

Michael Gonsior, PhD
Assistant Professor

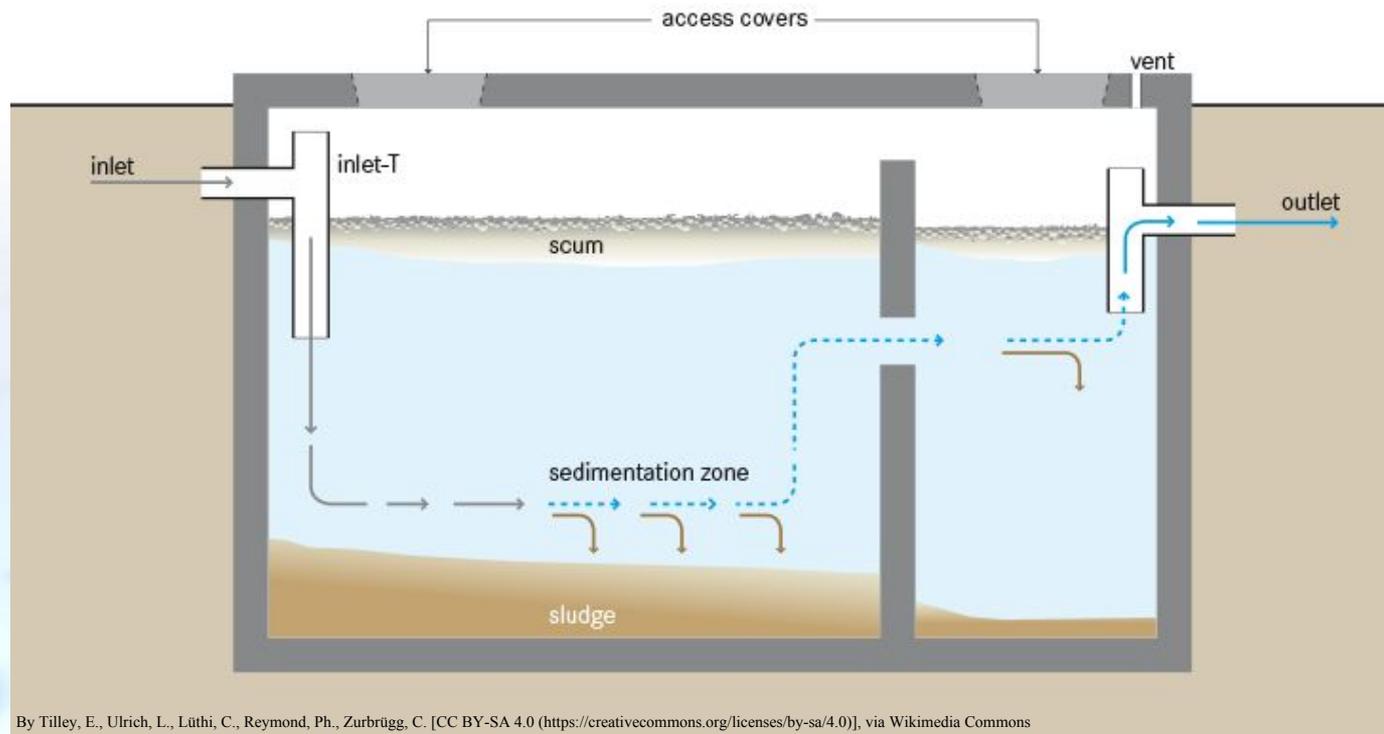


University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Evidence of organic wastewater tracers in streams near septic system



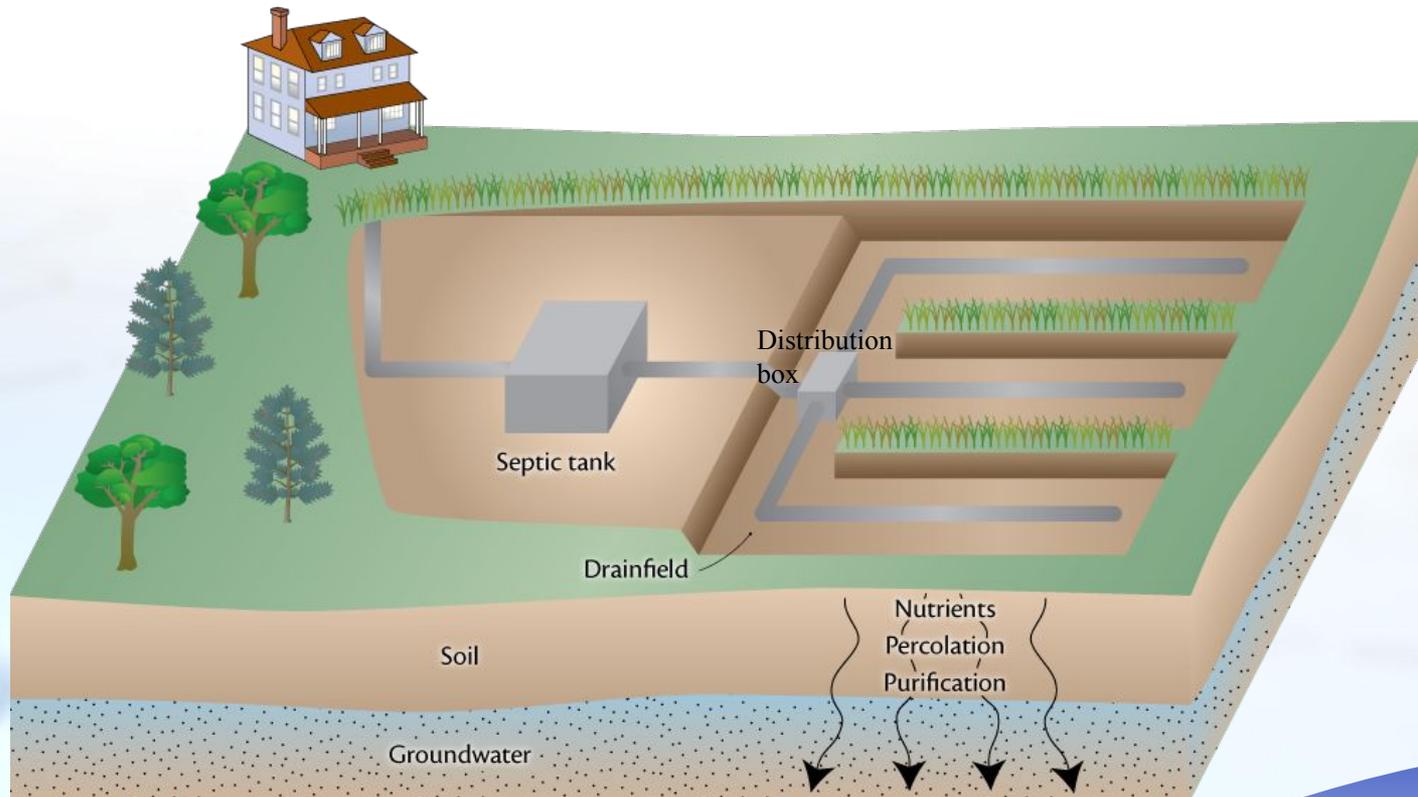
How Does a Septic System Work?



By Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. [CC BY-SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0/>)], via Wikimedia Commons

How Does a Septic System Work?

A typical septic system

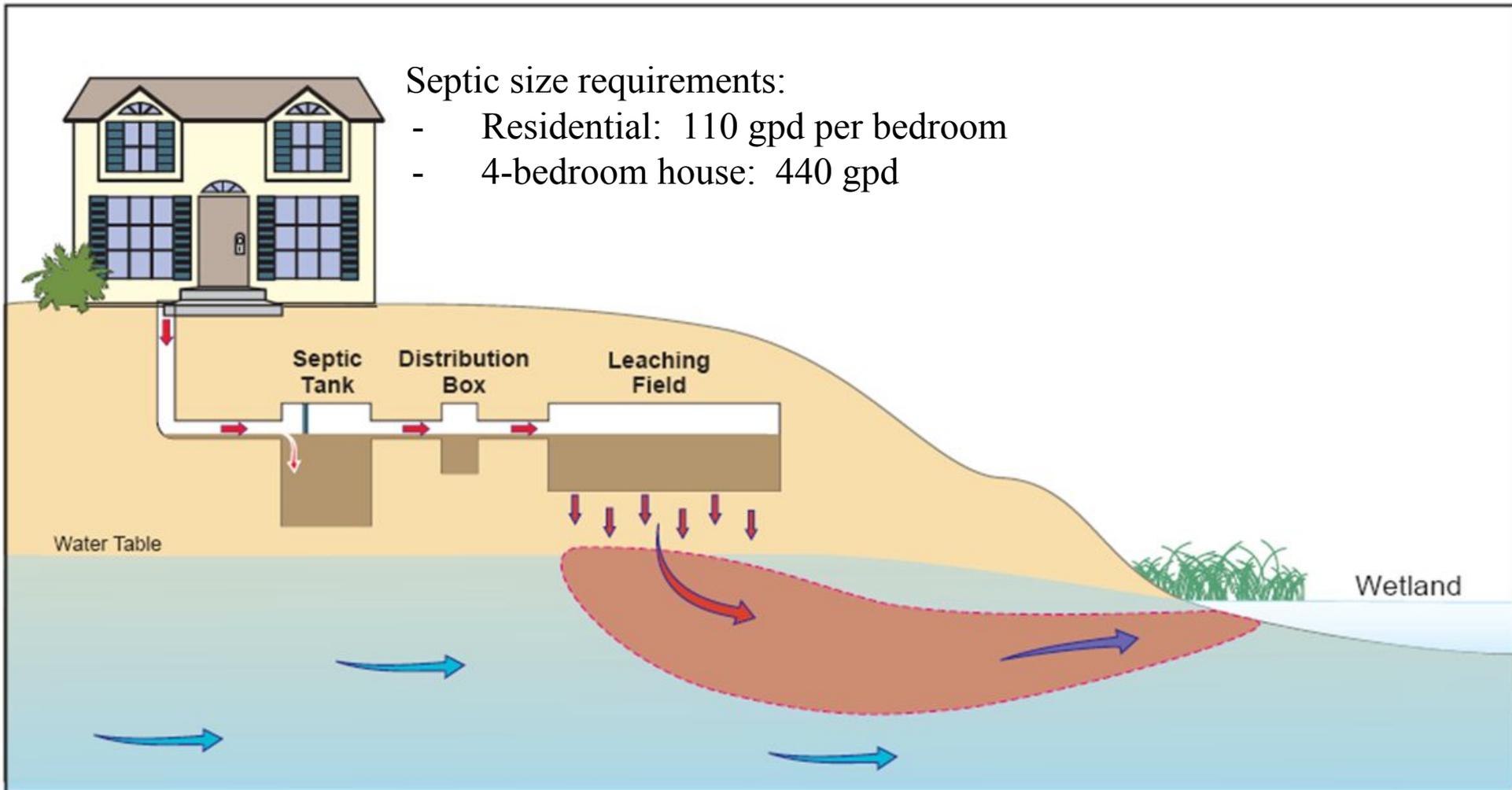


Integration and Application Network, UMCES (<http://ian.umces.edu/imagelibrary/displayimage-7023.html>)

How Does a Septic System Work?

Septic size requirements:

