Bunker Silage Storage Leachate and Runoff Management

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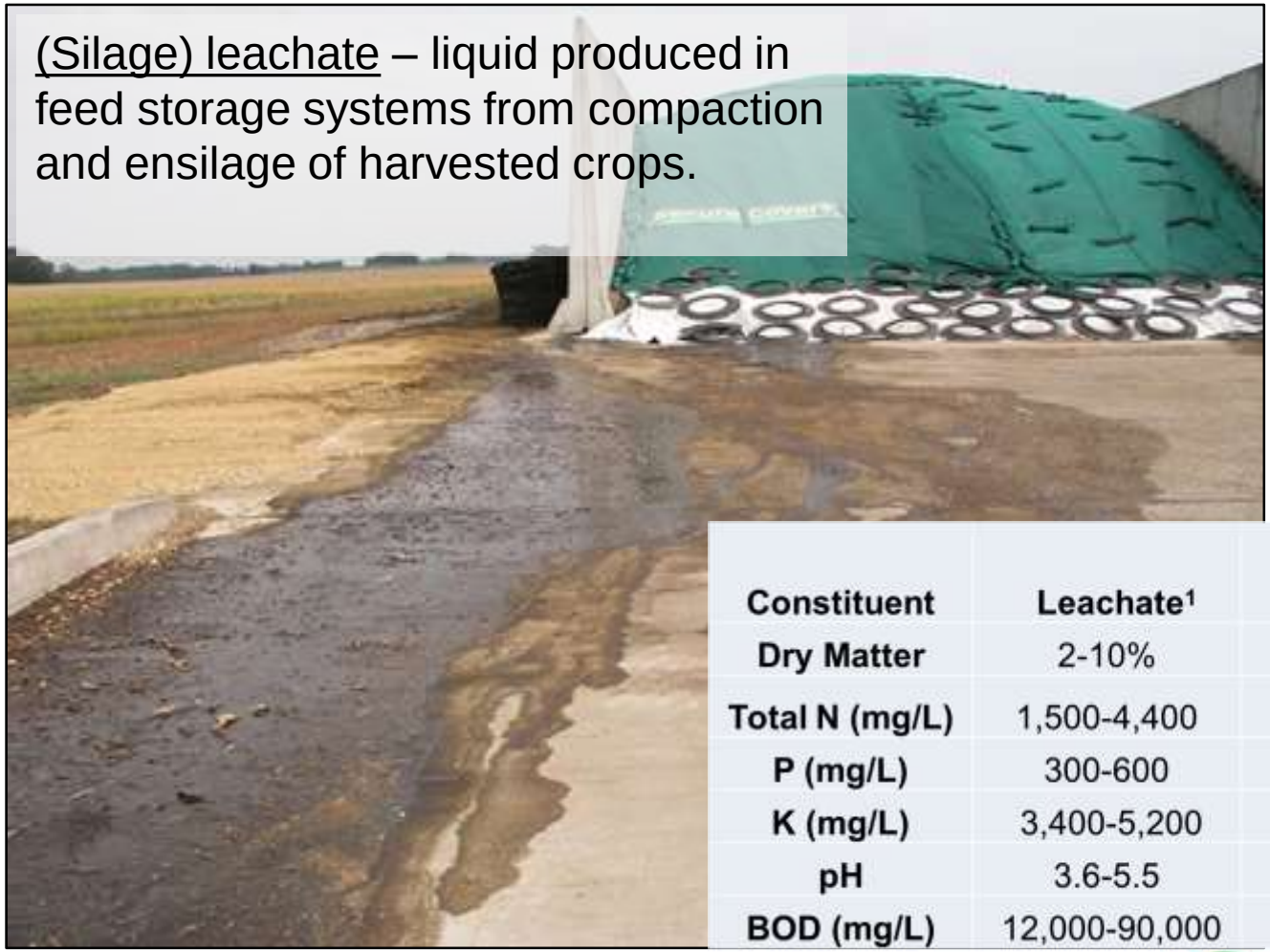
Silage Leachate

