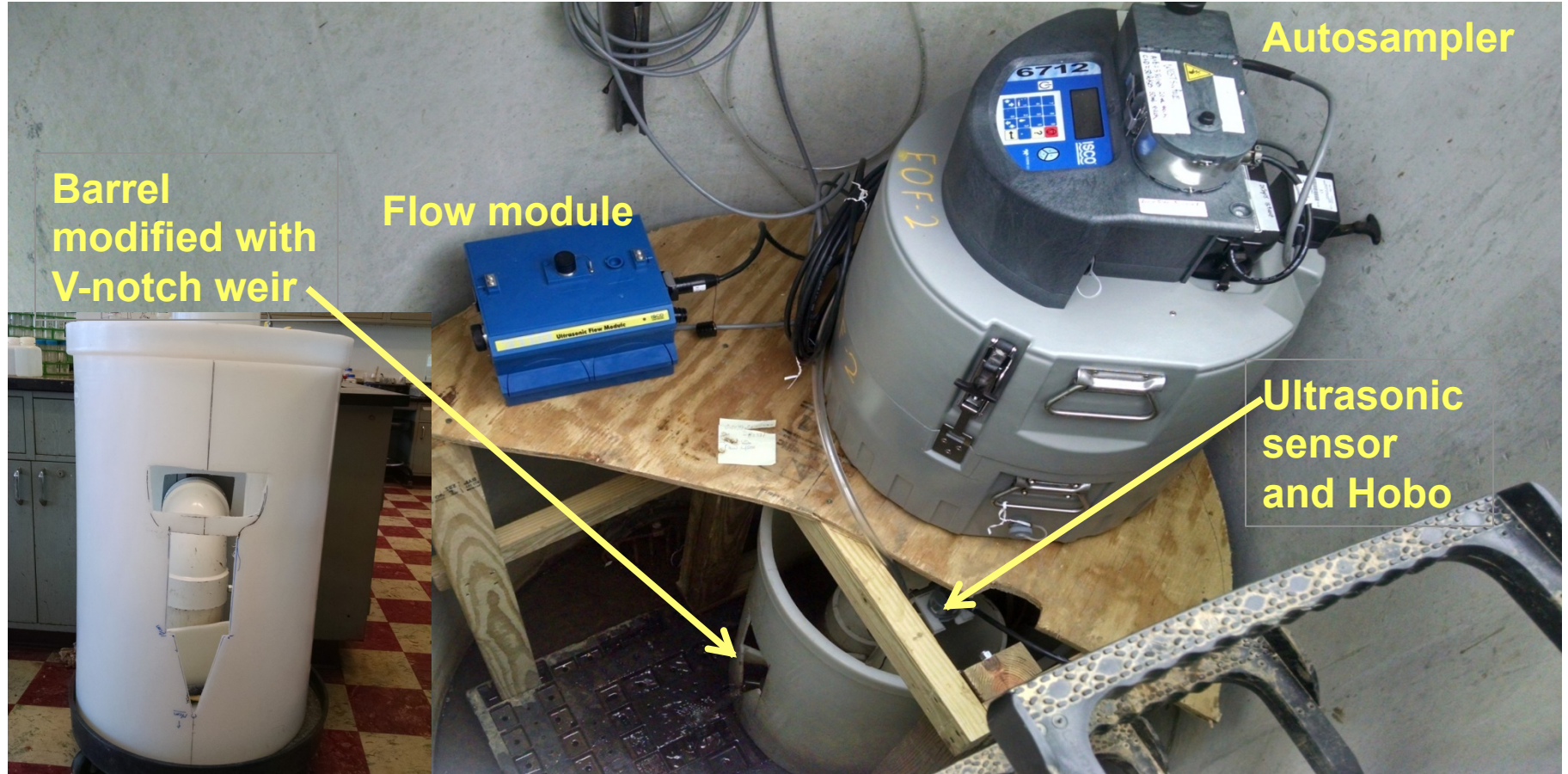
- Measure N, P, and TSS loading in surface runoff and tile flow during baseline period
 - 2-year baseline
 - 4-year treatment
 - Controlled drainage
- 1.2 m tile depth
- 10.2 m lateral spacing

