THE UNIVERSITY of WISCONSIN MADISON

Horizontal Bunker Silage Storage Leachate and Runoff Management

January 11, 2017

Becky Larson

Assistant Professor and Extension Specialist

University of Wisconsin-Madison

Aaron Wunderlin, Discovery Farms

Eric Cooley, Discovery Farms

Mike Holly, USDA ARS

Biological Systems Engineering
UNIVERSITY OF WISCONSIN–MADISON

DISCOVERY FARMS WISCONSIN

UW Extension
University of Wisconsin–Extension

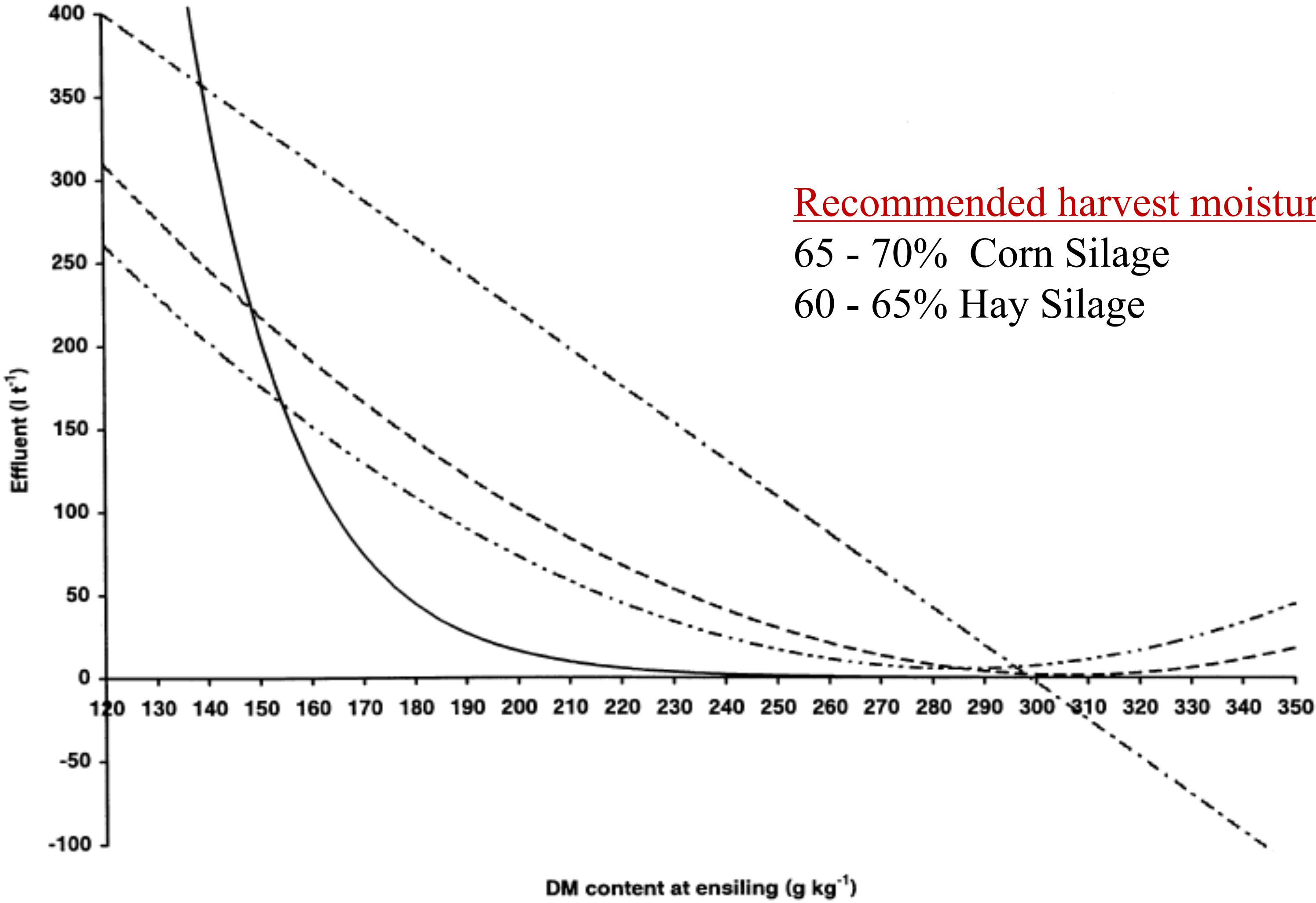
Silage Storage

Loading and Compaction

Dry Weather Leachate

THE UNIVERSITY of WISCONSIN MADISON

Leachate Production Based on Dry Matter Content



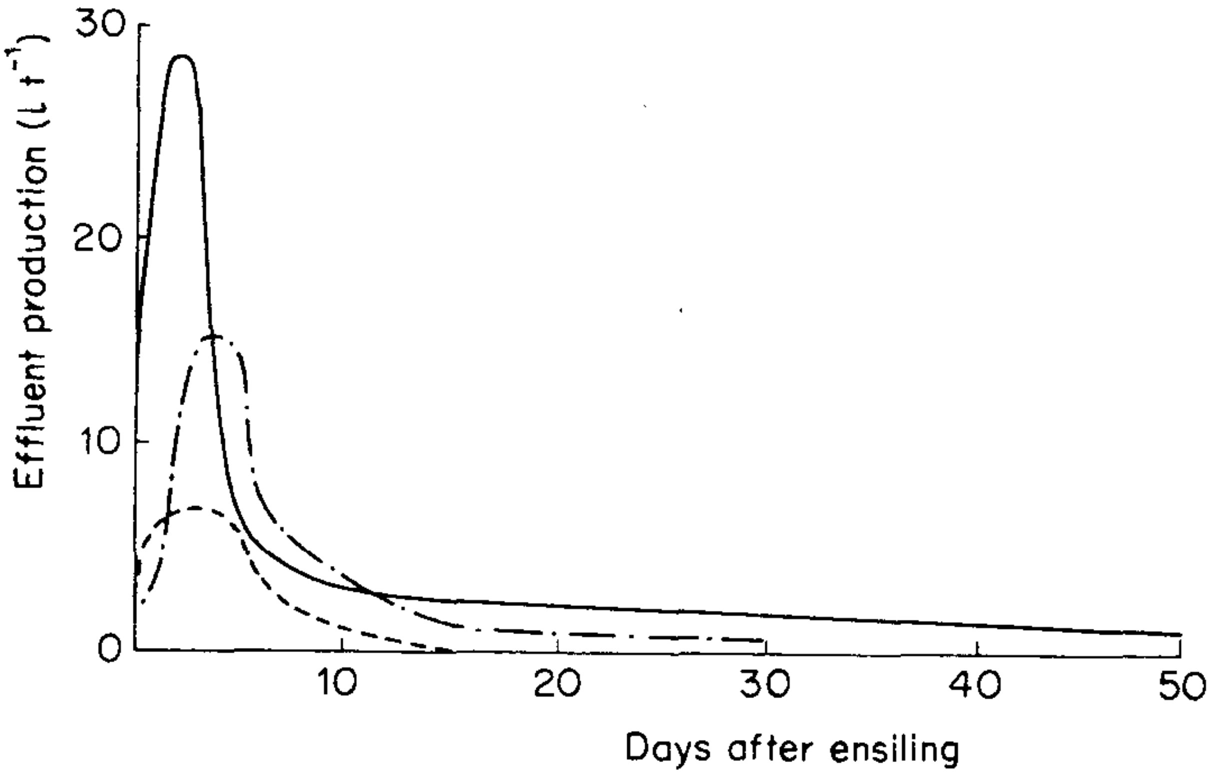
Recommended harvest moisture

65 - 70% Corn Silage

60 - 65% Hay Silage

Bastiman (1976) and Bastiman and Altman (1985) (– - - –); Sutter (1957) (– – – -); Zimmer (1974) (– – –); Haigh (1999) (—)

Timing Leachate Production



'igure 8.4. Patterns of effluent production.[49] Silage DM content (g kg^{-1}): ———— 158; —·—·— 182; ------ 219

McDonald 1981, Referencing Bastiman 1976

Dry Weather Silage Leachate

Constituent	Leachate[1]	Liq. Dairy Manure[2]
Dry Matter	2-10%	5%
Total N (mg/L)	1,500-4,400	2,600
P (mg/L)	300-600	1,100
K (mg/L)	3,400-5,200	2,500
pH	3.6-5.5	7.4
BOD (mg/L)	12,000-90,000	5,000-10,000

[1]Cornell 1994
[2]Clarke and Stone 1995

Dry Weather Silage Leachate

Dry Weather Silage Leachate

THE UNIVERSITY of WISCONSIN MADISON

Corrosive - Concrete Erosion