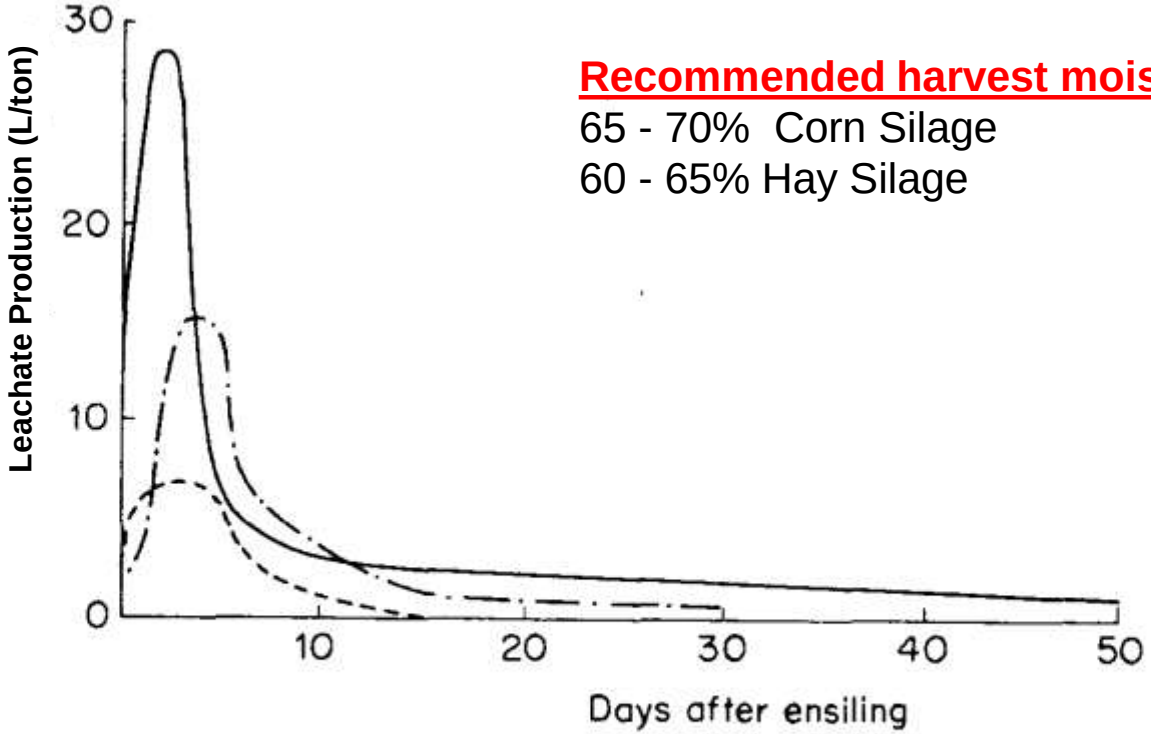


(Silage) leachate – liquid produced in feed storage systems from compaction and ensilage of harvested crops.

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

Leachate Production



Recommended harvest moisture

65 - 70% Corn Silage

60 - 65% Hay Silage

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

Mc Donald 1981, Referencing Bastiman 1976

Leachate

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Leachate

Runoff

<u>(Feed storage) runoff</u> – precipitation induced flow from feed storage systems as a result of rain/snowmelt flowing through stored feed, litter, and spoilage piles; essentially “diluted leachate”.

Litter and Spoilage

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Runoff Concentrations

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 (mg/L)	12,000-90,000	5,000-10,000	500 - 61,210

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

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Impacts of Runoff

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Rain Water Infiltration

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Minimizing Runoff Concentrations

- **Protect** from water
  - Cover when filling if rain is forecast
  - Cover/wrap side walls
  - Cover and seal edges
  - Divert clean water away
  - Minimize exposure when feeding
- **Clean** pad (remove litter) particularly if rain event is forecast
- **Cover** spoilage and litter piles until removal

Collection System Design

- *Objectives*
- Minimize collection volumes
  - Reduce storage and hauling requirements
- Reduce environmental impact
  - Collect high strength waste
  - Low strength waste to treatment systems

- *Current System Design*
  - Capture 1st flush, unconfirmed
    - Exists in urban runoff, why not here?

Collection Designs are Numerous

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Treatment Using Filter Strips