Surface water instruments

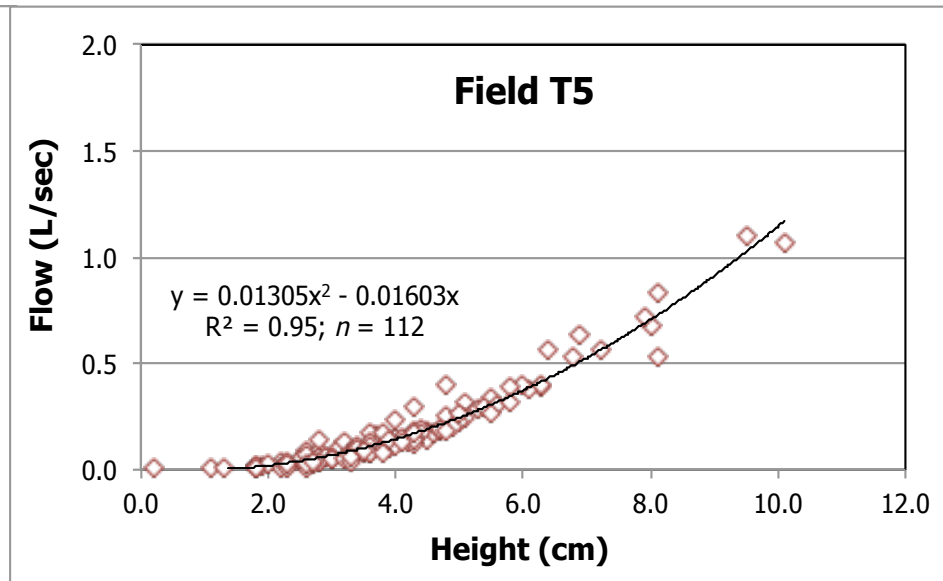
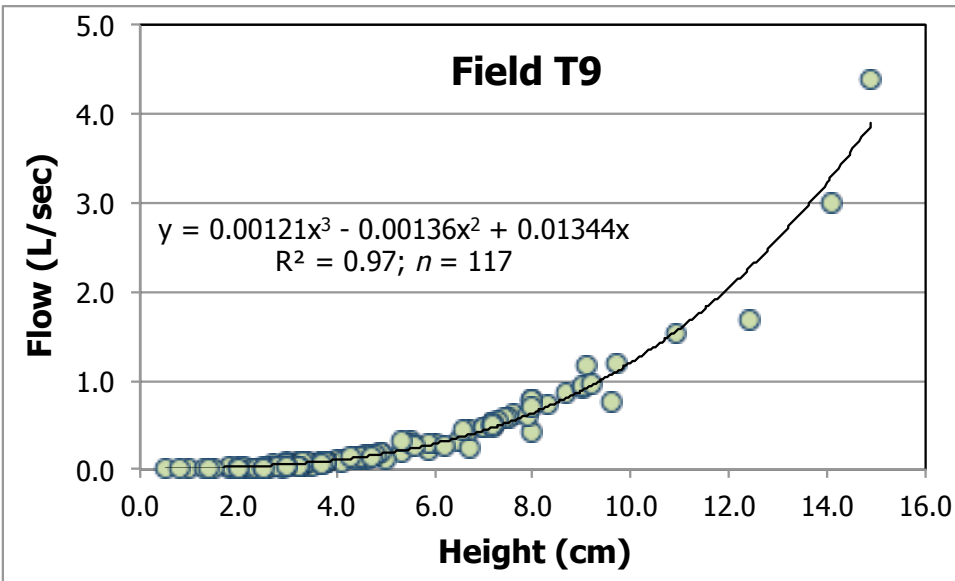


- Flow-based sampling: 200 mL/0.70 mm of runoff
- Total suspended solids, total N, nitrate-N, ammonium-N, total P, and soluble reactive P