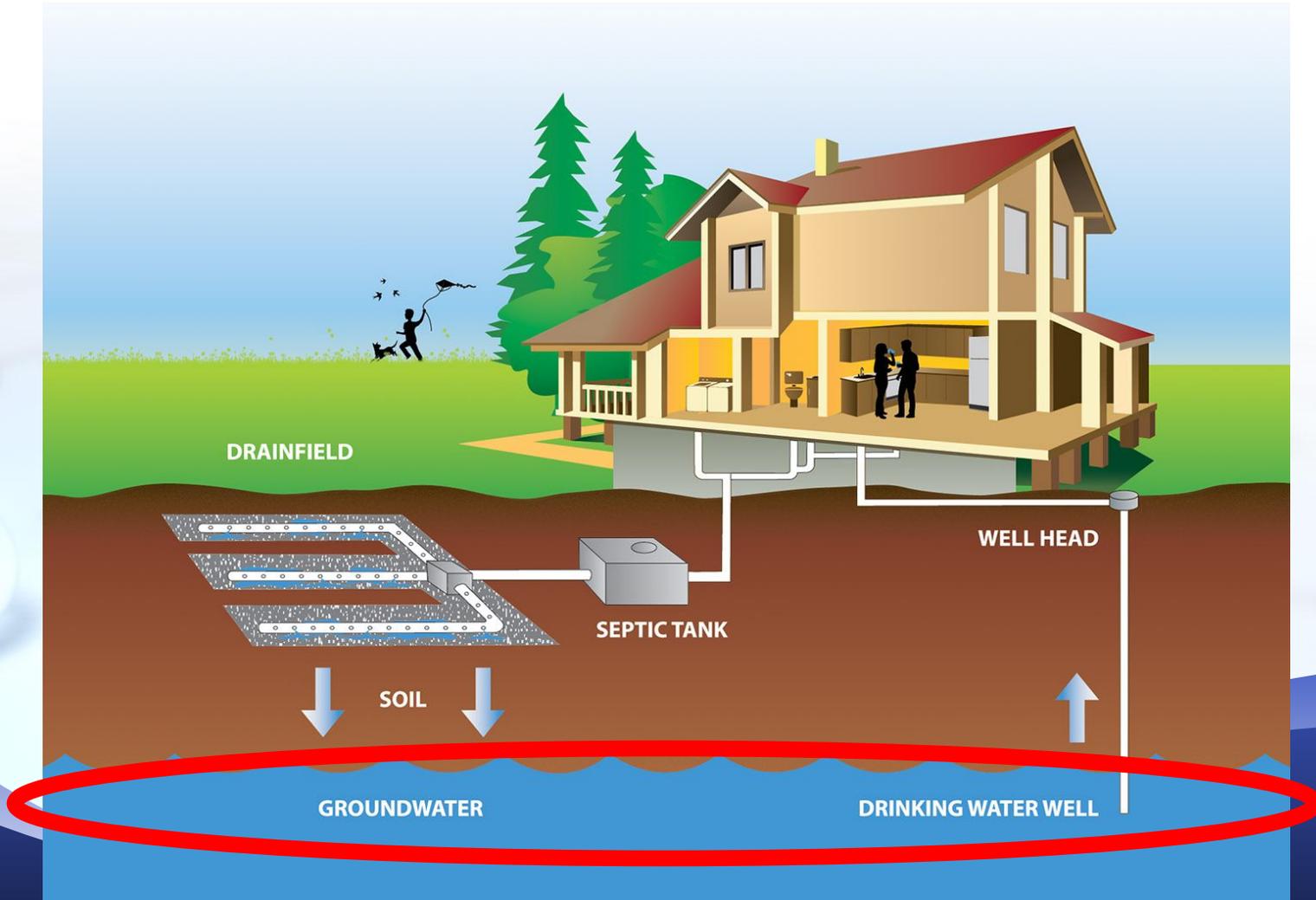
- Residential: 110 gpd per bedroom
- 4-bedroom house: 440 gpd



How Does a Septic System Work?



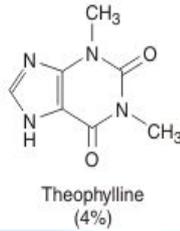
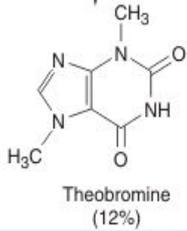
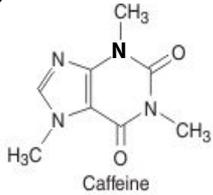
How Does a Septic System Work?



Detergents

Wastewater Tracers:

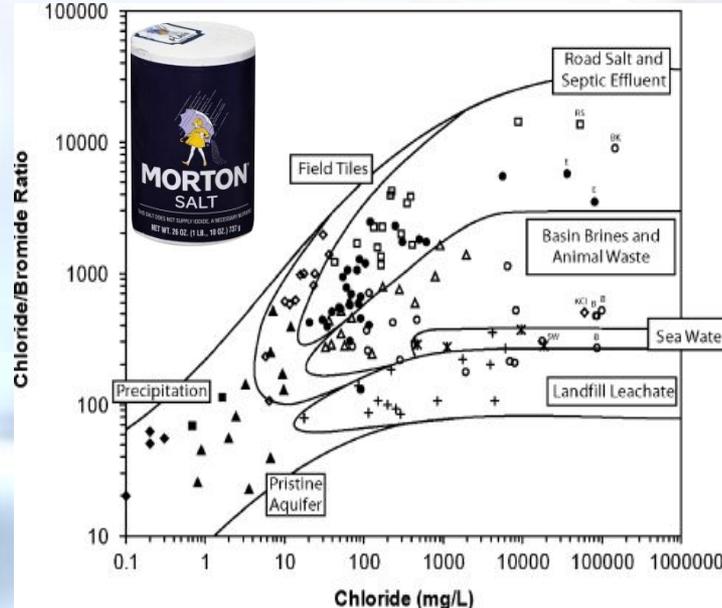
Coffee



Artificial Sweetener



Salt (NaCl)