Runoff

THE UNIVERSITY of WISCONSIN MADISON

Snowmelt Runoff

Runoff Concentrations

THE UNIVERSITY of WISCONSIN MADISON

Constituent	Leachate[1]	Liq. Dairy Manure[2]	Runoff
Dry Matter	5% (2-10%)	5%	0 - 4.6%
Total N (mg/L)	1,500-4,400	2,600	20 - 1,356
P (mg/L)	300-600	1,100	8 - 659
K (mg/L)	3,400-5,200	2,500	n/a
pH	3.6-5.5	7.4	4 - 7
BOD_5 (mg/L)	12,000-90,000	5,000-10,000	500 - 61,210

Impacts of Silage Runoff

Impacts of Silage Runoff

Management

Management to Minimize Silage Storage Runoff Constituent Concentrations

- Cover
  - Top
  - Maintaining face (minimize exposure)
  - Cover/wrap side walls
  - Cover when filling if rain is forecast (minimize water additions)
- Clean pad (remove litter) particularly if rain event is forecast
- Cover spoilage and litter until removal (removal can include many options, land application, composting, digestion, among others)

Silage Storage Collection System Design

- Minimize collection volumes
  - Reduce hauling requirements
- Reduce environmental impact
  - Collect high strength waste for storage and land application
  - Send low strength waste to treatment systems

PRIOR TO RESEARCH

Capture the initial volume and send to storage as it has the highest concentrations

- This assumed a first flush scenario exists where the first portion of the runoff has higher strength than remaining runoff, unconfirmed
- First flush exists in urban runoff, though it would follow this pattern