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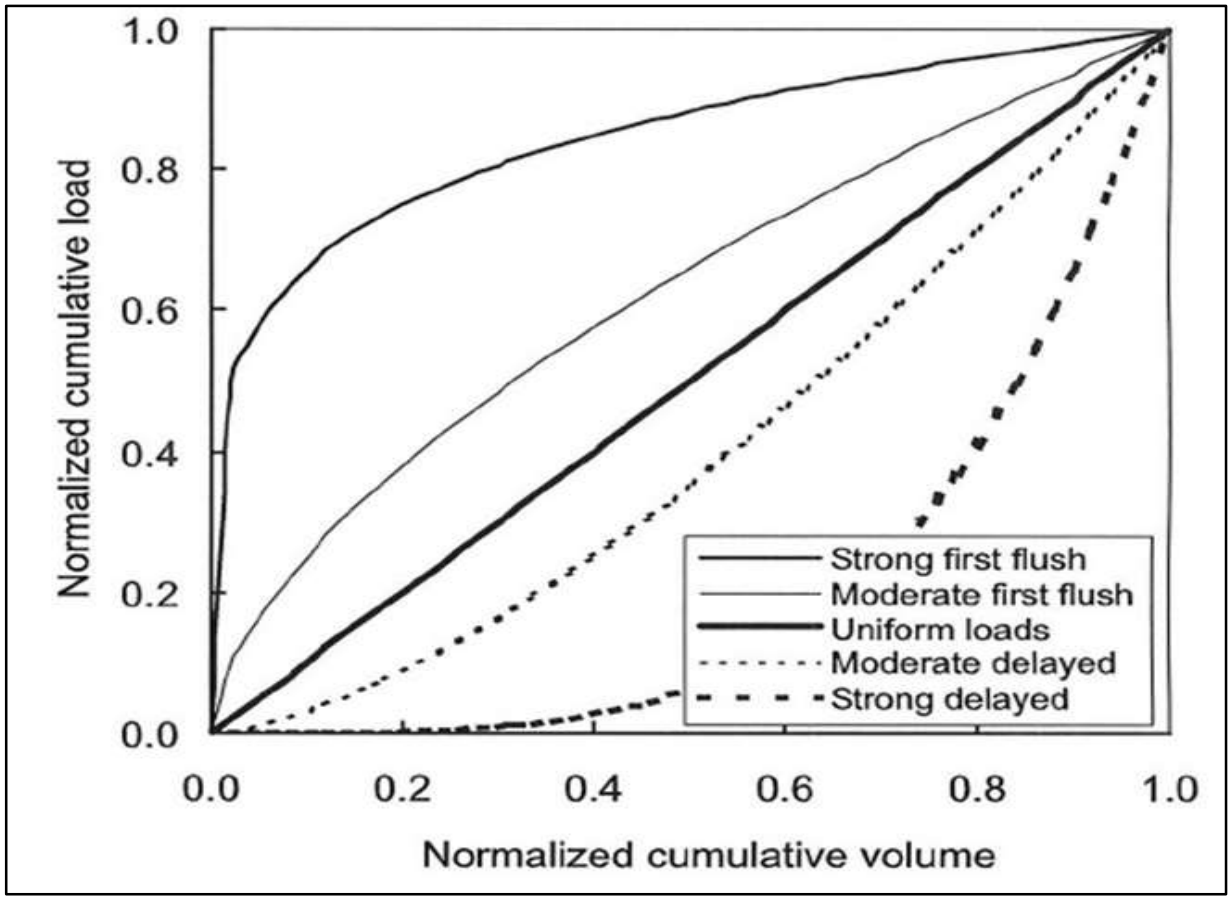
Does a First-Flush Exist?



(Taebi & Droste, 2004)

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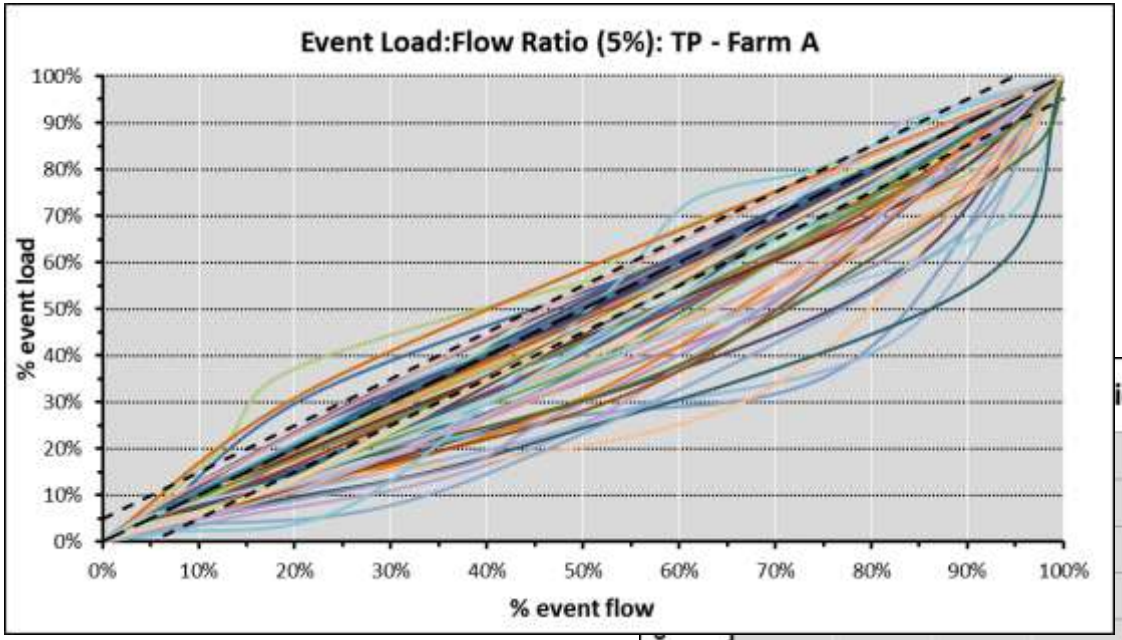
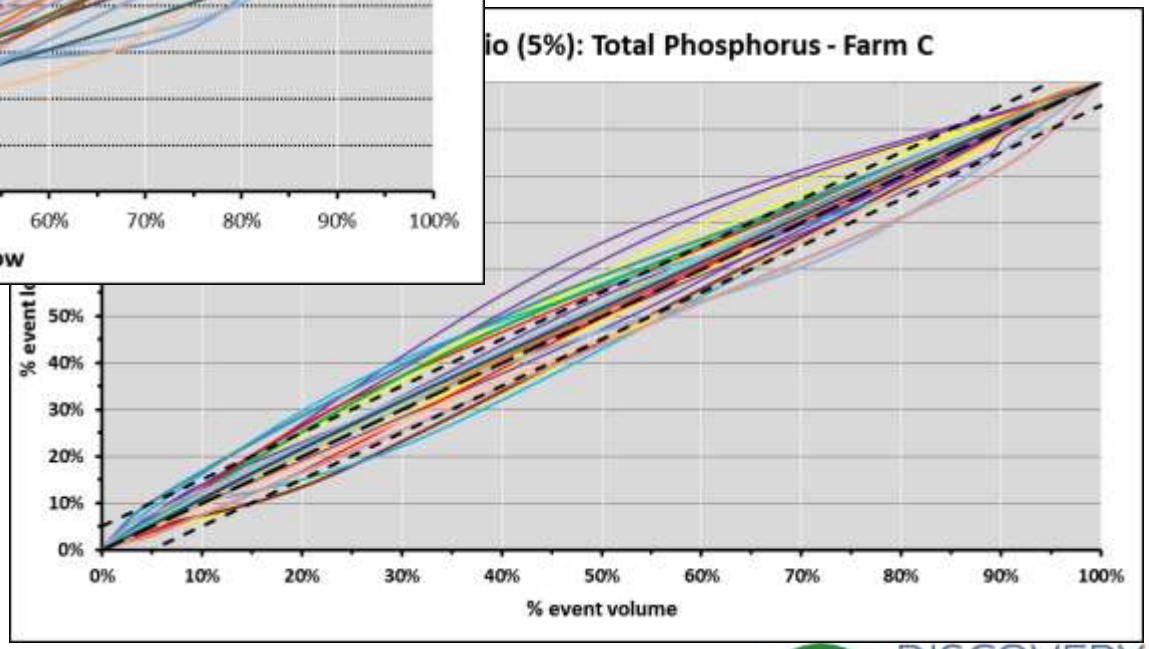
Normalized Phosphorus Data