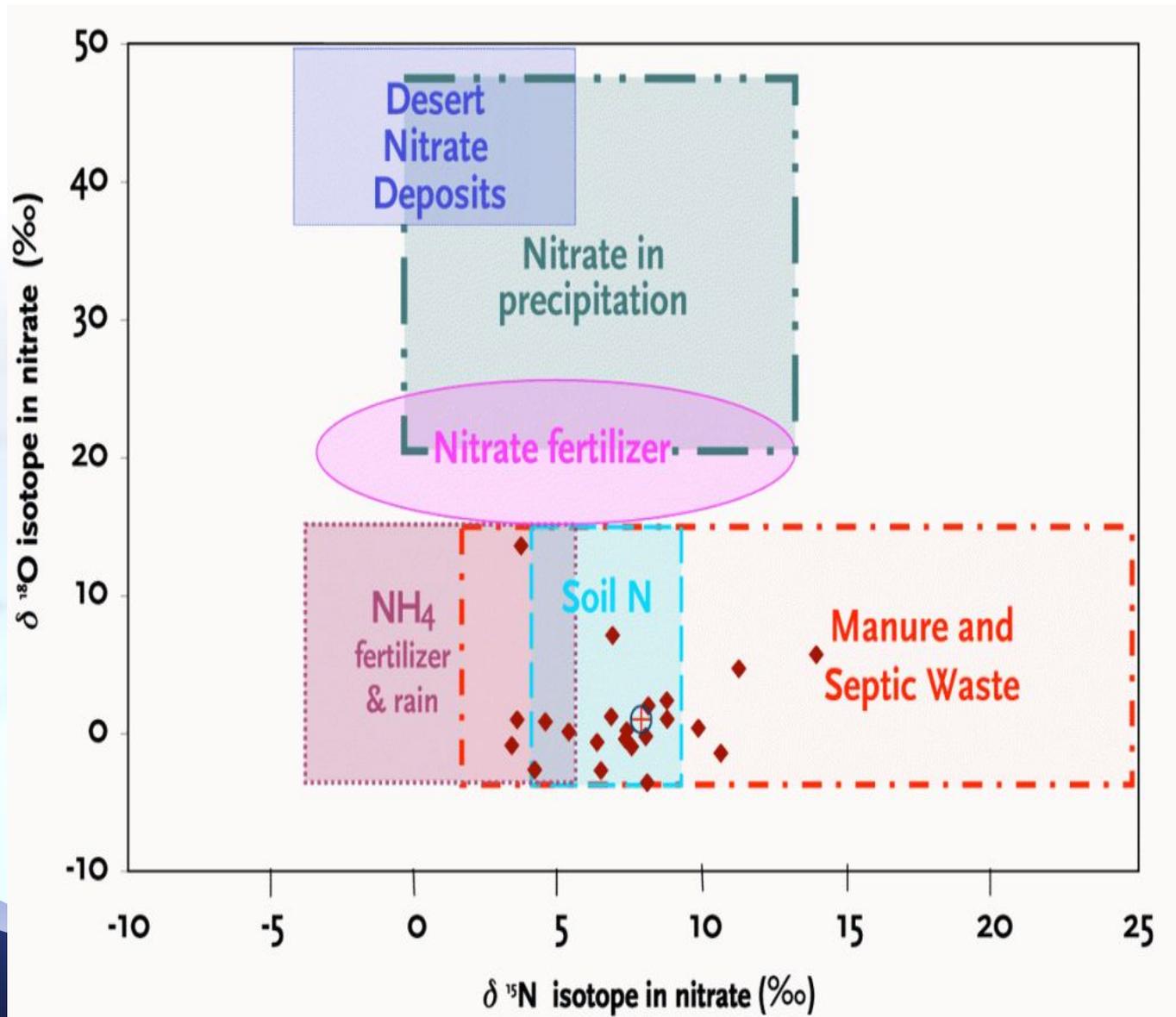


Pharmaceuticals



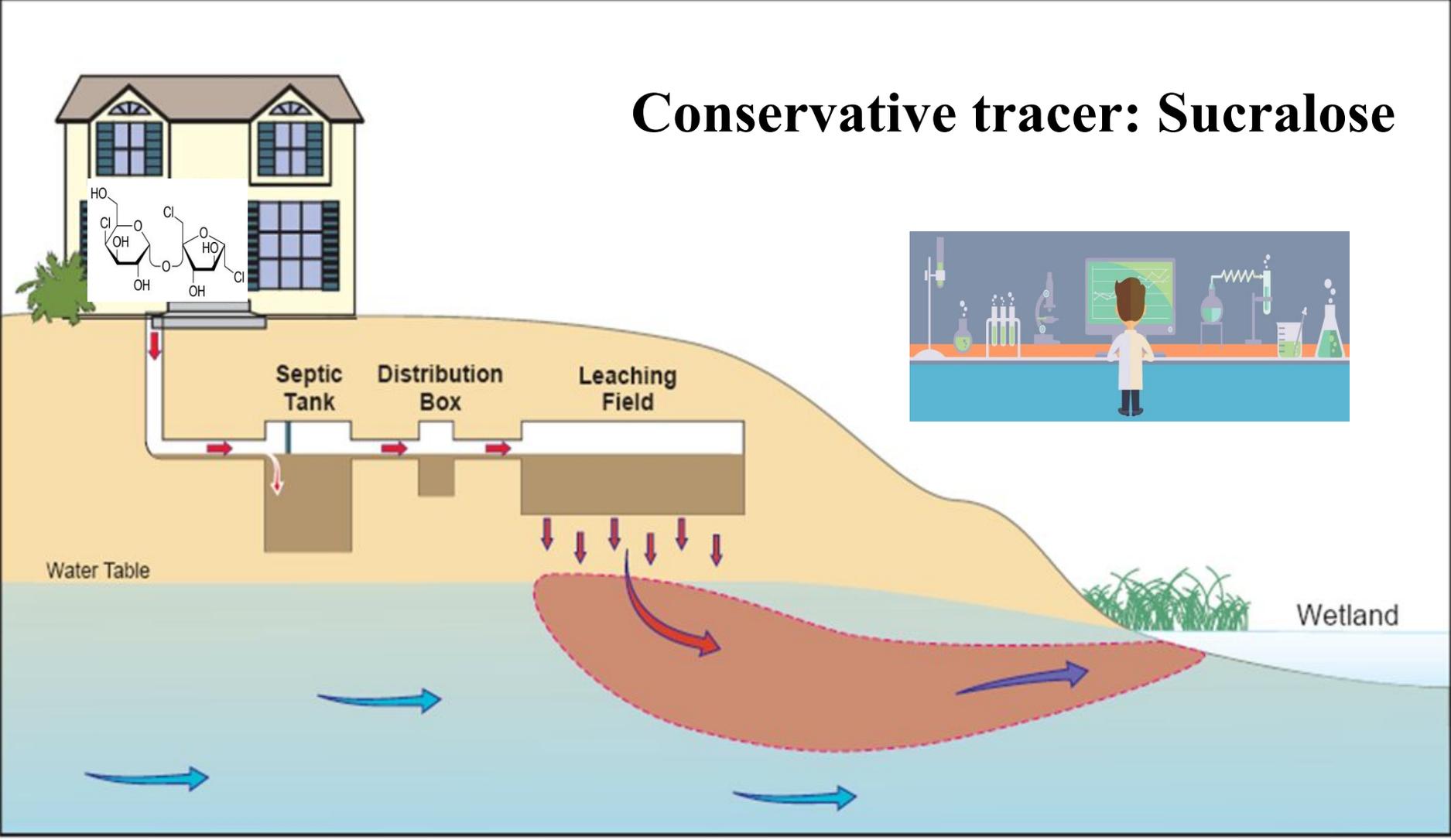
Characterization and Identification of Na-Cl Sources in Ground Water, Volume: 44, Issue: 2, Pages: 176-187, First published: 23 September 2005, DOI: (10.1111/j.1745-6584.2005.00127.x)