Subsurface tile drain setup



Tile drain flow curves

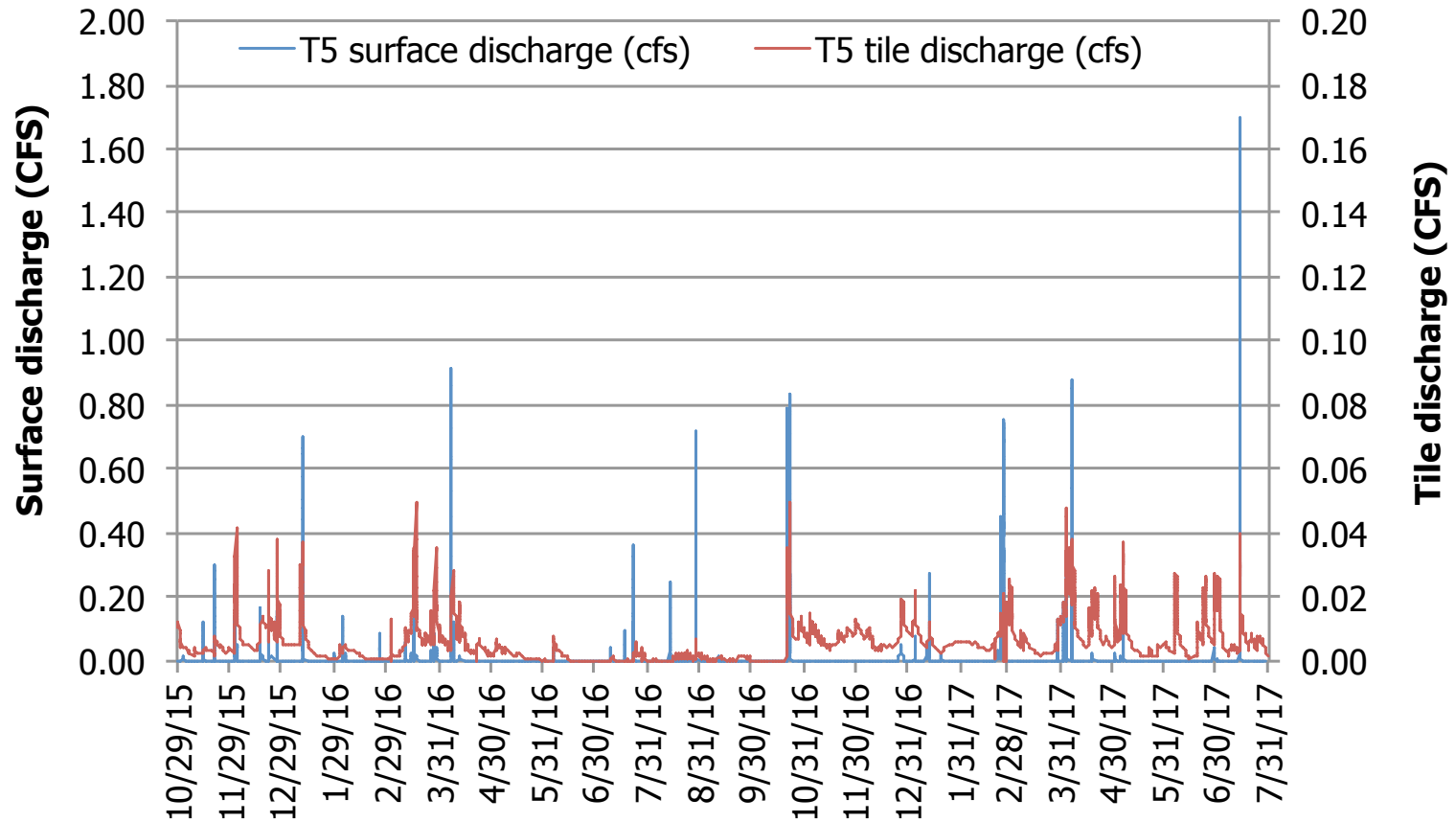


Agronomic considerations

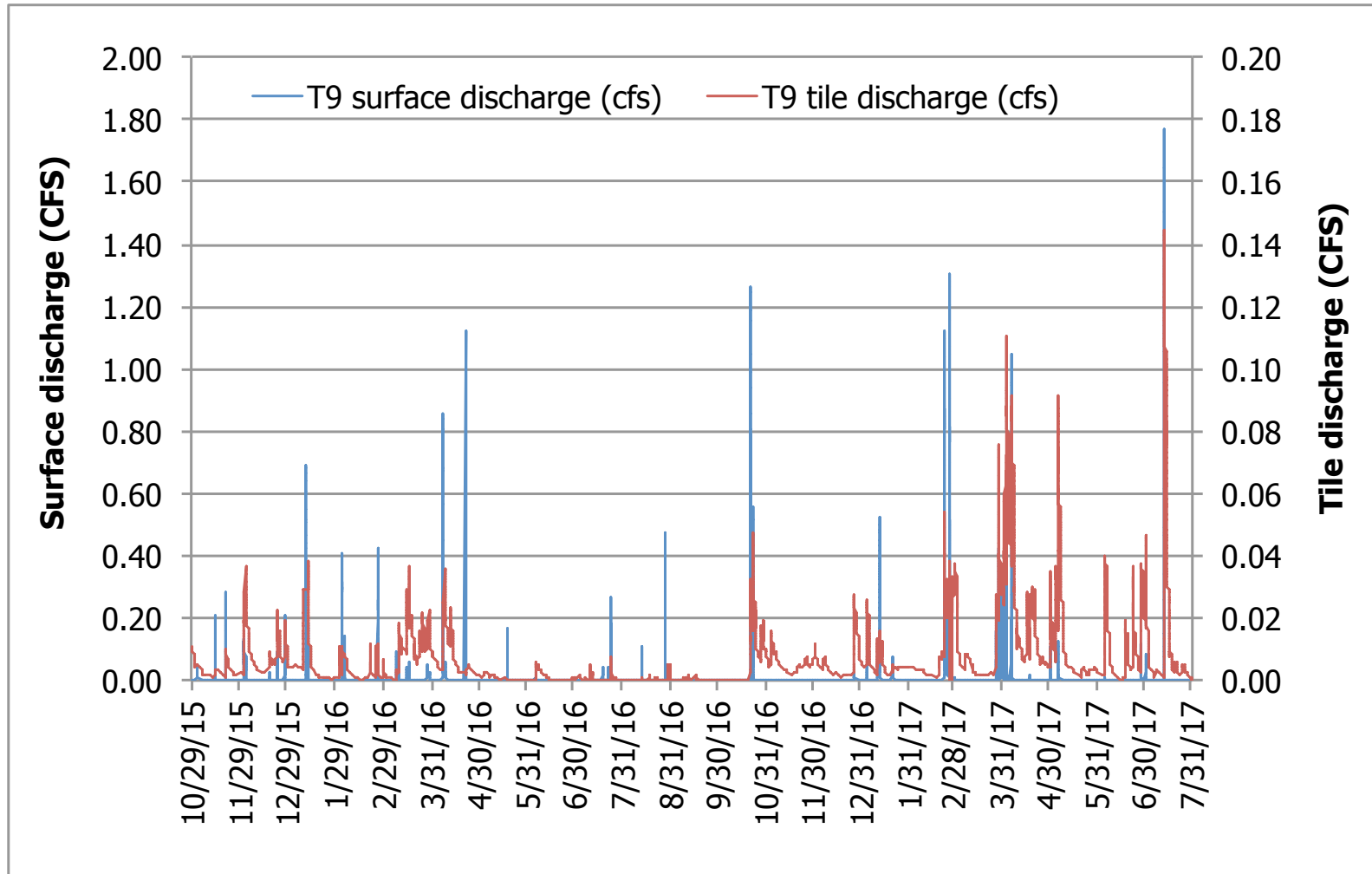


- Fields managed as corn for silage
- Soil test P: low/medium (1.5 to 2.5 mg kg^{-1})
- 112 kg ha^{-1} of 23-12-18 fertilizer at planting
- 90 kg ha^{-1} UAN applied as a sidedress
- Liquid manure in early October 2015 ($37,000$ L ha^{-1})
- Composted dairy manure May 2017 (50 Mg ha^{-1})

