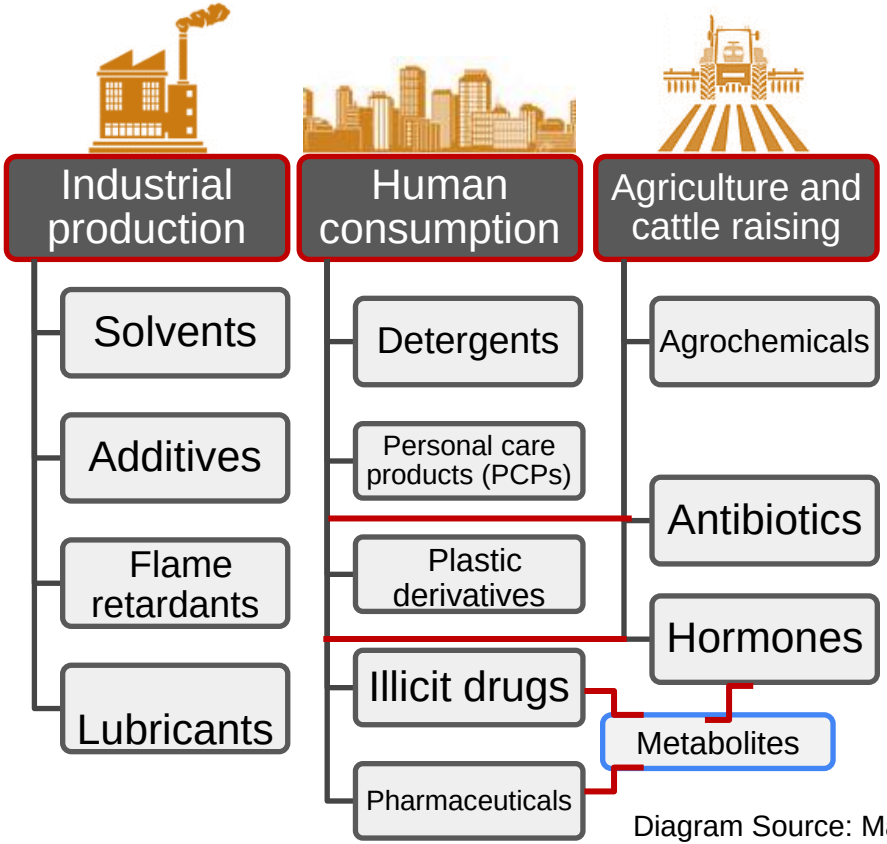
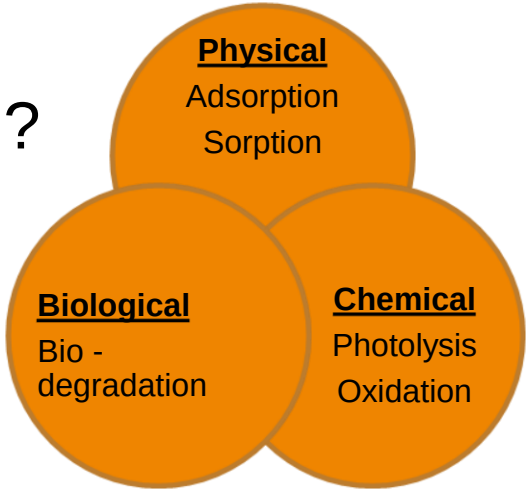
Chemicals of Emerging Concern (CEC) Mobilization through Septage Application

Elizabeth Boor

Opinions in this presentation are my own and not a position of NOWRA

What are Chemicals of Emerging Concern?





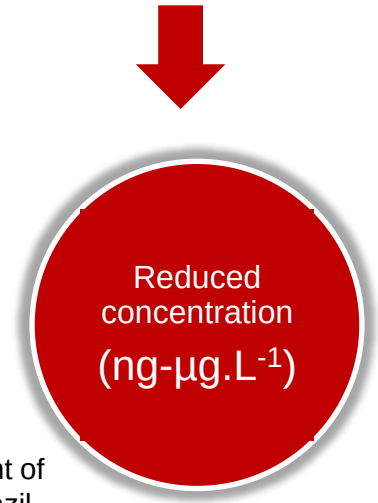
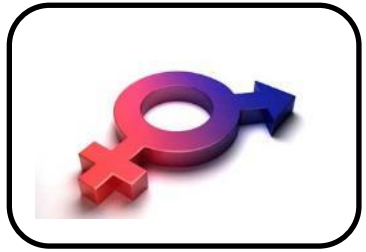


