

Fate and Transport of Micropollutants in the Drainfields of Onsite Wastewater Treatment Systems



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What are Septic Systems?

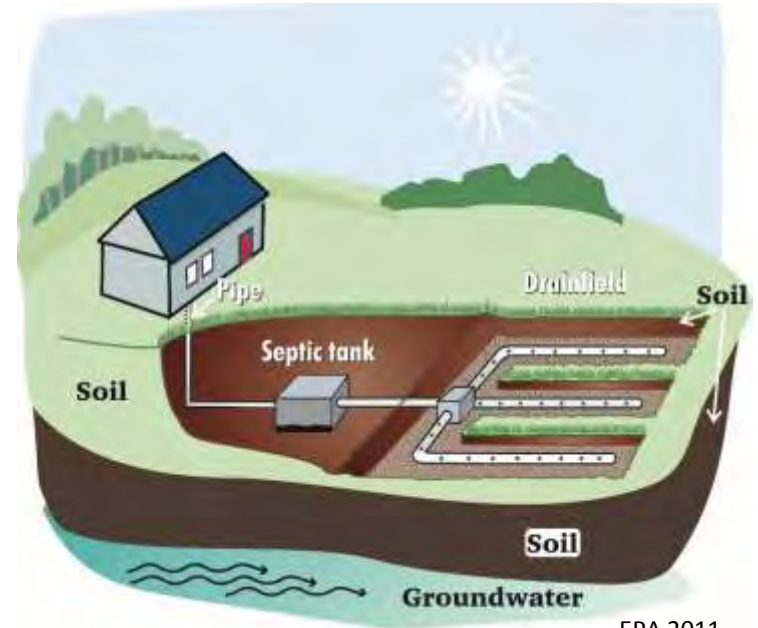
- Septic systems are known as onsite wastewater treatment systems (OWTS)
- Used to treat and dispose of small amount of wastewater, usually from individual house or business
- Number of septic systems in US & Florida:

USA:

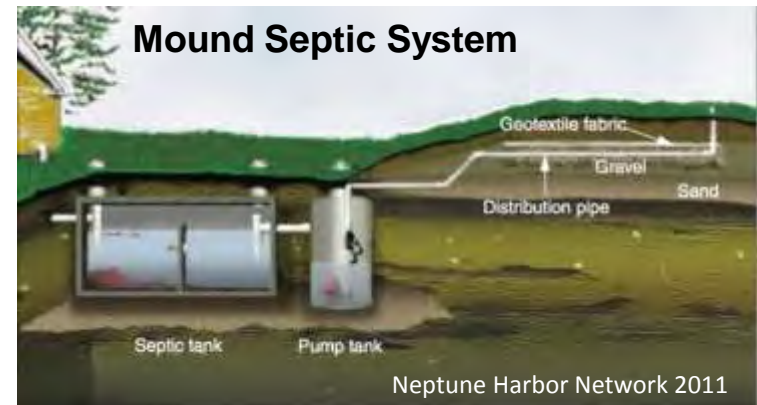
- 25% households or 60 million people
- Annual discharge: 800 billion gallons

Florida:

- 33% households or 6 million people
- Annual discharge: 156 billion gallons from ~2.5 million septic systems
- 40% of OWTS located in coastal areas



EPA 2011



Neptune Harbor Network 2011

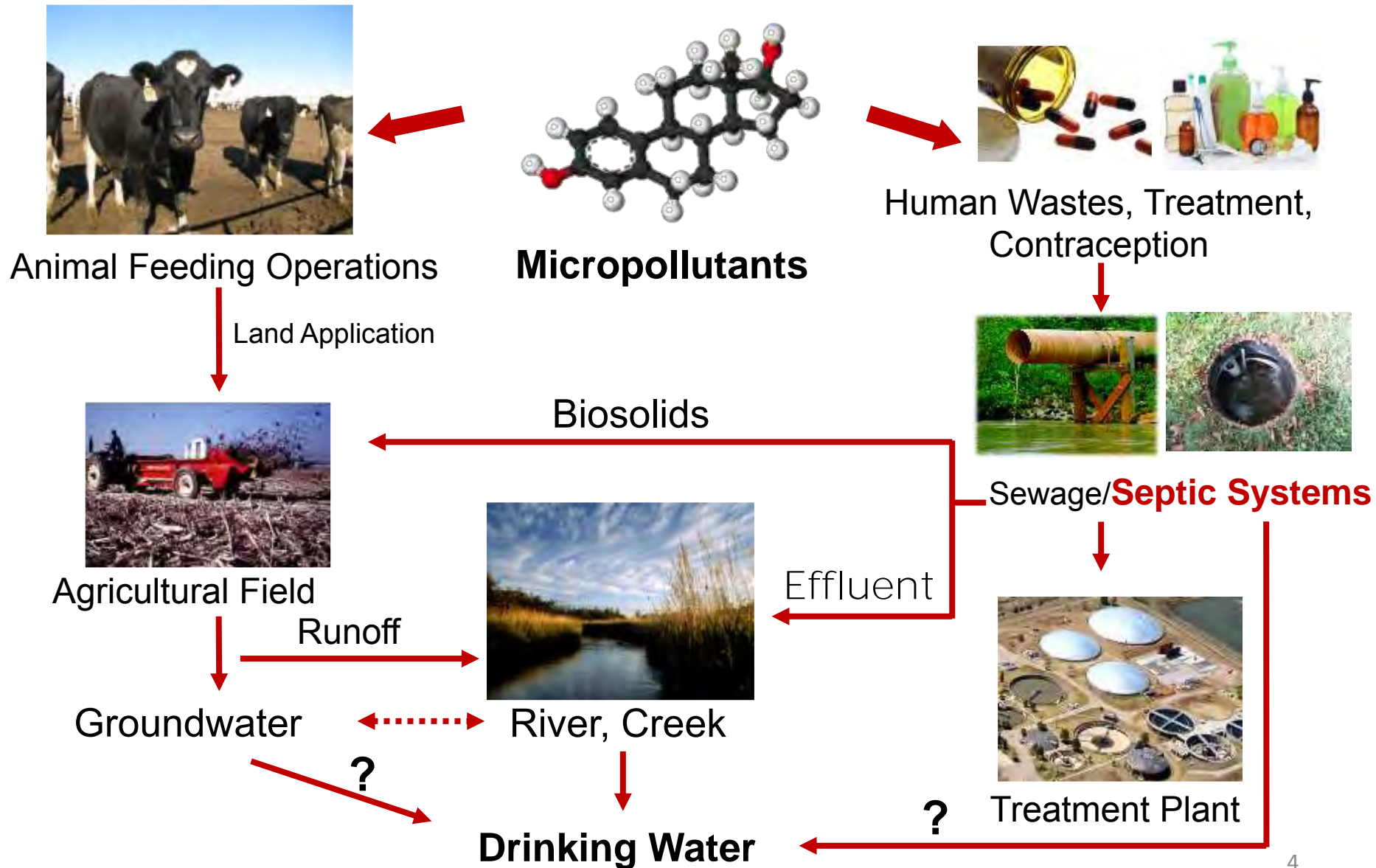
Why Worry About Micropollutants?

- Micropollutants originate from human activities:
 - Pharmaceuticals: Over-the-counter, prescription, veterinary drugs
 - Hormones
 - Personal care products



- Endocrine disruptors mimic or block the action of the body's hormones
- Micropollutants can be present at very low levels (e.g., ng/L), but with potential to adversely impact humans and ecosystems
- Transport of micropollutants from septic systems can impact drinking water supplies

What Is the Fate of Micropollutants in the Environment?