Collection

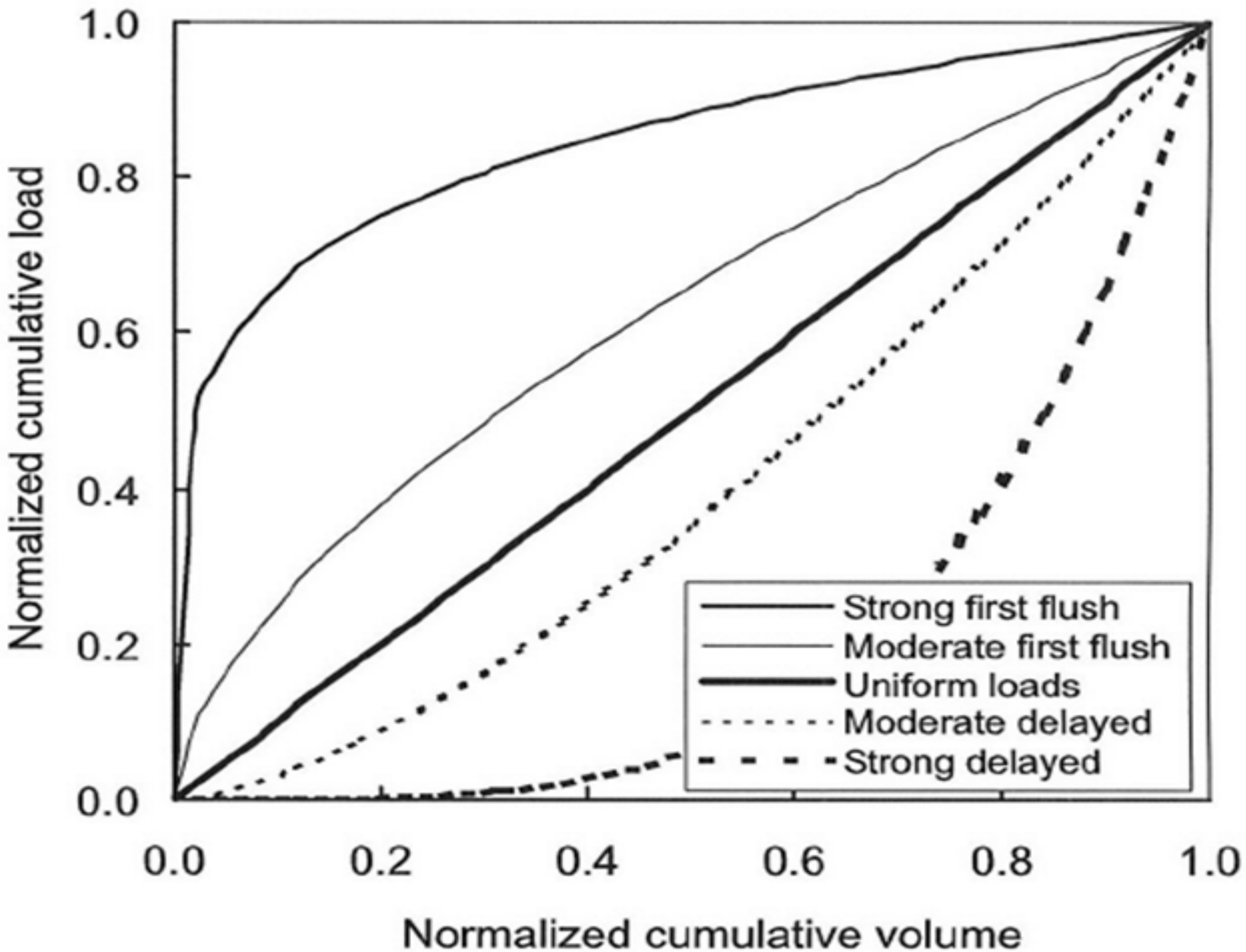
Collection Designs are Numerous

Collection Designs

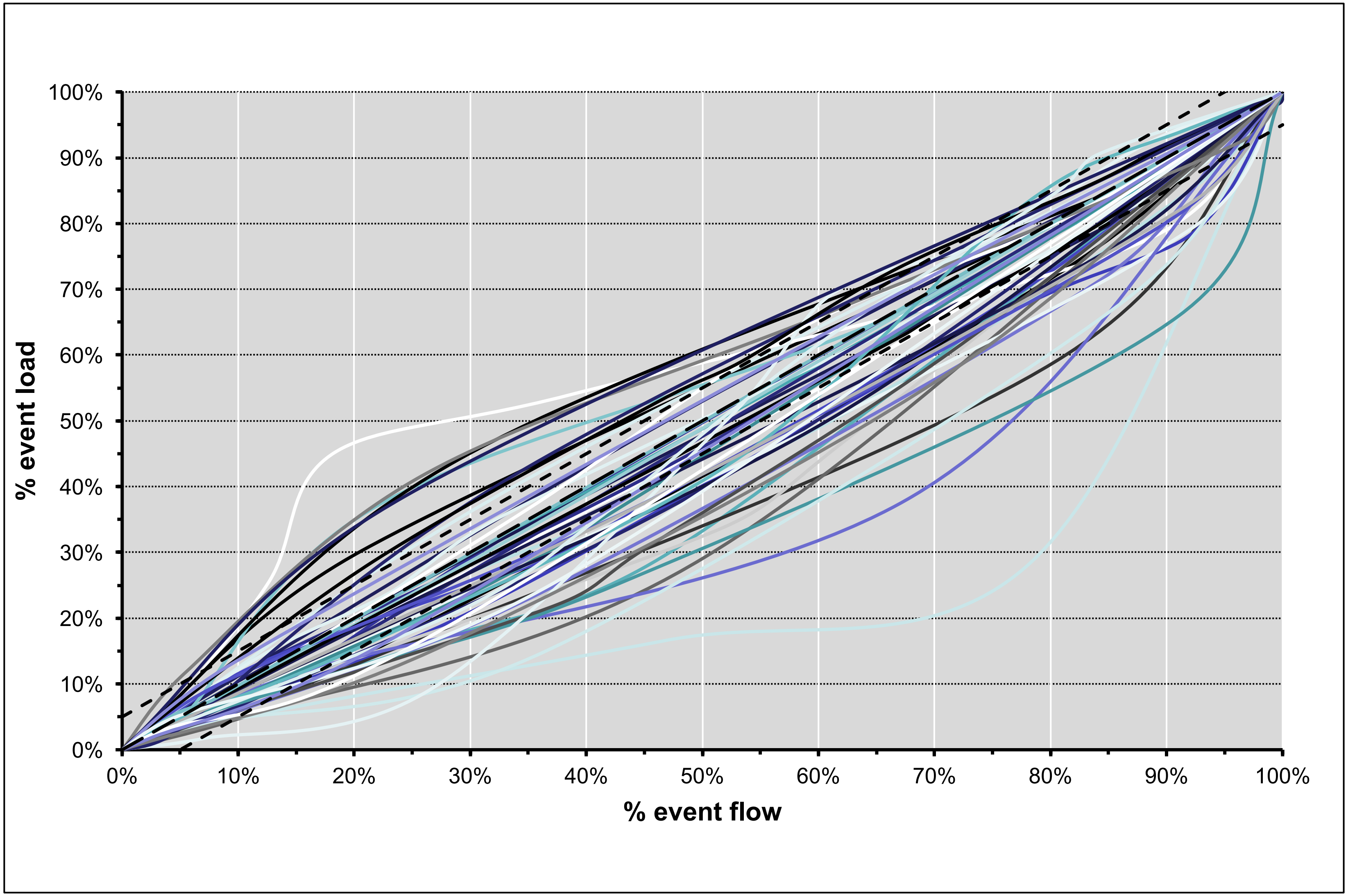