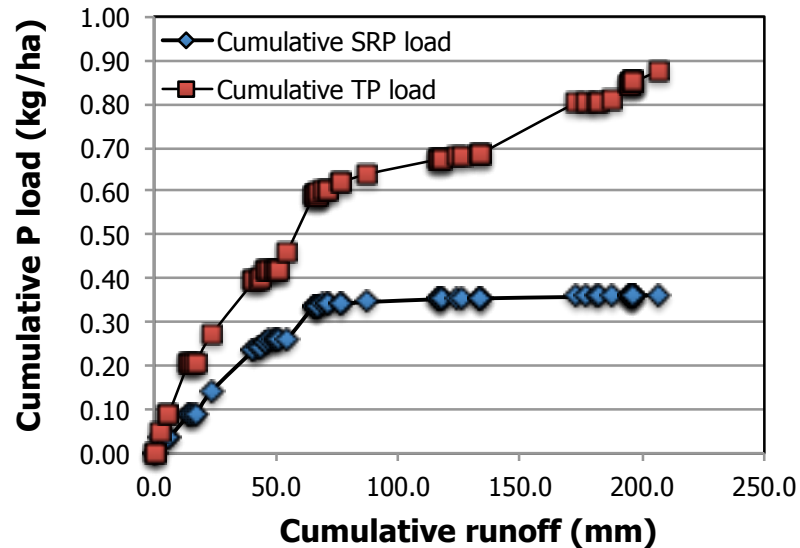
Surface runoff discharge



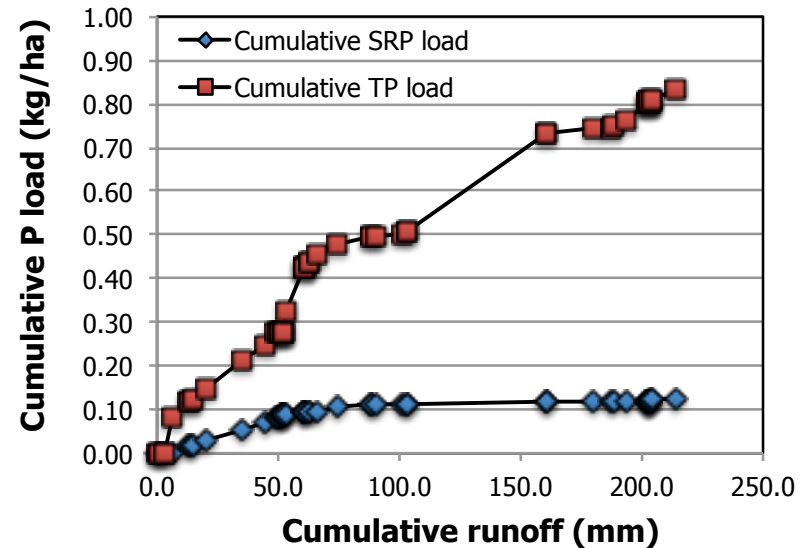
Tile drain discharge



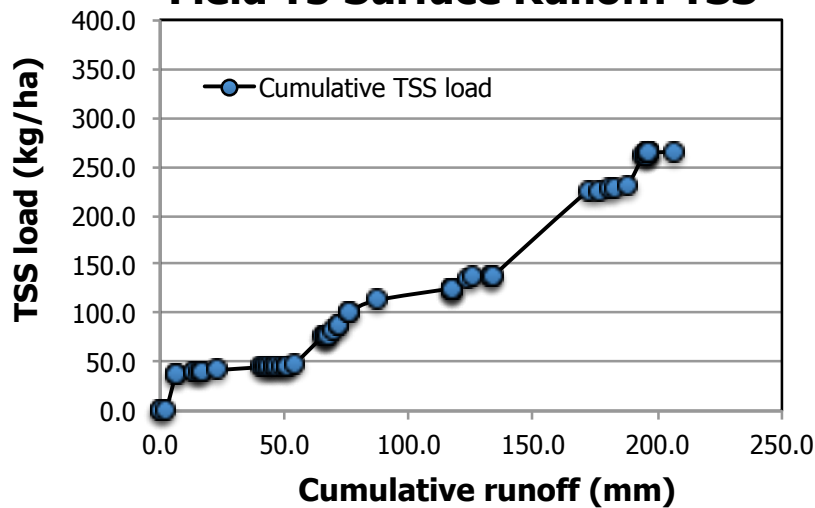
Field T5 Surface Runoff: P



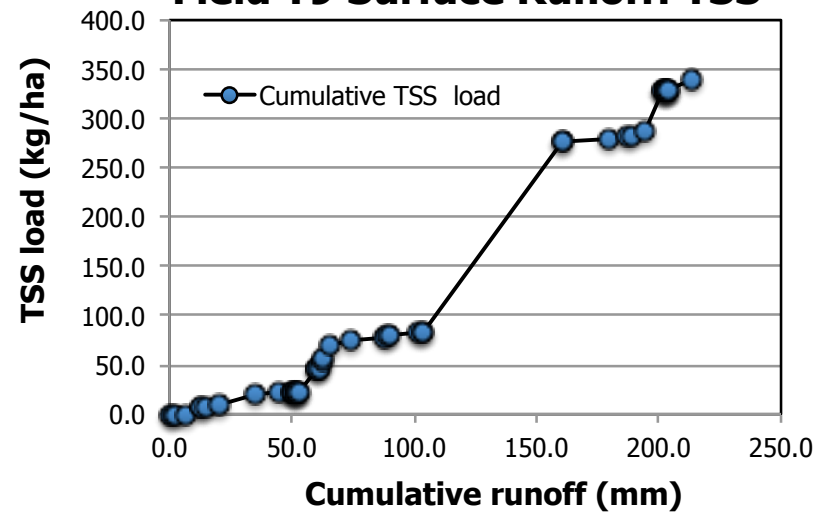
Field T9 Surface Runoff: P



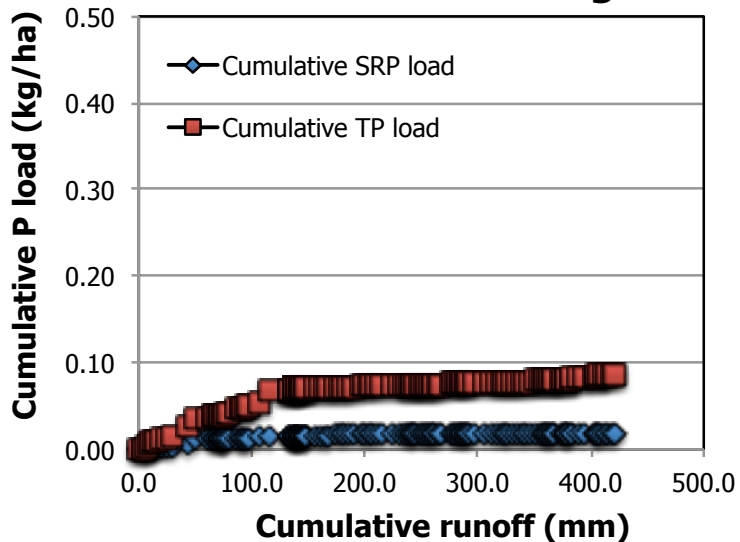
Field T5 Surface Runoff: TSS



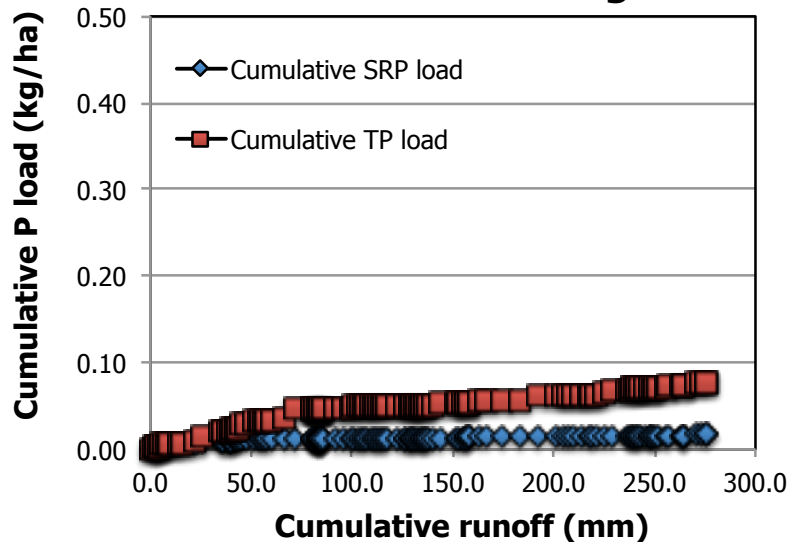
Field T9 Surface Runoff: TSS



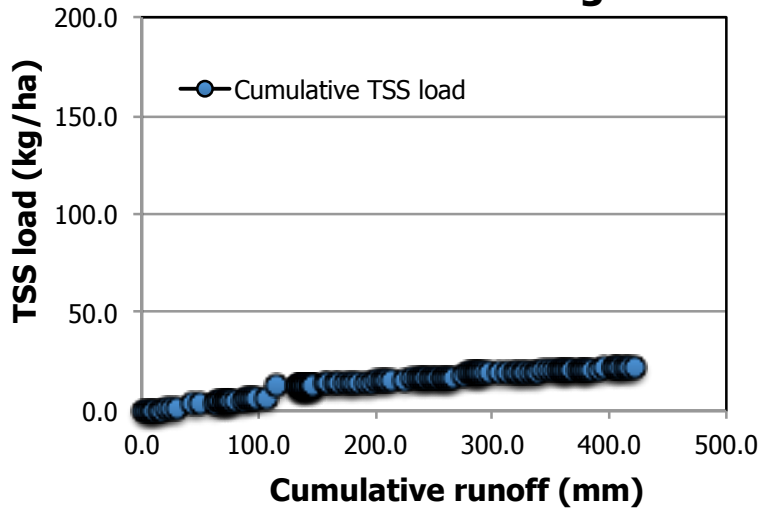
Field T5 Tile Drainage: P



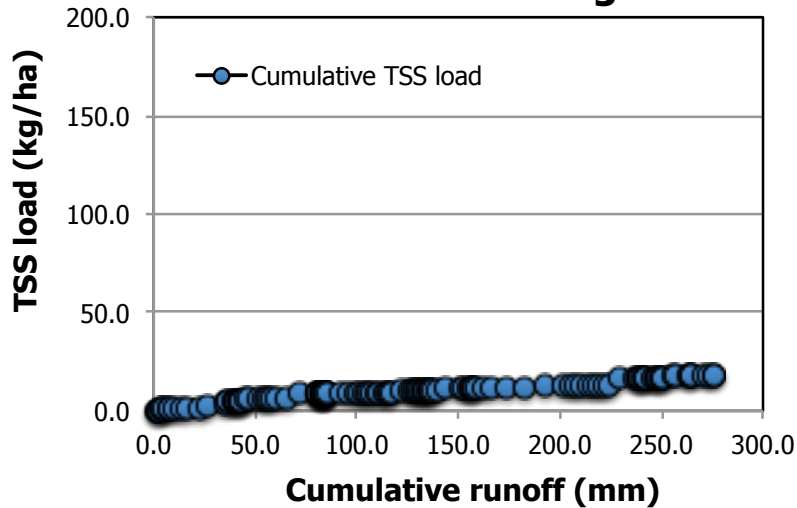
Field T9 Tile Drainage: P



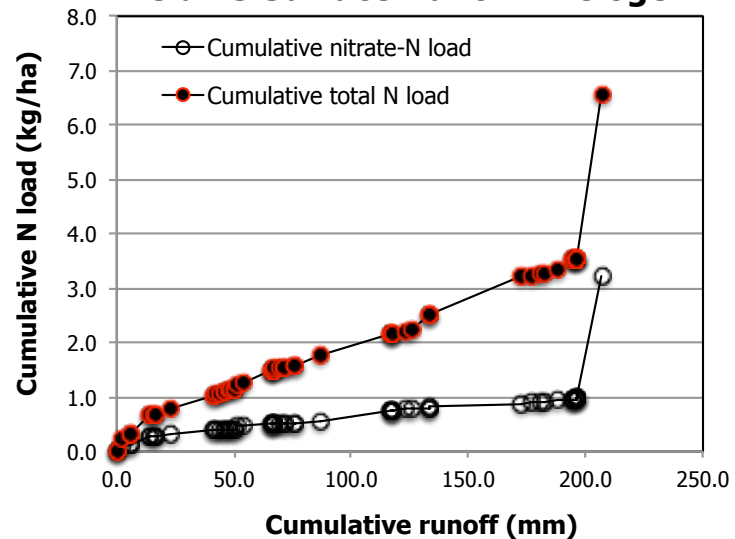