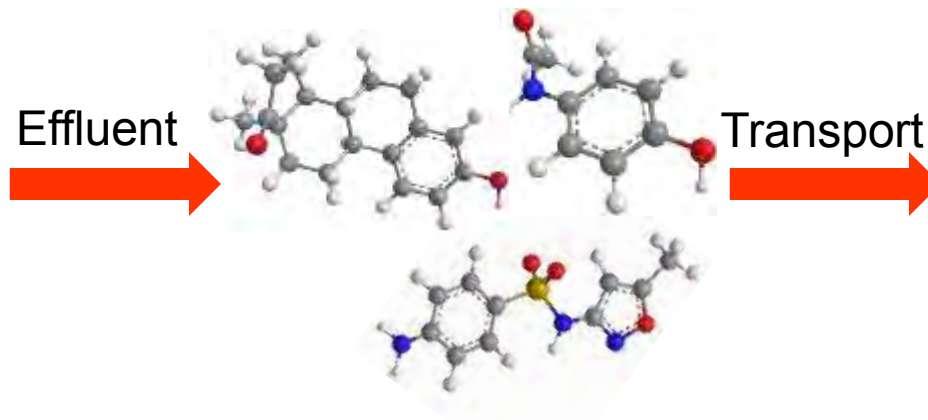


Objectives

- Investigate the occurrence, behavior, and leaching of selected pharmaceuticals and personal care products (PPCPs) in septic drainfields
- Determine the mass balance of selected PPCPs in mounded drainfields of conventional septic systems

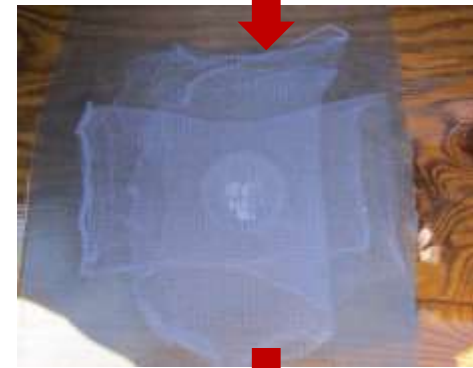
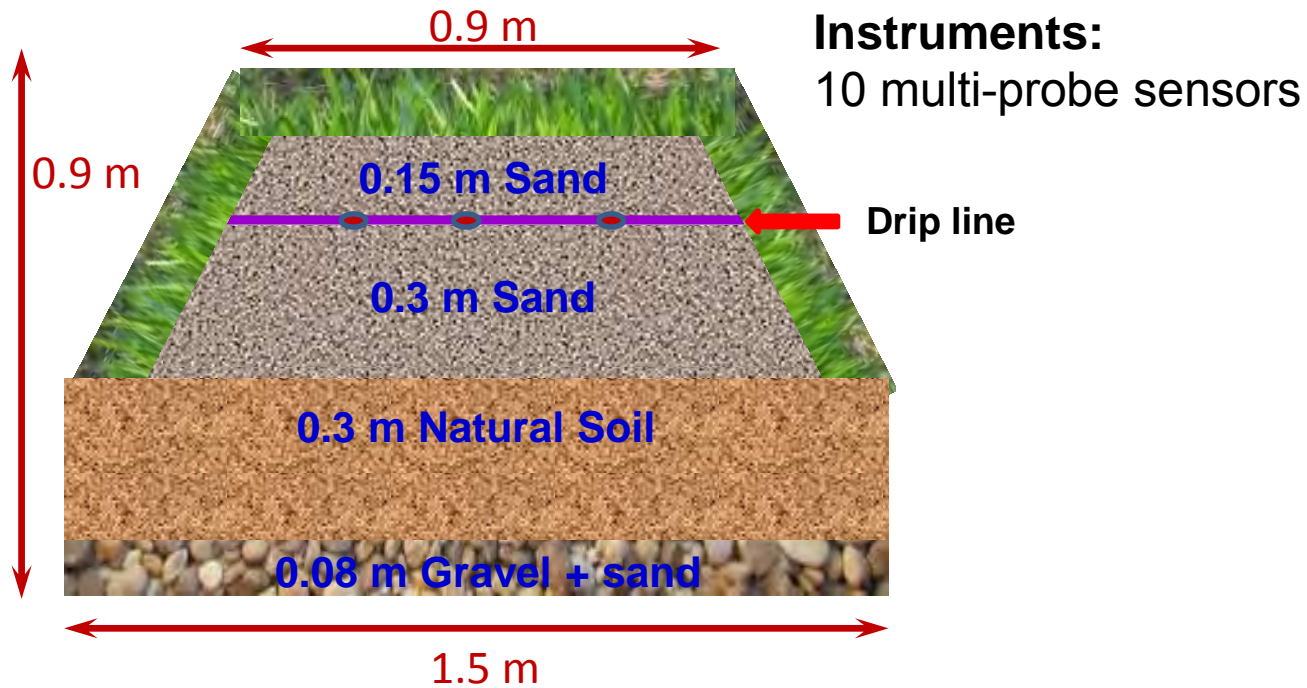


Septic tank



Septic drainfields

Methods: Construction of Small Drainfields



Methods: Construction of Small Drainfields



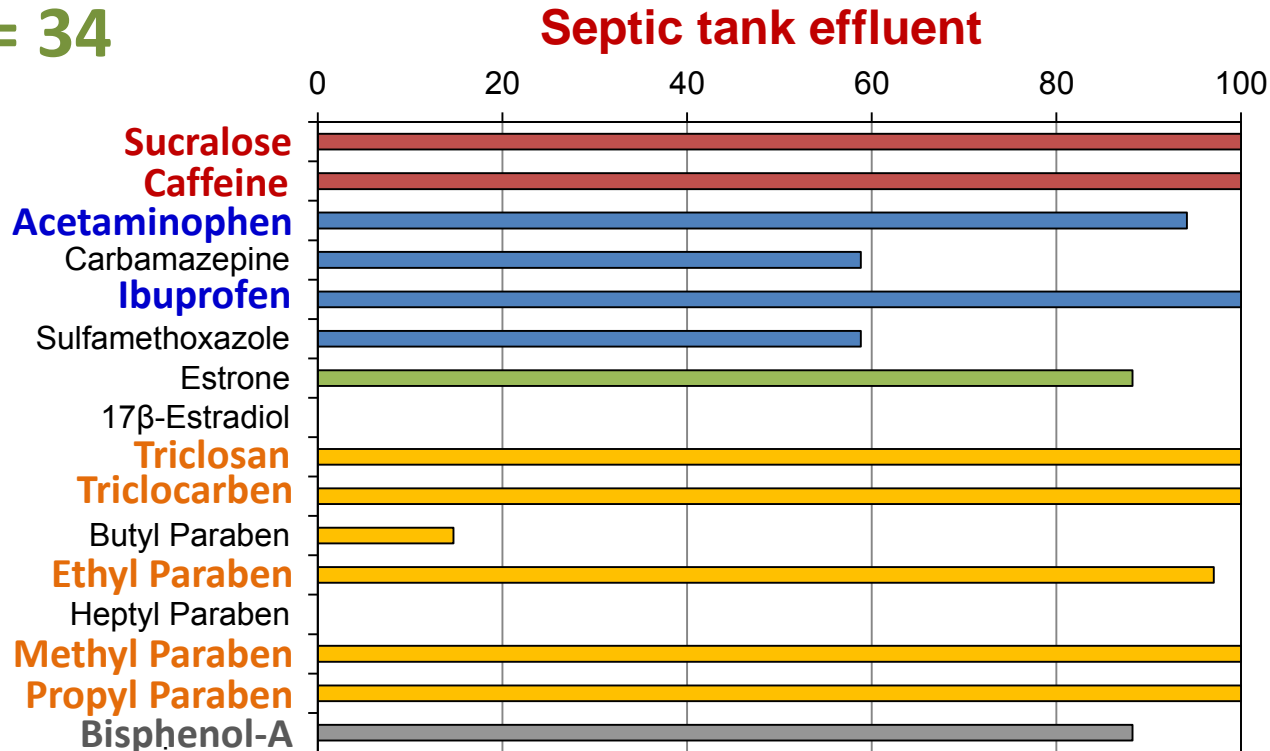
Analysis

- Water samples were analyzed by solid-phase extraction and LC-MS/MS
- 17 selected PPCPs

Markers 2	Pharmaceuticals 4	Hormones 3	PCPs 7	Plasticizer 1
Sucralose (sweetener)	Acetaminophen (analgesic)	Estrone (reproductive hormone)	Triclosan (antimicrobial agent)	Bisphenol-A (plasticizer)
Caffeine (stimulant)	Carbamazepine (anticonvulsant)	Estradiol (reproductive hormone)	Triclocarban (antimicrobial agent)	
	Ibuprofen (anti-inflammatory)	Ethinyl Estradiol (ovulation inhibitor)	Butyl- Ethyl- Heptyl-Paraben Methyl- Propyl- (preservative)	
	Sulfamethoxazole (antibiotics)			

PPCPs Detection Frequency (Jan-Aug 2013)