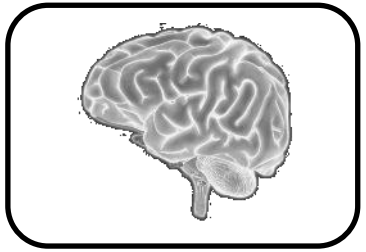
Diagram Source: Maria Clara Starling, Department of Sanitary and Wastewater Engineering, UFMG Brazil

Why Should we Care?



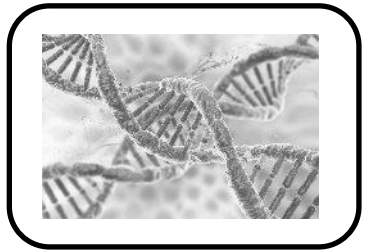
Feminilization and behavioral changes in fish.

(Kidd et al., 2007; Black et al, 2008)



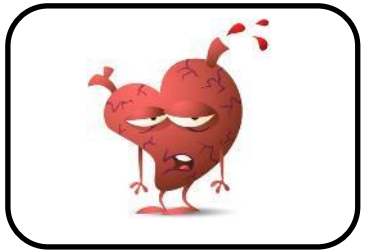
Neurological, reproductive and immunological disruption in animals.

(Fowler et al. , 2012)



Selection of antibiotic resistant genes in bacteria.

(Pruden et al., 2006)



Obesity, heart diseases and diabetes type II in humans.

(Vrijheid et al., 2016)

Diagram Source: Maria Clara Starling, Department of Sanitary and Wastewater Engineering, UFMG Brazil

Importance to SSTS in MN

- 618,102 Subsurface Sewage Treatment Systems in MN alone (2020)
- 42.3 billion gallons of wastewater treatment
- 75% of drinking water comes from groundwater sources in MN