Wastewater Tracers: Compound-specific isotope analysis



Wastewater tracers and their quantification

Conservative tracer: Sucralose

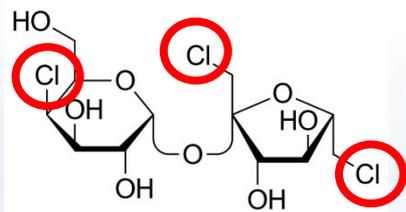


Wastewater tracers and their quantification

Artificial sweeteners

(e.g. Sucralose (Splenda®))

stable



LC-MS/(MS)



Standards
commercially
available



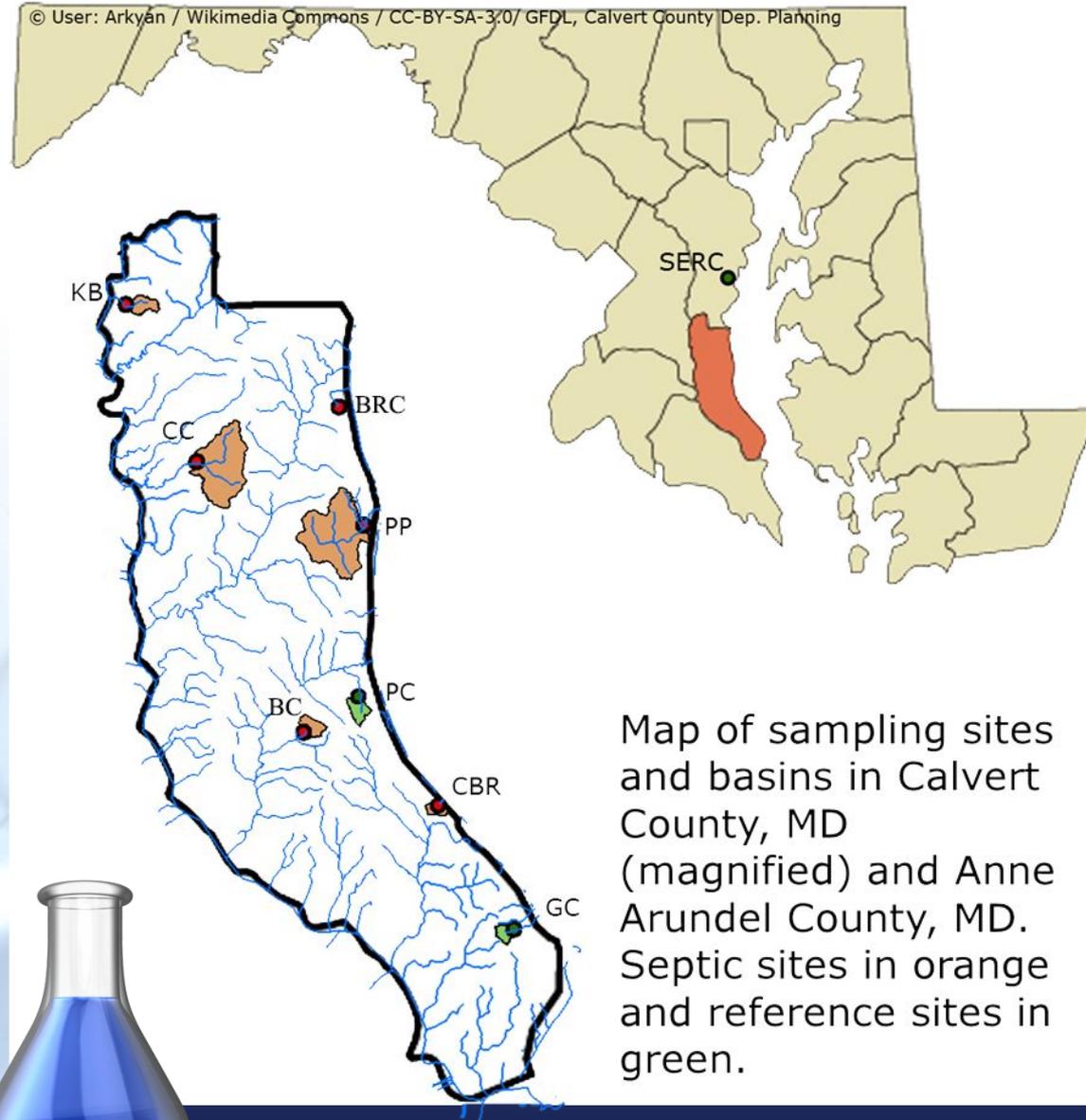
Overall research approach

- 1. Determine water properties**
- 2. Analyze nutrients**
- 3. Determine Stable Isotopic Composition**
- 4. Quantify emerging contaminants and stable tracers**
- 5. Non-targeted screening to discover new wastewater tracers**

Sampling Design

- Year-long, monthly sampling of 3 streams draining forested reference basins and 6 streams with high septic densities (>80 septic systems/mi²)
 - Various sizes (0.02-4.8 mi²)
 - Mix of BAT and traditional
 - Very low agricultural land use
 - No WWTPs
- Direct Sampling of BAT and traditional effluent

CBR - Calvert Beach Run (Calvert Beach/Long Beach)
CC - Cocktown Creek (Huntingtown - draining into Patuxent)
BRC - Brownies Creek (Chesapeake Beach(Summer City))
GC - Grays Creek (Calvert Cliffs State Park)
KB - unnamed stream south of Kings Branch (Dunkirk)
PC - Parkers Creek (American Chestnut Land Trust: Parkers Creek Preserve)
PP - Plum Point Creek (Huntingtown - draining into Bay)
BC - tributary of Battle Creek (draining Oakland Hall neighborhood)
SERC - (Smithsonian Environmental Research Center)



Sampling Design

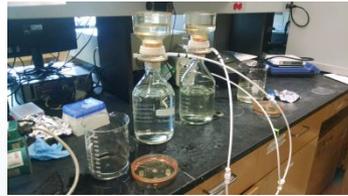
	Area (mi ²)	% Forested	% Agriculture	% Impervious	Traditional Septic Density (systems/ mi ²)	BAT Septic Density (systems/mi ²)
Septic						
CBR	0.21	14.9	0.0	30.0	198	29
CC	3.91	35.0	5.8	17.1	144	2
CV	0.04	45.2	0.0	22.0	1431	81
KB	0.53	35.0	13.3	17.8	131	2
PP	4.84	57.2	8.7	10.5	106	1
SMB	0.53	90.7	2.5	3.1	9	77
Reference						
GC	0.35	87.6	6.4	3.5	9	0
PC	0.53	71.7	12.7	4.4	12	0
SERC	0.02	100.0	0.0	0.0	0	0



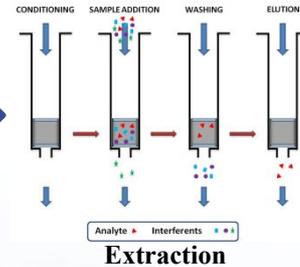
Septic Detectives at work....



