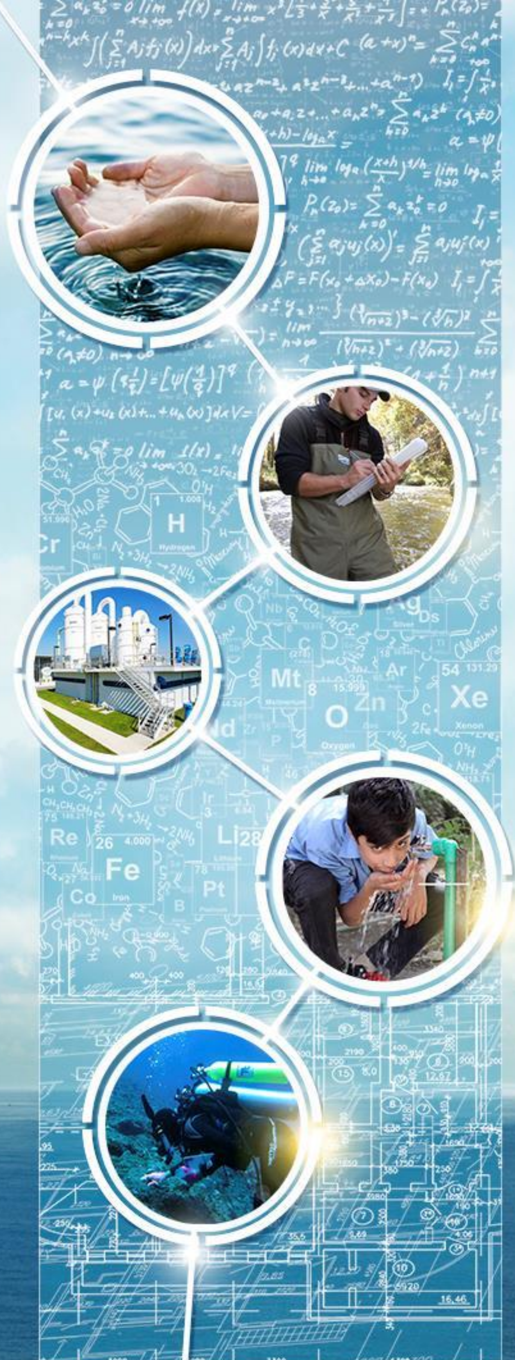

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Phase 6 Septic System Loads: Nitrogen Attenuation Expert Panel update

November 4, 2015

Victor D'Amato

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Septic System Loads (Attenuation Expert Panel)

- Background/current status
- Nutrient delivery conceptual framework
- Current attenuation estimates
- Report

Program Background

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- Program assumes 5 kg/cap/year TN generated
  - 20% reduction in drainfield
  - 60% attenuation between drainfield and receiving water
  - 100% TP reduction (zero delivery from onsite systems)
- *TN reduction credits* for pretreatment (*exsitu)* and improved dispersal (*insitu)* addressed by previous BMP Panel

Insitu practice ***Exsitu practice***	**Conventional baseline**	**Shallow pressure dosed**	**Elevated mound**
Septic tank baseline	4.0 kg/p/yr (0%)	2.5 kg/p/yr (38%)	2.5 kg/p/yr (38%)
Intermittent Filters	3.2 kg/p/yr (20%)	2.0 kg/p/yr (50%)	2.0 kg/p/yr (50%)
Constructed Wetland	3.2 kg/p/yr (20%)	2.0 kg/p/yr (50%)	2.0 kg/p/yr (50%)
IFAS	2.0 kg/p/yr (50%)	1.25 kg/p/yr (69%)	1.25 kg/p/yr (69%)
Recirculating Filter	2.0 kg/p/yr (50%)	1.25 kg/p/yr (69%)	1.25 kg/p/yr (69%)

Conceptual Framework for Attenuation

- Focus on amending the assumption of 60% nitrogen removal in conventional systems to be spatially variable
- Vadose Zones (#1 and #2)
  - Starts where effluent is distributed into drainfield: address dispersal/*insitu* system type
  - Use STUMOD for effluent-affected zone (#1) supplemented with data
  - Unaffected vadose zone (#2) – identify areas where denite anticipated
  - Function of soil texture, organic carbon, loading rate, redox conditions, etc.
- Groundwater Zone (#3)
  - Denitrification rate and distance from surface water
  - Consider soil texture, physiographic province, hydrogeology
- Transitional Zones (#4)
  - Identify situations where additional attenuation is expected (e.g., riparian areas, hyporheic zone)
  - Ignore small-stream attenuation: being dealt with by others