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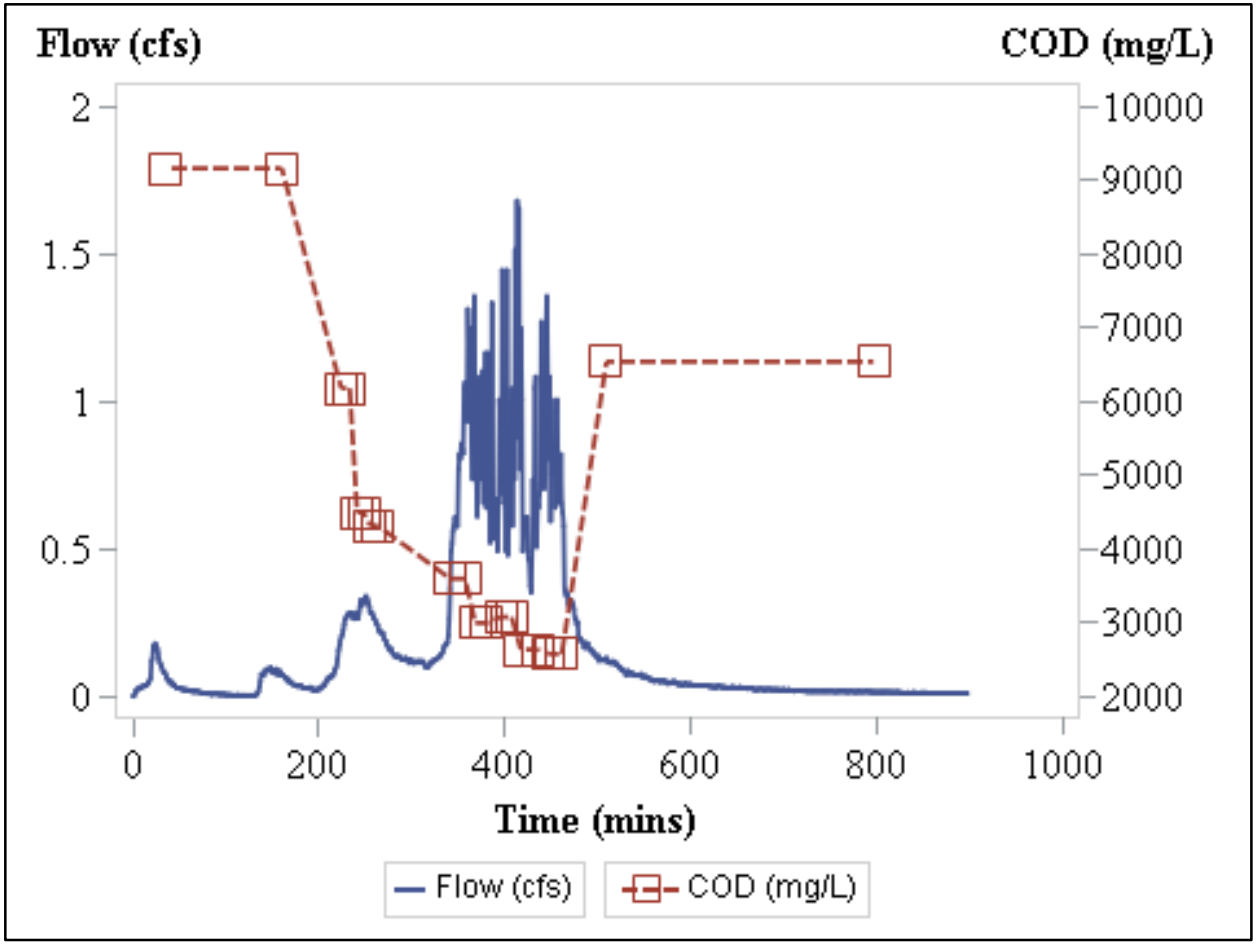
? 1st Flush ?