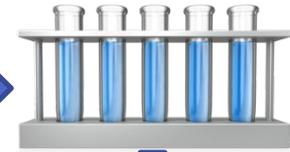
Sampling
(12 x year @ 9 streams)



Filtration



Extraction



Analysis

- Quantification of septic wastewater tracers
- Fingerprinting of unknown organic compounds

Analysis

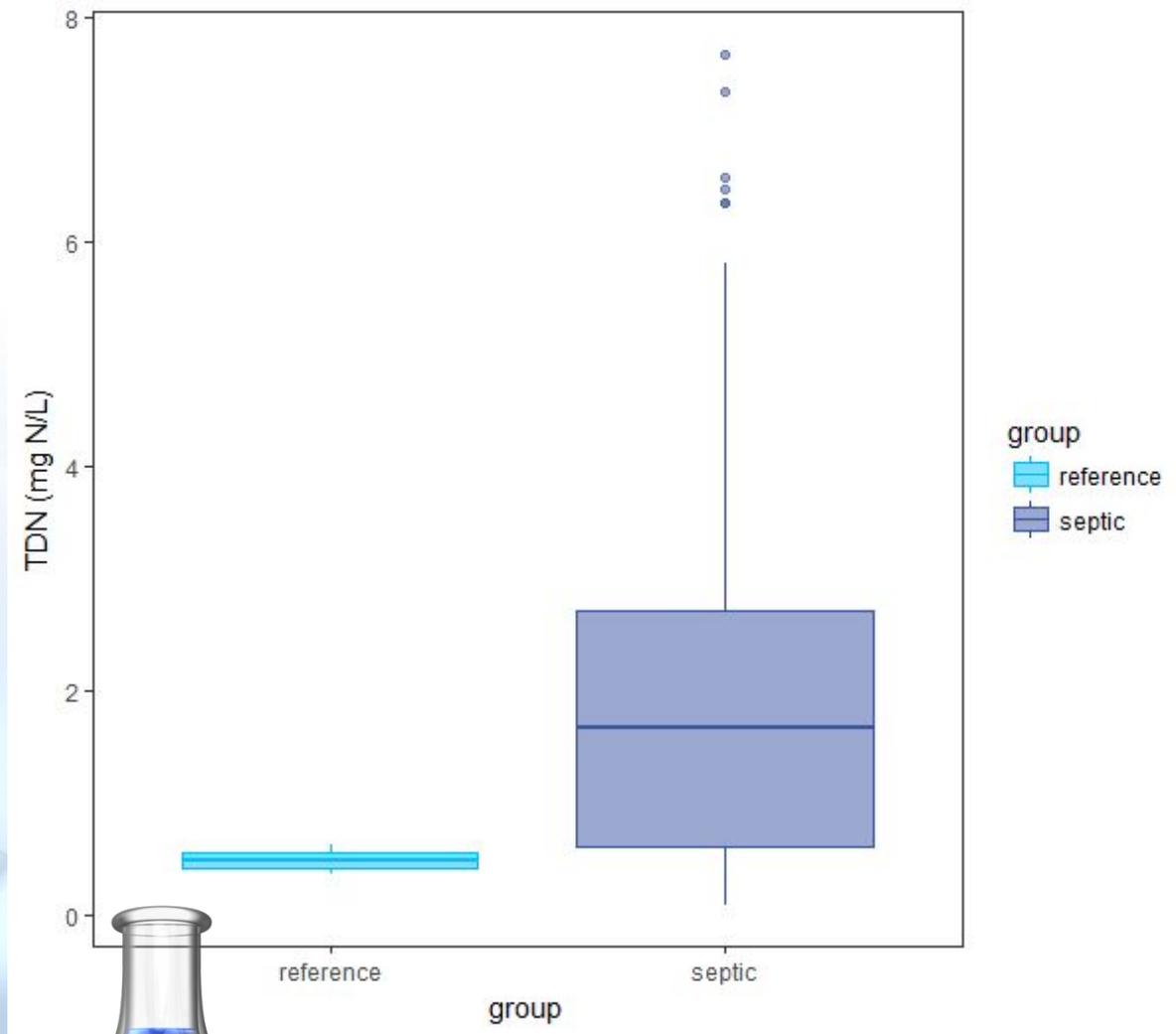
- Nutrients
- Nitrate Isotopes
- DOC, TDN
- Optical Properties
- Etc.



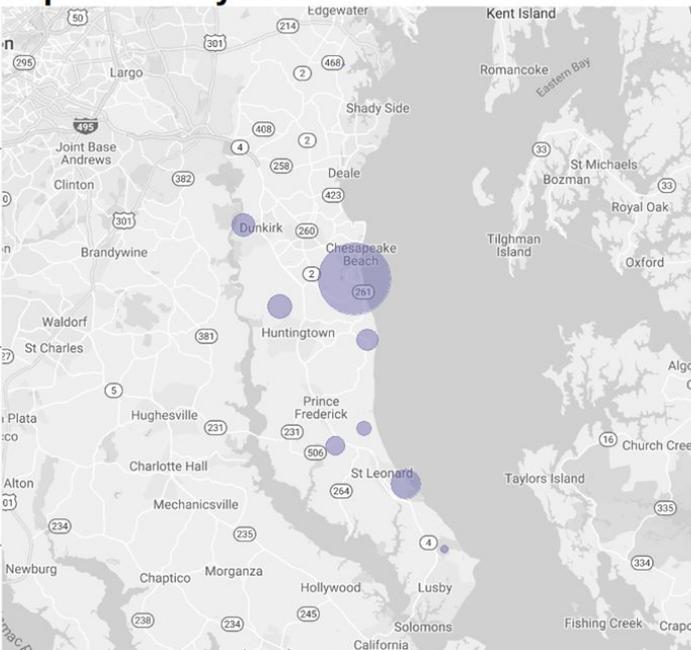
- 1) Are streams directly connected to septic effluent?
- 2) How much of the water in a stream is coming from septic systems?
- 3) How much of the nutrients is coming from Septic Systems?
- 4) (How effective are advanced septic systems?)