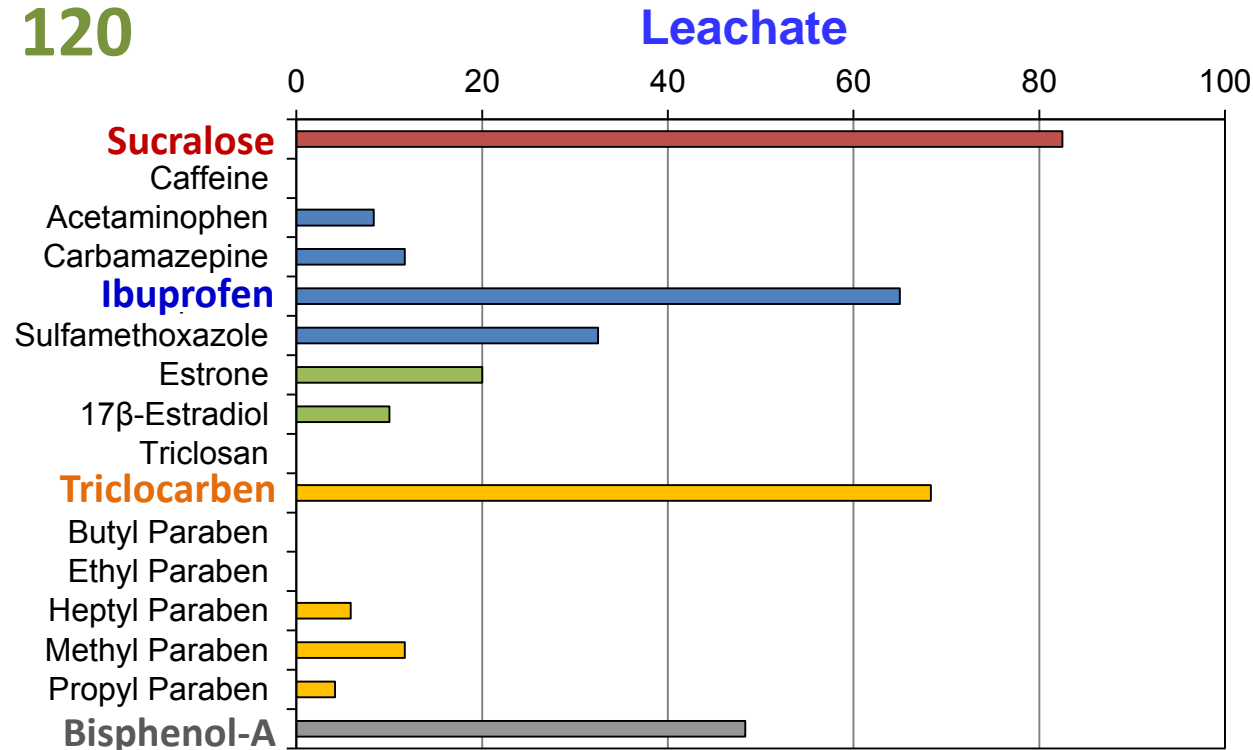
N = 34



- 14 PPCPs were detected in effluent
- The most frequency detected compounds:
 - Markers: sucralose and caffeine (100%)
 - Pharmaceuticals: acetaminophen and ibuprofen (>90%)
 - Hormones: estrone (88%)
 - PCPs: triclosan, triclocarban, ethyl-, methyl-, and propyl paraben (>90%)
 - Bisphenol-A: 88%

PPCPs Detection Frequency (Jan-Aug 2013)

N = 120

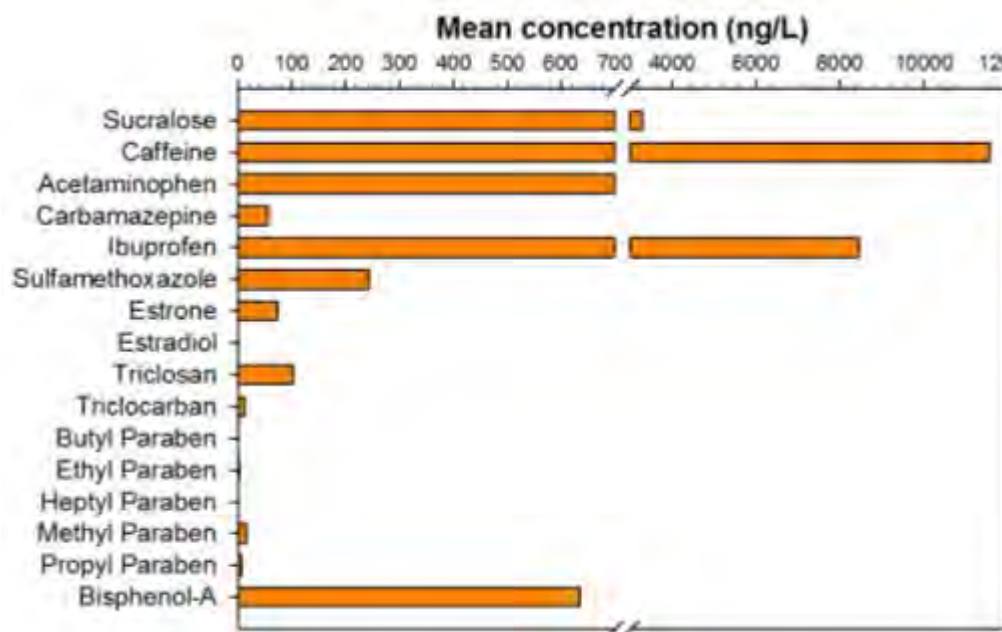


- 12 PPCPs were detected in leachate
- The most frequency detected compounds:
 - Markers: sucralose (83%)
 - Pharmaceuticals: ibuprofen (65%)
 - Hormones: <20%
 - PCPs: triclocarban (68%)
 - Bisphenol-A: 48%