- Why is it that only ~10% of the events have characteristics of a 1st flush?

% of Events	N	P
Linear:	73%	75%
Delayed flush:	17%	23%
1st flush:	10%	3%

Concentration-Flow Relationship



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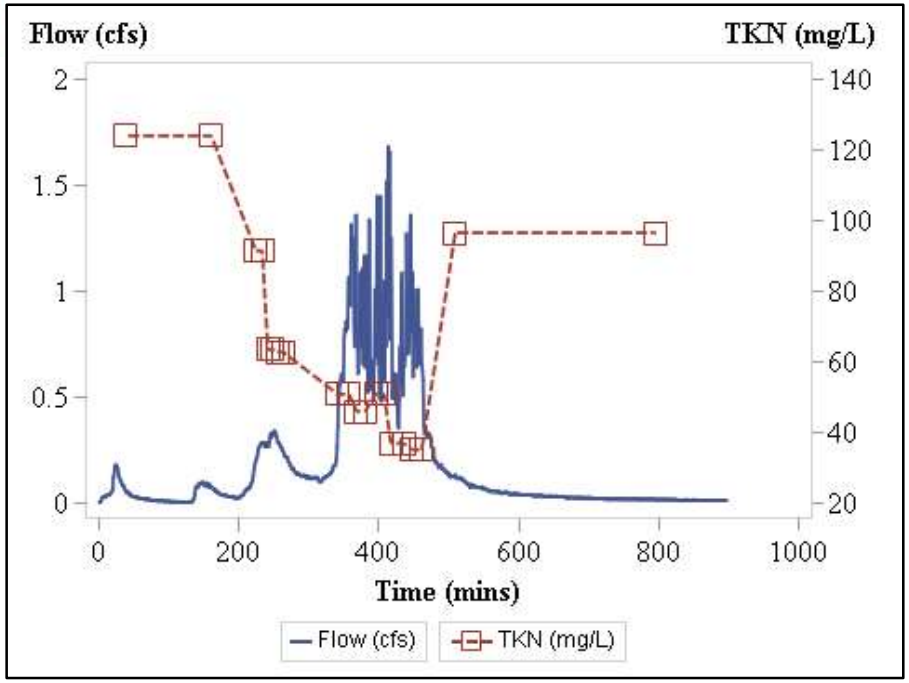
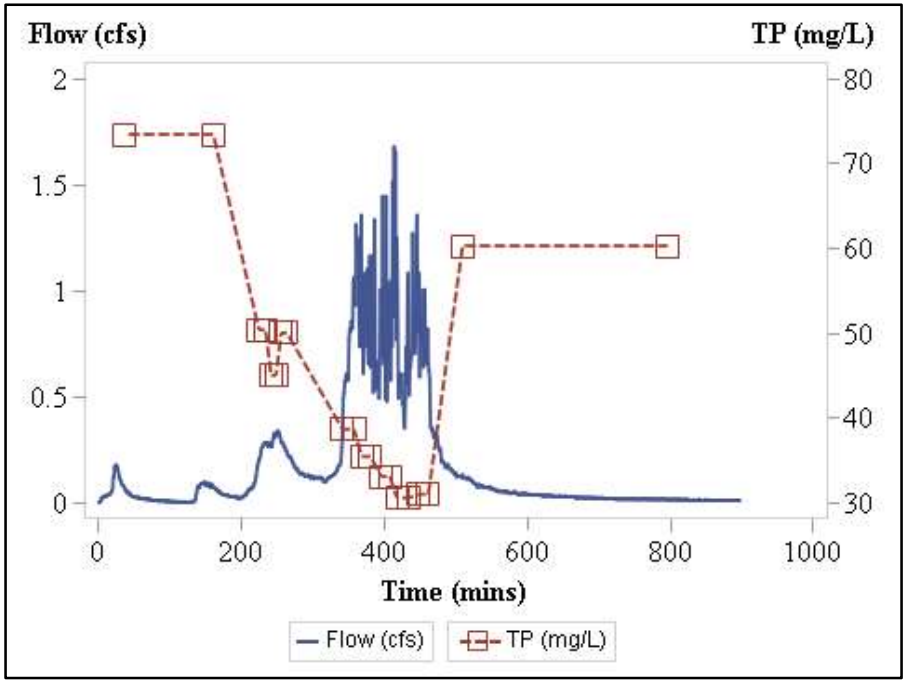
Constituent Correlations