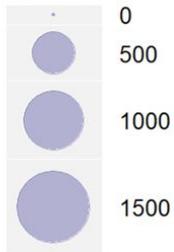
Nutrient Data



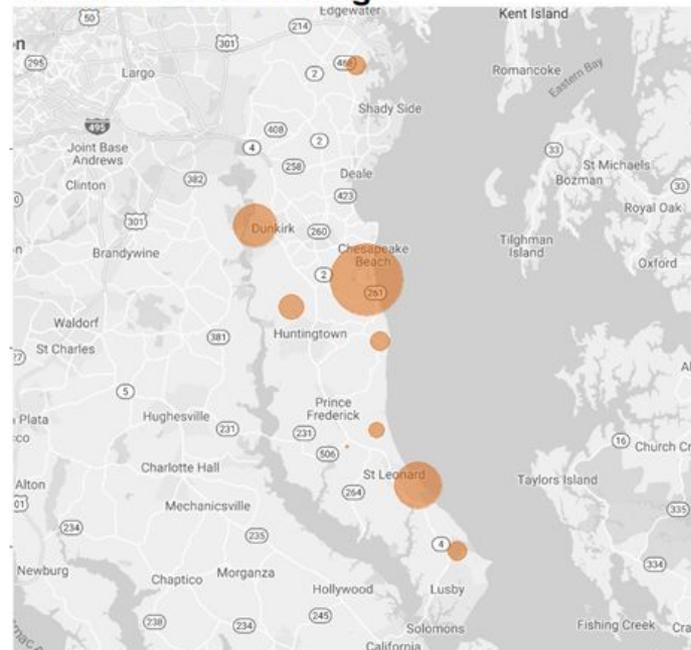
Septic Density



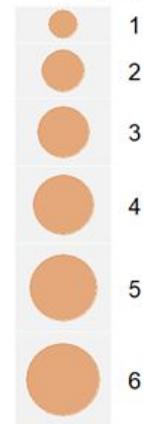
systems / sq mi



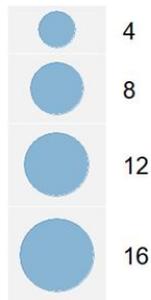
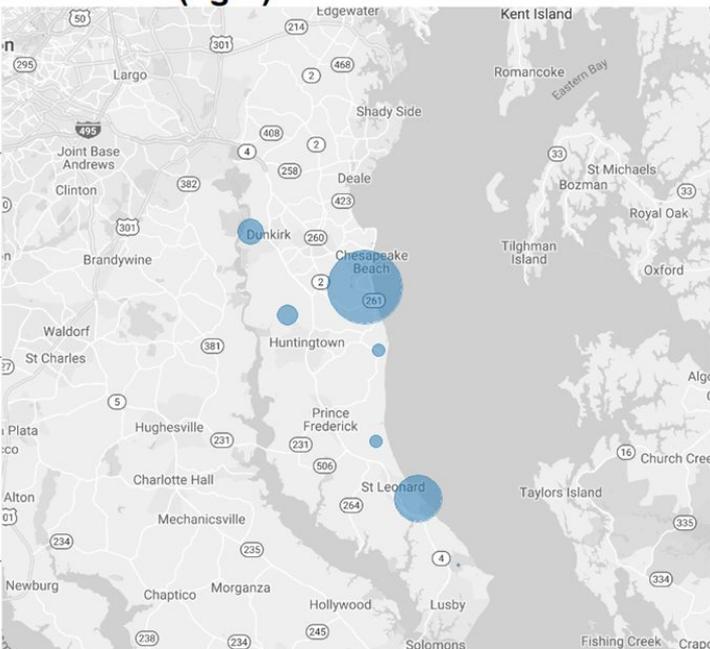
Total Dissolved Nitrogen



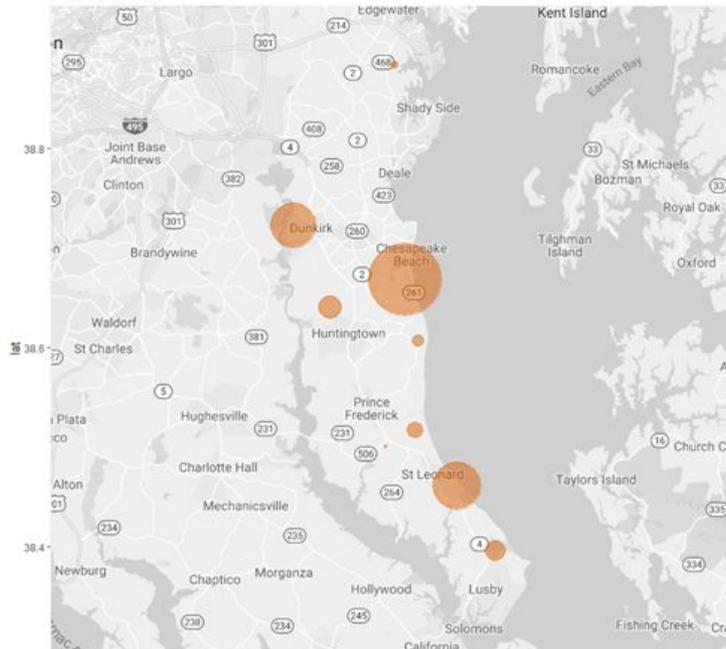
TDN (mg N/L)



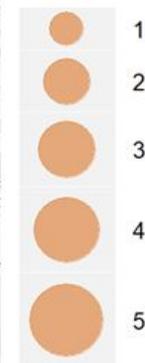
Sucralose (ug/L)



Nitrate



Nitrate (mg N/L)

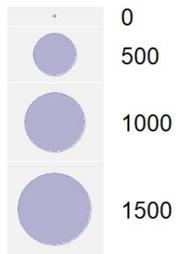


Nitrogen in comparison to surfactant intensity (shampoos, cleaners, dishwasher detergents, etc.)