Summary of Mean Concentrations of PPCPs in STE and Leachate

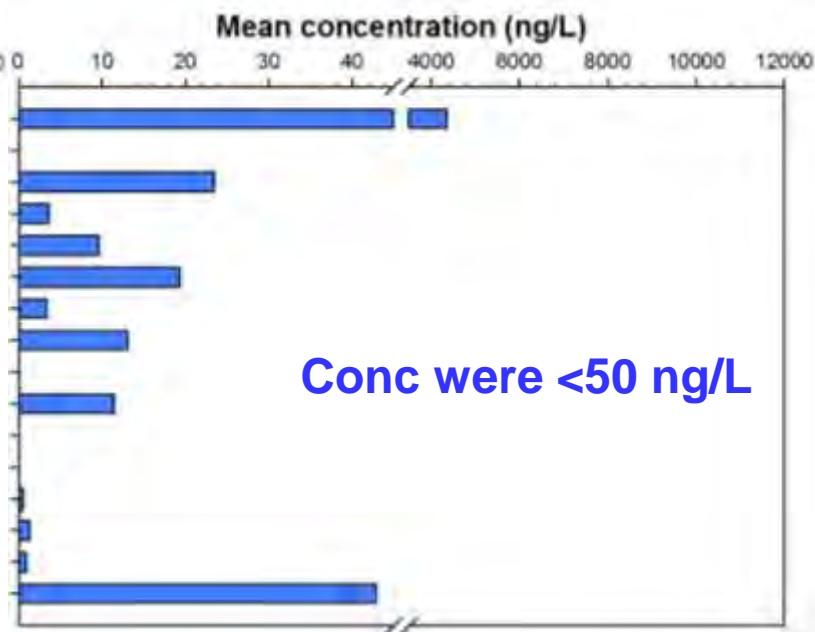
N = 34

Septic tank effluent



N = 120

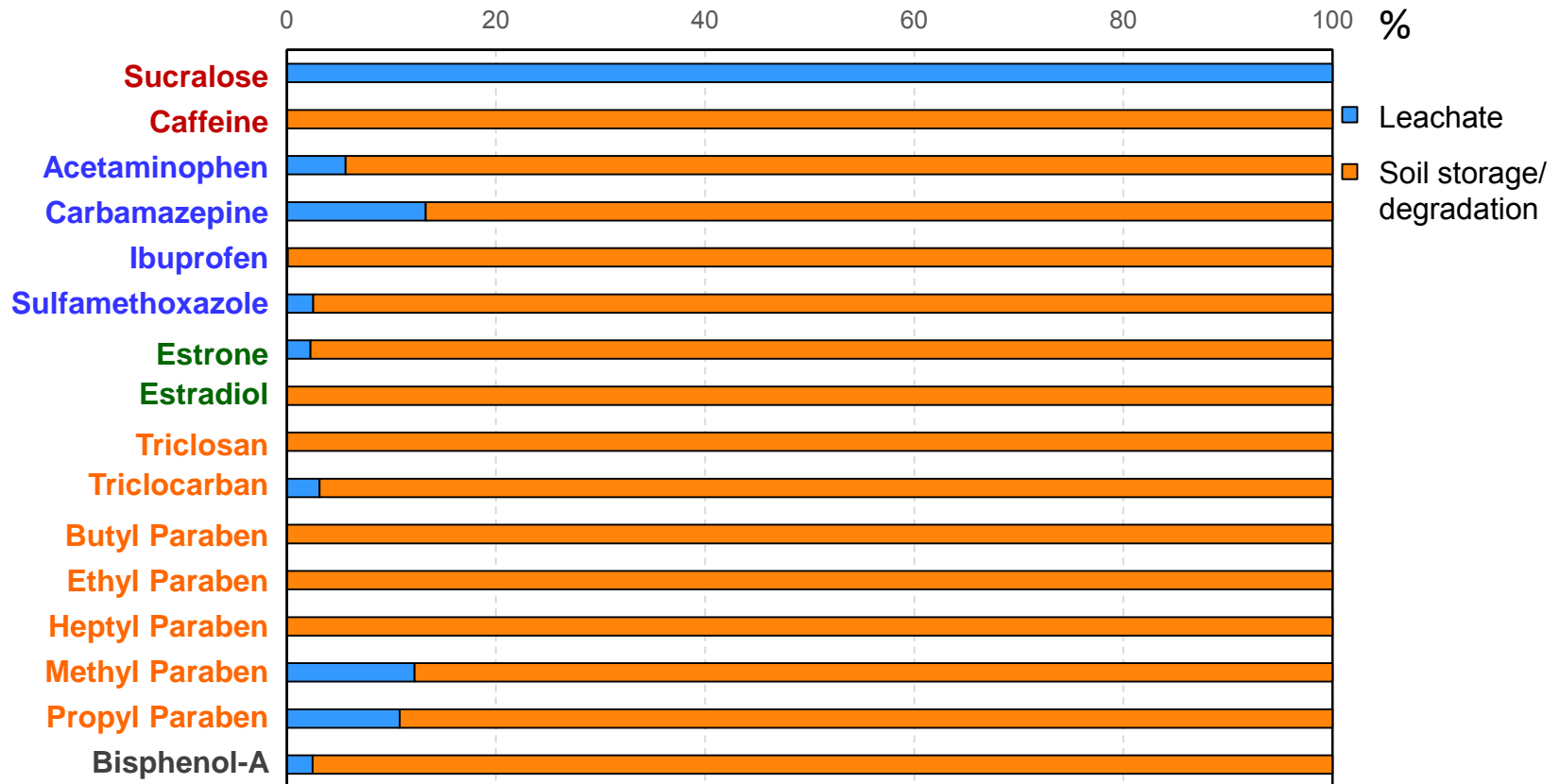
Leachate



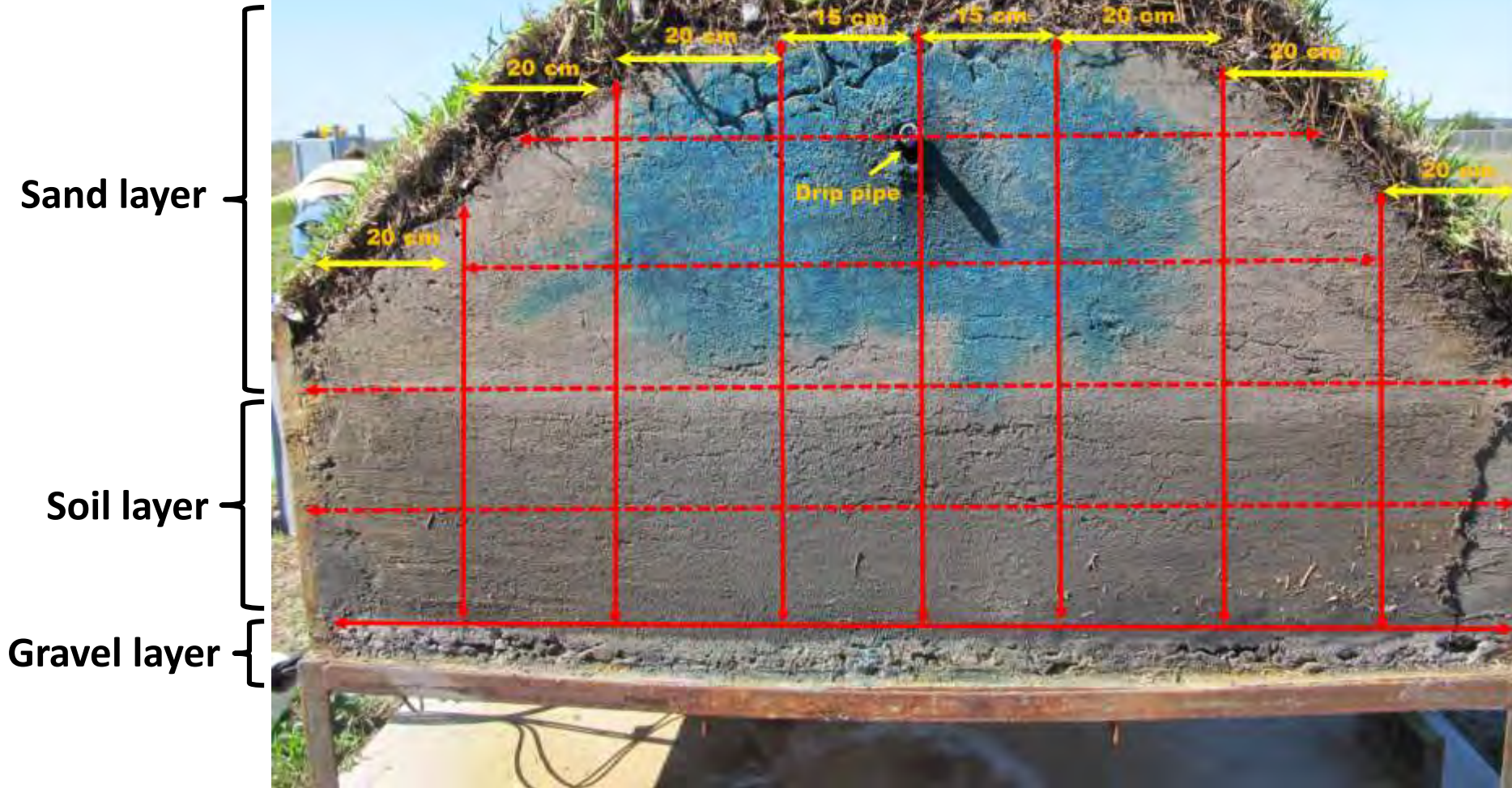
- PPCPs are present in effluent and septic drainfields
- PPCPs concentrations decreased as effluent percolated in vadose zone

Mass Balance of Micropollutants in Drainfields

- <20% of applied PPCPs in STE recovered in leachate
- >80% either remained (stored) in soil, degraded in unsaturated soil zone
- <2% plant uptake



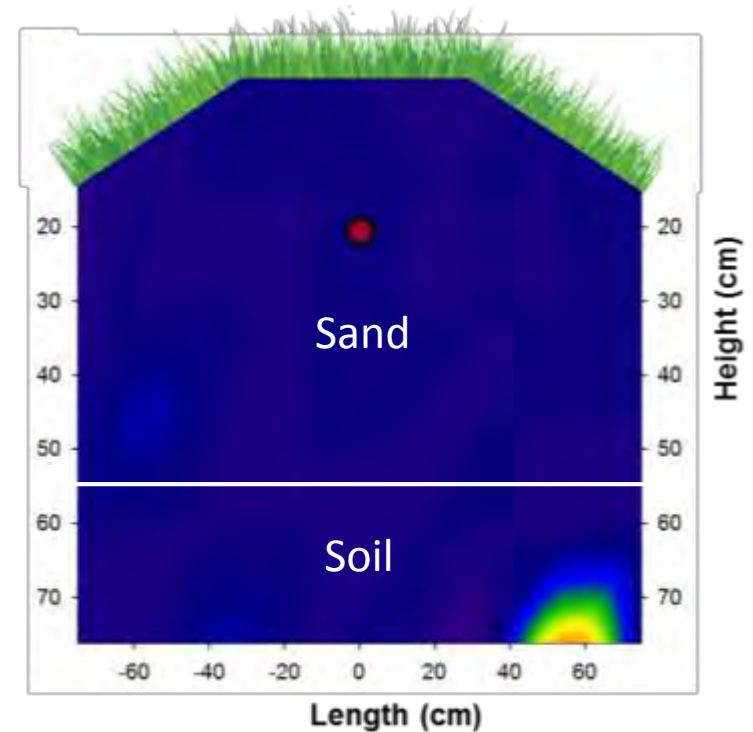
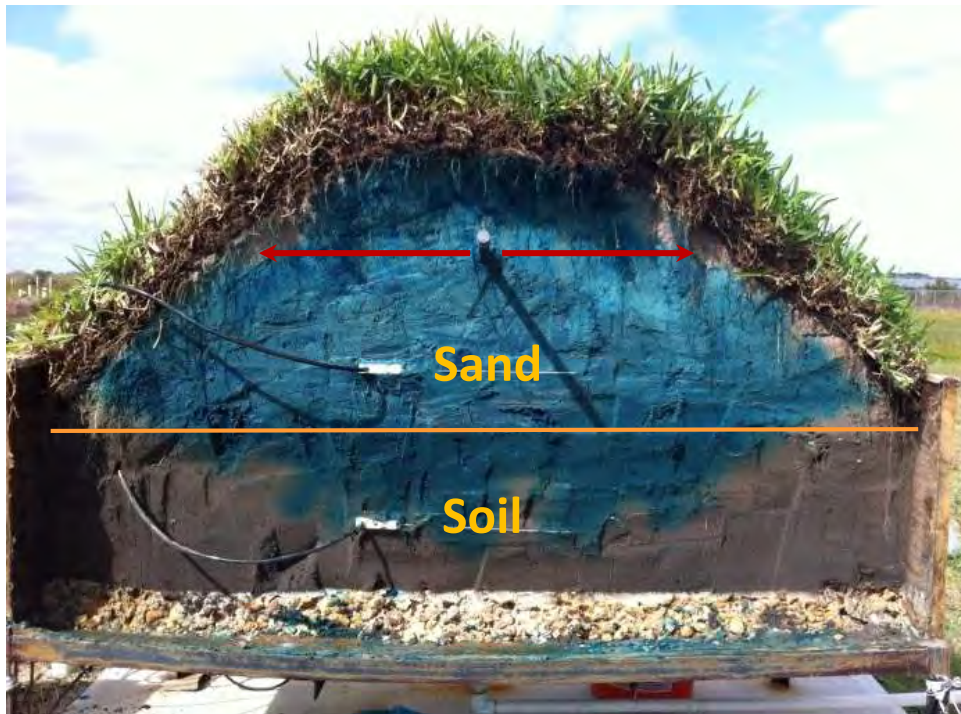
Where Are PPCPs in the Drainfields?