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

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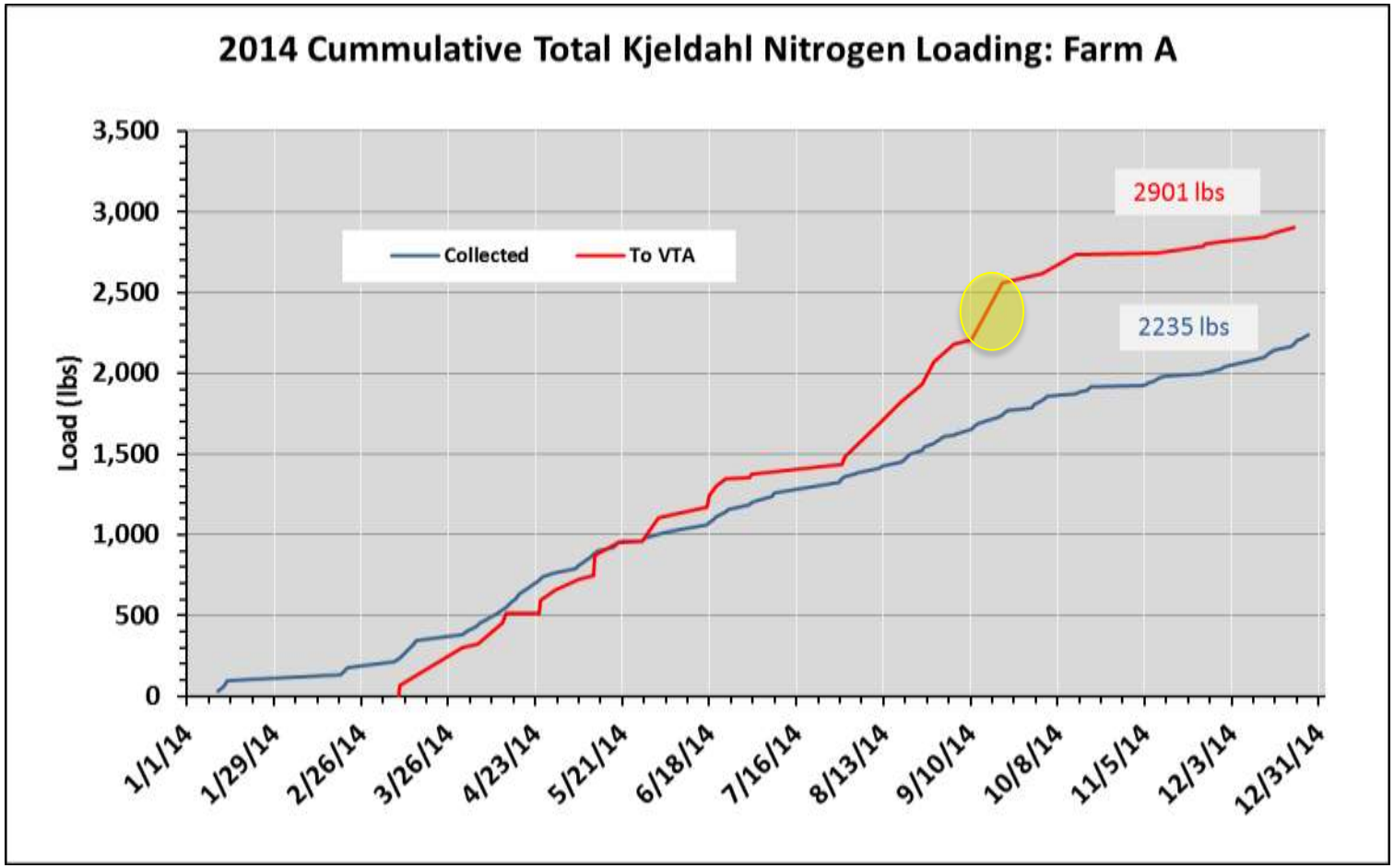
Annual Loading