Treatment Using Filter Strips

THE UNIVERSITY of WISCONSIN MADISON

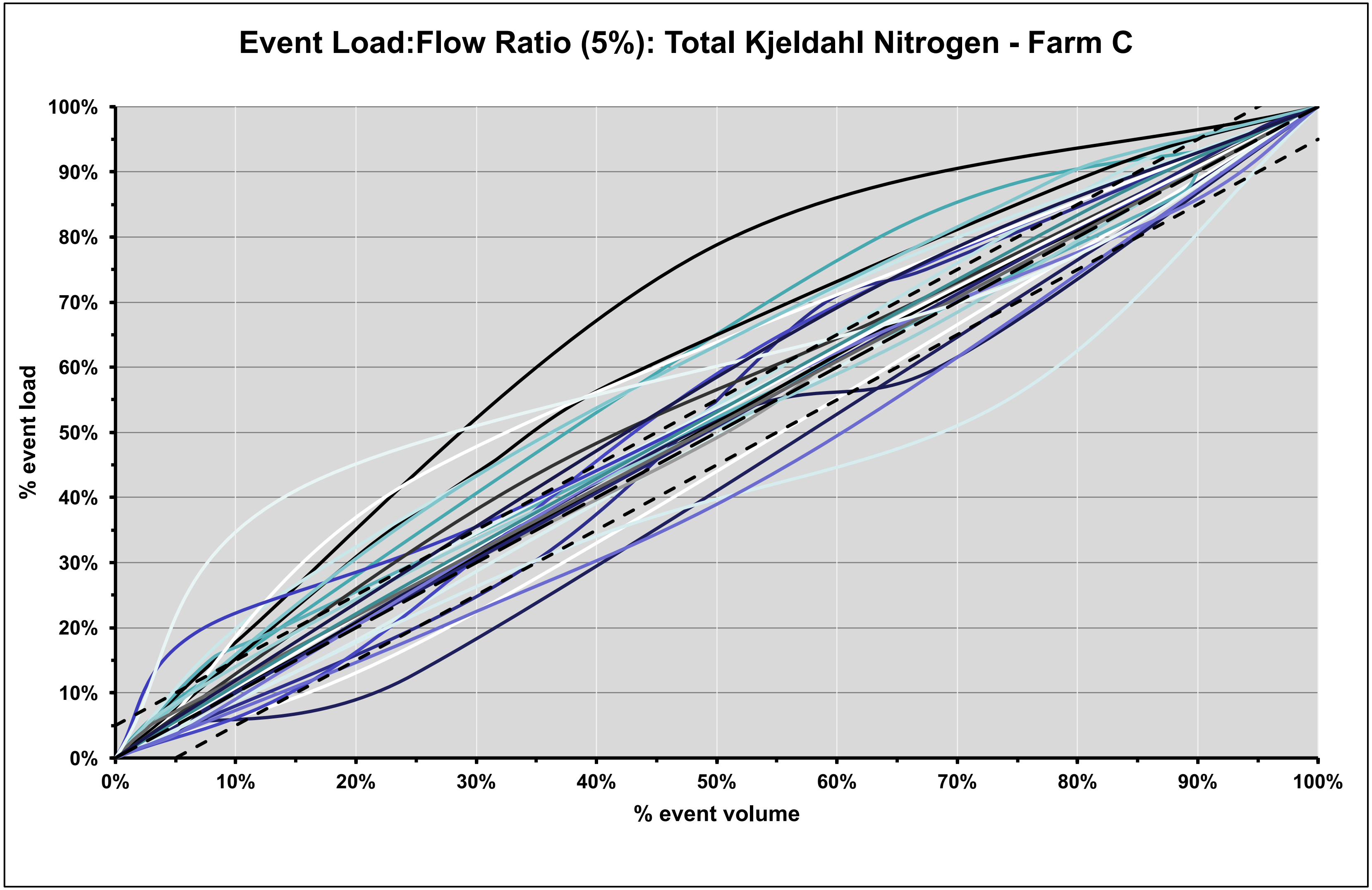
Does a First-Flush Exist?