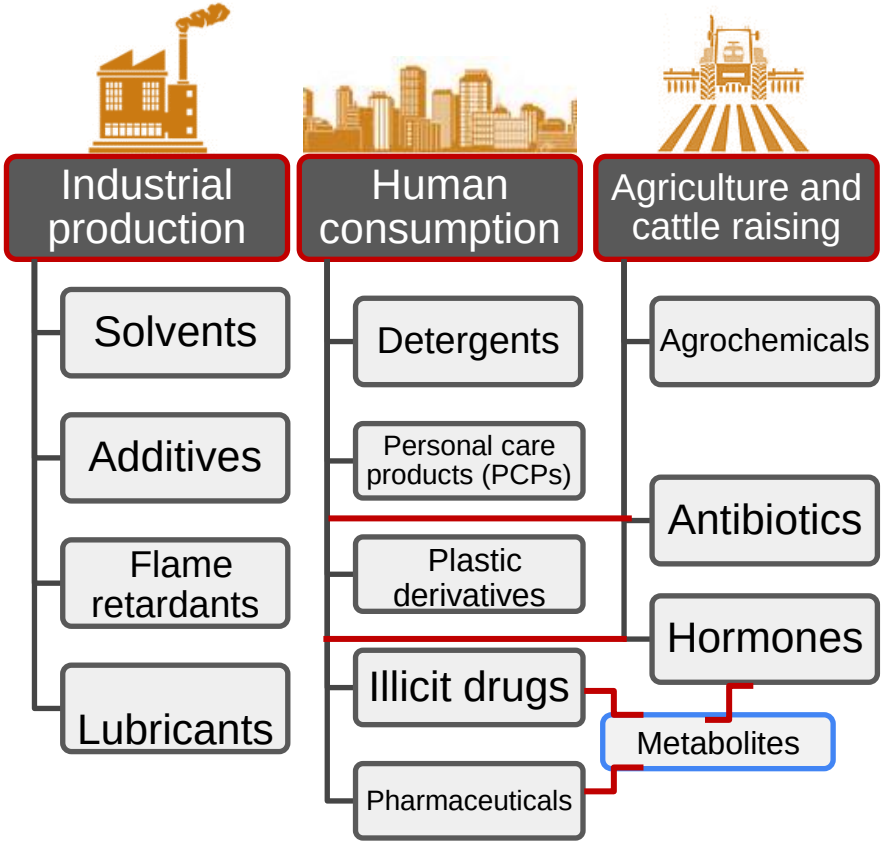
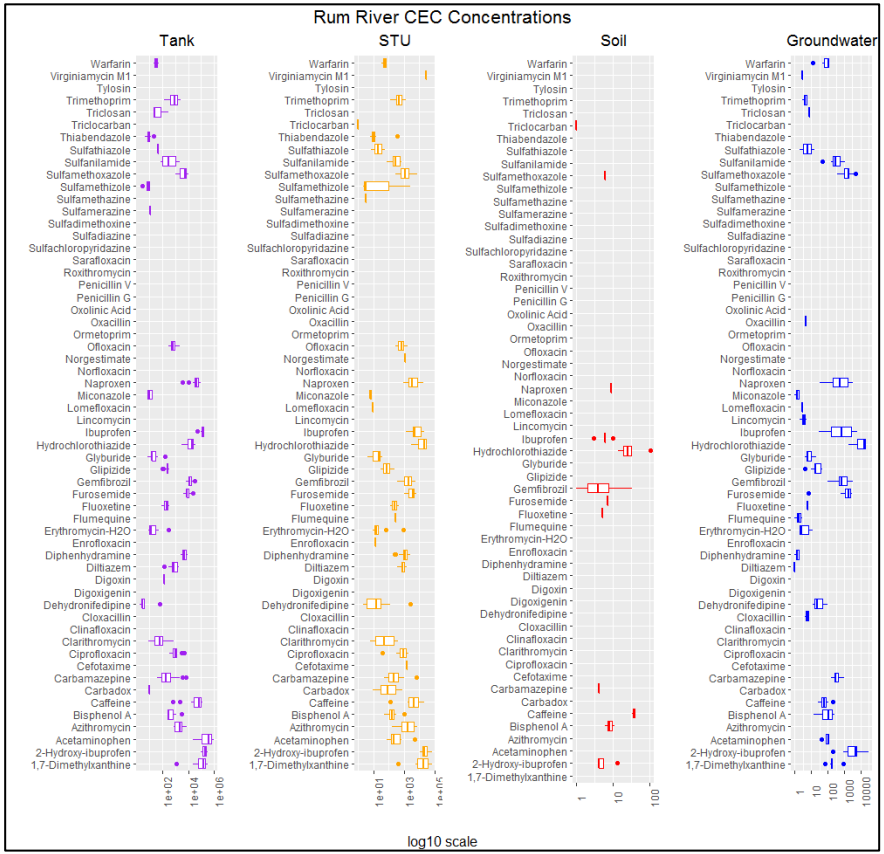


Diagram Source: Maria Clara Starling, Department of Sanitary and Wastewater Engineering, UFMG Brazil