- Investigate
  - Timing
  - Load collected vs. load to VTA
  - Volume collected vs. load collected

- Seasonality and a few events
  - Snowmelt
  - Big rains
  - Filling

Nitrogen Loading



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Collection Design Recommendations

- **First flush rarely exists!**
  - Not the greatest load per volume
  - Collect low flow only
  - Or continuous throughout

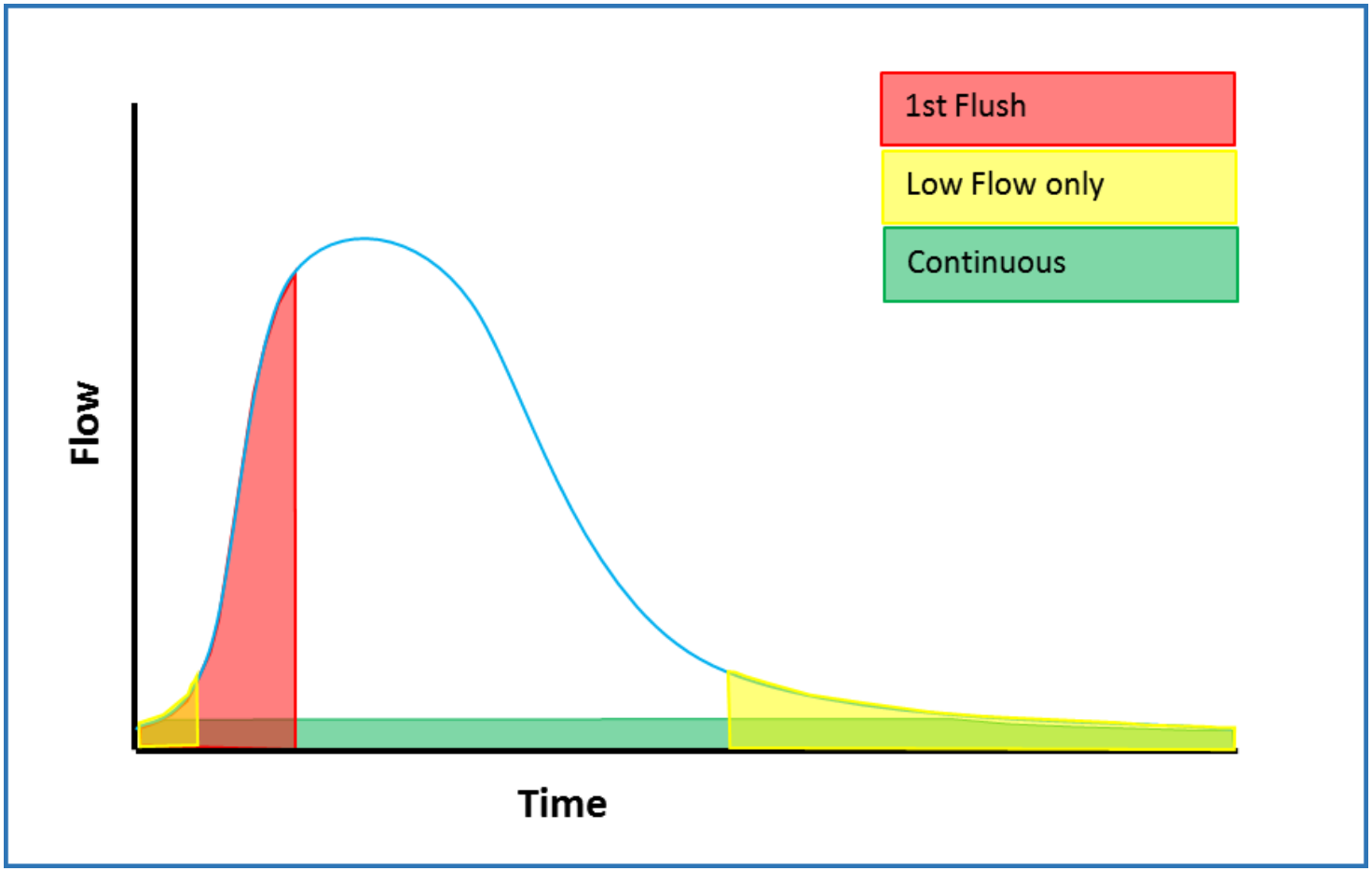
- Additional collection within 2 weeks of filling

Collection Design Recommendations

- All flow to single collection point
- Provide subsurface drainage

- Inspect and Maintain facilities
  - Feed storage area
  - Collection system
  - Filter strip
  - Address potential issues