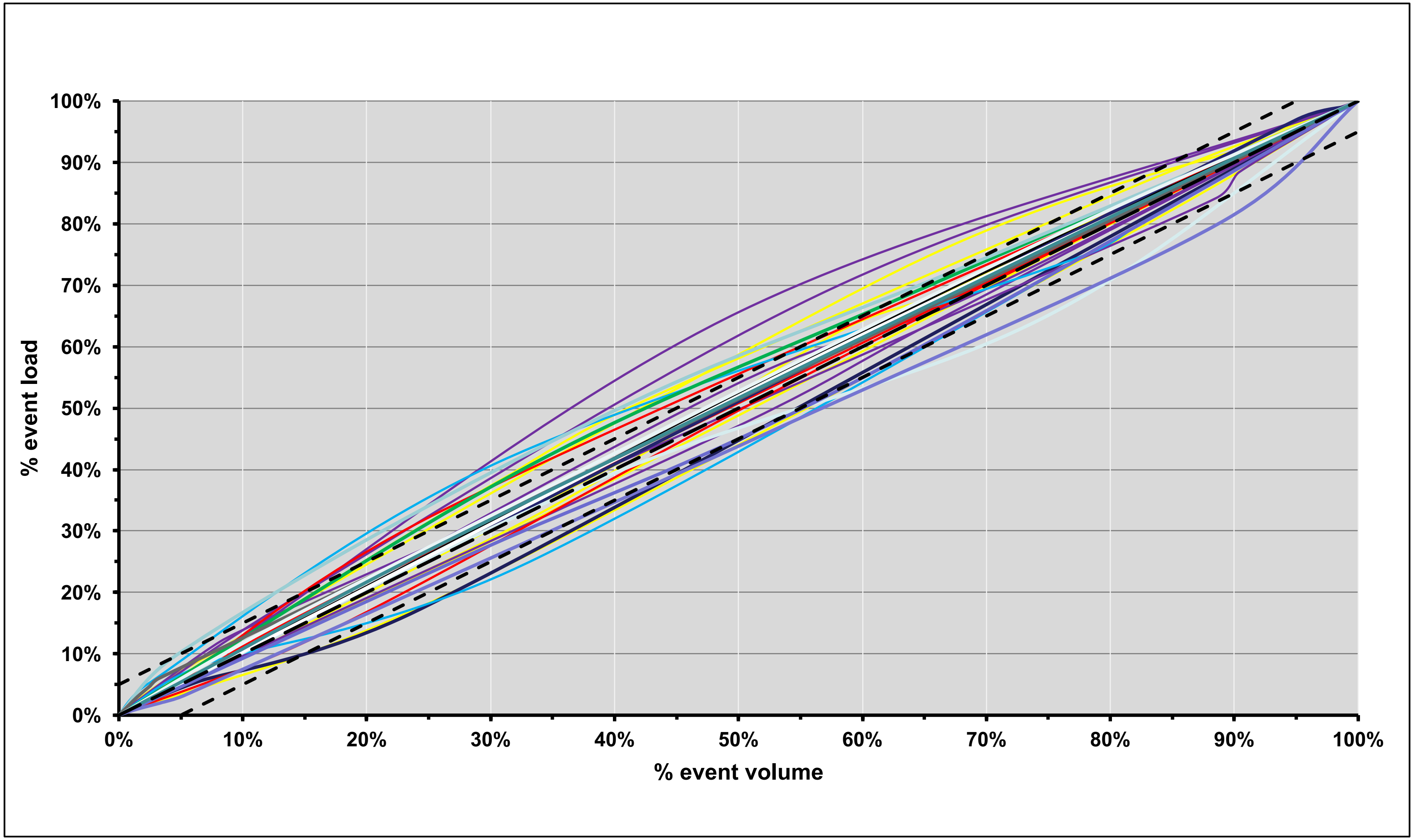
Normalized TKN Data – Farm 1



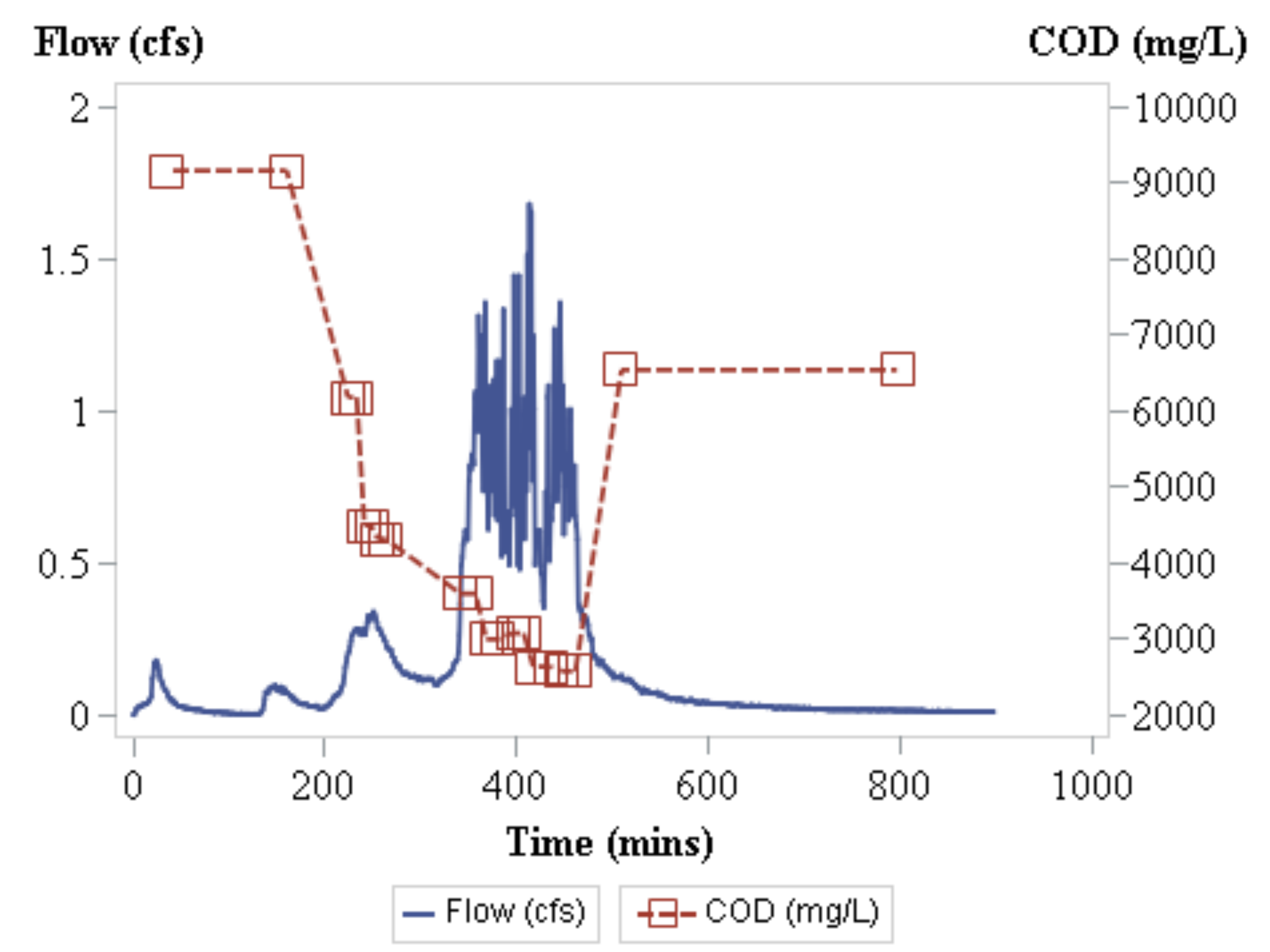
Normalized TKN Data – Farm 2