Field T5 Tile Drainage: TSS



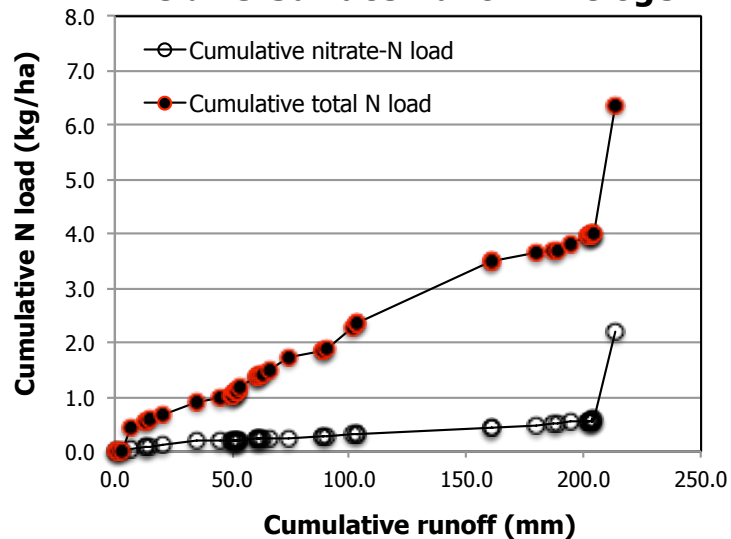
Field T9 Tile Drainage: TSS



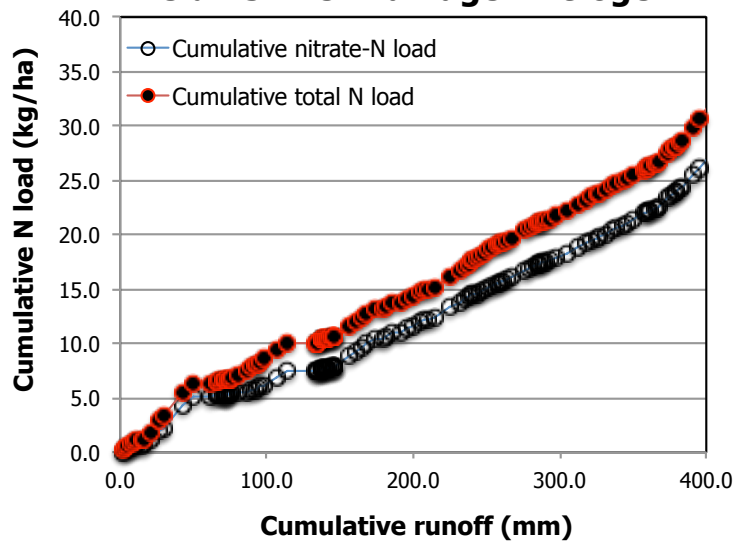
Field T5 Surface Runoff: Nitrogen



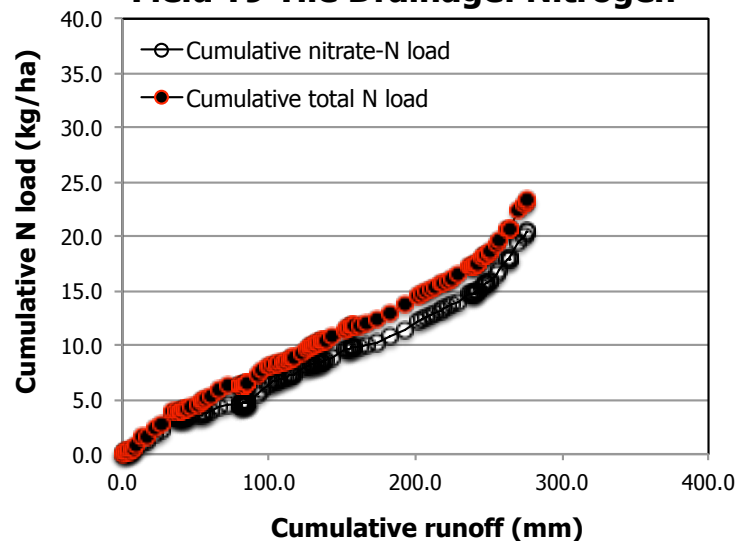
Field T9 Surface Runoff: Nitrogen



Field T5 Tile Drainage: Nitrogen



Field T9 Tile Drainage: Nitrogen



Nutrient export in runoff

Pathway/field	Runoff	SRP	TP	TSS	Total N	Nitrate-N	Amm-N
	mm yr ⁻¹	-----kg ha ⁻¹ yr ⁻¹ -----					
Surface T5	120.8	0.21	0.51	155.1	3.9	1.9	0.08
Tile T5	246.0	0.01	0.05	13.1	20.8	17.8	0.19
Surface T9	125.1	0.07	0.49	198.9	3.7	1.3	0.11
Tile T9	161.4	0.01	0.05	10.6	13.7	12.0	0.14