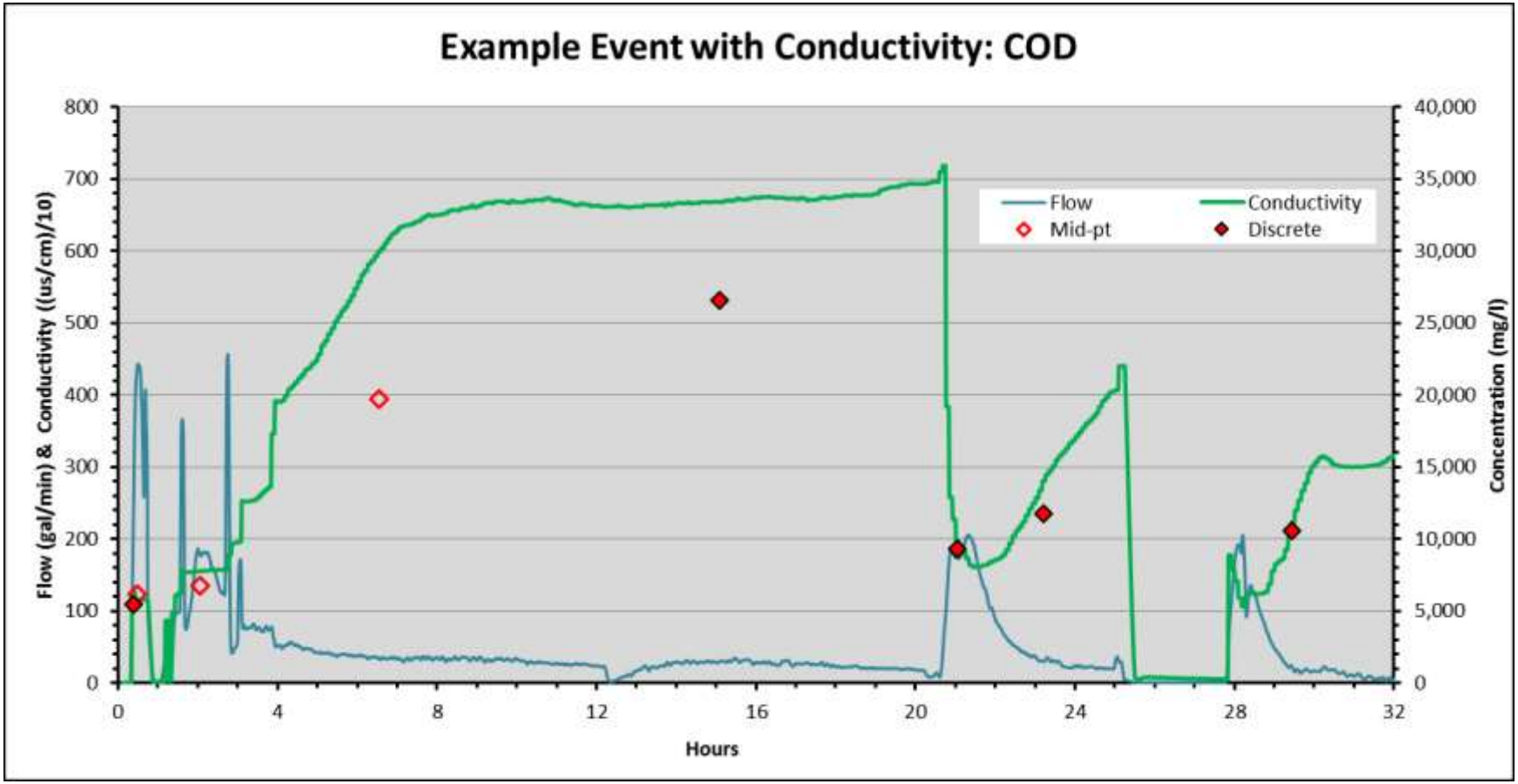
Design Concepts



Low Flow Collection

- Greater loading collected when collecting the low flow.
- Low flow collection uses peak flow rate of a designed storm.
  - 1% of the peak flowrate from a 2-year 24-hour design storm
- Peak flow rates can be calculated using one of many methods, e.g. Rational Method.
  - By hand or with software, e.g. HydroCAD

Conductivity Metering



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Key Filter Strip Design Components

- Soil profile provides treatment
  - Complex
    - Soil type
    - Soil depth
    - Slope
    - Vegetation
    - Etc

- Avoid high groundwater table or shallow depth to bedrock

Key Filter Strip Design Components

- Ensure even application across filter strip
  - Irrigation pods
  - Grade evenly (difficult to achieve, need to supervise)
  - Rock checks for spreading
    - Impermeable membrane
    - 2-4 inch round stone
    - Every 100 feet of length

- Spreader at point of discharge to filter strip

Inefficient Filter Strip

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Spreader at Discharge

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To be continued…

- Other analysis being conducted
  - Recommended loading: filter strips
  - Timing and variation
  - Effect of feed volume and area covered
  - Conductivity metering

- Low flow collection = greater load collected
  - Loading with same volume
  - Volume with same loading
  - Effects
    - Economics
    - Designs

Thank You!

Questions/ Comments

http://www.uwdiscoveryfarms.org

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