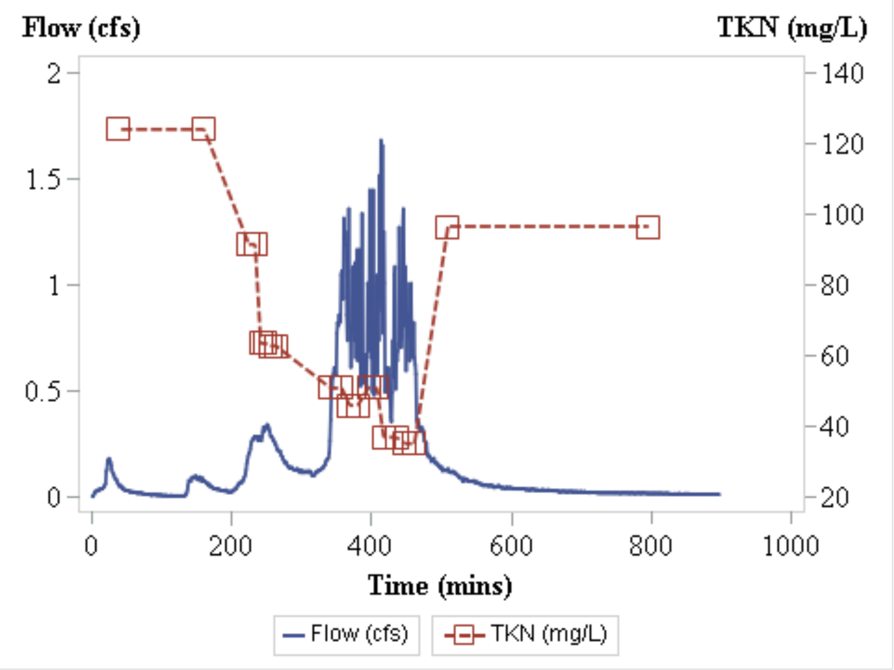
Normalized Phosphorus Data – Farm 3

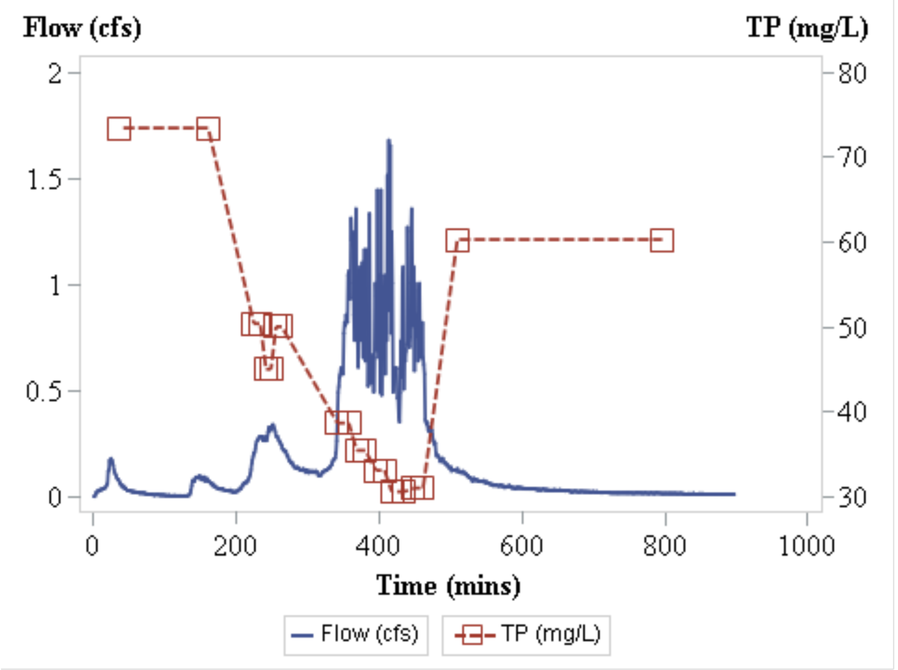


Relationship of Flow vs. Concentration



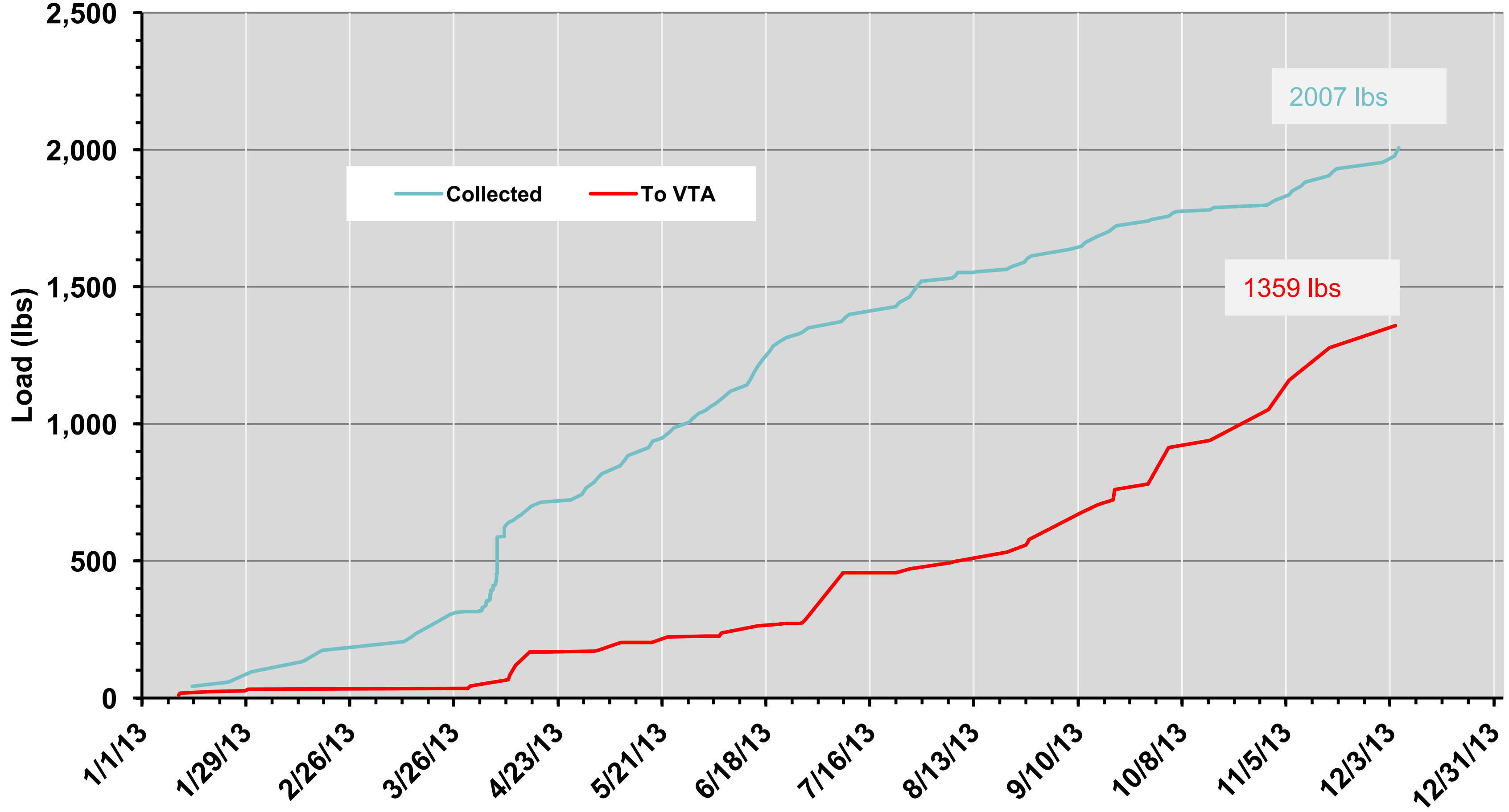
Constituent Correlations





- All constituent data (TKN, TP, TS, COD, BOD) was statistically correlated EXCEPT pH which was negatively correlated