Spatial Distribution of PPCPs within Drainfield

Acetaminophen

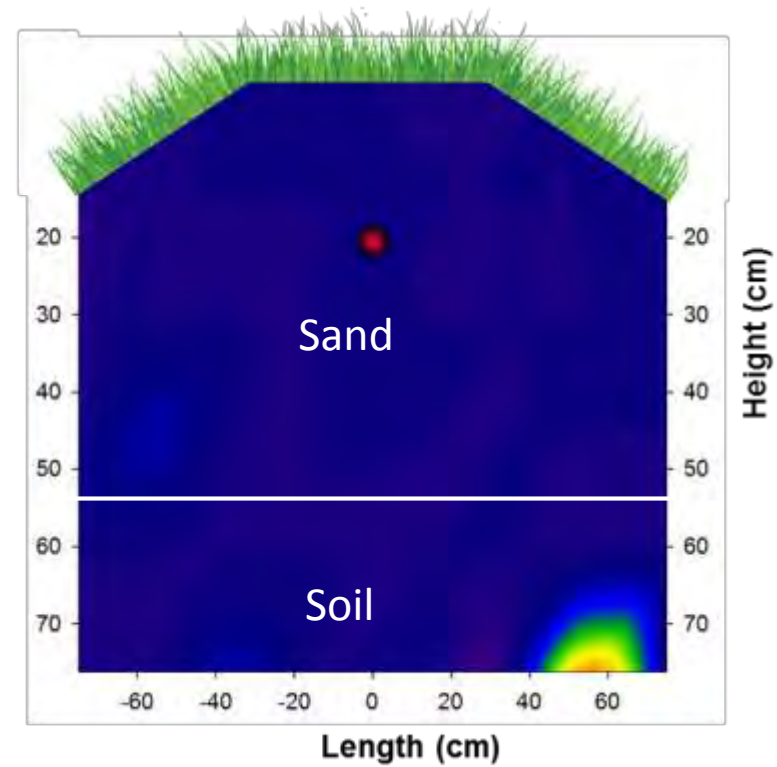
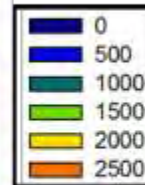
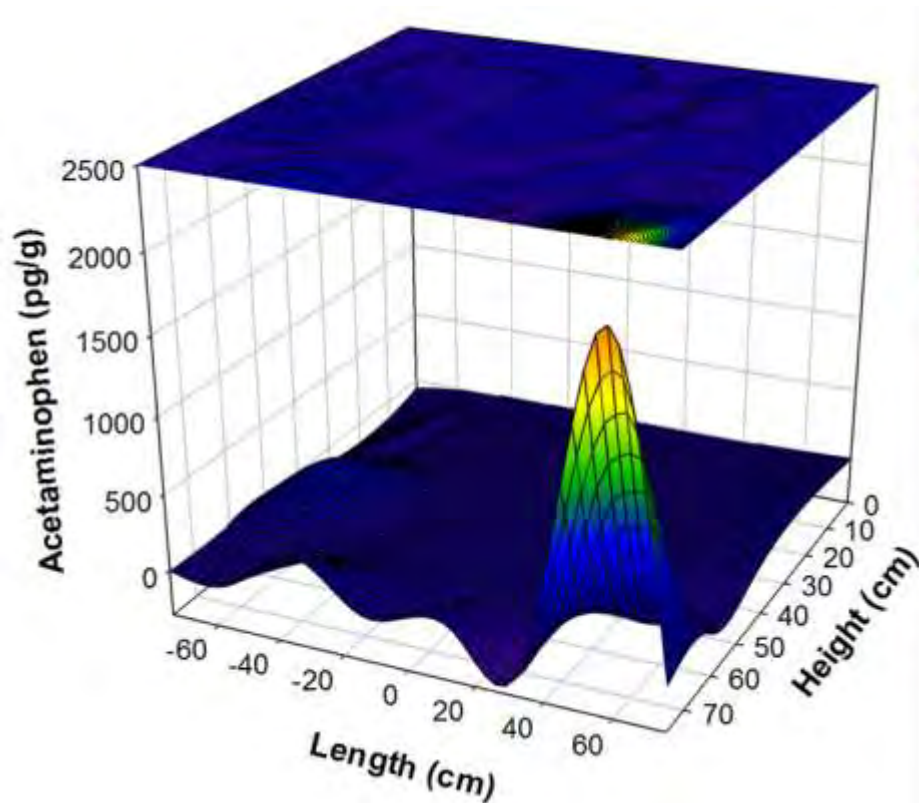
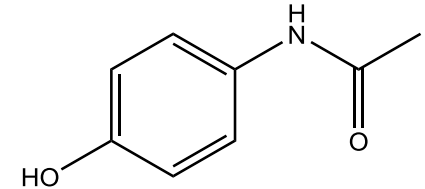
- 250- 2024 pg/g on the bottom side



Spatial Distribution of PPCPs within Drainfield

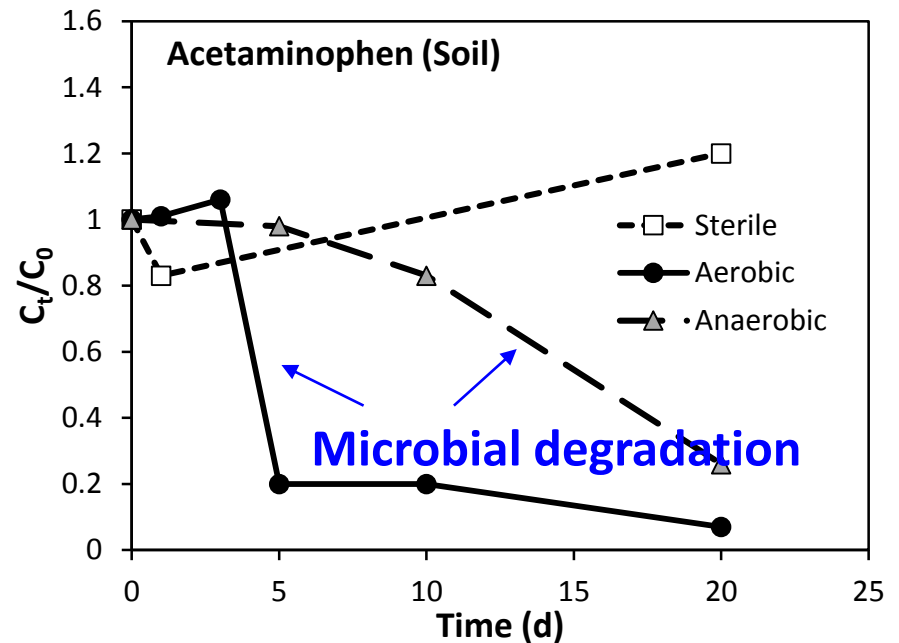
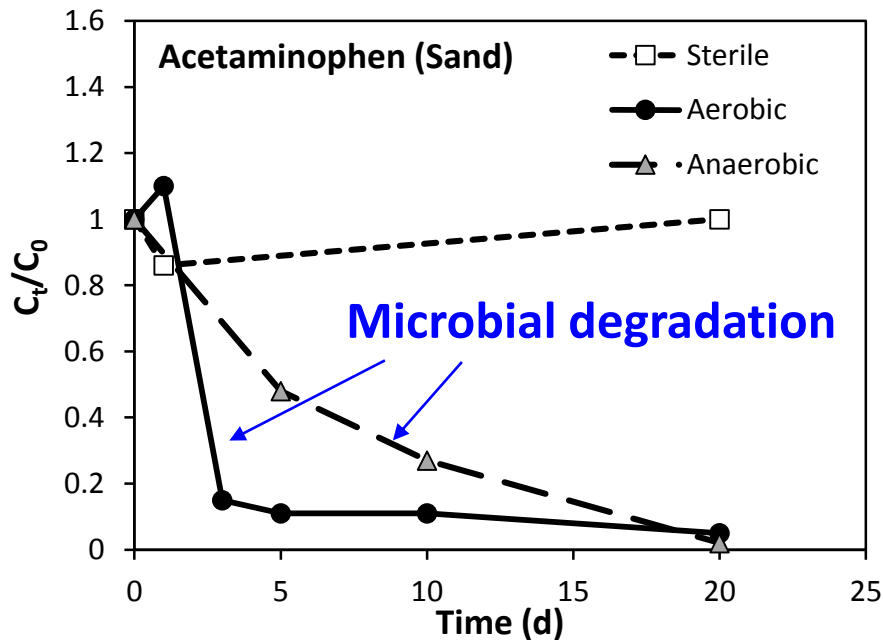
Acetaminophen