History of CEC with the Onsite Sewage Treatment Program

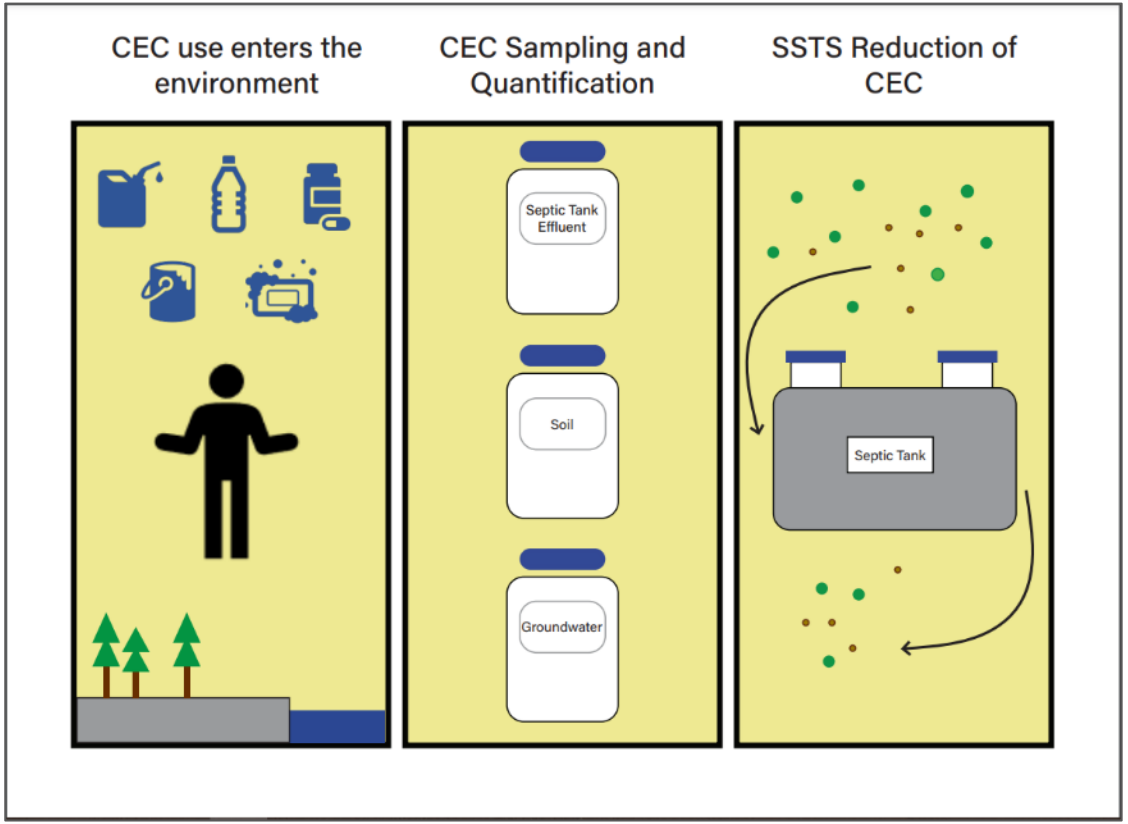
- Sampling since 2019
- Targeting MNDOT RAs
- STU performance
- Soils
- Groundwater



Past Results from previous MNDOT studies

- Some CEC are treated
- STUs offer additional treatment
- Groundwater separation is crucial

- Solids removal is an important step in CEC treatment

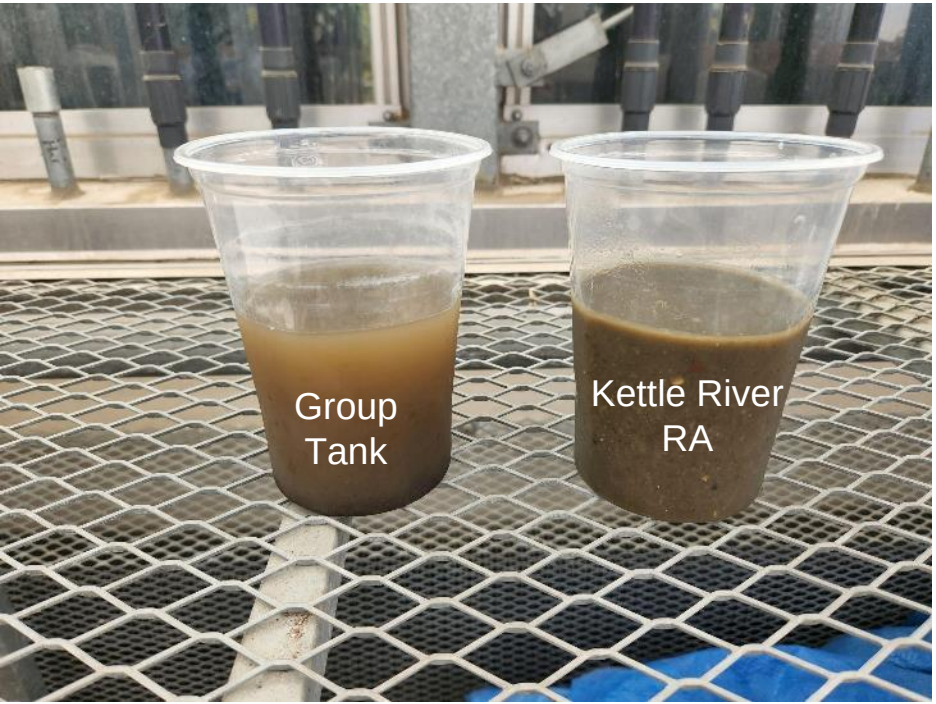


My Experimental Set Up

MN Rules for Safe Septage Application

- Pathogen Elimination: 25lb lime / 1,000 gal or 2.99g lime / liter (over 12 pH)
- Hydraulic Loading Rate: 10,000 gal/acre/day
- Maximum Allowable Nitrogen Application: for wheat, 50lbs N/acre/year