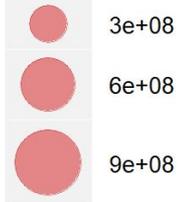
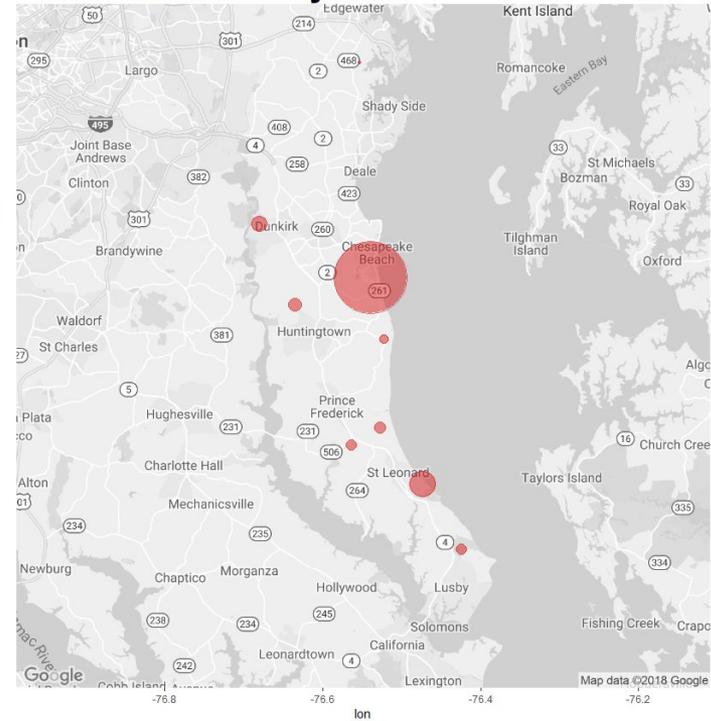
Septic Density

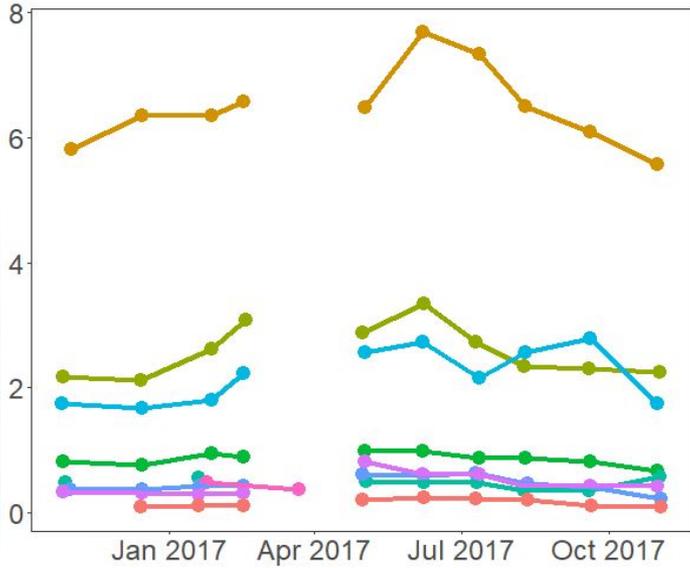


systems / sq mi

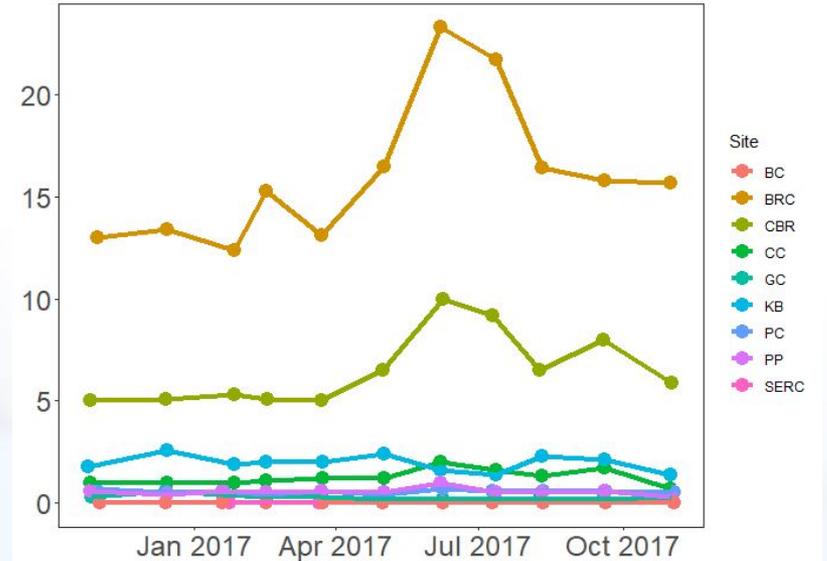


Surfactant Intensity





Total Dissolved Nitrogen (mg N/L)



Sucralose (µg/L)

Wastewater tracers and nitrogen loading

$\frac{\text{Conservative tracer conc. in septic}}{\text{Conservative tracer conc. in stream}} = \text{Percent contribution of wastewater}$

$\frac{\text{Non-conservative Tracer conc. in septic}}{\text{Non-Conservative Tracer conc. in stream}} = \text{Percent removal during its journey}$

How much reactive nitrogen is originating from septic systems ?



An excellent graduate student



Acknowledgements

- **Katie Martin (PhD candidate)**, Dr. Lora Harris, Dr. Andrew Heyes
- Mindy Forsyth, Erin Reilly, and Isabel Sanchez
- Steve Kullen, Dr. David Brownlee of Calvert County Department of Planning & Zoning
- Matthew Cumers of Calvert County Department of Health Services
- TDN, TDP, PO₄, NO₂-NO₃, NH₄, PN, PP, and PC measured by UMCES Nutrient Analytical Services Laboratory
- NO₃ isotopes measured by Joel Bostic and Dr. Dave Nelson at Appalachian Laboratory
- DOM isotopes measured by Dr. Cedric Magen



Thank you – Mahalo - Tēnā koutou



Questions?
More Information?

Michael Gonsior

gonsior@umces.edu

<http://www.umces.edu/michael-gonsior>



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