- 250- 2024 pg/g on the bottom side



Spatial Distribution of PPCPs within Drainfield

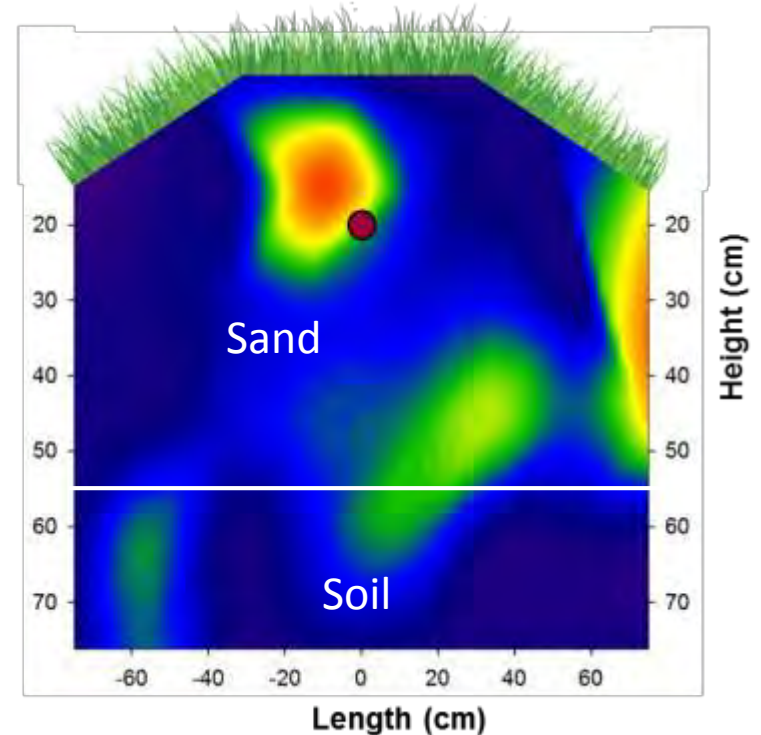
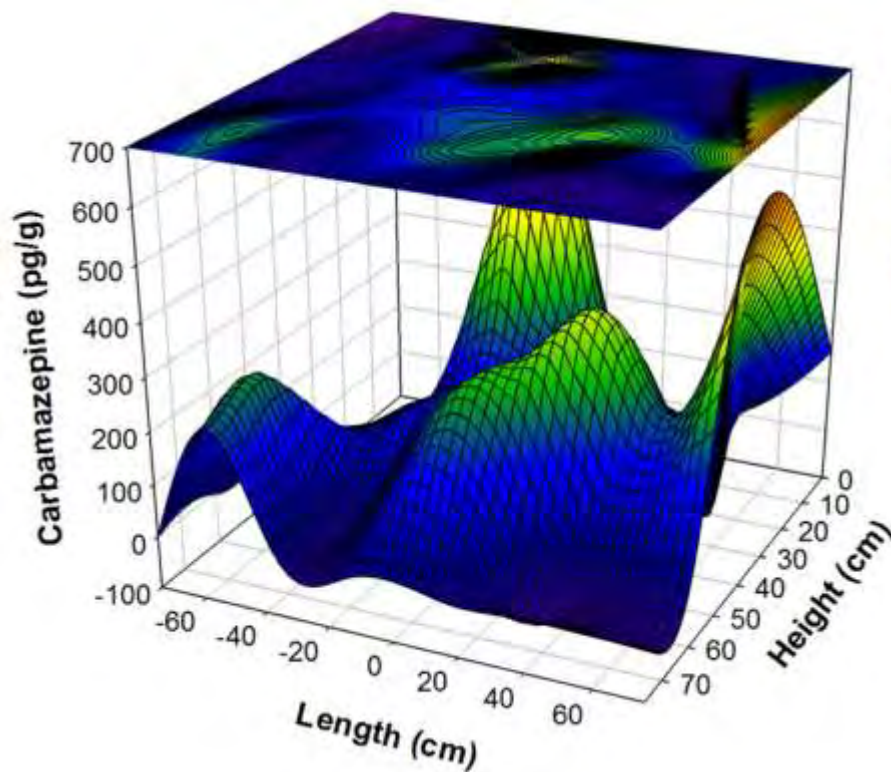
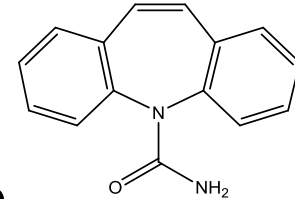
Acetaminophen



Spatial Distribution of PPCPs within Drainfield

Carbamazepine

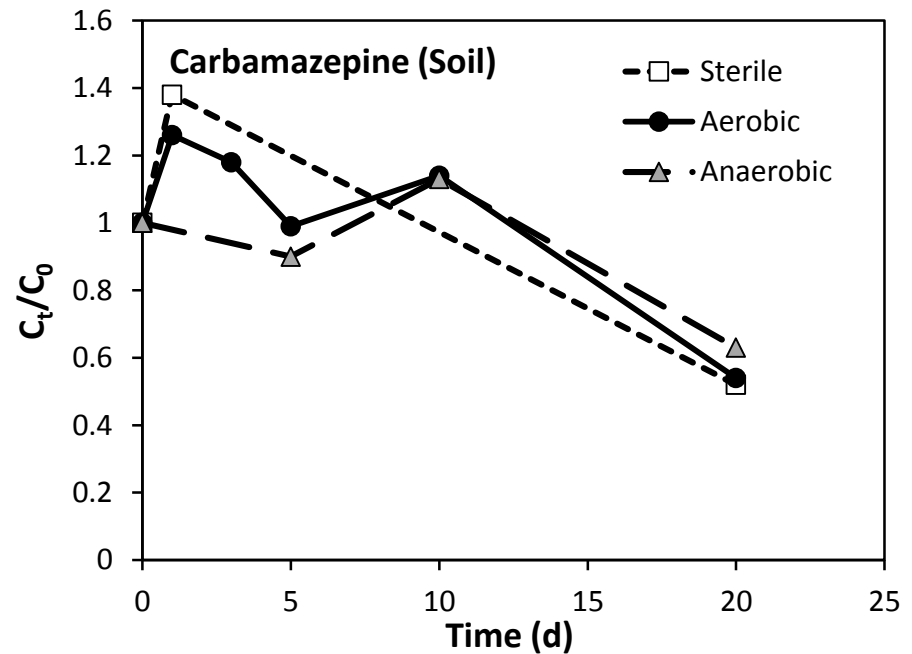
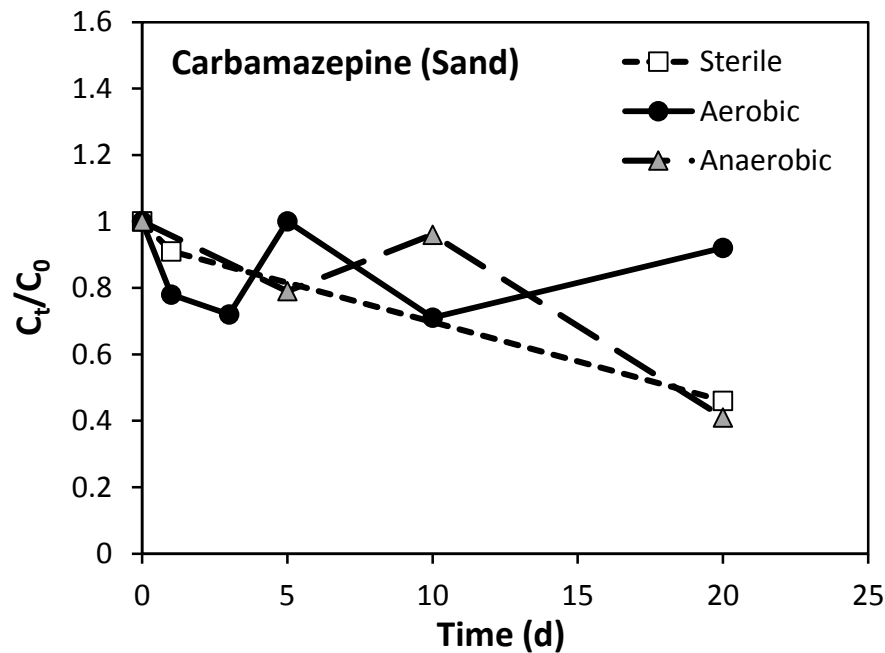
- 77- 594 pg/g on the top and side