My septage samples



My septage samples

Residential Group Tank

		Data		Mean	SD
pH		6.84	6.85	6.845	0.005
TSS	mg/L	2540	2060	2300	240
BOD	mg/L	900	2100	1500	600
TKN	mg-N/L	133	122	127.5	5.5
TS	mg/L	3580	3700	3640	60
Total Phosphorus		mg-P/L	20	19.5	19.75

MNDOT, Kettle river Rest Area

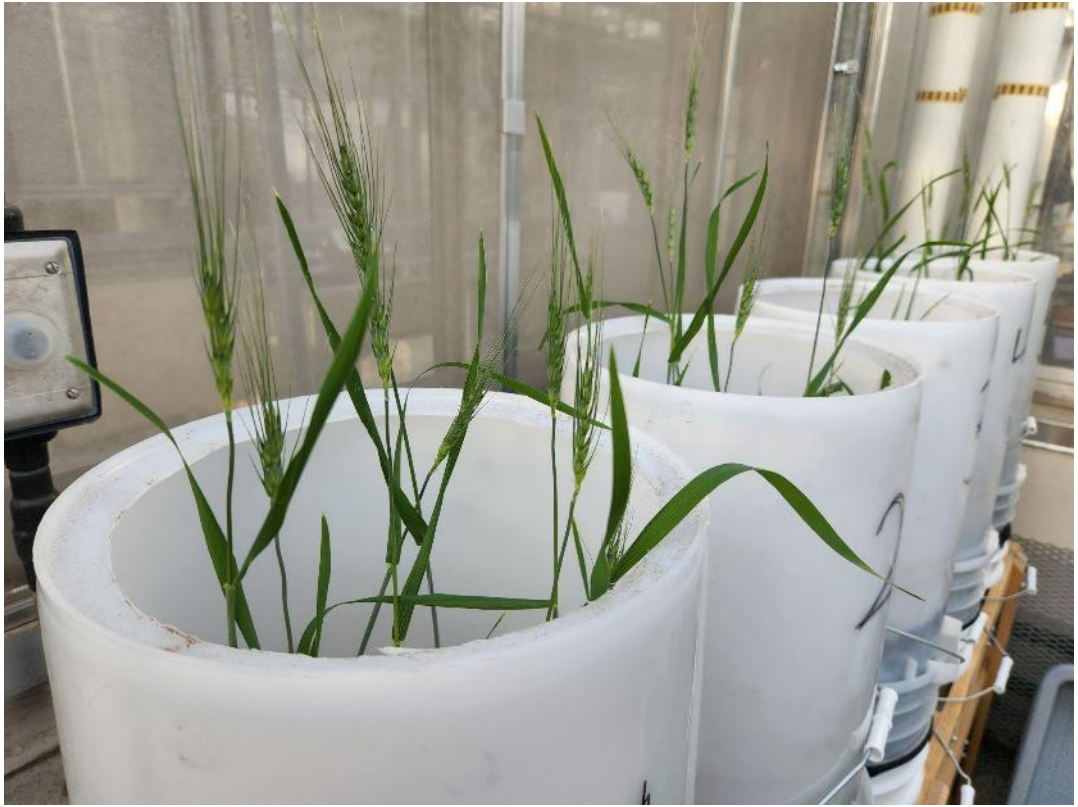
		Data		Mean	SD
pH		5.35	5.35	5.35	0
TSS	mg/L	3800	3200	3500	300
BOD	mg/L	15000	12000	13500	1500
TKN	mg-N/L	287	304	295.5	8.5
TS	mg/L	5000	5600	5300	300
Total Phosphorus		mg-P/L	77.9	61.4	69.65