Conceptual Framework

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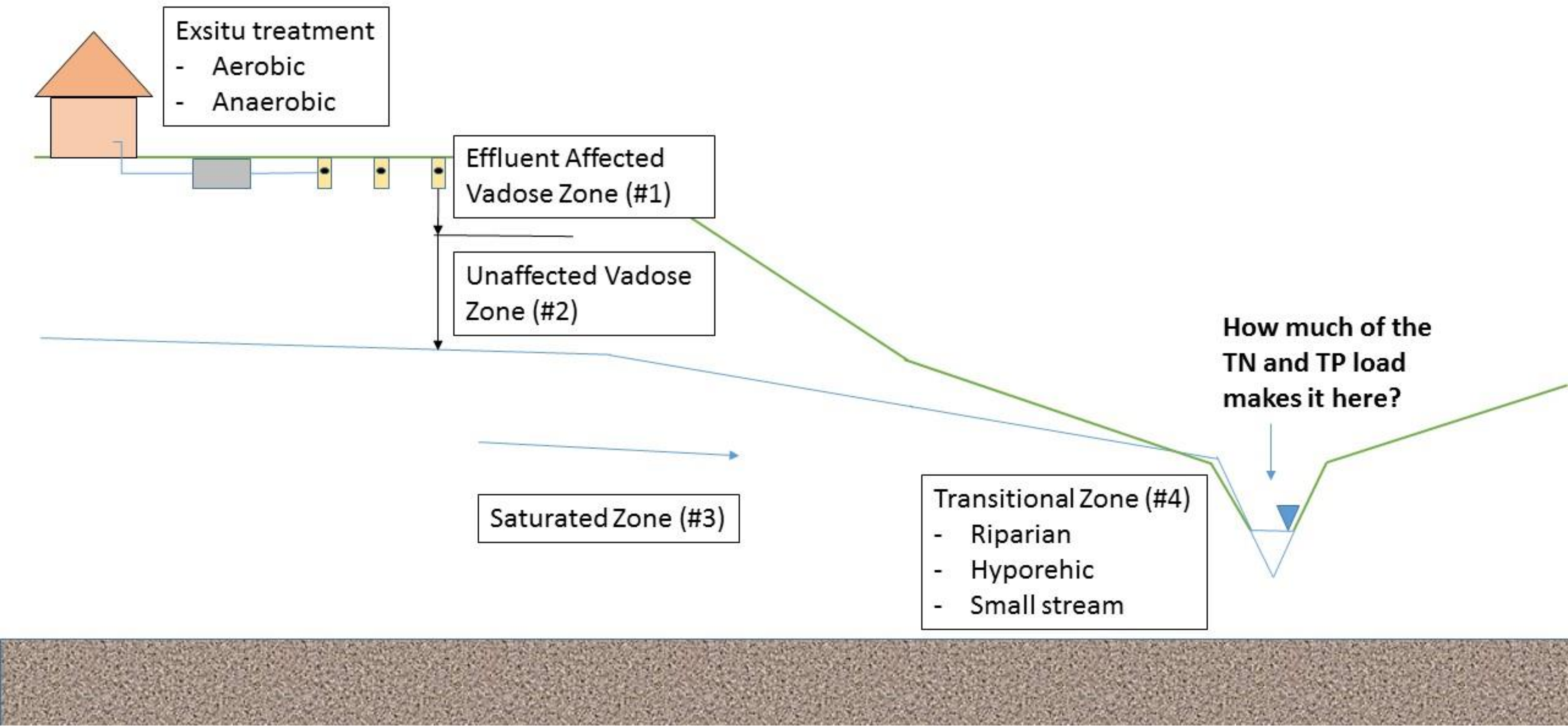
Assume: residential wastewater, 5 kg TN/cap/year