Spatial Distribution of PPCPs within Drainfield

Carbamazepine

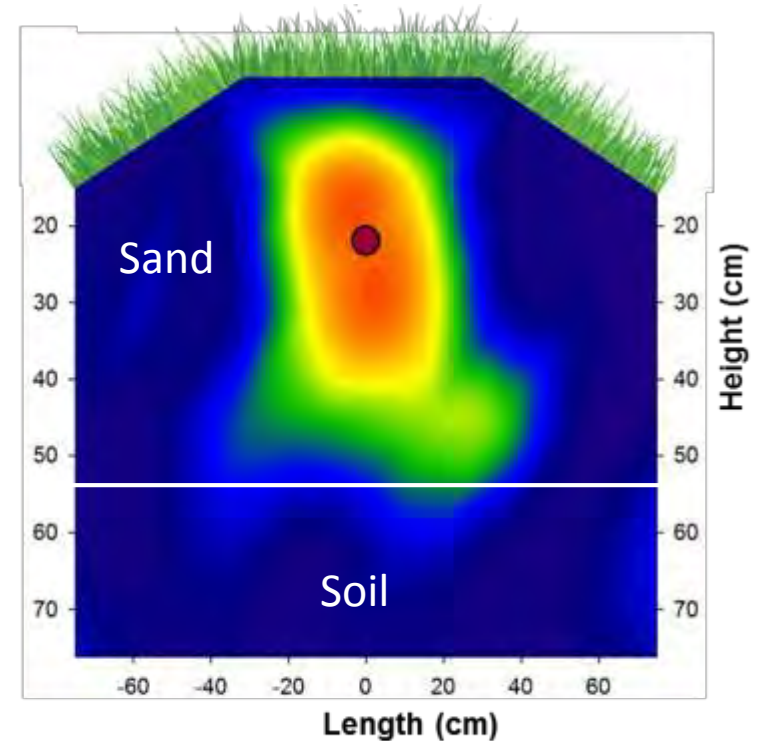
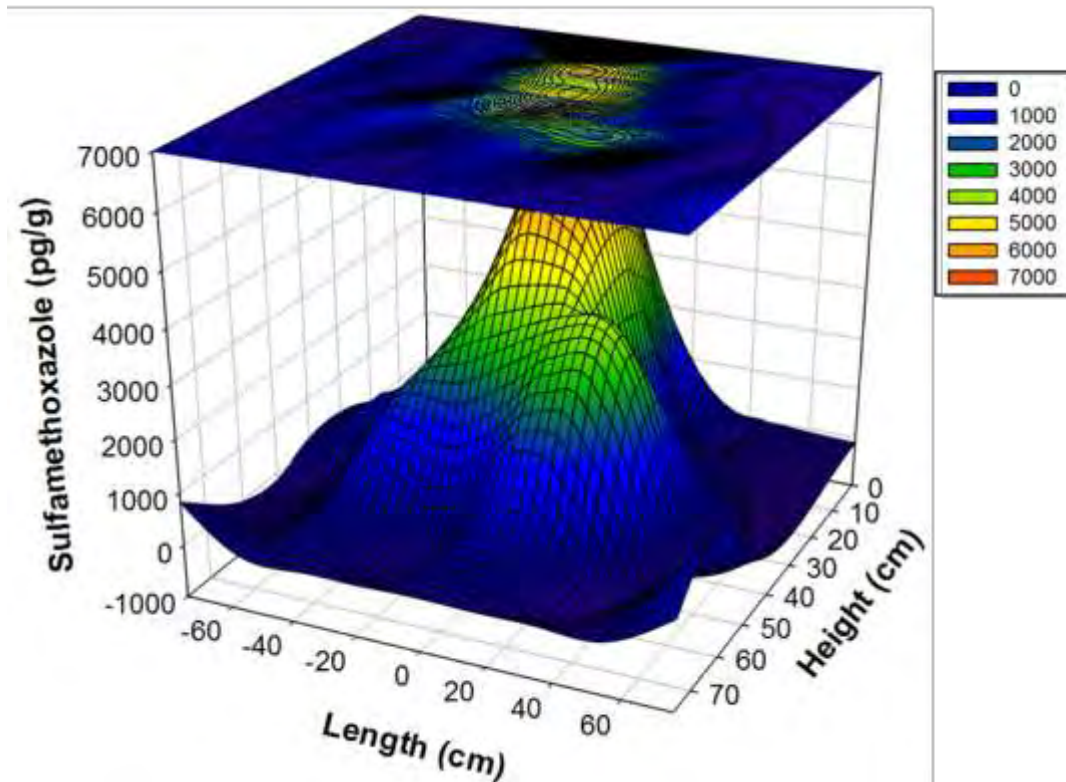
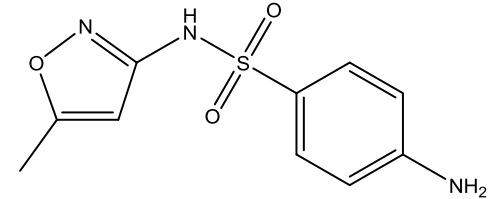
- Carbamazepine relatively resistant to removal in the environment (Gomez et al. 2007)



Spatial Distribution of PPCPs within Drainfield

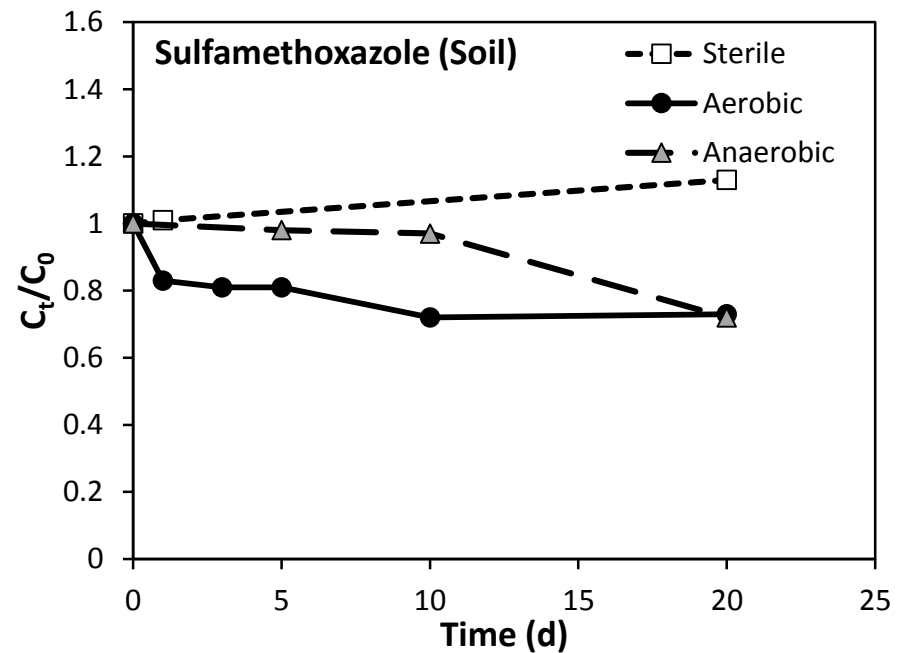
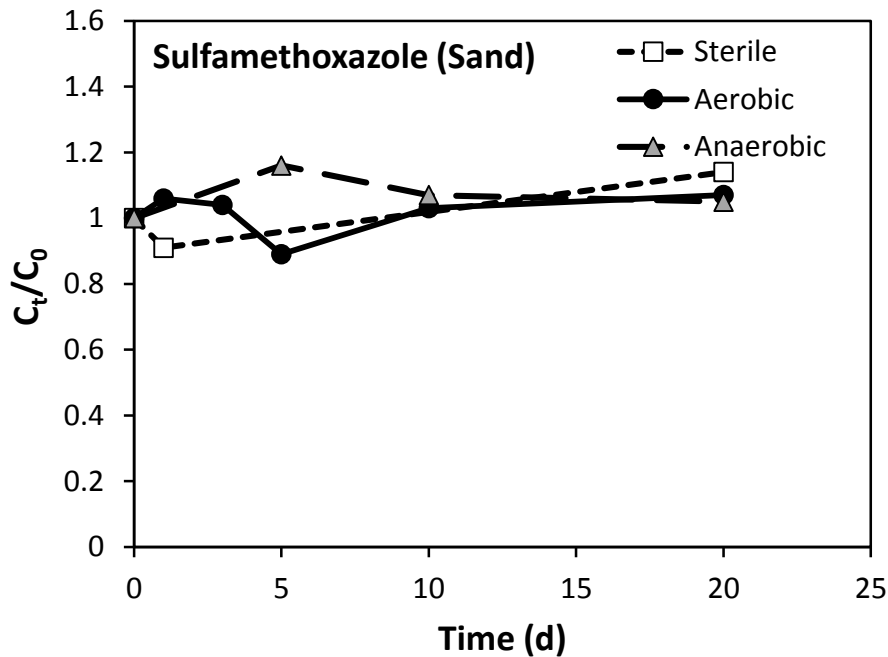
Sulfamethoxazole