Growing the Wheat

Growing the Wheat

- 4 inch “rain event”

Growing the Wheat



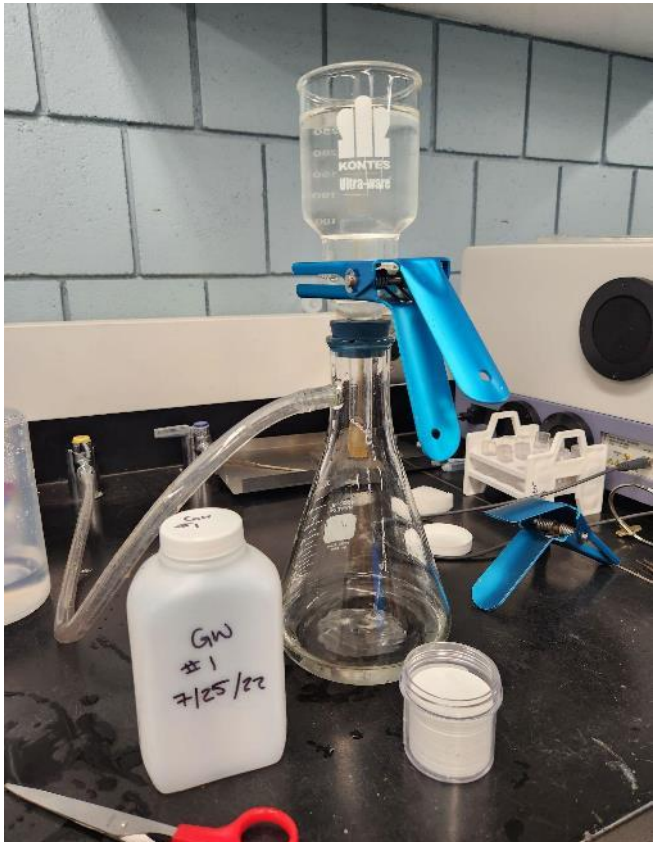
Sample Collection

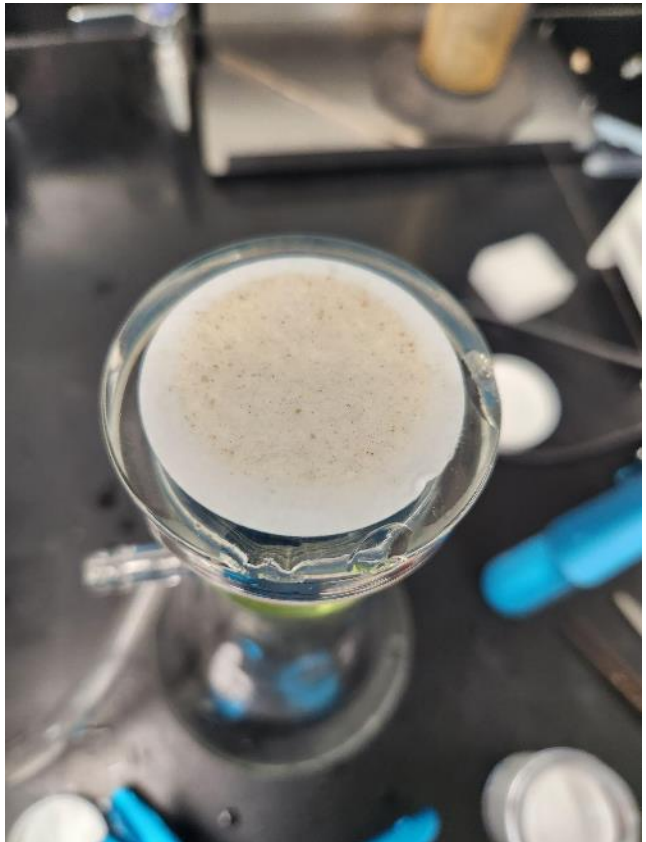
Solids Preparation

- QuEChERS vs U of M compost extraction method
  - **Qu**ick **E**asy **Ch**eap **E**ffective **R**ugged **S**afe
  - Optimized for high water samples