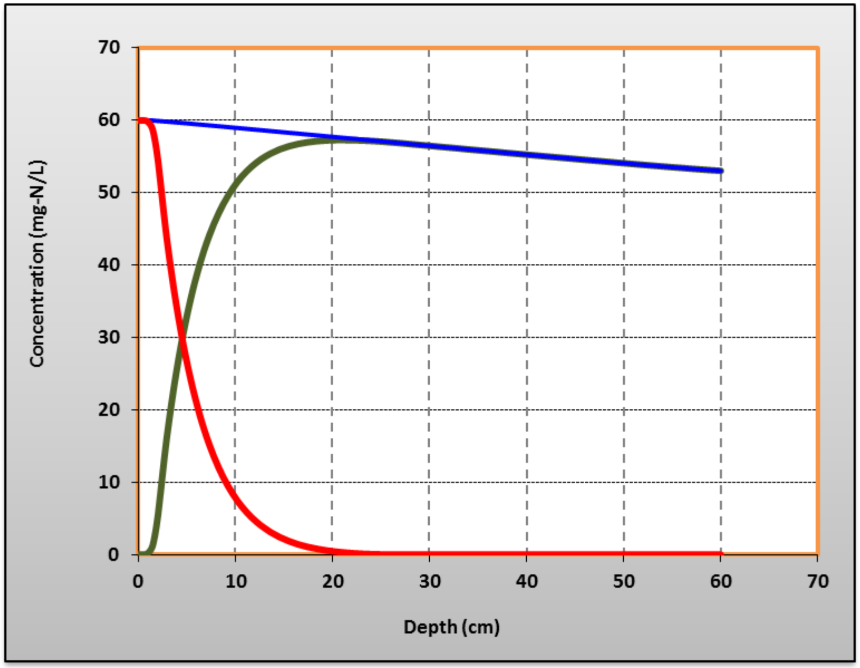


Zone 1 Estimation Approach

- Conventional system
- Used STUMOD to determine attenuation rates
  - 12 soil textural classes with hydraulic properties from Rosetta database
- Kept in mind field experiments
  - Bradshaw and Radcliffe (2013) attenuation rates in well-drained clay were about 50%
  - Colorado experiments that sands should be 20-30%
- Assumed that STUMOD could provide differences between soil textures
  - Confirm using USGS SPARROW model – empirical, spatially-differentiated regression

STUMOD

- Spreadsheet model developed by Mengistu Geza at Colorado School of Mines
- One dimension
- Model space extends from infiltrative surface to bottom of “treatment zone”
- Determines the steady state concentrations of NH_4 and NO_3 in the treatment zone
- Input concentrations are NH_4 = 60 mg/L and NO_3 = 0 mg/L
- Models nitrification and denitrification
  - Both are affected by water-content and temperature
- Assumes an exponential decay distribution of C below infiltration surface
- Can be run with or without plant uptake



Draft Zone 1 Soil Attenuation Factors

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Soil textural class	Loading rate (cm/day)	Attenuation	Average
Sand	4	0.07	
Loamy sand	4	0.14	0.17
Sandy loam	3	0.23	
Loam	3	0.22	
Silt loam	1.8	0.60	
Clay loam	1.8	0.59	
Sandy clay loam	1.8	0.30	0.47
Silty clay loam	1.8	0.43	
Silt	1.8	0.41	
Sandy clay	1	0.53	
Silty clay	1	0.66	0.61
Clay	1	0.64	

Proposed Overall Attenuation Factors

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Model				Overall	Sand	Loam	Clay
Current Bay model		*		68%			
SPARROW				66%			
Valeila et al (2000)				74%			
Proposed w/ Piedmont GW					85%	90%	93%
Proposed w/ Coastal Plain GW					71%	81%	86%
		*	to large streams				

- Coastal Plain: TN reduction in groundwater (zone 3) is a function of residence time (distance between system and surface water).
- Piedmont: Residence times typically sufficient with reasonable setbacks.

Additional SPARROW Model Runs

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- Use proposed Zone 1 estimates as inputs to SPARROW
  - Determine a “predominant surficial soil texture” for each of the SPARROW catchments using SSURGO, etc.
  - For each catchment, multiply the raw wastewater TN loadings by the appropriate Zone 1 attenuation factor
- Objectives
  - Better (versus initial SPARROW with septic run) statistical metrics could validate STUMOD-based approach to Zone 1 reductions
  - SPARROW outputs could inform Panel understanding of the effect of the Zone 2-4 processes, spatially (empirical Zone 2-4 data is currently quite limited)

Limitations/Assumptions

- Only quantify reductions for conventional septic tank systems
- Only quantify TN (address TP qualitatively)
- Doesn’t explicitly address malfunctioning and legacy systems
- Will address systems with BMPs
- Integrate transitional zone efforts with other ongoing ChesBay work

Report Outline

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- Introduction
  - Background
  - Historical approach
  - Other approaches
  - Proposed mechanistic approach
  - Challenges and limitations
- Methods
  - Weight of evidence approach
  - Literature
  - Modeling
  - Hydrogeomorphology
- Results and Discussion
  - Effluent affected vadose zone
  - Unaffected vadose zone
  - Groundwater zone
  - Transitional zones
- Conclusions and Recommendations
- References

Look for report to be released in Spring 2016

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