T5 Surface:Tile	0.49	18.9	10.2	11.8	0.19	0.10	0.39
T9 Surface:Tile	0.77	7.1	10.8	18.8	0.27	0.11	0.75

- P and TSS export dominated by surface runoff
- N export mainly from tile drain flow as nitrate-N

Nutrient inputs & crop removal

Year/Field	Total P₂O₅ inputs	Total N inputs	Corn yield	P₂O₅ removal	N removal
	lb/ac	lb/ac	tons DM/ac	lb/ac	lb/ac
2016					
T5	12	123	1.60	16	36
T9	12	123	2.56	26	57
2017					
T5	102	257	3.05	31	68
T9	102	257	4.23	43	95

Percent of nutrients lost in runoff

Year/Field	% P loss	% N loss
2016		
T5	1.7	16.4
T9	1.5	11.0
2017		
T5	0.2	7.8
T9	0.2	5.3



Flow weighted mean concentrations

Pathway/field	SRP	TP	Total N	Nitrate-N	Amm-N
	-----mg L ⁻¹ -----				
Surface T5	0.18	0.42	3.2	1.6	0.07
Surface T9	0.06	0.39	3.0	1.0	0.09
Tile T5	0.004	0.02	8.5	7.2	0.08
Tile T9	0.01	0.03	8.5	7.4	0.10

■ EPA nitrate-N drinking water standard = 10 mg L⁻¹

Summary

- Importance of year-round monitoring
- Field hydrology key driver of nutrient losses
- P loss driven by surface runoff/erosion
- N loss driven by leaching to tile drains
- Winter cover crops: opportunity to reduce particulate P in runoff and nitrate loss in tile flow?
- How will control drainage impact N and P loss?