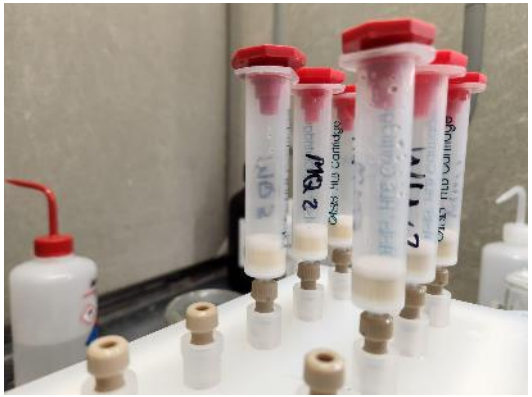
Centrifuge Septage

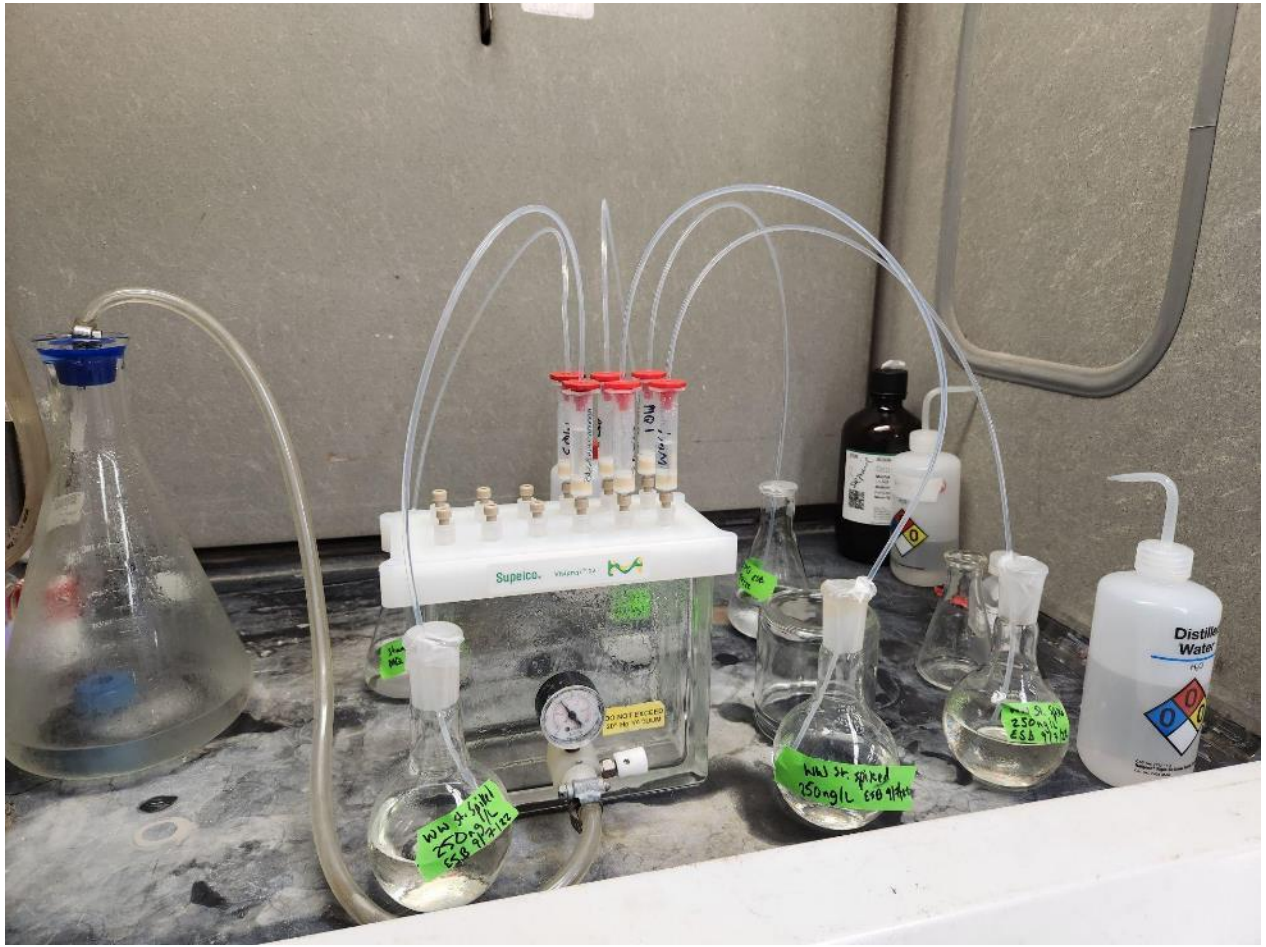
Sample Filtration





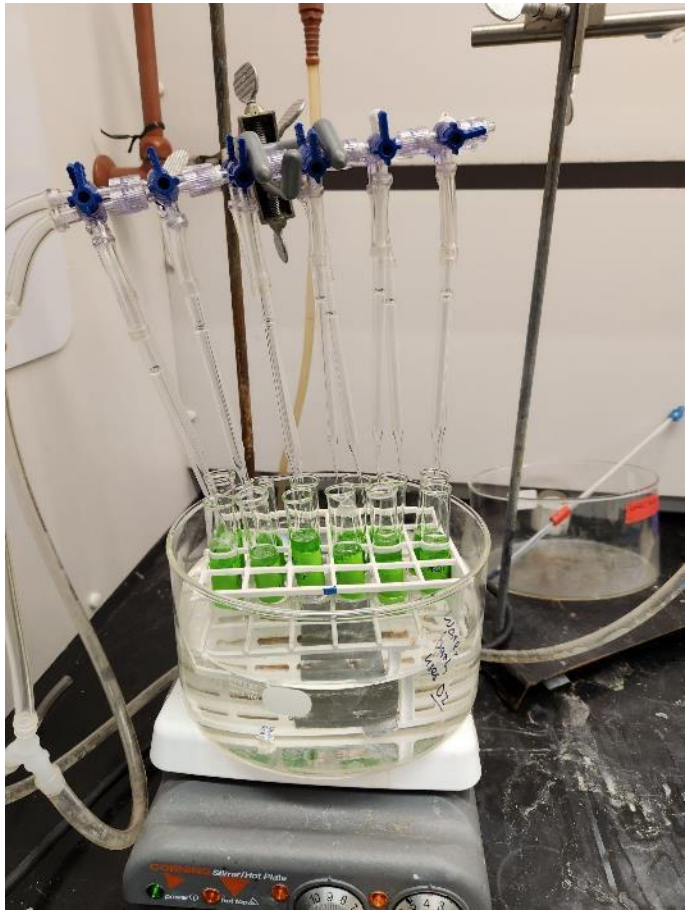
SPE process



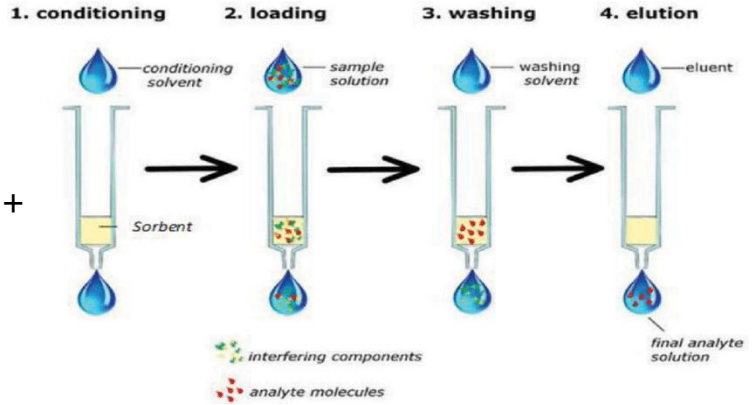


SPE process

- Elution
- Nitrogen Evaporation



Summary of Sample Prep

Centrifuge and Filtration + 

+ Nitrogen Blow off

Bongeka et al., 2019

Mass Spectrometry

- Creation of standards and methods
- Labeled standards
- 6 targeted CEC
  - Ibuprofen (pain killer)
  - Naproxen (pain killer)
  - Acetaminophen (pain killer)
  - Azithromycin (antibiotic)
  - Erythromycin (antibiotic)
  - Triclocarban (antibiotic)

Contact Information

This research is ongoing. For results, visit the OSTP website (septic.umn.edu) or contact me at boorx007@umn.edu