Total TKN Loading

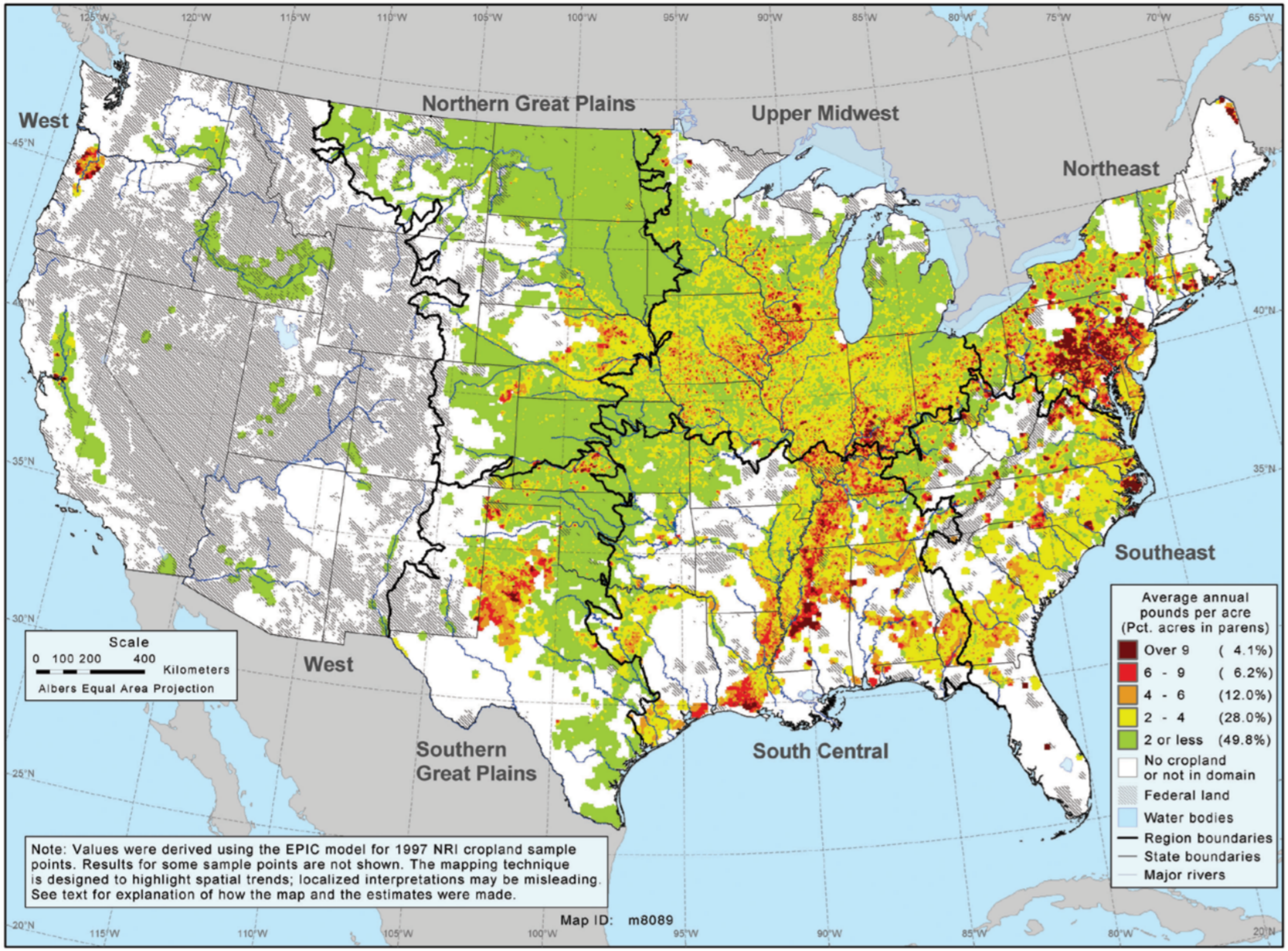


Loading per Acre of Bunker Area

Site	TP		TKN	
	pounds/acre/year			
D	893	1,668	3,308	5,047
E	1,529	2,585	6,125	8,986
F	458		13,348	

Phosphorus Losses from Cropland

Map 28 Estimated average annual per-acre phosphorus loss summed over all loss pathways (elemental P)



NRCS, 2006

Equivalent Crop Acres

Highest Phosphorus Loss Fields
(9 lbs.ac.yr)

Site	Equivalent Field Acres	
D	99	185
E	170	287
F	51	

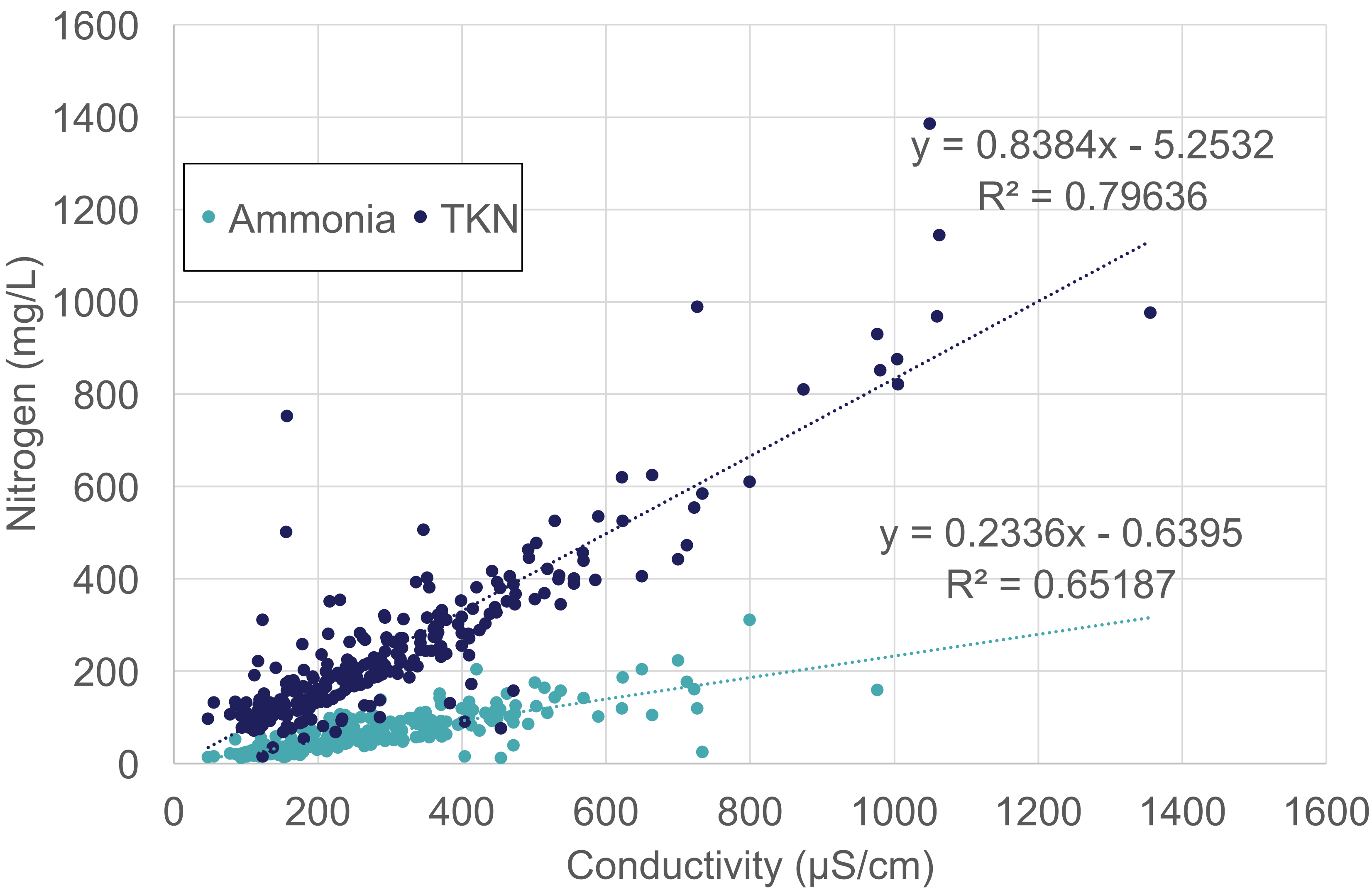
Average Phosphorus Loss Fields
(2 lbs.ac.yr)

Site	Equivalent Field Acres	
D	447	834
E	764	1,293
F	229	

Collection Design Recommendation

- First flush does not exist so collecting initial runoff does not target collecting the greatest load per volume collected
- Recommended to collect low flows only (stop collecting during high flows)
- If the system design to shut off during high flows is not practical, collect low flows throughout the storm
- Additional collection of runoff within 2 weeks of filling will increase load collection
- Grade your pad to ensure all flows enter at one central collection point
- Check pad for cracks or other potential issues and repair
- Provide subsurface drainage to collect leachate which permeates through the pad

Conductivity Meter to Route High Strength Runoff to Storage



Thank You!