- 134- 5109 pg/g in the middle

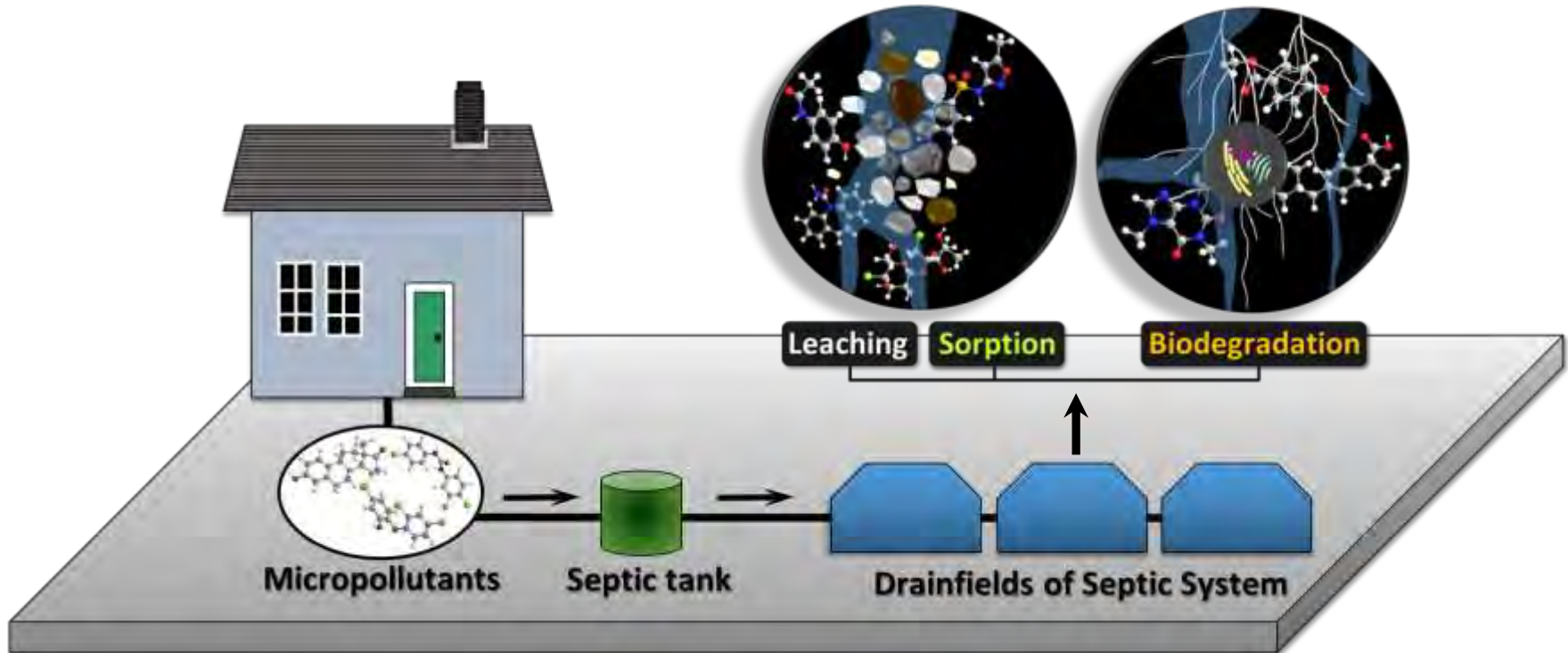


Spatial Distribution of PPCPs within Drainfield

Sulfamethoxazole

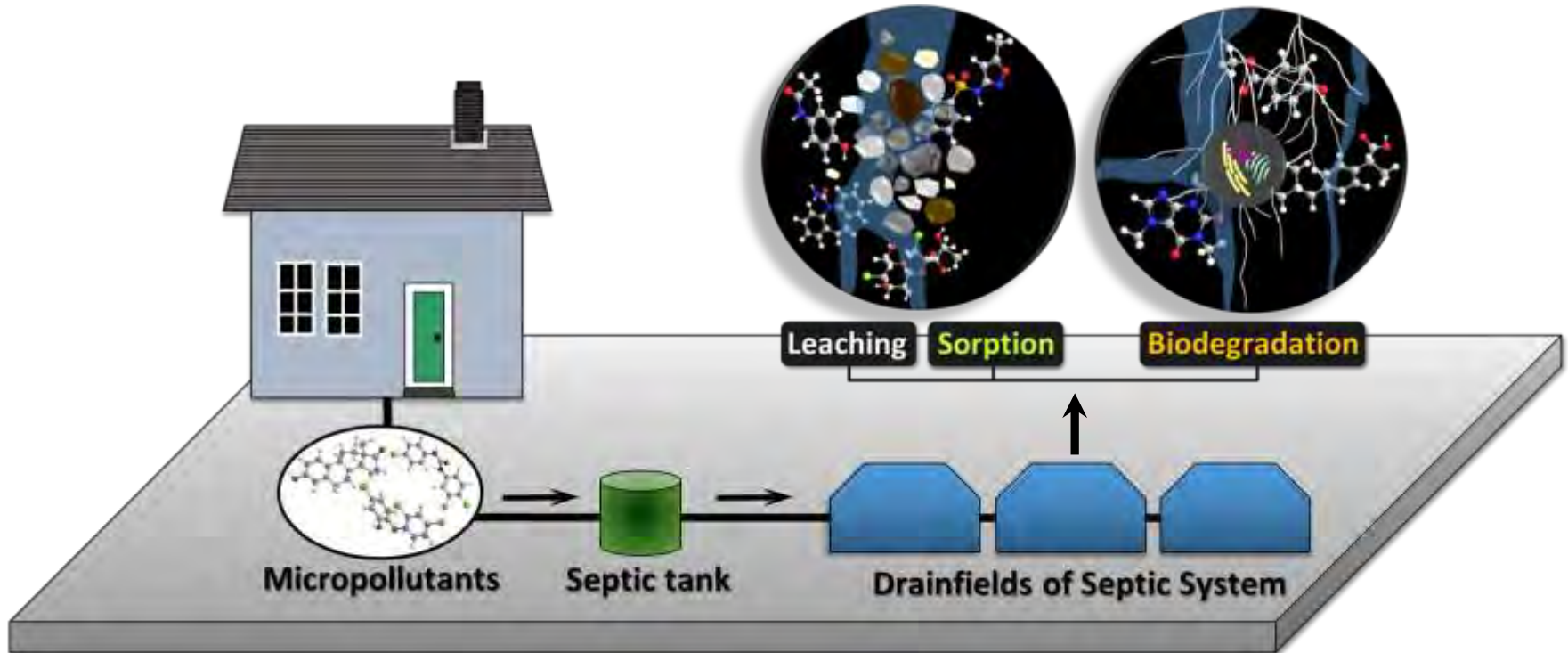


Summary



- Micropollutants are present in effluent, drainfields, and leachate.
- Concentrations decreased as effluent percolated in vadose zone

Summary



- Mechanisms of micropollutants attenuation in the drainfield may include a combination of sorption and degradation in the vadose zone.

Thank You!

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Questions?

